South African Journal of Art History

Volume 27 Number 1 2012

The Expertise of Architecture and its History

The South African Journal of Art History is a peer reviewed journal publishing articles and review articles on the following subjects:

Art and architectural history
Art and architectural theory
Aesthetics and philosophy of art
Visual culture
Art and the environment
Film and photography
History of craft
Design

ISSN 0258-3542
Available on Sabinet
Website: www.sajah.co.za
Archive: UP Online

South African Journal of Art History
Volume 27, number 1, 2012

The SAJAH is published by the Art Historical Work Group of South Africa
Chairperson: **Gerald Steyn**
Treasurer and Publication Secretary: **E.A. Maré**
Cover design: **Johann Opperman**
Layout: **notanotherjoe: Joh Deetlefs**
Printed by: **Procopyprint**

South African Journal of Art History
Volume 27, number 1, 2012

Contents

Editorial

The Expertise of Architecture and its History

Raymond Quek
Bond University, Gold Coast, Australia
E-mail: rquek@bond.edu.au

Many historical architectural constructions have been recorded and studied, but not all have been theorised. There seems to be a disconnection at several levels between the discourses of architectural history and the history of architectural ideas. The assumption that empirical description of implicit acts of design automatically results in theory also neglects the formative and contextualising role played by ideas, knowledge and interpretation in creative acts of architectural embodiment. Further, both Architectural History and the history of Architectural Ideas seem to be disconnected in the present given the dual dominance of the scientific and the moral–ecological paradigms. This split condition results in the view that theory can only be induced into architectural history from the present, thereby overlooking adjacent histories of ideas and intellectual currents available at the time of making. As temporal displacement and the theoretical reinvention of history increasingly overrule continuity, tradition and translation, architectural knowledge loses sight of its intrinsic transformations. This special edition of SAJAH examines the dialogue between architectural history and the history of architectural ideas.
Key words: Architectural history, History of Ideas

In the profession of architecture, the architect is surrounded by experts who invariably know more about structures, materials, construction techniques, finance, real-estate, landscape, lighting, plumbing, electrical fittings, mechanical plants, sociology, history, politics and so on; and on whose expertise the architect consults. The Architect's singular claim to a distinctive un-borrowed expertise, *sui generis*, is the ability to order space through design, roping in these various talents to realise a vision of ordered space. Some might argue that the interior designer also orders space. We argue that the interior designer, as with the landscape architect or urban designer, offer parts of the same expertise, though somewhat delimited in scope by the declaration of their bounded specialised territories. The generic architect typically exceeds these limitations by dealing with all forms of spatial ordering, the paucity of positive exemplars or the proliferation of negative exemplars in the architectural profession notwithstanding. The independence of this ability raises the question of the possibility of Architecture's autonomy as a discipline, and this has been a subject of some considerable debate in the late twentieth century.[1] Indeed, Architecture has had a difficult position as a form of intellection, rising from its sub-classification amongst medieval *armatura* to its awkward struggles of fit within the modern University.

Unlike the other professions of Law and Medicine, Architecture schools often find themselves as subsets of a Faculty of Engineering, Social Sciences, the Fine Arts, Construction Management or Real Estate. Routinely every few years the same polemic content is recast by a different author in the Higher Education press, revisiting the argument that 'Architecture should not be a University offering'. The heavy demands for institutional infrastructure, especial pedagogical arrangements, atypical teaching methods, high student workloads, and unscientific assessment criteria are common in architectural education and certainly contribute to the discipline's awkwardness within the traditional academic institution. This is further compounded by the nature of the discipline as a form of knowledge. As an academic discipline Architecture

has an uneasy relationship with research; which it has been forced to engage with at the tail end of the twentieth century without having clear terms of reference as to what, how and why the activity of Architecture, the discourse of Architecture, or the profession, are researchable, can be researchable, are even possibly open to research, relative these three different states of the discipline.

In the Renaissance two senses of nature were crystallised from earlier medieval modulations of ideas thought to have Greek origins: *natura naturata* and *natura naturans*.[2] The passive sense of *natura naturata* refers to created nature, and *natura naturans*, the activity of nature. These distinctions are immensely useful for understanding Architecture as forms of knowledge. In so far as these states of nature are concerned, the activity of nature as creating nature is similar to the activity of architecture - architectural design creates, and in the process creates new knowledge and new nature. The passive sense of Architecture's ballast, its *natura naturata*, is undeniably its history, as a form of knowledge. These are the two states of interest within this paper – the profession might be characterised as a tertiary state: a rendering of services from the activity of Architectural Design, deriving from Architecture's *natura naturata* and *natura naturans*.

In the sense of architecture as active nature, all designs create anew, and the syllogism follows therefore, that all architectural design is research. To isolate Architectural design activity as academically rewardable research would seem somewhat futile, as the core activity is always already 'research' - new design is inherently the generation of something novel, a new way of ordering or a new ordering. This differs markedly from the search for new knowledge in medical sciences, for example in the search for a new cure. In medical science there is always a clear higher goal to which new knowledge in traditional academic circles is always in subservience; whereas in architecture as *activity*, as *natura naturans*, the process and the consequences leads to the generation of new knowledge as an end in itself – *natura naturans* has created new nature, new architecture is generated as new knowledge or ideas. The activity in this sense is ontological development, whether experimental, speculative or conservative, as opposed to *re*-search as epistemological understanding. The activity of design in itself depends on a search for information to support that activity, and to this end seeking this information serves design as the consequence.

On the other hand, research in architecture as *natura naturata*, operates in similar ways to traditional academic exploration: there is a base core of created nature as ballast, from which new knowledge can be purposeful via research, as epistemology. Architecture's 'stuff', its nature comprises of its unique body of knowledge, and that is architectural history. Again, one might argue that construction knowledge or the science of materials might belong in this territory; it is equally effective to argue that architecture and architects has little expert claim over the scientific development of materials or the science that comes with it. In the activity of design, the architect may find new ways to use a material, e.g. glass, but the architect certainly did not invent glass, nor does the science of glass manufacture belong to Architecture. In these times we might note that the drafting of computer code is really the skill of the Information Technologist and despite the present proliferation of digital *aided* design, the architect is the applicator or the operator of that technology, and not its generator. This is not the case with Architectural History. This body of knowledge belongs exclusively to Architecture, and is distinct to Art History, political history or social history. Within Architectural history, there is the history of Architecture, and the history of Architectural ideas. The activity of generating anew continually feeds into historical record, and historical distance gives the architectural act either elevated active significance or consignment to the far reaches of archival memory. Potential dislocations between the two have already been observed, where architectural history and the history of

its ideas have been confronted by the unravelling of historiography.[3] Architectural History's activating potential is seen in the fulcrum that divides history and theory, a knife edge between past and future that seems to have a unique potency and existence in design discourse, and which would be paradoxical in many other disciplines. We will distinguish in this text, three different usages of the term *Historicism*, which are defined as follows:

Historicism $_1$ This is the taxonomical tendency to surmise the past as a series of temporal bands, as relative epochs, each with an equally relative zeitgeist.

Historicism $_2$ This is the tendency to be stirred by reverence or nostalgia for the past, and results in the practical mimicry of historical precedent as a consequence.

Historicism $_3$ This form sees historically determined patterns as models for future predictions, especially in the social sciences. Karl Popper in his book *The Poverty of Historicism offered a* critique of Historicism$_3$. In a sense, Architectural Theory is a form of historicism$_3$, particularly architectural theory fuelled by critical social theory, carrying with it with all of Popperian impoverishment, as it speculates on the future from prior patterns.[4]

Alan Colquhoun made similar distinctions of three notions of historicism,[5] although he separated nostalgia and historical mimicry, whilst we argue herewith that nostalgia and mimicry are motivation and action of the same idea of historicism$_2$ and is distinct form the other two senses. Whist we are familiar with post-modern historicism$_2$, all design architects engage with some manner of precedent and invariably hostoricism$_3$ is inevitable as a contributory study to the activity of architectural design.[6] Even in the extreme instance where history is decried, it has to be firstly present and accounted for to be dismissed, for example by Peter Eisenman.[7] Ironically, Eisenman's mentor Colin Rowe, was part of a teaching crew with Bernard Hoesli that claimed to have liberated historical precedent from the shackles of the Beaux Arts method and transformed precedent to an active agent in the process of design knowledge, via the processes of diagramming 'history'.[8] It has been argued that modern Swiss Architecture, e.g. that of Herzog and DeMeuron, is a product of this teaching,[9] though one must counter this rather narrow and romantic view with conspicuous the oversight of the now historically distanced post-modern episode, which seemed to privilege the study of historical precedent in quite different ways, and which graced the rest of the world with their pastel coloured existence. One of the issues that had arisen in the post-modern era of the late twentieth century is that of tradition, and its confusion with history.

Regardless of the lack of homage that the present might care to acknowledge both history and tradition invariably influence the present. As forms of knowledge they are not limited to reference of what is known, but how that past actively informs the crafting of new ideas. The distinction between history and tradition can be clarified from the observation of vernacular craft. In vernacular craft continuity is assured through the unselfconscious propagation of a limited set of constraints that preserves authentic unity and meaning, and which we refer to as 'tradition'. Unlike 'history', knowledge in the traditional sense is present only in the immediate past, and is made available to subsequent generations. Truth is self-evident and meaningful creative craft is organically stable with incremental and gradual change. Tradition is linear whilst History operates as an open ended selective matrix. Fischer von Erlach offered a History of Architectural examples in his *Entwurff einer historischen architectur* published in 1725.[10] His Karlskirche in Vienna demonstrated this rupture with linear time as the eclectic references have no traditional continuity but show rather how historically open the matrix could be. Stanford Anderson argued that the adoption of historical reconstructions from such a disconnected matrix ironically creates

a distance from the past as opposed to the adjacency offered via traditional linearity.[11]

W.A. Eden defined the process of architectural tradition as an act of transmitting or handing down involving at least two parties and scrupulously commented that the transaction may be hampered by inadequacies of thorough receipt or complete transmission.[12] At the height of postmodernity in the late twentieth century, John Hancock addressed this dilemma directly with a theory of precedent. In his theory, he set out to limit historical diversity such that there would be convincing limits, returning to the traditional approach of classical rhetoric *pace* the reliance on the modern rationality. Hancock argued that architecture could be durable without being timeless, valuable without being absolute, and justifiable without being wholly and utterly true.[13] Hancock's theory was influenced by his analysis of the similarities and differences between the architectural and the legal professional and the scientific tradition. He noted that architecture differs inherently in its processes of dealing with historical precedent; architecture cannot supersede precedent like a dead law or a disproved hypothesis but accumulates in a referential repository called history, as its created nature, *natura naturata*, with re-usable exemplars. As exemplars, there is firstly historical precedent by accumulation, `where prior work constitutes the necessary background in a line of continuing development and to which new work is in proximity; secondly, precedent by analogy, `where prior work reveals the previous solutions for similar problems, which new work resembles in overall organisation; and finally, precedent by application, 'where prior work is the durable embodiment of the appropriate effectiveness of rules, techniques, or ideas, from which new work adapts or reuses precepts in new situations.'[14]

Certainly in practice, tertiary education and in scholarship, architectural history and the history of architectural ideas have not always been as closely connected as has been assumed. Many historical architectural constructions have been recorded and studied, but not all have been theorised. The position of precedent in either historical or traditional sense is seldom outlined when brought to bear on a new work of architecture. In historiographical argument, precedent might take an evidentiary role, but in practice, evidence has no quarter in the activity of design. A little-known book arising from a conference published several articles of varying scholarship, position and perspectives that have mused on the relationship of Architectural history and the design studio.[15] In one article David Dunster calls *Theory* 'the trade union' of ideas.[16] There seems to be a disconnection at several levels between the discourses of architectural history and the history of architectural ideas. Several others in the same title, published at a time when French Literary Theory was perspiring and reaching its exhaustion in fashionable Architectural thought, have also noted this view. The assumption that empirical description of implicit acts of design automatically results in theory also neglects the formative and contextualising role played by ideas, knowledge and interpretation in creative acts of architectural embodiment. British architectural history from the sixteenth and seventeenth centuries for instance is well known, but has seldom been understood in a strong theoretical framework on its own terms. Inigo Jones and Lord Burlington never propagated architectural ideas in their own names but in the name of Palladio, and Eduard Sekler was at pains in his attempt to re-inscribe Wren into continental European discourse.[17]

Habermas has famously argued the case of the increasing rational social conditions of modernity,[18] and further to the rationalisation of architectural culture, both Architectural History and the History of Architectural Ideas seem to be disconnected in the present given the dual dominance of the scientific and the moral–ecological paradigms, the latter creating a fervent religiosity around its ideology that seems to have affected architectural thought and practice unproductively, resulting in the systematic policing of new building designs to meet bureaucratic standards of risk aversion, and which have not demonstrated significant, if any, reduction of

those environmental risks. There is crass commercial greed in every quarter of life, building development included – at the heart of this is the fact that new building development is artificial at its core, and is at odds with natural ecology. Has architecture not always been about the mediation of inhabitation on territorial environment? C.P. Snow has already famously noted the absence of a genuine dialogue between the sciences and the humanities,[19] and perhaps Snow's accusation of luddites rings true once more: it is not clear if the environmental lobby has realised how much of its discourse is not fundamentally ecological but reflects the desired prolongation of artificial interests and habitats with prescribed abstinences in a rather luddite manner than seems to have no optimism in new technological or creative solutions in the fear for the future.

The erosion of historical thought as an activator is also prominent in the current interest in parametrically controlled generation of emergent shapes as possible morphological variations fit for human inhabitation. Space, and the ordering of it now seem all but secondary in much of current architectural production. The profession is vulnerable once again to its actual purpose and place in society. The expertise of the architect is currently exposed to colonisation, and it is with caution that one embarks on its defence. It would seem opportune then in this volume to return to this question of the dialogue between ideas and history, to return to the stuff of architecture and examine its dialogue with its activity of design.

In his essay *Von eine arman recihen manne* published in 1900 (Loos, 1921), translated as "The Poor little Rich Man",[20] Adolf Loos discuss the limits of the activity of design through the parable of the architect's intrusion into the life of a client - the "rich man". Loos does not concretely outline the limits in legislative declaration, but rather communicates a resonant lesson through the form of a parable. In so doing he understood that architectural knowledge could be profoundly communicated symbolically or poetically, in a manner that would be corrupted or limited if it were not. Had he declared finite limits of architectural design, the lesson of design limits could not have been communicated with the same profundity. Not requiring precise knowledge of limits, the reader of the story nevertheless understands a moral sense of limits tacitly. The understanding of architectural space as a phenomenal entity is similar, we cannot be precise about spatial boundaries but we can recognise it and understand it: we never admit to having an insufficient numerical measure of space, but we will declare insufficiency as 'not enough'. Nikolaus-Ion Terzoglou's essay traces detailed ideas of space from Newton to Boullée to uncover the 'mental space' so as to locate the conceptual ground of architecture. Arguing for a theoretical resolution between form and function, John Hendrix presents a survey of what he calls contradiction, and offers a case in demonstration of a proposed resolution. Estelle Maré's study of Leonardo's thought experiments in this volume examines his creative process and the influence of themes of concatenation and linkages. Discussing the precision of knowledge, and validating our example of Loos' parable of tacit understanding in architectural knowledge, Maré observes: "His (ed. Leonardo da Vinci's) scientific enquiry into anatomy by means of dissection was expressed in precise terms in anatomical drawings, while his architectural sketches of churches may be interpreted as works of fiction in which he expresses their mediating function between human beings and an infinite cosmos that in his era could only be symbolically understood." Gerald Steyn's examines Le Corbusier's town planning ideas and reveals historical sources, and offers a view that challenges conventional notions that Le Corbusier's modernist work ruptured with historical knowledge. Steyn Diez-Pastor's notion of *Architectology* supports the idea that the commonality of architectural knowledge is generated by the specificity of the discipline. Tzonis and Lefaivre's paper, updated and republished here for its cogency on the subject, and argue for a revitalised sense of historical understanding, as they quote Wölfflin (1888): "We still have to find the path that leads from the cell of the scholar to the mason's yard." Indeed.

Notes

1 See e.g. Tzonis, Alexander & Lefaivre, Leanne. (1984)

2 Bialostocki, Jan. (1963: 19-30)

3 Jarzombek, M. (1999: 488–493) & Jarzombek, M (1999: 197–206). These papers share the same ethos and to some extent content and argument.

4 Popper, Karl R. (1986). Also see: F Meinecke, (1972). Latterly, historicism2 and historicism3, have become the subjects of Van Pelt & Westfall (1991)

5 Colquhoun, Alan. (1991: 3–31)

6 The study of precedents is often called 'research' and this adds to the confusion of academic research.

7 Eisenman, P. (1984: 155–173)

8 Caragonne, Alexander. (1995) See also: Jansen, Jürg (1989)

9 Hanisch, R., & Spier, S. (2012: 655–686)

10 Fischer von Erlach, J. B. (1725) For an English version see: Fischer von Erlach, J. B. (1737)

11 Anderson, Stanford. (1982: 109-118)

12 Eden, W A. (1942)

13 Hancock, John. (1986: 65-77)

14 Hancock, John (1986: 66-68)

15 Hardy, Adam, and Necdet Teymur. (1996).

16 Dunster, David. (1996: 130)

17 Sekler, Eduard F. *(*1956)

18 Habermas, J., & Ben-Habib, S. (1981: 3–14)

19 Snow, C. P. *(*1964)

20 The essay was written as a veiled attack on J.M. Olbrich and was originally published in *Neus Wiener Tagblatt* on 26 April 1900.

Works cited

Anderson, Stanford. 1982. Types and conventions in time: toward a history for the duration of change of artifacts, *The Yale Architectural Journal*, MIT Press, Cambridge (Mass): 109-118.

Bialostocki, Jan. 1963. The renaissance concept of Nature and Antiquity, in *The Renaissance and Mannerism: Studies in Western* Art(2): 19-30. Princeton: Princeton University Press.

Caragonne, Alexander. 1995. *The Texas Rangers: Notes from the Architectural Underground*. MIT Press.

Colquhoun, Alan. 1991. Three kinds of historicism, *Modernity and the Classical Tradition: Architectural Essays*, 1980-87. The MIT Press: 3 – 31.

Dunster, David. 130. The histories of architecture and the architectures of history, *Architectural History and the Studio*.

Eden, W A. 1942. *The Process Of Architectural Tradition*. London.

Eisenman, P. 1984. The end of the classical: the end of the beginning, the end of the end, *Perspecta* (21): 155–173.

Fischer von Erlach, J. B. 1725. *Entwurff Einer Historischen Architectur: in Abbildung unterschiedener berühmten Gebäude des Alterthums und fremder Völcker; umb aus den Geschicht-büchern, Gedächtnüß-münzen, Ruinen, und eingeholten wahrhafften Abrißen, vor Augen zu stellen*. Leipzig.

Fischer von Erlach, J. B. 1737. *A Plan of Civil and Historical Architecture*. translated by T. Ledieard. London.

Habermas, J., & Ben-Habib, S. 1981. Modernity versus Postmodernity. *New German Critique*, (22), 3–14.

Hancock, John. 1986. Between history and tradition: notes toward a theory of

precedent', *Harvard Architecture Review 5 - Precedent and Invention*. Rizzoli: 65 - 77.

Hanisch, R., & Spier, S. 2012. History is not the past but another mightier presence: the founding of the institute for the History and Theory of Architecture (gta) at the Eidgenössische Technische Hochschule (ETH) Zurich and its effects on Swiss Architecture, *The Journal of Architecture* 14(6): 655–686.

Hardy, Adam, and Necdet Teymur. 1996. *Architectural History and the Studio*. London: ?uestion (sic) Press.

Jansen, Jürg et al. 1989. *Architektur lehren - Bernhard Hoesli an der Architekturabteilung der ETH Zürich = Teaching architecture : Bernhard Hoesli at the Department of Architecture at the ETH Zurich*. Eidgenössische Technische Hochschule Zürich, Institut für Geschichte und Theorie der Architektur.

Jarzombek, M. A. 1999. Prolegomena to critical historiography, *Journal of Architectural Education* 52(4): 197–206.

Jarzombek, M. 1999. The disciplinary dislocations of (architectural) history, *Journal of the Society of Architectural Historians* 58(3): 488–493.

Loos, Adolf. 1921. *Ins Leere Gesprochen*, Prachner, Vienna: 198-203

Meinecke. F. 1972. Historicism, London

Popper, Karl R. 1986. *The Poverty of Historicism.* Routledge.

Schumacher, Patrik. 2011. *A New Framework For Architecture*. 1. Wiley.

Sekler, Eduard F. 1956. *Wren and his Place in European Architecture*, Faber and Faber, London.

Tzonis, Alexander & Lefaivre, Leanne. 1984. The Question of Autonomy in Architecture, *The Harvard Architecture Review* 3 - *Autonomous Architecture*, MIT Press.

Van Pelt, Robert Jan & Westfall, Carroll. 1991. *Architectural Principles in the Age of Historicism,* Yale University Press.

Raymond Quek is Professor of Architecture at the Soheil Abedian School of Architecture, Bond University, Australia. His current roles are Head of Architecture and Director of the Architectural Research Centre. He has taught in Universities in the UK, Singapore and New Zealand.

Architectology®: architectural knowledge construction

M. Concepcion Diez-Pastor
IE School of Architecture / IE University, Segovia, Spain

Recent theoretical debates on the sources of architectural knowledge tend to dissect architecture into a set of atomized disciplines, or else define it as a multidisciplinary matter. Such are for instance the most recent debates held by the EAAE on the issue of architectural theory between 2006 and 2010. However, as Pedro Vieira de Almeida (2005) and other theoreticians – i.e. Alexander Tzonis, Liane Lefaivre – have long claimed, architectural theory – here considered a part of architectology – has its own knowledge sources within architecture itself. Despite its lacking a clearly defined corpus which may lets us establish clear boundaries, architectural theory does not belong to science, history, social studies, philosophy or aesthetics. All these fields have their own requirements and means to articulate a universal discourse of their own, not always or often coincidental with that of architecture. Thus it seems easier to define what architectural knowledge is not than to establish what it is in fact. Architectural knowledge does not own 'the' truth, but rather it is constructive in the terms described by Popper (1934), Kuhn (1962) or Bourdieu (1967). Architectology draws from the example of cousin disciplines like music – where it is but a natural, almost inherent consequence – or that of the 'French school' – where architectural theory is a discipline in its own right, established as such since 1968 – this article aims to claim for the right of architecture to own a global process of its own through which to understand architectural knowledge as a whole. It is constituted as a system of sub-bodies of knowledge central to the major field of architecture. All of these are considered as timely contributors of knowledge to this field, and therefore having played a central role throughout times, to the present moment. Architectology comes to adopt all of the methods needed in architectural research and knowledge construction.
Key words: architectology

Some prior considerations

The way architectural thought is built remains a matter of big discussion not just for theorists but for architects in general as well. However, as most of them have pointed out – i.e. Torres Balbás, Benevolo, Montaner, Vieira da Silva, Pallasmaa, Tzonis and Lefaivre – architectural knowledge cannot be explained from one exclusive point of view. In fact, that is the reason why history, social science, construction, structural calculus or architectural theory are not enough to produce by themselves a sensitive explanation of how knowledge is constructed.

In general terms, the process of knowledge building starts with epistemology. Epistemological thought requires that knowledge building be understood in terms of truth. As such it must then answer a set of philosophical questions such as what counts as knowledge, how can it be acquired, how and to what extent a given object can be possibly known, or how can we know to what extent do we know? Therefore, epistemology is the major philosophical method in building knowledge in absolute terms. Be that the case of architecture, it would be subject to the same process as truth is in Foucault's (1969) definition – shifting through various *episteme* (ἐπιστήμη) throughout history. Fucault's is but a historical a priori judgement that grounds knowledge and the discourses from it derived. Yet, *episteme* should be claimed as a part of architecture in as much as it opposes *doxa*.

Architecture, as a major art, is not just partly *episteme*, but also *techne* (τέχνη) and *poiesis* (ποίησις). *Techne* is responsible for architectural production and its achievement of objectives. It resembles *episteme* in that both of them involve the knowledge of principles. But whereas

techne means making or doing, *episteme* relates to a disinterested knowledge or understanding of things. But still, *techne* reflects the imperfections of humankind and nature (Aristotle), resembles 'craft-like' knowledge (Socrates), and bares a negative aspect if associated with art. All of these would place architecture as *techne* in opposition to the principles of art – namely, in its claim for aesthetical emotion, perfection and beauty. Therefore, *techne* as 'linear narrative in the presentation of knowledge' proves limited (Popper, 2002), and opposes *poiesis* as 'dynamic presentation of knowledge'. *Poiesis*, the nexus missing, reconciles thought, matter, time and spirit with the world. It is the key 'to understand the secret' (Tzonis & Lefaivre, 1986 ix) purpose of architecture. *Poiesis* explains the architectural aim for immortality through the search for beauty and perfection. In architectural terms, *poiesis* would produce commotion of the soul through the cultivation of virtue and knowledge.

Dewey (2005), for instance, tried to explain these sentiments from the perspective of architecture as a pure art, by saying that 'The true artist sees and feels in terms of his medium', and that 'What makes a material a medium is that it is used to express a meaning which is other than that which it is in virtue of its bare physical existence: the meaning not of what it physically is, but of what it expresses' (Dewey 2005:196). However true these statements may be for art in general, architectural objects and knowledge cannot be defined as just products of an 'artistic feeling', nor could the architectural matter be fully understood in terms of what it merely expresses in the hands of the architect. As Tzonis and Lefaivre (1986) well stated, '[architecture] works as a *formal system*…It tries to identify the kind of logic associated with this system, what Vitruvius called the *logos opticos*…' (Tzonis and Lefaivre, 1986: 2; original stress). As their argument points out, the key question for architecture is how does it carry meaning and acquire social value. Is it legitimate to study buildings as formal objects only? And their implicit answer is 'No'. That would contradict Focillon's 'world of forms' (Tzonis and Lefaivre 1986: 2) by reducing such world to a 'contour or a diagram' which forms are not (Focillon 1943: 6).

In order to explain how architectural knowledge is produced

> 'We have to envisage form in its plenitude in all its aspects, form as construction of space and matter, that becomes evident through equilibrium of mass, light and dark variations, tone, key, brushstroke that are 'architectured', sculpted, painted or graved' (Focillon 1943:6).

Otherwise, says Focillon, it would not be possible to explain architectural practice, that which made it knowledgeable, as in order 'To exist…it is necessary that form measures and qualifies space' (Focillon 1943: 7). Here Dewey's claim of material as a medium 'to express meaning' (Dewey 2005: 196) appears as essential for architecture, its principal goal being to produce space. However, not any space qualifies as architectural: 'It is a matter of proportion qualitatively felt. A lyric ode may have it when a would-be epic misses it…' (Dewey 2005: 217). He too rejects considerations of form or appearance: 'Volume, like roominess, is a quality independent of mere size and bulk' (Dewey 2005: 218).

And still, architectural knowledge is not yet explained, nor can it be fully understood under either scope. Architecture is not only an art, or not just any art, hence the mechanisms by which it is ruled are not exactly the same as those that rule the other arts. There is not a single, universal architectural truth, as epistemology claims there should be, nor one single way to get to it. Experience has its say in architecture, as its knowledge is constructive. As Tzonis and Lefaivre (1986) explain, and architects well know, architecture is a long, time consuming, enriching and enlightening process aimed at building an object – the *archifact*®. To reduce such process to the mere object itself, namely the building, would be an error. It would mean not

just to disregard what it took to get to the *archifact*, but also it would reduce the object to the category of something that results from sensitive experiences, aimed at producing but sensitive experiences in turn.

As Popper (2002) suggested with his 'theory of falsability', never sensitive experiences precede theory. If that proved to be true, then what would be the need in answering how to get from sensitive experience to theory? Moreover, should we try by all means to find such an explanation, we would find ourselves committed to writing the 'manual of creativity' or even the 'manual of architecture' which was never the aim of architectural theory. Such a text-book does neither exist nor could Vitruvius (1st BC) be accused of ever having tried to write it, as some would like to think. All that he aimed at doing was to give a structure (Giddens 1984) to architectural knowledge, to explain its real contents, its technique, and that remains unchanged. Architecture too produces *ad hoc* 'non-architectural' hypotheses from which to justify itself, which are 'false'. Moreover, in historical terms Popper (2002) comes to help us understand Benevolo's (1984: 12) claim against historical determinism in architecture. As Popper, he too rejects the linear discourse as applied to describing knowledge.

Kuhn (1962) established a new concept of paradigm that aimed at tearing down any previous conceptual paradigms within which to work. The novelty consisted of including his 'paradigm shift', with which he translated into scientific terms the way in which architecture had been working for centuries. Changing paradigms is not an easy task, nor has it been so for architecture. In fact, it has required big individual efforts too. Central to Kuhn's theory are contextualization and evolution. These, with the aid of cyclical revolutionary periods gave the impulse needed to put an end to the contradictions of former discoveries and rules. In that sense, architecture has the structure of Kuhn's scientific revolutions.

When he introduced the concepts of 'bulks of knowledge' and 'mutual knowledge', Giddens (1984: 4) was tacitly subscribing Bourdieu's (1967: 142) idea of *habitus*. All of these are central concepts for the construction of architectural knowledge in that architecture itself is a social, thus common fact and a cultural realization too. As such, it is highly dependent on its context. Therefore, as a natural, almost direct deduction from the former argument, it must be said that no single, unique, or uniform architectural truth would prove to be 'architecturally true', universally valid. This applies both in the general social context as established by Giddens, but also in the more individualistic one of the *habitus* which Bourdieu (1967: 142) used to connect the artist's purpose with the world around – a world understood in terms of culture and society. Interestingly, it is the purpose that results from that context, and from the artist's interactions with it (Bourdieu 1967: 142), rather than the reverse, as architects tend to think.

The role of architectural theory

It is not with disregard to architectural theory that it claims for its own rights as a discipline. In a detailed analysis, Pedro Vieira da Silva (2005) studies three of the main relationships usually established in, and at times undifferentiated from architectural theory: those with science, philosophy and aesthetics. As Vieira da Silva says,

> 'Today theory has lost its prescriptive, normative character, yet it has won a sense of *methodology* and framing, with which it aims to understand how to articulate people and things within the same consistent system, considered as structural variables of architecture; which expressive materials compose the architectural language de facto; how do these articulate and interact; how are the actions of the project enchained so allowing to decipher, be it in its slightest amount, the process of the project making' (Vieira da Silva, 2005:10; author's emphasis).

It is true that, from this perspective it is not as easy to define what the role of architectural theory is, as it is to determine what it is not. The fact that it is lacking a corpus from which to establish it limits and boundaries clearly does not help. It not a science, but neither is it a philosophy or fed by aesthetics.

As science, architectural science bares a certain artificial 'aggiornamento': the architect's reaction against technical blooming that produces a certain complex on her or him. Science would provide architecture with an added dose of credibility and prestige – as science often does with most disciplines (Macdonald 1995). Theory is necessarily related to not just science, but also with different kind of sciences – from physics and mathematics to chemistry, material science etc. However, this is circumstantial kind of relationship limited to work hypothesis, suggestions of method and other such questions which architecture must admit and from which it must profit, yet renouncing any scientific pretensions, as Vieira da Silva remarks (2005: 8).

Theory has often been paralleled with philosophy as well. Yet philosophical thought is committed to its own requirements forcing it to articulate a kind of discourse universally valid. In front of it, the possible discourse of theory looks as the reverse (Vieira da Silva 2005: 8). Architects are not required to have, and usually do not have any kind of philosophical training. This is to say that architects and their activity must not be subject to, least ruled by a field of knowledge that is beyond their knowledge and control. As Vieira once again remarks, '…the fact that there exist philosophers who have studied the field of architecture with more or less success does not mean that their speculation derives in any practical orientation whatsoever' (Vieira da Silva 2005: 8). The clearest examples would be those of Bachelard (1994) wondering about the poetic sense of space, and Heidegger's (1993) wondering about the sense of dwelling. Vieira da Silva (2005:9) wonders about the real practical consequences of these for architecture as language, which to us is to say, architectural knowledge. In other words, the relationships between architecture and philosophy are not in the least cause-effect ones. The methodological consequences of applying philosophy to architecture or to its language have not yet been reported.

As to aesthetics, Vieira da Silva (2005: 9) again argues that there is no way to explain architecture through aesthetics, so opposing as much Adorno's (1984) thesis as Zevi's (1960). Yet, he assumes the risk of so doing by explaining that both of them are thus connecting the theoretical production with the aesthetical research. However, this is to us a needless risk, telling from the various other examples given above. As Vieira da Silva remarks, both of them '… belong to different knowledge universes which despite the relationships they may establish – as they would have been supposed to do – have no effective articulation of any possible mutual dependency or substitution' (Vieira da Silva 2005: 9), as the development of one of them does not essentially affect the other one.

However, there are other fields also affecting theory, and even almost fretting it, such as history. As Benevolo well pointed out, there are undeniable risks in applying the linear discourse to describe knowledge. That is, by the fact that every historical event must be determined by a corresponding fact of any kind, be it legal, economical, social or any other such. For this reason Benevolo (1984: 12) suggests that it is the architect's task to re-read history in architectural terms, producing both an analysis and an interpretation different from the traditional ones. And he goes on saying that it is the architects' competency 'to make explicit the methodological implications' inherent to the architectural experience (Benevolo, 1984: 12). Such an enterprise in search for he advancement of architectural thought, he continues, require that the architect would introduce the 'methodological doubt' as the method of analysis of all the knowledge acquired.

And it is precisely here that we find what has been said to constitute the main traditional method in architectural theory: phenomenology (Aravot 2010: 8). The first one being hard to apply, Aravot says, it is phenomenology through the experiences of the surrounding life-world that brings architecture into being. In her statement, Aravot not only explains how is phenomenology 'the method applied in architectural practice' but also 'the one tacitly forwarded as part of architectural education' (Aravot 2010: 8), whether those who practice it may be aware of that fact or not. She establishes a new subcategory for the cases when it is applied by architects as their practicing method: '"phenomenology in practice" [which]is however a "weak phenomenology"' (Aravot 2010: 8). We will not get into the particulars of the method as described by Aravot (2010:8-9) through a detailed comparison with the transcendental phenomenology she terms 'philosophers' phenomenology'. Yet, the method so described does not explain architectural though as a whole, other than '[focusing] on conscious experience *from a first person's point of view*' (Aravot 2010: 8; our stress).

Therefore, only the critical method seems to remain. That being the most needed within the architectural context, it is the very architects who have renounced it to a great extent. In their self-consideration as artists, they do not feel subject to self criticism hence the field of criticism is left for 'others', no matter if completely or partly layers in architecture. These tend to face criticism of architecture in the same terms and grounds as they would criticise any other art, with the undesired result of weak architectural criticism. Architects either do not cross the border line of critical inquiry for lack of interest or due to their lack of understanding of the purposes of such an effort (Vieira da Silva 2005: 9).

Through the will to join more prestigious fields of knowledge, theory seems directed towards what Tzonis (1972) explained as 'the inability of the profession to explain its origin and evolution' (1972: 14). This would seem to have led us to close the circle, where it not for one fact, interestingly pointed out by Vieira da Silva that the focus of theory rejects any tendency to simplify general accessibility to the architectural work. Instead, it searches for every thing that contributes to underline its global condition in terms of materials and dynamic articulations. Theory's biggest concern then is the 'internal structure' of architecture due to which it will search for all that may be found within any of its cracks that may possibly contribute to enhance its sense of expression and its significance. These, Vieira da Silva says, are but 'the collateral effects' (Vieira da Silva 2005: 10) of theoretical inquiry.

Architectology

At times the theoretical field seems too tight so as to give an impulse to the claim for a bit more openness. In fact, the above explained would let us infer that theory allows for speculation, and little more. In spite of the fact that speculation is very much needed, it is true that architecture claims for greater investigation about the construction of architectural knowledge, as much as it would benefit from deeper, more serious criticism from inside.

Criticism, says Vieira da Silva (2005:11) should not be done, however, by making judgements, establishing hierarchies and interpreting and analysing the *archifacts* in a normative way. This, he asserts, would constitute a limited critical method. Instead, from the moment when theory rejected being normative, criticism must have renounced to produce judgements. In fact, so it should be as long as the *archifact*, as any other work of art, 'needs no help from extra redeemers. It is by nature its own redeemer' (Vieira da Silva 2005: 11). It needs not be aware of anything other than its own sake.

From the condition of academic research into architecture, *architectology* should include critical theory and architectural criticism within as much as the formerly referred constituents of architecture – from the science of materials, construction and structural calculus to history, social studies, theory or composition. Only considering all of these as a whole will the elements of architectural knowledge make sense letting us reach a broad understanding of architecture as a multifaceted discipline. Any apparent contradictions would then vanish as its condition as a major art reconciles with its practical aims. This way architecture could indulge to proudly show its internal equilibrium between *episteme*, *techne* and *poiesis* within which revolutions are possible (Dewey 2005: 196). Foucault's (1969) shift through various *episteme*, if understood as a means of exploration, would make full sense as an architectural method.

Moreover, it is within such wholeness that 'the art of established "orders"' can be overcome by 'revolt against fixation in social classes as by technological developments in cement and steel', as Dewey (2005: 196) plainly put it. However, rather than be just a cause attributable to 'the very nature of the artist's work' (Dewey 2005:197), in the case of architecture the technical revolution ought to take pace, and be validated before the architect shows her or his nature. Only such a fact could explain that the revolutions in architecture are keen to take place as much outside the classical canons, as Dewey argues (2005: 196-97), as within them, in the way exposed by Tzonis and Lefaivre (1986). As they thoroughly explain, architectural logic can thus be traced from classical times so that 'classical logic' (Tzonis and Lefaivre 1986: 243) is not privative of ancient Greece and Rome. Rather, it is a way of understanding and assembling architecture, 'the classical system and its poetics of order' (Tzonis and Lefaivre 1986: 243) feasible even nowadays. It can be applied in the strictest way, yet it admits criticism in what Tzonis and Lefaivre termed 'critical classicism' (1986: 273). Throughout time both systems and many others have coexisted with as many interpretations could ever be imagined. From Palladio's interpretation of Vitruvius – to name just one – and Inigo Jones or Lord Burlington's interpretation of Palladio, to the ways in which 'classical architecture[has] been engaged in many contradictory meanings and uses since the Reinassance' (Tzonis and Lefaivre 1986: 274). It has been attached as a sign of the bourgeois identity as much as an 'agit-prop' for the Stalinist regime (Harbison 1998:181), central to the Nazi identity (Macdonald 2006) or innate to that of the Franco regime (Diez-Pastor 2012). From what Tzonis and Lefaivre define as 'strangemaking', (1986: 276), they establish a critical line through which to look for 'new ways of expression outside the classical canon' (Tzonis and Lefaivre 1986: 279), thus exploring a completely different path: the absolute destruction of the classical canon. This process aimed to 'forge another formal anticlassical canon' that gave birth to many of the most remarkable works of the 20th century – from Lissitzky's, Chernikov's or Rietveld's to Le Corbusier's Villa Savoye, Mies van der Rohe's Crown Hall and Seagram or Aldo van Eijck's orphanage in Ijsbaanpad (Tzonis and Lefaivre 1986: 280-81).

Such a timeless system has only been able to subsist for the single reason that it holds criticism within, as it informs each and every one of the many subsystems by which architecture is constituted. That is, it does not give way to a closed process, but rather to an open one. It is an open process where change and transformation are accepted as much as assertion and dissention, whereas in any case it proves rigorous and full of potential and dynamism. In their final visionary statement, Tzonis and Lefaivre (1986: 281) picture the actual situation:

> 'The world of classical architecture today is a world of scattered forms that in their incompleteness can be seen as icons of decomposition…The time direction of the classical fragments that still surround us points to two diametrically opposed paths…The critical potential of classicism might arise from the fact that we belong to a generation of crisis, and frequently, of counterfeit culture, in

> which there is a disintegration of human relations at every level of association…Children of happier times might find [in the classical system] a discipline of the mind…They might see in this imperative for order and rationality a quest in the domain of thinking – but also what Thomas Mann (1957) called "the highly cherished idea of a perfected humanity"' (Tzonis and Lefaivre, 1986: 281-87).

Therefore, as Tzonis and Lefaivre (1986) seem to point out any other system is somehow related to the classical system, hence ready to be explained and understood through it. The classical system is thus central to *architectology* – or as expressed by Wallace Stevens (1923), 'Required, as necessity requires'.

Works cited

Adorno, T. 1984. *Aesthetic Theory*. London: Routledge. [(1970) *Ästhetische Theorie*. Frankfurt am Main: Suhrkamp Verlag.]

Aravot I. 2010. Phenomenology as Architectural Method, in I. Aravot and E. Neuman (eds.) *Invitation to ARCHIPHEN. Some Approaches and Interpretations of Phenomenology in Architecture*. Bucharest: Zeta Books.

Bachelard, G. 1994. *The Poetics of Space*. Boston-MASS: Beacon Press. [(1958) *La poétique de l'espace*. Paris: Presses universitaires de France.]

Benevolo, L. 1984. *Introducción a la arquitectura*. Madrid: Hermann Blume. [(1960) *Introduzzione all'architettura*. Roma-Bari : Gius. Laterza.]

Bourdieu, P. 1967. 'Postface'. In E. Panofsky, *Architecture gothique et pensée scolastique*. Paris : Les Editions de Minuit.

Dewey, J. 1934/2005. *Art as Experience*. New York-NY: Penguin.

Diez-Pastor, C. 2012. Architectural koinè and Trans-National Spanish Architecture, in R. Quek and D. Deane (eds.) *Nationalism and Architecture*. London: Ashgate (in press).

Focillon, H. 1943. *Vie des Formes*. Paris: Presses Universitaires de France.

Foucault, M. 1969. *L'Archéologie du savoir*. Paris: Gallimard.

Harbison, R. 1998. *Thirteen Ways: Theoretical Investigations in Architecture*. Boston-MASS.: MIT Press.

Heidegger, M. 1993. Buidling, Dwelling, Thinking, In *Basic Writings*. New York: Harper Collins. [(1951) *Bauen, Wohnen, Denken*. Darmstadt. Lecture given at the University of Darmastadt.]

Kuhn, T. 1962. *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.

Macdonald, S. 1995. Consuming science: public knowledge and the dispersed politics of reception among museum visitors, *Media, Culture & Society* 17:13. Accessible at http://mcs.sagepub.com/content/17/1/13 [Last visited, 28th February, 2012.]

- 2006. Words in stone?: Agency and identity in a Nazi landscape, *Journal of Material Culture* 2006 11: 105. Accessible at: http://mcu.sagepub.com/content/11/1-2/105 [Last visited, 28th February, 2012.]

Popper, K. 2002. *The Logic of Scientific Discovery*. London-New York: Routledge. [*Logik der Forschung*. 1934.]

Tzonis, A. and Lefaivre, L. 1986. *Classical Architecture. The Poetics of Order*. Cambridge-MASS, London: MIT Press. - (1972) *Towards a Non-Opressive Environment*. Boston-MASS : MIT-Press.

Vieira De Almeida, P. 2005. *Da Teoria, oito lições*. Porto: ESAP.

Vitruvius, M. *De Architectura libri decem*, 1st century BC. [*The Ten Books on Architecture*. Harvard University Press, Cambridge-Mass, 1914. Translated by Morris Hicky Morgan.]

Von Hildebrand, A. 1901. *Das problem der Form in der bildenden Kunst*. Heits & Mündel, Strasbourg.[*The Problem of Form in Painting and Sculpture*. GE Stechert & Co., New York, 1907.]

Zevi, B. 1960. *Architettura in nuce*. Roma: Collaborazione Culturale.

Concha Diez-Pastor, Doctor Architect, obtained her PhD from Madrid School of Architecture-ETSAM (Spain). She is a registered Architect and Master of Research (MRES, University of London). As a Professor of Architectural Composition and Theory, she has taught at IE School of Architecture (Segovia, Spain) and ETSEIA – Universidad SEK (Segovia, Spain), and at Universidad Camilo José Cela (Madrid, Spain) as Assistant Professor. Her research interests are in the interface between culture, space and the generation of architectural thought throughout time. Therefore, they combine the reciprocal relations between architecture, society and culture and their implications for architecture as an art with its own corpus of thought. She has presented and published papers on Architectural Research Methods, Modernist and Avant-garde Architecture, Social Housing, Vernacular Architecture, Architectural 'Difficult' Heritage, Architecture for Tourism and Leisure, Visual Culture, and Romanesque Architecture. She is also the author of Carlos Arniches and Martín Domínguez, Architects of Madrid's '1925 Generation' (2005), about these two central figures of Madrid's Modernist Architecture. She has also contributed to several works, the latest of which is '"Architectural Koinè' and Transnational Spanish Architecture', in R. Quek, D. Deane and S. Butler (eds.) Nationalism and Architecture (2012), published by Ashgate.

Theorizing a contradiction between form and function in architecture

John Hendrix
Professor of Architectural History, University of Lincoln, UK
E-mail: jhendrix@lincoln.ac.uk

The contradiction between form and function should be seen as an important element in architecture. Modernist functionalism prioritized the necessity that form is seen as a consequence of function, adapting Louis Sullivan's credo that "form follows function," although Sullivan was not talking about the functional requirements of a building in relation to its form - he was talking about relationships in nature and the creative process. Nevertheless, architecture needs to be understood beyond the formula of "form follows function." This is not to deny the importance of functionalism in architecture, or to deny that there is a necessary relation between form and function in architecture, but only to reveal that the contradiction between form and function also plays an important role in architecture.

Key words: form, function, eidos, functionalism, natura naturans, lineament, uitbeelding, phenomenal transparency, deep structure, pictorial ambiguity, transformational relation, Bioconstructivism

The thesis is that the contradiction between form and function should be seen as an important element in architecture. The contradiction between form and function in architecture is proposed as a historical architectural construction that has not been theorized, a historical philosophy underlying theories of architectural practice that has not been articulated. By "form" is meant the visual appearance of a building (line, outline, shape, composition); by "function" the structural and functional requirements of a building (construction, shelter, program, organization, use, occupancy, materials, social purpose). Form of course can be said to have a metaphysical "function" to represent or express an idea, but that sense of the word is not used here. Both terms have modern connotations, related to the dictum "form follows function," but both have also played a role in architecture throughout history. In the twentieth century, form is the visual shape or appearance of a building. This is made clear in books ranging from Paul Frankl's *Principles of Architectural History*, to Rudolf Arnheim's *The Dynamics of Architectural Form*, to Peter Eisenman's *The Formal Basis of Modern Architecture*.

Form as appearance goes back to the classical distinction between eidos and hyle, form and matter. Plato defined eidos or idea as an archetype, separate from matter. Aristotle maintained the distinction, but said that eidos participates in hyle, and is in fact the ousia or being of the natural world. The Latin forma was used by the Romans as a synonym for both eidos (conceptual form) and morphe (sensual or sensible form). Vitruvius, in De architectura in the first century BCE, used the words imago, idea, species, and eurhythmia, all referring to form or visual appearance (either conceptual or sensible). He distinguished between ratiocinatio, the intellectual apprehension of architecture, and fabrica, the craft of architecture. In dispositio (arrangement), orthographia is the image (imago) of a building, and the result of cogitatio is the visual effect. The elements of dispositio—ichnographia (plan), orthographia (elevation), and scenographia (perspective)—are described as ideae (eidos or forma). Eurhythmia is venusta species (beautiful form); eurhythmia is derived from rhythmos, or form.

The Aristotelean commentators and Scholastics distinguished between sensible form (morphe, species sensibilis) and intelligible form (eidos, species apprehensibilis), form as property of the object and form as a product of the mind, as an incorporeal likeness of matter.

Kant defined form as an a priori intuition, a transcendental idea, of phenomena. The distinction between sensible and intelligible is related to the distinction between signifier and signified in language or rhetoric, which also has a modern connotation, in twentieth-century Structural Linguistics, but has played a role in visual theory since Vitruvius. According to Vitruvius, architecture consists of "that which signifies and that which is signified" (quod significatur et quod significat, in De architectura I.I.3).[1] That which signifies is the verba, or words in rhetoric, the material vocabulary of architecture, and that which is signified is the res (proposed thing, relation). As Leandro Madrazo Agudin says in The Concept of Type in Architecture: An Inquiry into the Nature of Architectural Form, "the concept of Form in architecture will reveal itself as permanent and ubiquitous" (51), and the three kinds of form defined by Vitruvius, structural, sculptural, and geometric, "exist in architectural works of all times" (81).[2]

The modern connotation of the function of a building is related to its use or utility (as defined for example by Hitchcock and Johnson in The International Style, 1932). This concept also goes back to Vitruvius, in that a building must have utilitas (usefulness), firmitas (firmness), and venustas (beauty), and these have also played a role throughout the history of architecture, with different cultural and historical nuances. According to Edward Robert de Zurko in *Origins of Functionalist Theory*, "Functionalism is generally associated with…the practical, material needs of the occupants of the building and the expression of structure" (7).[3] As Peter Eisenman wrote, in "Notes on Conceptual Architecture," "there is no conceptual aspect in architecture which can be thought of without the concept of pragmatic and functional objects…" (Eisenman *Inside Out: Selected Writings* 1963–1988, 16).[4] But as Le Corbusier wrote in the early twentieth century, "Architecture has a different meaning and different tasks from showing constructions and fulfilling purposes. Purpose is here understood as a matter of pure utility, of comfort, and of practical elegance" (as quoted in Adolf Behne, The Modern Functional Building, 134).[5] While the emphasis in the functionalism of the twentieth century has been on utility and program, structure plays a role as well, and each has been present throughout the history of architecture in various ways. In the nineteenth and twentieth centuries, geometrical form replaced sculptural form, and "functional goals merely replaced the orders of classical composition as the starting point for architectural design," as Eisenman wrote in "The End of the Classical" (Eisenman *Inside Out: Selected Writings* 1963–1988, 154).[6]

There are many examples in the history of architecture which display the contradiction between form and both structure and program. The goal of this thesis is not to challenge or criticize the legitimacy of functionalism in architecture. The synthesis of form and function plays a dominant and valuable role in architectural design. The present thesis is only intended to add another dimension to architectural composition and expression, without diminishing the importance of functionalism. In fact, successful contradiction between form and function can only be achieved after the functional requirements are fully understood. If the definitions of the terms throughout the history of architecture are examined, it can be seen that a contradiction between form and function is often present in architecture.

The distinction between form and function is related to what are seen as the "communicative" roles of architecture, in expression or representation, and the "instrumental" roles of architecture, in utility and technology; this distinction can in turn be related to the distinction between "culture" and "civilization," described by various authors, including C.P. Snow in The Two Cultures, and Nikolaos-Ion Terzoglou in "Architectural Creation between 'Culture' and 'Civilization'", in *The Cultural Role of Architecture*. According to Christian Herrmann, the duality of form and utility plays a role in every aspect of human life, including the life of the soul. Architecture has a role, as a work of art, to express a metaphysical or transcendental idea which is not connected to its

material presence. This is the definition of art. The transcendental can be the formal, conceptual, expressionistic, intellectual, numinous, spiritual, or aesthetic aspect of architecture.

According to Friedrich Schelling, in *The Philosophy of Art* (1859), because architecture is always necessarily tied to the material, to its physical and structural requirements, in order for architecture to be art, to communicate an idea not connected to its material requirements, architecture must be the "imitation of itself as the art of need" (§ 111),[7] that is, its visual appearance must contradict its physical requirements, its form must contradict its function. As Karl Friedrich Schinkel said, "Two elements must be distinguished precisely" in architecture: "the one intended to work for practical necessity and the one that is meant only to express directly the pure idea" (as quoted in Adolf Behne, *The Modern Functional Building*, 88).

As twentieth-century architectural discourse was dominated by the idea that there should be a causal relation between form and function in architecture, that "form follows function," the purpose of this thesis is to suggest that the contradiction between form and function also plays a role in architecture. As Madrazo Agudin points out, "in spite of their adherence to functionalism, the architects of the Modern Movement did not leave out the aesthetic significance of form. As a matter of fact, functionalism alone cannot explain the forms of modern buildings" (380). As Rudolf Arnheim asserted in *The Dynamics of Architectural Form*, "Physical function does not sufficiently determine form and no such determination explains why a visible kinship should result between function and expression" (256).[8] With expression based in form, "expression is not identical with a building's physical properties: a building may be soundly built yet look flimsy and precarious. Nor is expression identical with what the viewer, rightly or wrongly, believes the physical structure of a building to be" (254).

According to Adolf Behne in *The Modern Functional Building*, while function is the consequence of individual need, form is "the consequence of establishing a relationship between human beings" (137). Architecture in its form is an expression of human identity and the human condition, a poetic expression of the human spirit. The juxtaposition of function and form stages a dichotomy between the material and transcendent, the real and the ideal, matter and mind, the instrumental and the communicative, which results in artistic expression and communication.

Geoffrey Scott, in *The Architecture of Humanism*, defined the humanism of architecture as the "tendency to project the image of our functions into concrete forms…" (213).[9] In *The Architecture of Humanism*, there are examples given throughout history in which the appearance of structure in a building contradicts the fact of structure, the form of a building is unrelated to its social purpose, aesthetics are unrelated to construction, forms are produced irrespective of mechanical means or materials, forms are designed in excess of structural requirements, and the art of architecture is detached from mechanical science, all of which results in a humanistic architecture. An architecture that displays the contradiction between form and function is a humanistic architecture, an architecture that reveals the relationship between the human mind and the material world. Form is a product of the mind, while function is a product of matter.

In ancient Egypt, the symbolism of the pyramids can be seen in contradiction to their structure and accommodation of funerary programs. The non-structural role of peripteral colonnades on classical Greek temples, and optical adjustments to the temples, such as entasis, can be seen in relation to the deceptive nature of the objects of sense perception in the Allegory of the Cave in the *Republic* of Plato, and the conceptions of optics and perspective found in the *De architectura* of Vitruvius, and the *Enneads* of Plotinus. Optical refinements to the Greek temple, discovered in around 1837 by John Pennethorne and Joseph Hoffer, include horizontal

curvatures of the stylobate, entablature and gable; the leaning of columns, walls, antae, architrave, and frieze; and unequal sizing and spacing of columns and capitals. As Geoffrey Scott wrote in *The Architecture of Humanism*, "The Parthenon deceives us in a hundred ways, with its curved pediment and stylobate, its inclined and thickened columns" (157). The Doric column itself, he pointed out, "provides a support immeasurably in excess of what is required" (102).

Theories of *natura naturans* (imitation of the forming principles of nature) versus *natura naturata* (mimesis of natural forms) in classical architecture, involving the distinction between *eidos* and *morphe*, intelligible form and sensible form, are developed in the writings of Johann Joachim Winckelmann (*Histoire de l'art chez les anciens*), Francesco Algarotti (*Saggio sopra l'architettura*), Antoine Chrysostome Quatremère de Quincy (*Encyclopédie méthodique*, *De l'architecture égyptienne*), and Marc Antoine Laugier (*Essai sur l'architecture*). According to Johann Joachim Winckelmann in *Histoire de l'art chez les anciens* (1801), architecture is more "ideal" than the other arts because it does not imitate objects in nature; its forms are rather derived from the rules and laws of proportion, which are abstract concepts. Francesco Algarotti, in *Saggio sopra l'architettura* (1784), explained that architecture "must raise itself up with intellect and must derive a system of imitation from ideas about things that are the most universal and farthest from what can be seen…," that is, perceived by the senses. Thus "architecture is to the arts what metaphysics is to the sciences" (quoted in Sylvia Lavin, *Quatremère de Quincy and the Invention of a Modern Language of Architecture*, 107).[10] Architecture is necessarily metaphysical, because its design is derived from systems which are not directly connected to sensible perception.

According to Quatremère de Quincy, in the *Encyclopédie méthodique* (1788), classical Greek architecture was based on an underlying conceptual organization of abstracted forms and principles from nature, but it required in addition a dressing or costume that was completely disconnected from the forms of nature, and purely ideal. The result is that the "imitative system disguises the object imitated under a veil of invention and masks the truth with the appearance of fiction" (1:467) (quoted in Sylvia Lavin, *Quatremère de Quincy and the Invention of a Modern Language of Architecture*, 111). The imitation of imitation was necessary because of the transposition of the forms of the primitive hut from wood to stone. According to Quatremère, architecture has a moral responsibility to present the relation between human reason and nature as false, in the deliberate artificiality of its imitation. The contradiction between form and function in architecture can be found in the Tabularium Motif in Roman architecture, and the construction of the Pantheon.

The contradiction between physical and spiritual worlds is a constant theme in the symbolism of Christian and Byzantine architecture, the iconostasis, and Byzantine mosaics. The contradiction between form and structure can be seen in English Gothic architecture in the development of the rib vault beginning at Durham Cathedral. According to Paul Frankl in *Gothic Architecture*, the Gothic style began when diagonal ribs were added to the Romanesque groin vault, the rib being defined as an arch added to the surface of the vault. The Gothic is thus defined as involving the articulation of structure, beyond structure itself. The rib can be seen as a signifier for structure, a linguistic element in architecture, which removes the reading of the form of the architecture from the immediate presence of the architecture, in its structure or function, in the same way that language functions as a system of signifiers which is removed from that which it purports to signify.

The undermining of the French Gothic system began at Canterbury Cathedral, in the work of William of Sens and William the Englishman, which resulted in contradictions between form

and structure. The contradiction in the architecture is related to the contradiction between reason and faith in the dialectical process of the Scholasticism of Anselm of Canterbury (*Monologion*, *Oratio ad sanctum Nicolaum*), the "Father of Scholasticism." In the architecture, the sensible form, the design of the elevation, contradicts the intelligible form, the structural logic of the building. In the dialectic, the intelligible can be represented in terms of vision, "by the progress of sight from shadows" (Plato, *Republic* 532),[11] from the dark beyond human understanding, as described by Anselm in his *Oratio ad sanctum Nicolaum*. The exercise of the dialectic is ultimately carried out by reason in the realm of faith without the aid of the senses, and culminates in pure thought, *noesis*, the "summit of the intellectual realm."

Figure 1
Saint Hugh's Choir, Lincoln Cathedral, c. 1200.

The contradiction between form and structure in the asymmetrical vaulting of Saint Hugh's Choir at Lincoln Cathedral (figure 1), possibly designed by Geoffrey de Noyers, can be seen in relation to precedents at Canterbury and possible symbolic purposes relating to the mathematical and geometrical organization of the architecture. The vault is composed of non-structural ribs: the ridge pole and tiercerons, forming triradial ribs. Nikolaus Pevsner called the vault "the first rib-vault with purely decorative intentions" (*An Outline of European Architecture*, 207),[12] as it is composed of non-structural geometries posing as structural elements.

The mathematical and geometrical symbolism can be understood in relation to the writings of Robert Grosseteste, Bishop of Lincoln 1235–53. The geometries used in the architecture at Lincoln Cathedral—bent and curved lines of varying lengths, conic sections, convex and concave surfaces—correspond to the geometries described by Grosseteste in his treatises on light and optics, *De Luce* and *De Lineis, Angulis et Figuris*. The geometries are described by Grosseteste

for the purpose of explaining the functioning of natural phenomena, in particular the diffusion and rarefaction of light. Grosseteste's description of the functioning of natural phenomena in geometrical terms is an architectonic catechism which corresponds to the architecture of the cathedral, the form of which represents the Scholastic understanding of the structure and function of the natural world, as a cosmology, in contradiction to the actual structure of the building.

Contradictions in English Gothic architecture are related to the contradiction between the organic and inorganic in architecture as discussed by Georg Wilhelm Friedrich Hegel (*Introductory Lectures on Aesthetics*) and Friedrich Wilhelm Joseph von Schelling (*The Philosophy of Art*) at the beginning of the nineteenth century. A call for the necessity of the contradiction between form and function in architecture is found in the writings of Hegel and Schelling, in order for architecture to be art. According to Hegel, the art form "refers us away from itself to something spiritual which it is meant to bring before the mind's eye" (*Introductory Lectures on Aesthetics*, XV),[13] and the forms of architecture are "merely set in order in conformity with relations of the abstract understanding" (CIX), in mathematics and geometry, rather than material function. The beauty of art is beauty that is born "of the mind" (I, II), and not of the material. According to Schelling, "Architecture can appear as free and beautiful art only insofar as it becomes the expression of *ideas*, an image of the universe and of the absolute" (*The Philosophy of Art*, §107), as architecture must be the "imitation of itself as the art of need" (§ 111). Architecture cannot be organic form, so it must represent organic form in the idea, as in the vaulting of English Gothic architecture, to which Nikolaus Pevsner refers as "palm-fronds." The symbolic contradicts the organic as the human mind contradicts nature. The symbolic is the self-realization of the artificial construction of meaning. Philosophy is "symbolic science," as described by Schelling, as seen in Scholasticism.

How architecture is perceived (in the apperception of intelligible form as opposed to perception of sensible form) and the contradiction between sensible forms and intelligible forms in perception and intellection, can be found in the writings of Aristotle, Plotinus, Grosseteste, Leon Battista Alberti, Gottfried Wilhelm Leibniz, Immanuel Kant, Rudolf Arnheim, and Peter Eisenman, to name a few. As Rudolf Arnheim asserted, a view of a building is synthesized from a multiplicity of views, and a work of architecture is "a mental image synthesized with greater or lesser success from partial views" (*The Dynamics of Architectural Form*, 111), leading Arnheim to conclude that "expression is not identical with a building's physical properties," nor its physical structure, as is the case in English Gothic architecture.

In the Renaissance, the contradictions between the facades and the structures and symbolic programs of the buildings in the architecture of Leon Battista Alberti (Palazzo Rucellai, Santa Maria Novella, Sant'Andrea in Mantua), and Alberti's designs based in syncretic combinations and underlying proportioning systems, can be understood in relation to the writings of Alberti (*De re aedificatoria*) and Marsilio Ficino (*De amore*), for example, derived from classical sources (Plato, *Timaeus*, *Phaedrus*; Aristotle, *De anima*; Vitruvius, *De architectura*; Plotinus, *Enneads*; Proclus, *Elements of Theology*). The writings include Alberti's distinction between lineament (the lines in the mind of the architect) and matter, and his theory of *concinnitas* or visual harmony. Lineaments are the outline of a building, consisting of lines and angles, as conceived in the mind (as *eidos* or *species apprehensibilis* in intellect and imagination), separate from matter, as in the *ratiocinatio* of Vitruvius. In the *De re aedificatoria*, "It is quite possible to project whole forms in the mind without any recourse to the material…" (I.1).[14] *Concinnitas* is defined as the "form and figure" of a building, that which is "pleasing to the eyes," and is "the main object of the art of building" (IX.5). Alberti followed Vitruvius in his definition of *concinnitas* or beauty in *De re aedificatoria*: "It is the task and aim of *concinnitas* to compose

parts that are quite separate from each other by their nature, according to some precise rule, so that they correspond to one another in appearance" (VII.4). *Concinnitas*, like apperception, transforms disparate and unrelated sensible perceptions into a coherent whole, in a disjunction between perception and what is perceived, a contradiction between visual form and material function.

On the façade of the Palazzo Rucellai (figure 2), the forms of structural classical columns perform no structural function, and the bays of the façade do not correspond to the structure of the building. On the façade of Sant'Andrea in Mantua, the forms of a Greek temple front and Roman triumphal arch are combined for a Catholic church, a contradiction in representation and purpose. The trabeated elevations on the interior of the basilica conceal Gothic-style buttressing in the bays, as at St. Peter's in Rome. The contradiction between the lineament (as *archê* or archetypal principle) and matter is expressed in Renaissance painting as well, and is found in the theories of vision of Ficino (*De amore*, *Theologia Platonica*) and Alberti (*De pictura*). As Alberti explained, a building consists of "lineaments and matter, the one the product of thought, the other of Nature; the one requiring the mind and the power of reason, the other dependent on preparation and selection" (*De re aedificatoria*, Prologue), in the realms of form and function.

Figure 2
Leon Battista Alberti, Palazzo Rucellai, Florence, 1452–70.

According to Geoffrey Scott in *The Architecture of Humanism*, the humanistic architecture of the Renaissance, and the visual expression of humanistic ideals, entailed a contradiction between form and function. The form of the building was often "disproportionate, and even unrelated, to the social purpose it ostensibly fulfils…" (26). The decorative use of the Orders

did not express structure and was contrary to construction. Forms in architecture were not used in relation to "the mechanical means by which they were produced," the "materials out of which they were constructed," or "the actual purposes they were to serve" (32). Arches and pilasters on Renaissance buildings were employed in ways that contradicted the structural purpose for which they were designed, a phenomenon that can be found throughout Renaissance, Baroque, and Neoclassical architecture.

Alberti's theory of vision was applied to his prescriptions for composition in painting and architecture. The contradiction between form and function can be seen in Donato Bramante's trompe l'oeil compositions in Milan, where trompe l'oeil space contradicts real space, as in the trompe l'oeil perspective devices in the paintings of Andrea Mantegna and Leonardo da Vinci. The contradiction between form and structure is seen in the Mannerist devices of Michelangelo (Laurentian Library, Porta Pia) and Giulio Romano (Palazzo del Tè, figure 3). The contradiction between form and structure in the Mannerist devices of Giuilo Romano is related to the architectural use of tropes or figures of speech, and the inherent contradictions in rhetorical language. Tropes in poetic language, such as metaphor, metonymy, or synecdoche, contradict the ability of the language to convey literal meaning, but result in poetic expression. In language or architecture, poetic expression requires the contradiction between form and function. Mannerist compositions culminate in the architecture of Federico Zuccari in Rome (Palazzo Zuccari), which is related to the theoretical discussions of the Accademia di San Luca (Federico Zuccari, *L'Idea de' pittori, scultori ed architetti*; Romano Alberti, *Origine et Progresso dell'Academia del Disegno*; Pietro da Cortona, *Trattato della Pittura e Scultura*), and in particular the distinction between *disegno interno* (the design in the mind of the artist, *eidos*) and *disegno esterno* (the physical design, *morphe*).

Figure 3
Giulio Romano, Palazzo del Tè, Mantua, 1526–35.

The contradiction between form and structure abounds in the architecture of Francesco Borromini (San Carlo alle Quattro Fontane, figure 4), influenced by classical philosophy,

Renaissance Humanism, the Accademia di San Luca, and the mysticism of the Counter Reformation. At San Carlo, the trabeated elevations again conceal structural buttressing; an exhaustive structural system is presented which serves no structural purpose, as if it were shadows on the wall of the cave in the *Republic* of Plato. Balusters are turned upside down, volutes are inverted, and straight and concave entablature sections alternate, without apparent rational purpose. But the seemingly bizarre formal juxtapositions have underlying rational explanations. Borromini's architectural forms can be related to the contradiction between dream thoughts and dream images in Sigmund Freud's *The Interpretation of Dreams* (1900), and the *coincidentia oppositorum*, or coincidence of opposites, which is found in philosophy, language, and psychoanalysis. According to Freud, while "little attention is paid to the logical relations between the thoughts, those relations are ultimately given a disguised representation in certain formal characteristics of dreams" (544–5),[15] as rational structures are disguised by Borromini's forms. As Freud describes, "Dreams feel themselves at liberty…to represent any element by its wishful contrary…" (353), as in the forms of Borromini, which contradict their functions.

Figure 4
Francesco Borromini, San Carlo alle Quattro Fontane, Rome, c. 1638.

Elements of the architecture of Karl Friedrich Schinkel (the Schauspielhaus in Berlin, figure 5) can be understood in relation to the writings of Friedrich Schelling and Georg Hegel. The ideas of Immanuel Kant (*Critique of Pure Reason*), Johann Gottlieb Fichte, Schelling (*The Philosophy of Art*), and Hegel (*Introductory Lectures on Aesthetics*) were understood by Schinkel through his friends Karl Wilhelm Ferdinand Solger and Wilhelm von Humboldt. Schinkel saw architecture as a theatrical stage set, and as a representation of the true underlying structure of reality, in contradiction to perceived reality. As Schinkel said, "Two elements must be distinguished precisely: the one intended to work for practical necessity and the one that is meant only to

express directly the pure idea." The trabeated façade of the Schauspielhaus in Berlin contradicts the structure and program of the building; according to Schelling, architecture must contradict itself in its form in order to express an idea and in order to be art. The Transcendental Idealism of Schinkel's architecture would influence the architecture of Ludwig Mies van der Rohe in the twentieth century, in the contradiction between mind and perception, form and function.

Figure 5
Karl Friedrich Schinkel, Schauspielhaus (Konzerthaus Berlin), 1818–21.

In the *Critique of Pure Reason* (1781) of Kant, space and time, and geometry and mathematics in architecture, are transcendental a priori categories of mind which do not exist in the world of matter as given by perception, but are applied by experience, as influenced by the thought of George Berkeley. The form of architecture is an a priori representation in relation to its structure and program. As Kant wrote, when "I make the empirical intuition of a house by apprehension of the manifold contained therein into a perception, the *necessary unity* of space and of my external sensuous intuition lies at the foundation of this act…" (92).[16] Without the a priori intuition, apperception, cognition and discursive reason would not be possible. The form of the house is drawn according to the synthetical unity of the manifold in space, which does not exist in material phenomena, but rather only in the mind.

As geometry and mathematics, as a language or a form of representation, architectural form mediates between thought and the sensible world given by perception. Objects of perception are given by signs or representations in the thought of Berkeley (*An Essay Towards a New Theory of Vision*; *Alciphron*; *The Theory of Vision or Visual Language Vindicated and Explained*); and words in language as signs do not correspond to the objects they signify according to René Descartes (*The World, or a Treatise on Light and the Other Principal Objects of the Senses*). The relation between the signifier and the signified in language is arbitrary, corresponding to a contradiction between form and function in the language of architecture, and anticipating the theories of Structural Linguistics and Deconstruction in the twentieth century.

In the Structural Rationalism of Eugène-Emmanuel Viollet-le-Duc (*Dictionnaire raisonné de l'architecture*, 1854–68), style in architecture is seen as a conception of the mind, not a physical quality of a building. Style in art is "the manifestation of an ideal based on a principle" (232), a manifestation of *eidos* rather than *morphe*, of form rather than function.[17] The terra cotta ornament designed by Louis Henry Sullivan (Wainwright Building, Guaranty Building), contradicts the dictum for which Sullivan is known, that "form ever follows function" ("The Tall Office Building Artistically Considered," *Kindergarten Chats* 208).[18] Sullivan said that form should follow function in the creative process of the architect, and that "the essence of things is taking shape in the matter of things" in nature, but he did not say that the form of the building should follow the function of the building, its functional or structural requirements. As Robert Woods Kennedy wrote in the *Journal of the American Institute of Architects*, 1950, the dictum "was not interpreted by him as it was by the functionalists. He considers the business of properly relating them a matter of *professional technique*, not an end in itself" (199),[19] in the design of the building. As Marcel Breuer said, "Sullivan did not eat his functionalism quite as hot as he cooked it" (as quoted in Peter Blake, *Form Follows Fiasco*, 16).[20] Sullivan's causal relation is an example of organic functionalism, but as Richard Neutra suggested in *Survival Through Design*, operation also can follow appearance in nature, so function can follow form.

The relation between form and function in architecture for Sullivan is a dialectical relation, between the metaphysical and the material, the infinite and finite, life and death. In the "Kindergarten Chats" (1918), all forms "stand for relationships between the immaterial and the material, between the subjective and the objective—between the Infinite Spirit and the finite mind" (45), independent of the function of the building. Sullivan's ideas were influenced by Leopold Eidlitz (*Nature and Function of Art*), Ralph Waldo Emerson, Walt Whitman, and Hegel. According to Eidlitz, the design of a building is the expression of a transcendental idea manifesting itself in form through nature. For Sullivan, the essence of a building is in its appearance, not its structural or functional requirements. The gridded façade of the Bayard Building, for example, expresses the rhythms of life and death, eros and thanatos, growth and aspiration, as expressed in the *Leaves of Grass* of Walt Whitman. Sullivan was familiar with the Hegelian dialectic (*Philosophy of Mind*) through his friend John Edelmann, the dialectic of subjective and objective, particular and universal, organic and geometrical, which he incorporated in his architectural theory.

The dialectic of organic and geometrical, and form and structure, can also be found in the architecture of Victor Horta in Belgium (Tassel House, Maison du Peuple, Maison et Atelier Victor Horta). Forms which appear to be structural are in fact non-structural, producing a double reading of the forms in the contradiction between form and function. In the Tassel House (1893), a filigree iron bracket only plays a role visually, to affirm the continuity of a line. Rivets and bolts are used as ornamentation, extending to beams with rivets which serve no structural purpose. In the Maison et Atelier Victor Horta, rue Américaine 25 (1898–1900), non-structural plaster vaulting appears around the stairwell. Gilded metalwork under curved beams in the dining room appear to function as tie bars but do not, and a column at the entrance of the house appears to support a marble cantilevered ledge but does not. The fantastical architecture of Horta involves the dialectic of the human mind and nature, the transcendental idea and material forms, literal and figural, rationalist and poetic. The architecture suggests the Symbolist *chambre rêve*, involving the dissolution of the subject in space that would be described as psychasthenia by Roger Caillois ("Mimicry and Legendary Psychasthenia," *Minotaure*; *Le Myth et l'Homme*; *The Necessity of the Mind*), and the quality of *informe*, the dissolution of the boundaries of form. Horta's architecture evokes the Symbolist interior environment of artificiality celebrated in Joris-

Karl Huysmans' *A Rebours*, and the Symbolist landscape of artificiality and death celebrated in Georges Rodenbach's *Bruges-la-Morte*.

The theories and works of the De Stijl movement in Holland (Theo van Doesburg, *Spatial Diagram*; Gerrit Rietveld, Schröder House; Piet Mondrian) were influenced by the Hegelian philosophies of Mathieu Schoenmaekers and Gerard Bolland. Schoenmaekers distinguished between *uitbeelding* and *afbeelding*, between representation in visual depiction and the visual representation of an inner reality beyond visual appearance, as in the *Vorstellung* and *Geist* of Hegel (*Introductory Lectures on Aesthetics*), the manifestation of *Geist* or Spirit through *Vorstellung* or picture-thinking. The Absolute Spirit, beyond picture-thinking, can be invoked in the pure plastic work of art, according to van Doesburg. Categories of thought defined by van Doesburg in the perception of art, following Hegel, are based on classical conceptions of thought (Plato, *Republic*; Aristotle, *Metaphysics*, *De anima*; Proclus, *Commentary on the First Book of Euclid's Elements*) in the formation of a *Kunstreligion* towards a utopian society. The fixed panels on the exterior of the Schröder House have been called "trompe l'oeil" and "illusionistic": they are not the material they purport to be, they do not serve the function that they represent, and they mask the structure of the house. The form of the architecture contradicts the functional and structural requirements of the building, and the architecture can thus express the idea of the Absolute Spirit, the dialectic of the inner essence of being and the *Vorstellung*, representation in visual form and language.

Figure 6
Ludwig Mies van der Rohe, Classroom Building, Illinois Institute of Technology, Chicago, c. 1945.

The influence of De Stijl, and the contradiction between form and function, can be seen in the Barcelona Pavilion of Ludwig Mies van der Rohe, where there are no enclosing walls to provide shelter. The architecture can be seen as an architecture of text or signification in form, in the evocation of *Geist*, in the tradition of Transcendental Idealism. From Schelling (*The Philosophy of Art*), architecture must be a free imitation of itself; forms which are not functional must be functional in appearance, as in the I-columns on the facades of Mies' buildings in America. In the evocation of *Geist*, an absence is contained within the presence of the architecture, as in

the false column of the Miesian Corner (figure 6), wherein the form contradicts the structure. The trace of absence in presence corresponds to the instituted trace in language as described by Jacques Derrida in *Of Grammatology*. The trace or absence in language makes meaning and signification possible, according to Derrida. The absence at the core of presence in language can also be found in the *point de capiton* of Jacques Lacan, the connection between the signifier and signified which produces signification. Language for Derrida is *différance*, a play of differences which constantly defers meaning, revealing the absence at the core of presence.

The contradiction between form and structure can be found in the architecture of Frank Lloyd Wright (Robie House, Fallingwater) where hidden steel beams produce an organic Prairie Style aesthetic, and the architecture of Le Corbusier (Villa Savoye), where painted wood panels masquerade as machined forms according to the Purist aesthetic. At the Chapel of Notre Dame du Haut at Ronchamp, Surrealist forms contradict the structural requirements of the building, in the same way that in the dream work of Sigmund Freud (*The Interpretation of Dreams*, *On Dreams*), dream images contradict dream thoughts, being transformed through condensation and displacement, mechanisms which are applied to Surrealist compositions. At the Villa Stein at Garches, overlays and intersections of grids create spaces which contradict the organization of the building. Colin Rowe and Robert Slutzky ("Transparency: Literal and Phenomenal" (1955–6), *Mathematics of the Ideal Villa*) compared the phenomenon to a Cubist painting, and contrasted literal transparency with "phenomenal transparency," or real space with formal space in a conceptual reading of a work, following Gyorgy Kepes in *Language and Vision*. There is a "continuous dialectic between fact and implication" (169)[21] in the architecture of Le Corbusier, according to Rowe and Slutzky, a dialectic of form and function. Le Corbusier said that architecture is a "product of the mind," and that it is "art in the highest sense, mathematical order, speculation, perfect harmony through the proportionality of all relationships…" (as quoted in Adolf Behne, *The Modern Functional Building*, 134), apart from the material presence of the building.

Figure 7
Giuseppe Terragni, Casa Giuliani Frigerio, Como, 1939–40.

The contradiction between form and function, between the irrational appearance of the facades and the rational organization of the buildings, in the architecture of Giuseppe Terragni in Como (Casa del Fascio, Casa Giuliani Frigerio, figure 7), is attributable to the shifting and rotating of nine square grids in plan, and the overlapping of centripetal and centrifugal plan organizations, according to the analysis of Peter Eisenman ("From Object to Relationship II: Giuseppe Terragni, Casa Giuliani Frigerio," *Perspecta* 13). According to Eisenman, the architecture can be read within the framework of the "phenomenal transparency" of Colin Rowe, as a dialectic of surface structure (the appearance) and deep structure (the organization), borrowing the terms from the linguistics of Noam Chomsky (*Language and Mind*, *Cartesian Linguistics*), where surface structure is the phonetic symbol or syntax of a sentence, and the deep structure is the meaning produced or the idea communicated by language. The dialectic of surface structure and deep structure in the architecture, like the dialectic of Alberti's matter and lineament in the Renaissance, entails the contradiction of form and function. As Eisenman says in *The Formal Basis of Modern Architecture*, "the dictates of form are not always wholly reconcilable with the requirements of function…" (27).[22]

The visual experience of Terragni's buildings is fragmented, and is a composite of individual perceptions, in what can be called apperception, as described by Plotinus, Leibniz, and Kant. The experience of architecture as multiple perceptions, gathered together in a coherent conceptual totality, was also described by Paul Frankl in *Principles of Architectural History*, and Rudolf Arnheim in *The Dynamics of Architectural Form*. In the Casa Giuliani Frigerio, pictorial ambiguity is identified in the simultaneous occurrence of both an additive and subtractive compositional process, and centripetal and centrifugal organizations of forms, and in the dialectics of planar/recession, solid/void, horizontal/vertical, and in the juxtaposition of forms generated by the superimposition and shifting of grids in plan. Pictorial ambiguity is seen as a compositional strategy in architecture to transform conceptual structures into formal structures, and to allow formal structures to be read as conceptual structures. Pictorial ambiguity enacts the dialectic of thought in perception and what is perceived, and the contradiction between form and function in perception, and the contradiction between form and function in architecture.

The oscillation between the fragmented and shifting appearance in the surface structure in Terragni's buildings, and the conceptual organization in the deep structure, which are connected by "transformational relations," corresponds to the fragmented and shifting play of words in the *différance* described by Derrida, which reveals the presence of absence in signification. It is only through the absences, the gaps and oscillations in language, that the unconscious can be known, according to Jacques Lacan (*Écrits: A Selection*), following the influence of Freud (*An Outline of Psycho-Analysis*, *The Ego and the Id*). A late project by Le Corbusier, the Villa Shodhan in Ahmadabad, displays the same oscillation of readings and pictorial ambiguity as the buildings by Terragni, through manipulations of the nine square grid rendered in *béton brute*.

The manifesto of Postmodern architecture, Robert Venturi's *Complexity and Contradiction in Architecture*, posits contradiction as an important aspect of architectural composition, as a reflection of human identity. In his design of the Vanna Venturi House in Chestnut Hill, Venturi was inspired by the Casa del Girasole in Rome, designed by the Italian Neorationalist Luigi Moretti, which combines multiple historicist references to create an ambiguous, oscillating reading in relation to the program and organization of the building. In early house compositions by Peter Eisenman (Barenholtz Pavilion or House I, Falk House or House II, figure 8), and later projects (IBA Housing in Berlin, Wexner Center, figure 9), the form contradicts the structure as a column does not support anything, or a column does not reach the floor, or a gridded façade does not correspond to the structure of the building, for the purpose of displaying the contradiction

between the material presence of the building and the conceptual organization of the building, surface structure and deep structure, matter and idea.

Figure 8
Peter Eisenman, Falk House (House II), Hardwick, Vermont, 1969–70.

Figure 9
Peter Eisenman, Wexner Center for the Arts, Ohio State University, 1983–89.

In House I, beams clearly do not support anything; they in fact have "nothing to do with the structure of the building" (174), as Eisenman explains in *House of Cards*.[23] House II has two

structural systems, of columns and walls, creating a "nonfunctional redundancy" in which "each system's function was to signify its own lack of function," in an architecture which is an "imitation of itself as the art of need" in the words of Schelling. A hole in the floor or a false entrance contradict the program and organization of the buildings. Columns "'intrude on' and 'disrupt' the living and dining areas…" (169), according to Eisenman. The syntax of the compositions is as the syntax of language, using rhetorical devices to produce signification and to challenge the logic of signification at the same time. Eisenman borrows the syntactical structures of the architecture of Terragni, and the syntactical structures in the linguistics of Chomsky, to compose the trace or absence of presence in language, the void at the core of signification, in relation to the *différance* of Derrida (as described in *Positions*).

Figure 10
Renzo Piano and Richard Rogers, Pompidou Center, Paris, 1972–76.

Form contradicts function in several icons of Postmodernist architecture, including the Pompidou Center in Paris (figure 10) by Renzo Piano and Richard Rogers, where the structural and functional elements of the interior of the building are placed on the exterior of the building, in excess of the functional requirements of the building, displaying the excess production of Late Capitalism. The architects were again inspired by an Italian Neorationalist, Franco Albini, in a design for La Rinascente in Rome. Works by Daniel Libeskind (Denver Art Museum) or Frank Gehry (Guggenheim Museum in Bilbao, Walt Disney Concert Hall, Pritzker Pavilion, figure 11), also display a contradiction between form and structure in the excess use of materials, for aesthetic affect or appearance, in relation to the functional requirements of the buildings. The form of the Piazza d'Italia in New Orleans by Charles Moore functioned as a media icon in contradiction to the actual failed function of the structure, to provide a place to eat, resulting in a postmodern ruin. The architecture displays the excess and artificiality of Late Capitalism in Western culture, as does the Gehry House, the form of which is in contradiction to the function of the house, in structure and program, and to its own ideological basis, a tenet of Deconstructivist architecture.

Figure 11
Frank Gehry, Pritzker Pavilion, Chicago, 1999–2004.

Deconstructivist works by Zaha Hadid (Vitra Fire Station) or Coop Himmelblau (Rooftop Remodelling Project, Vienna) display a Constructivist aesthetic in contradiction to both the historical origin of the aesthetic and the structure and function of the building, as do the follies of Bernard Tschumi at the Parc de la Villette in Paris, whose goal was to relate the disjunction between form and function in architecture to the disjunction between the signifier and signified in language, as described in *Architecture and Disjunction*. The follies represent the point of escape from the orthogonal grid of rational thought and the logocentrism of the signifier, the irrational within the rational, absence within presence. The absence within presence is a *chôra*, as in the *Timaeus* of Plato, a place of becoming which is not a place, the "in between" between signifiers, the trace between presences. Architecture, according to Tschumi in *Architecture and Disjunction*,[24] is a "thing of the mind" rather than a "pictorial or experiential art" (84), in which its vocabulary elements, "facades, arcades, squares" (90), even architectural concepts, "place a veil between what is assumed to be reality and its participants," as does language itself. The form of the architecture veils the function. The form of the follies does not correspond to their program as parts of the park. The *chôra* was also the theme for a collaboration between Peter Eisenman and Jacques Derrida for the site in Paris, attempting to define the space of *différance*, and the void in signification, the gap in the definition of the postmodern subject.

A theoretical basis for Bioconstructivism in architecture was developed in the 1990s, including concepts proposed by Sanford Kwinter ("Landscapes of Change: Boccioni's *Stati d'animo* as a General Theory of Models," *Assemblage* 19), such as topological theory, epigenesis, the epigenetic landscape, morphogenesis, catastrophe and catastrophe theory. This development did not continue in the first decade of the twenty-first century, giving way to a "death of theory" in architecture, in deference to an overriding emphasis on material production, technological development, and consumerist novelty, as indicated in essays by Detlef Mertins ("Bioconstructivisms," *NOX: machining architecture*), for example, in which "self-generation" and "immanence" are seen to have replaced "predetermination" and "transcendence," and by Jane and Mark Burry (*The New Mathematics of Architecture*), which celebrates the complex

geometries which computer systems are able to add to architecture, seen as dynamic in relation to the "dead geometries" and "rectilinear dogma" of modernist architecture.

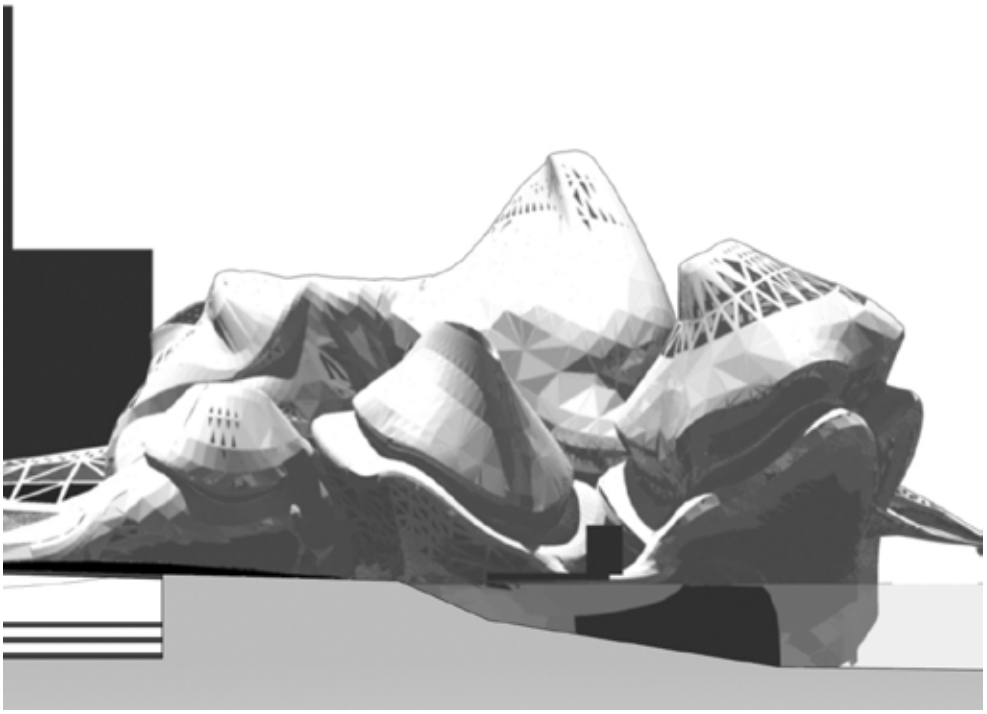


Figure 12
Amy Lewis, Endless Dreamscape Project, 2011.

An experimental project by Amy Lewis in a Graduate Design Studio led by Andrew Thurlow at Roger Williams University (figure 12) enacts a theoretical basis for Bioconstructivism in combination with a poetic expression, in the contradiction between form and function, in structure and program. The project combines the immanence and self-generation of Biomimesis with the transcendence and predetermination of poetic expression, displaying the relation between the signifier and signified in the contradiction between the form and the function, and the topological, epigenetic landscape, and morphogenesis and catastrophe that the computer-designed form is capable of representing. The project combines the dynamism of computer-generated forms with a historicist approach in the treatment of typologies and formal relationships, continuing the development of theory-based architecture, or architecture as art.

Bioconstructivist projects that display a similar contradiction between form and function include the Cardiff Bay Opera House Competition project by Greg Lynn, the Oblique WTC project by Lars Spuybroek, and the Atlantis Sentosa project by Frank Gehry with contributions by Greg Lynn. The project by Amy Lewis recalls the dialectical relationships of Louis Sullivan, of organic and geometrical, horizontal and vertical, mind and nature, life and death, in a poetic expression facilitated by the contradiction between form and function. The dialectical relation is based on the contradiction between the thesis and antithesis, from which a synthesis is drawn. The dialectical relation of form and function in architecture is an important element in architectural expression. Contemporary architecture sees an increasing neglect of the relation between form and function. Contemporary architects generate forms and justify them with function. In architecture, forms should be generated in relation to function, either as a response to it, or in contradiction to it.

In the neglect of theory, emphasis has been placed instead on the development of the technological means of architectural production, in particular computer programs, at the expense of the development of a theoretical or conceptual basis for architectural form-making. As Nikolaos-Ion Terzoglou writes, for example, "Architecture has concentrated mainly on technological means and instrumental procedures that, in certain cases, manage empty forms without conceptual content."[25] The discipline of architecture has increased its dependence on other forms of technological production. Terzoglou continues: "This situation has marginalized architecture as a form of mental expression and spatial imagination. An almost exclusive and one-dimensional emphasis on material and technological means reduces the ontological complexity of architecture and often leads to results which lack mental depth and spiritual purposes." Theorizing a contradiction between form and function in architecture hopes to suggest an architecture of mental depth and ontological complexity, in the place of empty forms.

Works cited

1 Vitruvius, 1931. *De architectura* (*On Architecture*), trans. Frank Granger (Cambridge, MA: Harvard University Press, [27 BCE]).

2 Leandro Madrazo Agudin, 1995. *The Concept of Type in Architecture: An Inquiry into the Nature of Architectural Form*, Zurich: Swiss Federal Institute of Technology.

3 Edward Robert de Zurko, 1957. *Origins of Functionalist Theory,* New York: Columbia University Press.

4 Peter Eisenman, 2004. Notes on conceptual architecture: toward a definition, in *Eisenman Inside Out: Selected Writings 1963–1988*. New Haven: Yale University Press.

5 Adolf Behne, 1996. *The Modern Functional Building*, translated by Michael Robinson Santa Monica: The Getty Research Institute for the History of Art and the Humanities.

6 Peter Eisenman, 1963–1988. The End of the Classical: The End of the Beginning, the End of the End, in *Eisenman Inside Out: Selected Writings*.

7 Friedrich Wilhelm Joseph von Schelling, 1989. *The Philosophy of Art* (*Die Philosophie der Kunst*, 1859), translated by Douglas W. Stott. Minneapolis: University of Minnesota Press.

8 Rudolf Arnheim, 1977. *The Dynamics of Architectural Form.* Berkeley: University of California Press.

9 Geoffrey Scott, 1980. *The Architecture of Humanism*. London: The Architectural Press [1914, 1924].

10 Quoted in Sylvia Lavin, 1992, *Quatremère de Quincy and the Invention of a Modern Language of Architecture*. Cambridge, MA: The MIT Press.

11 Plato, 1955, *Republic*, translated by Desmond Lee. London: Penguin Books, .

12 Nikolaus Pevsner, 1943, *An Outline of European Architecture*. Middlesex: Penguin Books.

13 Georg Wilhelm Friedrich Hegel, 1993, *Introductory Lectures on Aesthetics*, translated by Bernard Bosanquet, ed. Michael Inwood. London: Penguin Books.

14 Leon Battista Alberti, *De re aedificatoria* (*On the Art of Building in Ten Books*), trans. Joseph Rykwert, Neil Leach, Robert Tavernor (Cambridge, MA: The MIT Press, 1988).

15 Sigmund Freud, 1965, *The Interpretation of Dreams, The Standard Edition*, trans. and ed. James Strachey. New York: Avon Books.

16 Immanuel Kant, 1990, *Critique of Pure Reason*, trans. J. M. D. Meiklejohn. Amherst, NY: Prometheus Books.[1781].

17 Eugène-Emmanuel Viollet-le-Duc, 1990, *The Foundations of Architecture: Selections from the Dictionnaire raisonné*, translated by Kenneth D. Whitehead. New York: George Braziller.

18 Louis H. Sullivan, 1947, *Kindergarten Chats and Other Writings*. New York: Wittenborn, Schulz.

19 Robert Woods Kennedy, 1950, Form, Function and Expression: Variations on a Theme by

Louis Sullivan, *Journal of the American Institute of Architects* XIV (5) New York, The Octagon, November.

20 Peter Blake, 1974, *Form Follows Fiasco: Why Modern Architecture Hasn't Worked*. Boston/ Toronto: Little, Brown and Company.

21 Colin Rowe and Robert Slutzky, 1976, Transparency: Literal and Phenomenal, in Colin Rowe, *The Mathematics of the Ideal Villa and Other Essays*. Cambridge, MA: The MIT Press.

22 Peter Eisenman, 2006, *The Formal Basis of Modern Architecture*. Baden, Switzerland: Lars Müller.

23 Peter Eisenman, 1987. *House of Cards*. New York and Oxford: Oxford University Press.

24 Bernard Tschumi, 1994, *Architecture and Disjunction*. Cambridge, MA: The MIT Press.

25 Nikolaos-Ion Terzoglou, 2012, Architectural Creation between 'culture' and 'civilization', in *The Cultural Role of Architecture*, ed. Paul Emmons, Jane Lomholt, John Hendrix. Abingdon, Oxon: Routledge.

John Shannon Hendrix is a Professor of Architectural History at the University of Lincoln, UK, and an Adjunct Professor of Art and Architectural History at Roger Williams University, US. He is an American architectural and intellectual historian who has spent his career researching and writing about mostly European precedents in architecture and philosophy, for the purpose of suggesting alternatives to the practice of architecture and philosophy at the beginning of the twenty-first century.

Ideas of space from Isaac Newton to Étienne-Louis Boullée

Nikolaos-Ion Terzoglou
Dr. Architect, Lecturer, National Technical University of Athens, Greece
E-mail: initer@central.ntua.gr

This paper aims to prove that a fertile dialogue between architectural history and the history of ideas can open interesting perspectives for the understanding of the process of design. This dialogue, offering a reconstruction of the different mental contexts of each historical period, could prove to be essential for grasping the true meaning of design outcomes that belong to the same era. As a specific case-study, the present paper investigates the cultural interactions and the conceptual correspondences between the scientific spirit of the Enlightenment, philosophy and the architectural utopian projects of Étienne-Louis Boullée, based on the examination of various ideas of space. It is argued that after the Scientific Revolution of the seventeenth century and the major works of Isaac Newton and Gottfried Wilhelm Leibniz, the notion of space assumed an increasingly important role in the philosophical and architectural discourses of the Enlightenment. In this context, a general outline of the possible affinities and divergences between those distinct domains of eighteenth-century knowledge is traced, through the analysis of various interpretations of natural and urban space from Isaac Newton and Voltaire to Étienne-Louis Boullée.This analysis is a preliminary attempt to think the complex relations between the Humanities and the natural sciences in their Modern genealogical interdependences and tensions. Moreover, it can form the conditions for a better understanding of the intellectual environment that constitutes the meaningful ground of Boullée's design intentions.
Key words: space, mental context, history of ideas.

Ιδέες του χώρου από τον Isaac Newton στον Étienne-Louis Boullée
Η παρούσα μελέτη στοχεύει να αποδείξει πως ένας γόνιμος διάλογος ανάμεσα στην ιστορία της αρχιτεκτονικής και την ιστορία των ιδεών μπορεί να διανοίξει ενδιαφέρουσες προοπτικές για την κατανόηση της διαδικασίας του σχεδιασμού. Αυτός ο διάλογος, καθώς προσφέρει μία ανασυγκρότηση των διαφορετικών νοητικών πλαισίων κάθε ιστορικής περιόδου, θα μπορούσε να αποδειχθεί ουσιώδης για την σύλληψη του αληθινού νοήματος των σχεδιαστικών αποτελεσμάτων που ανήκουν σε αυτήν. Ως μία συγκεκριμένη μελέτη περίπτωσης, το παρόν άρθρο εξετάζει τις πολιτισμικές αλληλεπιδράσεις και τις εννοιολογικές ανταποκρίσεις ανάμεσα στο επιστημονικό πνεύμα του Διαφωτισμού, την φιλοσοφία και τα αρχιτεκτονικά ουτοπικά σχέδια του Étienne-Louis Boullée, βασιζόμενο στην διερεύνηση διαφόρων ιδεών του χώρου. Υποστηρίζεται πώς μετά την Επιστημονική Επανάσταση του 17ου αιώνα και τα μείζονα έργα του Isaac Newton και του Gottfried Wilhelm Leibniz, η έννοια του χώρου απέκτησε έναν ολοένα και πιο σημαντικό ρόλο στους φιλοσοφικούς και αρχιτεκτονικούς λόγους του Διαφωτισμού. Σε αυτό το πλαίσιο, σκιαγραφείται ένα γενικό περίγραμμα των πιθανών συγγενειών και αποκλίσεων ανάμεσα σε αυτές τις διακριτές περιοχές γνώσης του 18ου αιώνα, μέσα από την ανάλυση ποικίλων ερμηνειών του φυσικού και του αστικού χώρου από τον Isaac Newton και τον Βολταίρο έως τον Étienne-Louis Boullée. Αυτή η ανάλυση αποτελεί μία προκαταρκτική απόπειρα στοχασμού των πολύπλοκων σχέσεων ανάμεσα στις επιστήμες του ανθρώπου και τις φυσικές επιστήμες στις Νεωτερικές γενεαλογικές αλληλεπιδράσεις και εντάσεις τους. Επιπλέον, μπορεί να διαμορφώσει τις συνθήκες για μία καλύτερη κατανόηση του πνευματικού περιβάλλοντος που συγκροτεί το νοηματικό θεμέλιο των σχεδιαστικών προθέσεων του Boullée.
Λέξεις-κλειδιά: χώρος, νοητικό πλαίσιο, ιστορία των ιδεών.

The importance of histories of architectural and philosophical ideas for the history of architecture

If we try to avoid a prevalent empiricism which still reigns in architectural design education, we should have to admit that architectural synthesis is immersed in a world of ideas. And this statement can and must have validity for every period of architectural creation. If we accept this interdependence and connection between theory and praxis, between concepts and

projects or buildings, then a history of architecture necessarily presupposes a history of ideas *about* architecture and architectural spaces. In order to fully understand, interpret and evaluate a design outcome we must reconstruct the intellectual environment, the 'mental space' from which it has grown.

The aim of a history of architectural ideas would then be to locate the conceptual ground which ascribes a precise meaning to acts of design that result in definitive functional, structural and aesthetic qualities of proposed or built spaces. Re-connecting the history of ideas and the history of architecture could raise the contemporary level of awareness regarding the inherent complexity of architecture. This epistemological attitude presupposes a belief in the interdisciplinary character of architectural creation. Namely, the belief that many levels and qualities of discourses (scientific, philosophical, literary) can influence the formation of architectural ideas and leave a decisive impact on the creative process of design. In the present paper we will try to supply a 'proof' of the above assertions through a specific case-study. We will attempt to show how the utopian designs of Étienne-Louis Boullée owe a great part of their ideological meaning and richness to a long European tradition of thinking about the idea of space. We claim that in order to fully evaluate those designs and their intentions and place them correctly within a history of Enlightenment or 'Revolutionary' architecture, we should have in mind the intellectual background of certain fundamental discourses on the idea of space. Thus, the paper[1] aims to strengthen the dialogue between architectural history and the history of architectural ideas, arguing that a reconstruction of the specific mental context (what we have named a "mental space"[2]) of each era is absolutely essential for understanding the true meaning of design outcomes that belong to this era.

In order to reveal the connections among architectural history and the history of ideas as they are codified in the case of Boullée, we have to focus on the various interactions between natural science, the Humanities and cultural mentalities during the seventeenth and eighteenth centuries, in relation to certain ideas of space. It is common knowledge that seventeenth and eighteenth-century thought has developed different ways of understanding the concept of space in the realms of science, philosophy, metaphysics and architecture. Nevertheless, especially during the period of the European Enlightenment, those different domains of human knowledge seem to present certain common properties and intellectual affinities, despite the obvious fact that serious controversies and conflicts often emerged inside the distinct 'theoretical, mental and conceptual spaces' of the above disciplines. A brief outline of those conceptual correspondences and divergences will be developed, through the comparative interpretation and reconstruction of texts written by important representatives of the spirit of the Enlightenment and their predecessors. A preliminary selection of certain basic characteristics of the various ideas of space, as they are expounded in those texts, apart from shedding some light on the mental context that could explain some of Boullée's creations, could also contribute to a basic problem of contemporary interdisciplinary research in many academic institutions: the uneasy relationships and the frequent absence of dialogue between the natural sciences, social sciences and the Humanities. This problem is well known in the form codified by C.P. Snow in his book called "*The Two Cultures*".[3]

The 'Scientific Revolution' of the seventeenth century and the concept of absolute space

During the Scientific Revolution of the seventeenth century the seminal works of Galileo Galilei, René Descartes, Henry More, Blaise Pascal and Pierre Gassendi articulated a new scientific and humanistic worldview that culminated in the era of the Enlightenment. Those works paved

the way towards one of the most important contributions of seventeenth-century knowledge concerning the question of space: the conception of the idea of *absolute space* as formulated by Isaac Newton.[4]

Newton, contrary to Descartes, considered the existence of space independently from the physical matter of the bodies that occupy a certain part of it.[5] In his major work "*Philosophiae Naturalis Principia Mathematica*", which was the first complete hypothetico-deductive system of mechanics,[6] Newton distinguished between *absolute space* and *relative space* and defined the first as *homogeneous, immovable*, completely independent from anything external, sensible or material.[7] As he writes characteristically:

> Although time, space, place, and motion are very familiar to everyone, it must be noted that these quantities are popularly conceived solely with reference to the objects of sense perception. And this is the source of certain preconceptions; to eliminate them it is useful to distinguish these quantities into absolute and relative, true and apparent, mathematical and common..Absolute space, of its own nature without reference to anything external, always remains homogeneous and immovable.[8]

This new idea of space functioned as an absolute system of reference and measurement for the real properties of physical and sensible bodies.[9] It was a kind of uniform pedestal of natural bodies and their movements. Newton's absolute space had a real existence and was connected with God, as one of his attributes or as his *sensorium*.[10] The concept of absolute space was gradually accepted -not without resistance- from the majority of natural philosophers and scientists during the era of the Enlightenment,[11] because it did not only serve as a foundation for the new natural science of modernity that placed man at the center of the world as a free, autonomous, independent and creative source of knowledge but also did not exclude certain theological and religious ideas concerning the existence of God.[12]

Consequently, the concept of absolute space, in reality a *mathematical and mechanical* concept that was developed within the framework of seventeenth-century natural science, acquired a new philosophical meaning in the beginning of the eighteenth century and was connected with wider cultural connotations, aided by the intervention of Newton himself (*General Scholium*, *Opticks*).[13]

The intellectual origins of the Enlightenment: John Locke and pure space

John Locke took over Newton's idea of absolute space and transformed it into the concept of *pure space*,[14] within the framework of his own epistemological research for the foundation of human understanding through the analysis of the ideas of the human mind.[15] According to Locke, pure space is an idea of the mind completely distinct from the idea of solidity that accompanies the materiality of bodies: pure space does not have solidity, nor presents any material resistance, confirming Newton's thought, when transferred into the field of conceptual knowledge, into the internal structure of human thought.[16]

For Locke, space is a transformation of simple ideas of the mind: it has a metric nature, it is connected with distance and it is characterized by *immensity*.[17] The parts of space, which can be conceived independently from the solidity of matter, are indivisible, thus pure space is immovable.[18] Locke held the view that if space was not separate from material bodies, then he would have to accept that the bodily matter of the world is infinite and thus deny from God the power to annihilate a part of materiality.[19] Thus, in Locke's thought, as in Newton's, this same possibility of the existence or *of the conception within the human mind* of the existence of an infinite, immense, void space, totally independent from material objects, was closely connected

with the existence of an omnipotent God.[20]

Enlightenment controversies: Berkeley, Clarke, Leibniz

The idea of absolute space gradually assumed a wider cultural content and a deeper metaphysical meaning, and, through Locke and its transformation into pure space, acquired an important epistemological dimension in relation to the general conditions of human knowledge. The complex mathematical, metaphysical and epistemological implications of the concept of space were revealed with persistent clarity during the first two decades of the eighteenth century, not only through George Berkeley's attack on Newton's idea of absolute space and his relevant view that there can be no pure space without the existence of material bodies,[21] but mostly through the correspondence between Gottfried Wilhelm Leibniz and Samuel Clarke in 1715-1716.[22]

Clarke, a defender of Newton's absolute space, and Leibniz, opponent of Newton and advocate of the relational theory of space - namely the view that space is only the order of co-existence of material bodies[23] and does not have a real, independent existence - through their correspondence,[24] proved that those two distinct and different ideas of space[25] were not only connected with scientific and mechanical problems - such as the movement of bodies and the nature of physical forces - but referred to broader cosmological and humanistic issues and promulgated divergent interpretations concerning the idea of God and its relation to the world.[26] Leibniz's view of relative space proves the above assertions and is intimately connected with his

> demonstrations against real absolute space, which is an idol of some modern Englishmen. I call it an idol, not in a theological sense, but in a philosophical one; as Chancellor Bacon says, that there are *idola tribus, idola specus*. These gentlemen maintain therefore, that space is a real absolute being. But this involves them in great difficulties; for such a being must needs be eternal and infinite. Hence some have believed it to be God himself, or, one of his attributes, his immensity. But since space consists of parts, it is not a thing which can belong to God. As for my own opinion, I have said more than once, that I hold space to be something merely relative, as time is; that I hold it to be an order of coexistences, as time is an order of successions.[27]

Leibniz's attack on Newton's absolute space, as it is developed in the Third Paper to Clarke, does not only show his theological reservations about the new 'idol of the tribe and the cave'. He codifies very precisely that Newton's absolute space was intimately connected with the categories of 'infinity' and 'immensity', which will play a crucial role in Boullée's architectural thought.

Voltaire and the public spaces of the city

Voltaire, a major representative of the eighteenth century and the spirit of the French Enlightenment, had a thorough knowledge of the complex issues related to the different ideas of space propounded by Newton, Locke and Leibniz, and their multiple consequences for metaphysics, epistemology and cosmology, as can be confirmed by his "*Lettres Philosophiques*" (1734). In this work, and especially in the 13th Letter on Locke, Voltaire acknowledges that space belongs to the metaphysical concepts or the abstract ideas.[28] Moreover, Voltaire refers to the absolute power of God to influence matter and thus assumes the possibility of the existence of thought or feeling through matter, rejecting the Cartesian dualism between thought and matter as extension.[29] In this context, Voltaire accepts the independent existence of space and its difference from matter, contrary to Descartes. Consequently, in the 14th Letter, Voltaire identifies

the complete conceptual break between the full world of Descartes and the empty world of Newton.[30] Voltaire's ideas on space were further elaborated in the book called "*La Métaphysique de Neuton, ou Parallèle des Sentimens de Neuton et de Leibnitz*",[31] published in 1740, which articulated a new version of the first part of his "*Eléments de la Philosophie de Newton*", that had appeared two years earlier. In the first work, Voltaire attempts to reveal the metaphysical implications of Newton's natural science, accepting the existence of a *non-resistant space* (*Espace non-resistant*),[32]that is absolutely real and results necessarily from God's existence.[33] Voltaire's *pure space* (*espace pur*), the void, in direct analogy to John Locke's pure space, is immense and infinite, *immuable*, indivisible and constitutes an infinite mode and attribute of the infinite Being.[34]

Consequently, in Voltaire's thought, the distinction between infinite, pure space and matter, proves that matter does not exist with necessity, and thus shows the freedom of God to create it: pure space, in other words, confirms the freedom of God, which is the foundation of the freedom of man, a kind of freedom related to the spontaneity of human reason.[35] It is argued that Voltaire's approval of the independent existence of space connects the scientific concept of Newton's absolute space with Locke's epistemological concept of pure space, proving the free existence of God as an immaterial cause of matter[36] (*cause immatérielle*) and expounding the natural religion of men as bearers of a common reason. This common reason is the foundation of man's historical freedom, in direct analogy to the freedom of God, and relates to the community of the ethical principles that correspond to it.[37] According to our interpretation of Voltaire's thought, the common reason of men is related to their collective needs and concepts, revealing the importance of universally valid ethical principles for the foundation of political society.[38] In this way, Voltaire transforms the epistemological idea of Locke's pure space[39] and the metaphysical idea of Newton's absolute space into *a social and ethical dimension of space* as a foundation of the natural laws and principles that contribute to the common good of human society (*Bien commun*):[40]Voltaire's pure space reveals the common reference point and the universal rational basis of men, symbolizing the unitary nature of reason as a moral law of humanity that corresponds to the indivisible and unifying existence of an omnipotent God.[41] Consequently, Voltaire transposes the idea of space from the realms of metaphysics, natural science and epistemology to the social-ethical-political field, transforming it to a basis for the development of a civic-cultural science of man. In other words, Voltaire bridges the gap between the natural and the human sciences, through a new conception of symbolic space.[42]

Within the above context of an ethical, political and social conception of pure space, as propounded by Voltaire, it is not altogether irrelevant that in his text called *Des Embellissements de Paris* (1749), the French writer and philosopher argues for the need of creating *large open public spaces* in Paris, insisting on their importance for the ethical honour, the virtues and the quality of the common life of citizens in the urban environment.[43] We may indeed consider that public open spaces of the city are the *most direct symbolic representations of the ideas of absolute and pure space in the context of man's social, political and ethical everyday life*. Besides, Voltaire's ethical and social idea of pure space and its projection on the need for public spaces in the city, conceived as common fields of reference for the cultivation of social reason, public consciousness and civic virtue, had already been formulated, in another form, by the French architectural theorist Jean-Louis De Cordemoy, in 1706, in his text called *Nouveau Traité de toute l' Architecture*. Cordemoy lays stress on the need for spacious public places (*spacieuses*) and the importance of *vaste étenduë*, of a vast expanse, for the magnificence of the city,[44] blending the categories of the scientific and metaphysical ideas of space with the question concerning the architectural creation of public places in the city.

The *Encyclopédie*, D' Alembert and Montesquieu: science and aesthetics of pure space

This constant interaction between different modes and disciplines of knowledge concerning the problem of space permeates the most important document of eighteenth-century French Enlightenment thought, namely the *Encyclopédie* edited by Diderot and D' Alembert. In the article of the *Encyclopédie* named "Espace", the private and public spaces of the city are characterized as "entièrement immobiles", as entirely immovable, a category which was used by Isaac Newton to identify his idea of absolute space.[45]

Besides this reference, D'Alembert himself, in his *Discours Préliminaire*, following Locke, distinguished the material bodies from the *indefinite space* in which they are placed (*espace indéfini*), whose parts he characterized as "*immobiles*" and "*pénétrables*".[46] For D' Alembert, indefinite space is the general place of all the material bodies and has a separate existence from their material properties.[47] D' Alembert's approach to space is the view of a mathematician and a geometer, a rationalist reading stemming from the culture of the natural sciences. The connection of absolute and infinite, unlimited space, considered as a vast expanse, with the public spaces of the city and the spaces of nature, can also be traced in the *Essai sur le Goût* (1754) written by Montesquieu, where it is argued that man's soul and spirit wishes to constantly expand the horizon of its intuition, to cover more space and to guide man's vision far away, without any obstacle from particular material objects.[48] According to Montesquieu, art can lead the way in this expanded, clear vision of pure space, natural or man-made, physical or urban.[49] Montesquieu transposes the idea of space into the field of the aesthetics of nature and the philosophy of art, deepening its epistemological and ethical consequences.

Immanuel Kant and space as an architectural framework of the mind

Immanuel Kant, as a true representative of the Enlightenment, realized this new importance of space for the understanding of nature: in his Pre-Critical and important text called "*Concerning the Ultimate Ground of the Differentiation of Directions in Space*" (1768), Kant proved the distinct reality of the *absolute cosmic space of nature*[50] (*dem absoluten WeltRaum*), independently of matter, through the qualitative differentiations of the orientations of geographical and physical space, which are related to the physiological structure of the human body and especially to its distinctions between the left and the right hand.[51] Thus, Kant rejects the relational theory of space and accepts the existence of a *geometrical, universal, absolute and original space* that can only show and explain the physical differentiation of directions that we feel in geographical and physical space. This absolute space, according to Kant, is not an immediate object of external sensation: it is a *fundamental concept* (*Grundbegriff*) that allows for the possibility of every sensation.[52] This idea will be further developed by Kant in his *Critique of Pure Reason* (1781), in the section of the work entitled *Transcendental Aesthetic*, where space is defined as the pure order of sensibility, without any reference to sensible or material qualities of the objects, namely as a *pure intuition a priori* that forms the condition of the possibility of an outer experience of material objects.[53] Consequently, space is single, one and the same, has infinite magnitude and is characterized by objective validity, being a universal, common condition of the human capacity of representation of the sensible and material world.[54] In other words, Kant internalizes Newton's concept of absolute space within the mind of the knowing subject. At the same time, Kant's idea of space reminds Locke's and Voltaire's *pure space*. We claim that Kant transforms the ideas of pure and absolute space into a constitutional condition, a constructional *principle and type of knowledge* of the external world. In this respect, Kant attributes to space an organizational and architectural role in the shaping of man's thought.[55]

Étienne-Louis Boullée and pure architectural spaces of an ideal city

It is argued that the visionary architect Étienne-Louis Boullée,[56] in his text *Architecture. Essai sur l'art*[57] (1781-1793) develops a 'Kantian' *philosophy of architecture* that is trying to be commensurate with the spirit of the Enlightenment and the ideas of absolute and pure space, as we have already analyzed them.[58] Boullée's emphasis on the foundation principles of architectonic art, on the moral and social ideas that are created by architecture within the mind of men, on their relation to an intuition of God through nature that is ordered architecturally, along with his insistence on the priority of conceiving certain notions and ideas within the human mind before their physical realization into architectural works, remind relative thoughts formulated by Voltaire and Kant. Boullée, Kant and Voltaire seem to share very similar ideas concerning the metaphysics of Deism, the critical power of the human mind and the importance of moral principles and a priori concepts of reason for the structure of the sensible and social experience of man.[59]

In his numerous utopian designs, Boullée attempts to combine those ideas with the principles of pure geometry, in order to create the foundation of an ideal city which consists of large, exterior and interior public spaces and monumental buildings that express a symbolic, artistic, political and ethical content. The ideal city of Boullée's utopian drawings puts in mind of certain relevant ideas expressed by Voltaire, Montesquieu and Cordemoy.[60] In the context of Boullée's transcendental aesthetic theories and designs of pure architectural spaces and shapes, and in complete line with Montesquieu's thought, it is ascertained that perfect and regular geometrical figures, such as the sphere, create the ideas of harmony, perfection and symmetry within the human mind, thus urging the soul to expand its intuitions and embrace the whole universe.[61]

The written presentation of Boullée's utopian designs in his *Essai* leaves few doubts as to the idea of space that his ideal city and its monumental buildings delimit and embody: *immensity*, *grand tout* and *vast* are some of the categories that he uses to characterize his seemingly 'Newtonian' or 'Voltairian' concept of space. For example, describing his project for a 'public library', he writes:

> Ce projet consiste à transformer la cour…en une *immense* basilique éclairée par le haut…J'ai donc voulu que nos richesses littéraires fussent présentées dans le plus bel ensemble possible. C'est pourquoi j'ai pensé que rien ne serait plus *grand*, plus noble, plus extraordinaire et d'un plus magnifique aspect, qu'un *vaste* amphithéâtre de livres.[62]

We claim that Boullée conceives space as a *pure expanse* (*étendue*) that functions as an independent, unitary base, containing completely abstract, geometrical shapes of architectural forms.[63] The cosmological, Newtonian ground of this conception of space is clearly formulated by the French architect, when he presents his design for a basilica:

> Si avec de grandes images on est sûr de présenter aux hommes un tableau imposant, certes un temple érigé en l'honneur de la divinité doit toujours être vaste. Ce temple doit offrir l'image la plus frappante et la plus grande des choses existantes; il faudrait, si cela était possible, qu'il nous parût l'univers…(il doit) offrir le tableau de l'espace par le nombre d'objets que doit naturellement contenir une grande étendue.[64]

Moreover, we assert that Boullée understands architectural space as a geometrical measure, a human intuition and a delimitation of Newton's absolute space of nature, which is called by the French architect "*espace inconcevable*" – a very similar expression to the *espace indéfini* of D' Alembert – namely as a definition of natural, cosmological space within the context of distinct, pure, exterior or interior public spaces of the city.[65] In that way, according to our interpretation of

Boullée's thought, nature is activated, delimited and enclosed through architecture, and absolute, cosmic space is absorbed and related to pure, civic, public exterior places and to 'infinite', seemingly unlimited interior architectural spaces, which try to unite the universal, immense space of nature with the finite spaces of human life and civilization.[66] Boullée is quite conscious of this intention, when he describes the effects of perspective in his basilica:

> Les objets sont alors dans une disposition telle que tout contribue à nous procurer des jouissances. Leur multiplicité nous offre l'image de la richesse. La plus grande magnificence et la symétrie la plus parfaite, voilà ce qui résulte de l'ordre qui les établit dans tous les sens et les développe à nos regards de manière que nous ne puissions pas les nombrer. En prolongeant l'étendue des allées de sorte que leur fin échappe à nos regards, les lois de l'optique et les effets de la perspective nous offrent le tableau de l'immensité.[67]

In other words, Boullée seems to internalize within his vast public buildings the absolute, immense space of the natural sciences of his times, transforming it to a pure, internal space. Boullée transposes and applies Locke and Voltaire's 'pure space' into the field of architectural creation, inaugurating a utopian city of the Enlightenment. At the same time, this transposition or translation of an idea of space from the realm of natural and mathematical science to the field of architecture as a civic, social and human science, creates tensions, ambiguities and contradictions. Absolute and infinite space must be delimited and enclosed, in order to become habitable, meaningful and human. This geometric and social limitation produces a "relative", finite space, a distinct public place, which "*makes nature work*", as Boullée says ('mettre la nature en oeuvre').[68] We argue that an antinomy in Boullée's thought arises from his will to convey the idea or the intuition of absolute Newtonian natural space through a cultural, enclosed, relative, delimited human space. Helen Rosenau codifies this tension through the conceptual dualisms of finite/infinite and static/dynamic.[69]

The tension in Boullée's thinking and projects arises from the inherent nature of architecture as a discipline. Since architecture uses material and sensible bodies for the articulation and arrangement of habitable space, it is bound to the relative space of Leibniz. We could say that architectural spaces are always Leibnizian in a sense, since what they offer are orders of coexistences between material elements and bodies. The means of architectural expression are material articulations of relations among sensible elements. Thus, architectural space is always relative and finite. The real importance of Boullée's architectural ideas and creations is that he is trying to overcome the inherent limit of his discipline. Using finite arrangements of material relations among bodies, he is trying to suggest or to convey the idea, the image or the intuition (in a Kantian sense) of absolute, pure, infinite space, as it was articulated by Newton, Voltaire and Locke. This impossible limit is what gives meaning to Boullée's utopian designs. And his tools for suggesting those ideas are purely architectural: perspective, relations and alternations between light and shade, creative use of the void, absence of "functional" traces concerning the "use" of the buildings. Boullée thus arrives at an idea of pure or absolute architecture, an architecture with no functional objects inside its vast spaces. We claim that ignoring this essential intention of Boullée, namely the fact that through Leibnizian space[70] he approaches the impossible task of depicting absolute Newtonian space through architecture, we lose all the importance of his work. And we could not arrive at this conclusion if we did not reconstruct the intentional horizon of the world of ideas that informed his era and which reveals the true meaning of his designs. We claim that the dialectical tensions of Boullée's projects and thoughts stem from his attempt to reconcile Newton's and Leibniz's ideas of space through the language of architecture. A similar argument, but based on entirely different grounds, is put forward by Martin Bressani, in his important study "Étienne-Louis Boullée. Empiricism and the Cenotaph for Newton", where he writes:

> Boullée's purified spectacle encapsulates a vision of the infinite. He attempts to represent the inconceivable not through convention, but in a natural way. In this sense, his project reflects the anxiety generated by modern science. On the one hand the successes of Newtonian science made it possible to think of oneself as able to grasp the infinite and therefore as being at the center of all things. On the other hand, one realized with uneasiness that this (empirical) science depended necessarily upon a relative point of view.[71]

Those dialectical tensions between the "infinite" or "absolute" and the "relative", between the Newtonian and Leibnizian concepts of spatiality, are best revealed in the more characteristic and well-known architectural project of Boullée: his monument dedicated to Isaac Newton, in the form of a gigantic sphere that delimits an empty, public interior space, symbolizing the vast cosmos.[72] Boullée expressly states that through this utopian design he wanted to guide the citizens to a *determined* intuition of the "*immensity of space*",[73] which Newton himself had proposed with the concept of absolute space, thus closing a full circle of ideas of space during the Age of the Enlightenment.[74]As he writes:

> C'était dans le séjour de l'immortalité, c'était dans le ciel que je voulais placer Newton. Avec le dessin sous les yeux, *on verra ce qu'on aurait regardé comme impossible*. On verra un monument dans lequel le spectateur se trouverait, comme par enchantement, transporté dans les airs et porté sur des vapeurs de nuages dans *l'immensité de l'espace*.[75]

Étienne-Louis Boullée conceives the urban spaces of his ideal city as a transference of the absolute, geometrical and mathematical space of Newton and the mental, social and ethical spaces of Locke, Voltaire and Kant into symbolic, Leibnizian architectural spaces. Those spaces communicate a public sphere of collective ideals and values which aims to unify the Humanities and the natural sciences.

This interpretation can shed new light on the place of Boullée's contributions and thoughts within the history of western architecture. Emil Kaufmann was right in his assertion that the so-called 'Revolutionary architects' paved the way to the inauguration of the Modern Movement of the 20th century.[76] But he misses the real reason behind this statement. Kaufmann believes that Boullée's importance lies in a new conception of architectural forms. He writes:

> Boullée is significant as marking the first conscious employment of the new forms.[77] Of the three (revolutionary architects), Boullée represents primarily the struggle for new forms.[78]

We argue that Boullée is a harbinger of Modernity not because he inaugurated a new, "autonomous" vocabulary and syntax of forms,[79] but because he displaced architectural discourse from a focus on the category of 'form' to a focus on the category of 'space'. And that was 'revolutionary' indeed. Moreover, it is revolutionary because space is understood, maybe for the first time, as an a priori construction or structure of the human mind, in a Kantian perspective. This idea has immense consequences for the conception of architecture as a discipline, providing a fatal blow to the empiricism associated with Vitruvius. Moreover, Boullée tried to suggest through finite, material means, an absolute, pure, public space. And that is exactly what the Modern Movement of the 20th century tried to achieve.

Architectural space as a field of dialogue between human sciences and natural sciences

Ernst Cassirer, in the Introduction to his classic work titled *The Philosophy of the Enlightenment*, acknowledges that, during the eighteenth century, the social role of philosophy was greatly transformed. He writes:

> Instead of confining philosophy within the limits of a…doctrinal structure, the Enlightenment wants philosophy to move freely and in this immanent activity to discover the fundamental form of reality, the form of all natural and spiritual being.. Philosophy is no longer to be separated from science, history, jurisprudence and politics; it is rather to be the atmosphere in which they can exist and be effective.[80]

This ideal of the unity of human knowledge, which can be attested from the new role of philosophy during the eighteenth century, was also confirmed through our examination of the various ideas of space from Newton and Voltaire to Boullée. Our analysis has attempted to show that the *multiple metamorphoses of the ideas of absolute, pure and relative space*, in mathematics, epistemology, metaphysics, geometry, natural science, aesthetics, ethics and civic architecture, despite their internal disciplinary controversies, maintained family resemblances, analogies and correspondences that affirmed a dynamic conceptual unity of the category of 'space' in the various dimensions, mentalities, discourses and functions of human knowledge during the Enlightenment. Consequently, the "unity" of the Enlightenment stems from a series of "metamorphoses" and adjustments of a general cultural atmosphere and mentality concerning the idea of space into the specific "languages", the peculiar aims and the distinct conceptual tools of different disciplines. This movement of transpositions creates tensions and divergences that naturally arise but does not exclude the possibility of a fertile dialogue between the natural and the social and human sciences. The examples of the *Encyclopédie*, Voltaire and Boullée show that the *idea of space* was a central axis of reference and coherence for the humanistic thinking and the universal values of the Enlightenment, building the possible foundations of a unified science of man's social existence within the public, open architectural spaces of the city, whether real or ideal.

Today, the Humanities and the natural sciences are usually considered as totally independent and distinct disciplines, without any horizons of a mutual dialogue. It is argued that the case of Boullée has disclosed one interesting possibility: architecture could function as the creative environment of those "*open spaces of thought*" of whom Goethe speaks,[81] namely as a plane of interaction between the human sciences and the natural sciences, combining their inherent tensions into a communicative space that could contribute to a new science of human culture. Thus, we have seen how the strengthening of the connection between architectural history and the history of ideas not only reveals a different way of understanding Boullée's historical position within dominant traditions of Enlightenment and Modern thinking but opens the way for an enrichment of contemporary architectural education with valuable epistemological principles. In other words, the history of philosophical and architectural ideas can procure new meaningful interpretations of design outcomes and even enrich contemporary design methodologies with useful conceptual tools.

Notes

1 This study is an enlarged English version of the introductory part of a Post-Doctoral Research titled *Ideas of Space in the Twentieth Century*, which was elaborated at the Department of Humanities, Social Sciences and Law of the National Technical University of Athens from February 2007 to September 2008. I would like to thank Professor *Aristides Baltas*, the supervisor of this research, for his important comments and constant support during the project, and also for his decisive contribution to its publication in Greek (Nissos Publications, Athens, 2009), in the form of a book bearing the same title. A much shorter version of this study was read as a paper at the *12th International Enlightenment Congress*, which took place in Montpellier from 8 to 15 July 2007. The theme of the Congress was *Sciences, Techniques et Cultures au XVIIIe Siècle*, and was organised jointly by the *International Society for Eighteenth-Century Studies* (ISECS) and the *Société*

Française d' Étude du dix-huitième Siècle (SFEDS). I would like to thank *Claude Lauriol*, Professor of French Literature at the University of Montpellier and the Organizing Committee of the Conference, for accepting my paper for oral presentation at the first Cycle of Communications on *Voltaire*.

2 Terzoglou (2008: 74).

3 Snow 1998.

4 For a general account of the development of the ideas of space during the Scientific Revolution of the seventeenth century, see Čapek (1976: 73-95, 273-288).

5 Huggett (1990: 126-130).

6 Jammer (1954: 95).

7 Newton (1999: 408-409) and Einstein (1954: xv-xvii).

8 Newton (1999: 408).

9 Jammer (1954: 99-104) and Newton (1999: 409-415 and Earman (1989: 6-15).

10 Jammer (1954: 110-117).

11 See Leonard Euler, *Theoria Motus Corporum Solidorum*, in Čapek (1976: 113-119) and Jammer (1954: 110-139).

12 Jammer (1954: 2-3, 127-132). In this respect, see the works of Jacob Raphson, John Jackson, Joseph Clarke and Isaac Watts in Jammer (1954: 129). Also see the ideas of William Whiston in Israel (2001: 515-516, 518-520).

13 Newton (1999: 939-944) and Newton (1952: 403-404).

14 Locke (1959: 151-158).

15 Locke (1959: 27-32).

16 Locke (1959: 153-158).

17 Locke (1959: 218-224).

18 Locke (1959: 225-228, 231-232).

19 Locke (1959: 231-233).

20 Locke (1959: 232-237).

21 Berkeley (1982: 67-69).

22 Huggett (1999: 159-160). And Meli (2002: 455-464).

23 Huggett (1999: 146-147) and Israel (2001: 521-522) and Leibniz (1772: 337-339). For an examination of Leibniz's philosophical thought in relation to our subject see Russell (1900: 118-130).

24 Alexander (1956: 5-125).

25 For an elaboration and examination of this old debate from a contemporary perspective of the natural sciences see Earman (1989: 1-5, 12-26, 154-208).

26 Huggett (1999: 143-168) and Čapek (1976: 277-286).

27 Alexander (1956: 25-26).

28 Voltaire (1734 : 124).

29 Voltaire (1734: 128-137).

30 Voltaire (1734: 139-141).

31 For an examination of the metaphysical dimensions of Newton's thought see Stein (2002: 256-307).

32 Voltaire (1740: 1-8, 12).

33 Voltaire (1740: 9-12).

34 Voltaire (1740: 12-15).

35 Voltaire (1740: 12-27).

36 Voltaire (1740: 64).

37 For the relation of Voltaire's ideas on God with the ethical and rational values of man's social and historical existence see Deprun (1973 : 687-689), Copleston (1960: 20-23), Rosenthal (1955: 166-167) and Hazard (1963: 117-132, 391-403).

38 Voltaire (1740: 22-29).

39 For a general account of the influence of Locke's philosophical system on the era of the Enlightenment see Aarsleff (1994: 252-289) and Israel (2001: 522-527).

40 Voltaire (1740: 30-32).

41 Voltaire (1740: 32-35).

42 Etlin (1994: 3-4, 24-25).

43 Voltaire (1749: 99-111). For an analysis of the idea of the city as virtue and human progress in Voltaire's thought, see Schorske (1998: 6-7, 37-39).

44 De Cordemoy (1706: 130-131, 193-194).

45 Article "Espace" (Droit Civil) (1755: 956).

46 D'Alembert (1751: v).

47 D'Alembert (1758: v-vii). See also the Article Lieu (1765: 495-496).

48 Montesquieu (1993: 37).

49 Montesquieu (1993: 37-38).

50 Kant (1992b: 365-366).

51 Kant (1992b: 366-370). See also Walford, Meerbote (eds.) (1992: xv-xxxvii, lxxx, lxix, 458-459, note 4) and Huggett (1999: 203-212).

52 Kant (1992b: 371).

53 Kant (1998: 155-158) and Parsons (1992: 62-100). For the importance of the *Transcendental Aesthetic* for the foundation of public space and *espace laïque* see Porset (2003: 30, n. 12).

54 Kant (1998: 158-161, 192).

55 Kant (2006: 112, 674-675) and Kant (1992a: 395-400). For the relation of the transcendental aesthetic to the transcendental analytic and the problem of space in general, see Gardner (1999: 70-85). For the relation of Kant's thought to Newton's ideas see Clavier et al. (2003: 42-68).

56 Kaufmann (1939: 212-227).

57 Montclos (1994: 111-177).

58 Boullée (1993: 19-23, 28-31).

59 Boullée (1993: 34-36, 45-47, 52, 60-62).

60 Boullée (1993: 115, 117, 120) and Montclos (1994: 177-181). See also Etlin 1994: 13-24).

61 Boullée (1993: 61-62).

62 Boullée (1993: 133).

63 Boullée (1993: 70, 76, 81-82, 84, 91-93, 109, 143-144).

64 Boullée (1993: 81).

65 Boullée (1993: 84, 168).

66 Boullée (1993: 67-69, 71, 81) and Madec (1986: 80).

67 Boullée (1993: 82).

68 Boullée (1993: 30-31).

69 Rosenau (1953: 13).

70 Boullée (1993: 168).

71 Bressani (1993: 39).

72 For an analysis of the relations between Boullée's Monument to Newton and the scientific thought of his era see Stafford (1982: 241-278). For an exhaustive interpretation of Boullée's project see Vogt (1969). For an extremely interesting philosophical-epistemological interpretation of Boullée's Cenotaph for Newton, see Bressani (1993: 47-53).

73 Boullée (1993: 143).

74 For an examination of the concept of space during the Enlightenment, see Vidler (1995).

75 Boullée (1993: 142-143).

76 Kaufmann (1952: 434) and Kaufmann (2002: 17-25, 84-85).

77 Kaufmann (1939: 213).

78 Kaufmann (1952: 435).

79 Kaufmann (2002: 27-39, 61-63).

80 Cassirer (1951: vii).

81 Cassirer (1951: 360).

Works cited

Aarsleff, Hans. 1994. "Locke's influence", in Chappell, Vere (ed.), *The Cambridge Companion to Locke*. Cambridge: Cambridge University Press: 252-289.

Alexander, H.G. (ed.) 1956. *The Leibniz-Clarke Correspondence*. Manchester and New York: Manchester University Press.

Article “Espace” (Droit Civil). 1755. *Encyclopédie ou Dictionnaire Raisonné des Sciences, des Arts et des Métiers*. Tome Cinquième, Par une Société de Gens de Lettres; mis en ordre et amp; Publié par M. Diderot et quant à la partie mathématique par M. D’Alembert, Paris: Chez Briasson: David l’ aîné: Le Breton: Durand: 953-956.

Article “Lieu”. 1765. *Encyclopédie ou Dictionnaire Raisonné des Sciences, des Arts et des Métiers*. Tome Neuvième, Par une Société de Gens de Lettres; mis en ordre et publié par M. Neufchastel: chez Samuel Faulche: 495-499.

Berkeley, George. 1982. *A Treatise Concerning the Principles of Human Knowledge, Part I, Wherein the Chief Causes of Error and Difficulty in the Sciences, with the Grounds of Skepticism, Atheism, and Irreligion, are inquir’d into*, edited, with an introduction, by K.P. Winkler. Indianapolis, Cambridge: Hackett Publishing Company.

Boullée, Étienne-Louis. 1993. Architecture. Essai sur l’art, in *Étienne-Louis Boullée, L’Architecte Visionnaire et Néoclassique*. Textes Réunis et Présentés par J.-M. Pérouse de Montclos, Collection Savoir: sur l’ art, Paris: Hermann, Éditeurs des Sciences et des Arts: 41-182.

Bressani, Martin. 1993. Étienne-Louis Boullée. Empiricism and the Cenotaph for Newton, *Architectura* 23(1): 37-57.

Čapek, Milič (ed.) 1976. *The Concepts of Space and Time, Their Structure and Their Development*. XXII. Boston Studies in the Philosophy of Science, edited by Robert S. Cohen and Marx W. Wartofsky. Dordrecht, Holland, Boston, U.S.A.: D.Reidel Publishing Company.

Cassirer, Ernst. 1951. *The Philosophy of the Enlightenment*, translated by Fr.C.A.Koelln and J.P. Pettegrove. Princeton, New Jersey: Princeton University Press.

Clavier, Paul, Lequan, Mai, Raulet, Gérard, Tosel, André. Bouriau, Christophe. 2003. *La Philosophie de Kant*. Paris: Quadrige/PUF.

Copleston, Frederick. 1960. *A History of Philosophy* (6) *The Enlightenment, Voltaire to Kant*. London, New York: Continuum.

D’Alembert.1751. Discours préliminaire des editeurs, *Encyclopédie ou Dictionnaire Raisonné des Sciences, des Arts et des Métiers*. Tome Premier, Par une Société de Gens de Lettres; mis en ordre et publié par M. Diderot et quant à la partie mathématique par M. D’Alembert, Paris: Chez Briasson: David l’aîné: Le Breton: Durand: 1-45.

D’Alembert. 1758. *Traité de Dynamique*. Paris: Chez David, Libraire.

De Cordemoy, Jean-Louis. 1706. *Nouveau Traité de toute l’Architecture*. Paris: J.-B. Coignard.

Deprun, Jean. 1973. Philosophies et problématique des Lumières, Belaval, Yvon (ed.), *Histoire de la Philosophie* II*, Le Siècle des Lumières, La Révolution Kantienne*. Gallimard: 672-696.

Earman, John. 1989. *World Enough and Space-Time, Absolute versus Relational Theories of Space and Time*. Cambridge, Mass., London, England: The MIT Press.

Einstein, Albert. 1954. Foreword by Max Jammer, *Concepts of Space: The History of Theories of Space in Physics*. New York: Dover Publications: xiii-xvii.

Etlin, Richard A. 1994. *Symbolic Space, French Enlightenment Architecture and Its Legacy*. Chicago and London: The University of Chicago Press.

Gardner, Sebastian. 1999. *Routledge Philosophy Guidebook to Kant and the Critique of Pure Reason*. London and New York: Routledge.

Hazard, Paul. 1963. *La Pensée Européenne au XVIIIe Siècle, de Montesquieu à Lessing*. Fayard.

Huggett, Nick (ed.). 1999. *Space From Zeno to Einstein: Classic Readings with a Contemporary Commentary*. Cambridge, Mass. London, England: The MIT Press.

Israel, Jonathan I. 2001. *Radical Enlightenment, Philosophy and the Making of Modernity*, *1650-1750*. Oxford: Oxford University Press.

Jammer, Max. 1954. *Concepts of Space: The History of Theories of Space in Physics*, with a foreword by Albert Einstein. New York: Dover Publications.

Kant, Immanuel. 1992a. On the form and principles of the sensible and the intelligible world [Inaugural dissertation], Walford, David and Meerbote, Ralf (eds.), *Immanuel Kant, Theoretical Philosophy*, *1755-1770*. Cambridge: Cambridge University Press: 373-416.

Kant, Immanuel. 1992b. Concerning the ultimate ground of the differentiation of directions in space, edited by David Walford and Ralf Meerbote, *Immanuel Kant, Theoretical Philosophy*, *1755-1770*. Cambridge: Cambridge University Press: 361-372.

Kant, Immanuel. 1998. *Critique of Pure Reason*, translated and edited by Paul Guyer and Allen W.Wood, Cambridge: Cambridge University Press.

Kant, Emmanuel. 2006. *Critique de la Raison Pure*. Traduction, présentation et notes par Alain Renaut. Paris: GF-Flammarion.

Kaufmann, Emil. 1939. Étienne-Louis Boullée, *The Art Bulletin* 21: 212-227.

Kaufmann, Emil. 1952. Three revolutionary architects, Boullée, Ledoux, and Lequeu, *Transactions of the American Philosophical Society* 42 (3): 431-559.

Kaufmann, Emil. 2002. *De Ledoux à Le Corbusier. Origine et Développement de l'Architecture Autonome*, translated by l'Allemand de Guy Ballangé de Ruth Ballangé. Paris: Éditions de la Villette.

Leibniz, Gottfried Wilhelm. 1772. Philosophie de Newton, Émery, Jacques-André, *Esprit de Leibnitz, ou Recueil de Pensées choisies, sur la Religion, la Morale, l'Histoire, la Philosophie, etc., extraites de toutes ses Oeuvres Latines et Françoises 2*. Lyon: J.-M. Bruyset: 337-342.

Locke, John. 1959. *An Essay Concerning Human Understanding*, collated and annotated, with prolegomena, biographical, critical, and historical, by Alexander Campbell Fraser, two volumes. New York: Dover Publications.

Madec, Philippe. 1986. *Boullée*. Paris: F.Hazan.

Meli, Domenico Bertoloni. 2002. Newton and the Leibniz-Clarke correspondence, edited by I. Cohen, Bernard & Smith and E. George, *The Cambridge Companion to Newton*. Cambridge: Cambridge University Press: 455-464.

Montclos, Jean-Marie Pérouse de. 1994. *Étienne-Louis Boullée*. Paris: Flammarion.

Montesquieu. 1993. *Essai sur le Goût, précédé de Éloge de la Sincérité*. Paris: Armand Colin Éditeur.

Newton, Sir Isaac. 1999. *The Principia: Mathematical Principles of Natural Philosophy*, a new translation by I. Bernard Cohen and Anne Whitman, assisted by Julia Budenz. Berkeley: University of California Press.

Newton, Sir Isaac. 1952. *Opticks, or a Treatise of the Reflections, Refractions, Inflections & Colours of Light*, based on the fourth edition, London, 1740, with a foreword by Albert Einstein, an introduction by Sir Edmund Whittaker, a preface by I. Bernard Cohen and an analytical table of contents prepared by Duane H.D. Roller. New York: Dover Publications.

Parsons, Charles. 1992. The Transcendental Aesthetic, edited by Paul Guyer. *The Cambridge Companion to Kant*, Cambridge: Cambridge University Press: 62-100.

Porset, Charles. 2003. *Voltaire Humaniste*, Paris: Éditions Maçonniques de France.

Rosenau, Helen (ed.). 1953. *Boullée's Treatise on Architecture*. London: Alec Tiranti.

Rosenthal, Jerome. 1955. Voltaire's philosophy of history, *Journal of the History of Ideas* 16: 151-178.

Russell, Bertrand. 1900. *A Critical Exposition of the Philosophy of Leibniz*. Cambridge: University Press.

Schorske, Carl E. 1998. The idea of the city in European thought: Voltaire to Spengler, *Thinking with History: Explorations in the Passage to Modernism*. New Jersey: Princeton University Press: 37-55.

Snow, C.P. 1998. *The Two Cultures*. Cambridge: Cambridge University Press.

Stafford, Barbara Maria. 1982. Science as fine art: another look at Boullée's cenotaph for Newton, *Studies in Eighteenth-Century Culture* T. XI, Madison: 241-278.

Stein, Howard. 2002. *Newton's Metaphysics*, edited by I. Cohen, Bernard & Smith and E. George, in *The Cambridge Companion to Newton*, Cambridge: Cambridge University Press: 256-307.

Terzoglou, Nikolaos-Ion. 2008. Conceptual structures of architectural thought: Leon Battista Alberti-Étienne-Louis Boullée-Le Corbusier, *ELSA: Environment, Land, Society, Architectonics* 1(II): 73-79.

Vidler, Anthony. 1995. *L'Espace des Lumières, Architecture et Philosophie de Ledoux à Fourier*, translated by C. Fraixe. Paris: Picard.

Vogt, Adolf Max. 1969. *Boullées Newton-Denkmal, Sakralbau und Kugelidee*. Basel und Stuttgart: Birkhäuser Verlag.

Voltaire. 1734. *Lettres Philosophiques*. Amsterdam: Chez E. Lucas, au Livre d'Or.

Voltaire. 1740. *La Métaphysique de Neuton, ou Parallèle des Sentimens de Neuton et de Leibnitz*. Amsterdam: Chez Jaques Desbordes.

Voltaire. 1749. Des embellissements de Paris, *Oeuvres de Voltaire*, *Mélanges*. T.39, with prefaces, etc., by M. Beuchot. Paris: Werdet et Lequien fils: Firmin Didot Frères, 1829-1834: 99-111.

Walford, David, Meerbote Ralf (eds.). 1992. *Immanuel Kant, Theoretical Philosophy*, *1755-1770*. Cambridge: Cambridge University Press.

Nikolaos-Ion Terzoglou obtained a Diploma of Architecture (2000), a Master of Science (2001) and a Ph.D. (2005) at the National Technical University of Athens. His Ph.D. was awarded with the 2nd International ICAR-CORA Prize 2007 for the best Doctoral Thesis in Architectural Theory. He also holds a Degree of Painting from the Department of Fine Arts of the Athens School of Fine Arts (2009). After teaching courses on Architectural Theory at the University of Patras, Greece (2007-2010), he now holds the position of Lecturer at the School of Architecture of the National Technical University of Athens. He has published a book in Greek titled *Ideas of Space in the 20th Century* (nissos publications, Athens, 2009) and various articles in edited volumes and scientific journals.

History is returning to design

Alexander Tzonis
TU Delft & Liane Lefaivre, Universität für angewandte Kunst, Wien

> I looked up "history" in the dictionary. The definition I liked best was, "study of the past." Now any number of things can be the study of the past. Archaeology is the study of the past; it has more specific definitions than "history" does. How you choose to study history-whether as mainstreams, as isolated events, as typologies, etc.-however you choose to study it, there is no first rate and second-rate history implied by how you choose to study it.
> Lawrence Speck.
>
> When any field is undergoing development, it invents a simplistic framework on which things are hung. Then as the field expands, as it develops, the repertory begins to expand. I think we are moving out of that central spine on which everything was hung. We are moving into the study of social relationships, political relationships, vernacular, etc., and beginning to absorb more. The profession of architectural history is expanding. Many of these problems are resolving themselves.
> Dora Wiebenson.
>
> Whatever you propose to do, you have to make your own slides. Which means you have to have money to travel. I am struck by the fact that I teach courses to hundreds of students each year-mainline, bread-and- butter courses that go on year after year-but if I ask the university for the opportunity to travel, to see the buildings I am supposed to know something about, and to photograph them in ways that are appropriate for use in my lectures, they think all I am after is a summer in Europe.
> Richard Betts.
>
> While I have questions about this characterization of past historical scholarship, I generally agree with the authors' aims. The danger in their proposed method is that it threatens to pull the researcher away from the object toward an analysis of society, rather than bringing relevant data to the object under investigation.
> Stephen Tobriner.

Objects are not created in response to pure functional necessity, nor do they arise in the mind of the designer from an instinctual urge to create. They are the out- come of pre-existing conceptual frameworks whose structure is socially determined and whose aim is social. Buildings, cities, parks, and transportation networks are products of design decisions. These are implemented or enforced through institutions. Ultimately, interests operating in society support the conceptual frameworks and control the institutions.

In the final analysis all uses of design are social, all serve to create, to maintain or to dissolve human dependencies. But the functions of conceptual frameworks, institutions and interests are not always readily visible. Neither is their long-term impact on human relations. Whether by intention or by accident, these workings may be lost or buried. No other discipline can retrieve them as well as history. Any study of the social use of design must focus on the interactions which connect, over time, interests, institutional structures, conceptual frameworks, design decisions, design products and human relations.

The interaction between human relations and design products seems to be the subject of extensive investigations in environmental psychology, ergonomics and cultural anthropology. The fact is that those studies in most cases do not analyse in depth the social use of design. The reason for this stems from the methodological constraints inherent in the methods adopted in those fields. They provide a narrow understanding of the relationship between design and society, relying as they do on the methods employed in the physical sciences. As engineers

record the properties of materials by observing their behaviour under certain conditions, so these social scientists observe the behaviour of the users of the built environment in order to evaluate the design product.

In this respect they continue the tradition of Locke by viewing all phenomena of the world as "materials" and of relying on "observation" to acquire knowledge. By grafting the concepts and principles of mechanics onto design, this approach concentrates too narrowly on the observable behaviour of the user of the man-made environment and confuses description with explanation. By failing to take into account the dimension of time, it divorces the products from the forces that generated them and isolates the behaviour of the user from the overall context of human relations and of conditions that determine the system of rules within which the user perceives, chooses, and acts.

This is not to say that empirical data have no value in the study of design. It suggests rather that, in this case, the data assembled and the model used for organizing them are not sufficient to yield significant conclusions about the social use of design. No amount of analytical manipulation of those data can redeem these faults.

Similarly, there are shortcomings to the study of the man-made environment as "habitat." This approach borrows from the methodological and theoretical constructs of biology and ecology. It presents culture as an extrapolation of "animal tradition" differing from it "only in degree"[1] and design objects as extensions of the human body, products of individual needs of the human organism in its effort to adapt to its milieu, tools created by the interaction between the human physiology and the natural environment. These constructs, like the social engineering and the behavioural sciences models, offer descriptions as explanations. Although they do not exclude the dimension of time from their analysis of design, they ignore the social use of design products in the past, presupposing that humans and biological organisms operate similarly. They are unable to see design objects as part of an artificial world resulting from conceptual frameworks and institutions based on interests. Neither the model of mechanics nor the model of biology can be extended or applied by analogy to the domain of the man-made environment, because to understand how the man-made environment operates and how it affects human relations requires a perspective which only history can provide.

Not every kind of history can explain design. An insular history, based on categories that ignore the original interests, concepts and institutions, which determine the design decisions, can only be limited, not to say misleading. Such is the case, for example, with the architectural history developed by Sigfried Gideon, in a tradition reaching back at least as far as Choisy and Viollet Ie Duc.[2] The works of architecture of the past were perceived as springing from a primitive anticipation of the modern technology, the conspicuous search for new space and construction arrangements to demonstrate the novelty of construction techniques and materials and the legitimacy of their use. Such thinking was a-historical both in its contempt for the reasoning behind the objects of the past and in its ignorance of their former uses. False, such interpretations also contributed to the environmental devastation caused by modern architecture by providing it with a historicist license to freely replace the old urban fabric with new structures.

A very different approach to history of design is that of the stylistic school. It perceives the designed products not as answers to functionalist problems but as aesthetic creations asking only to be looked at and appreciated.[3] Early studies in this tradition endowed artistic creation with powers all its own. In order to account for the variety among design products, the amateurs of fine objects claimed that a style developed in cycles, that it "blossomed" and "withered" like

a "plant." The cyclical theory of history can be traced back as far as Plato's Laws. The broad application of this model tended to be open to idiosyncratic interpretation and conjecture.[4] And so it was for Winckelmann, for whom the reason for the "decline" of Greek art was that its "images...had been formed in all conceivable shapes and attitudes and it had become increasingly difficult to think of new ones."[5]

Heinrich Wölfflin is considered the leading opponent to the reaction to this cyclical model of history. He accused his predecessors of "never (having) systematically founded" their assumptions.[6] He undertook the creation of a sounder basis for the discussion on art; a kind of categorical framework, analogous to the one Kant developed in philosophy through his priori categories. Wölfflin postulated that changes in style come in succession and "they oscillate in an orderly way, between opposite 'forms of vision,' " which are the following: linear versus painterly, parallel surface versus diagonal depth, closed versus open, composite versus fused, clear versus unclear. "Art history," Wölfflin stressed, "is more than a 'translation of life' (Taine) into pictorial terms ...which attempts to interpret every style as an expression of the prevailing mood of the age. ...The moment we want to apply artistic standards of judgment in the criticism of works of art we are forced to try to comprehend formal elements which are unmeaning and inexpressible in themselves and which are developments of a purely optical kind."[7]

Wölfflin's investigation of history through abstract categories of pure visibility presupposed that the purpose of a design object was to create a visual aesthetic impact. It also rested on the assumption that such categories were universal. From this it followed that the visual properties of the object, its stylistic traits, fully expressed its meaning. Consequently only formal factors were incorporated into the analysis. Moral, religious, philosophical and political significations were abstracted, as were emotion and technique.

Alois Reigl proposed a method of historical analysis based on an a priori structure similar to Wölfflin's in that it also included a list of alternating abstract visual polarities. The categories themselves, however, were different: tactile versus visual, the presentation of the object isolated versus being placed in space, objective versus subjective.[8]

Although Riegl tried to develop a universal set of abstract categories, his analytical tools were still, like Wölfflin's, bound to the objects at which he aimed his analysis, those of the Ancient Near East and of the Roman and Early Christian periods. Moreover, Riegl based his analysis on the same assumptions as Wölfflin: that the purpose of design objects is to create a visual aesthetic impact. To explain the creation of design objects, he developed the concept of *Kunstwollen* following the theory of Schopenhauer that every human action is the product of forces, that every art relates to a will and that every stage of every art corresponds to an advancement of will. To explain how visual characteristics changed in time, Riegl asserted that periodic changes in style were the result of the pulse of the mentality of the time, what he called the *Denkweise*.

Whereas Wölfflin's and Riegl's stylistic analyses relied on formal aspects versus the content-bound or emotional characteristics of visual elements, Theodor Lipps and his follower, Wilhelm Worringer, stressed the opposite: expression and emotion. Forms have an impact on the viewer, they claimed, because he recognizes in them the expression of feelings, because he himself becomes incorporated in the forms or because "he unconsciously, [feels] inwardly the process of their formation." Forms are the outlet of "inner feelings," "the expression of spiritual unrest," "the liberation of [a] sense of vitality." Departing from the same suppositions as Wölfflin and Riegl and under the same influence of Schopenhauer about the aesthetic purpose

of design products, Worringer stressed that while "the will to form remains the same throughout the entire development," the differences in style are the results of an interaction between "stages" in feelings, in excitement, in pathos which dominate man in a period, and the kinds of material available which permit the expression of those feelings through works of art.

The stylistic analysis approach to the history of design had two basic limitations. The first was that although the methods strived to be universally applicable, they always remained bound to the set of objects from whose observation they emerged. As historians shifted their focus to new areas, the accepted stylistic categories met with operational difficulties since they could not account, even as criteria for classification, for all periods and places. New categories had to be advanced, always in keeping with the pre-supposition that the purpose of a design object was to foster a pure, abstract visual aesthetic impact. The second limitation of this approach to design history was its failure either to identify the actual use of the design object in a given period or to ex- plain the general phenomenon of the production of the man-made environment. This failure stemmed from the inability of the field to overcome the boundaries of its original program that is, defining the role of the design historian as an assistant to the amateur and the collector.

The historian of design was curator, connoisseur and author of *catalogues raisonnes* in which visual characteristics helped to date, to assign origin, to determine authenticity, to label and to appraise works of art. At the beginning of the nineteenth century, connoisseurship split into archaeology and art criticism. The archaeologist, and we refer here to the museum expert utilizing the lesson of philology, developed techniques and identified attributes for constructing taxonomies of design products of the past-with little concern for the tastes and preferences of his day and for the value of the objects as a collector's item. As a result, the archaeology of the last century, the new scientific connoisseurship, became a discipline as organized and challenging as that of mineralogy or botany, and equally indifferent to the problem of explaining the objects described and classified.

The design historian developed categories of classification. But the urge to evaluate was always present in his analysis. For this reason, his categories were dominated by contemporary aesthetics and a concern for the creation of new products. They reflected the taste of the day rather than the attitudes and sensibilities of the past. Winckelmann's categories were closely linked to the Neoclassical movement, Ruskin's to' the Pre-Raphaelites, Wölfflin's to the movement towards abstraction and Worringer's to expressionism.

The concern for evaluation was not without consequences. As Marc Bloch so sharply pointed out, "The habit of passing judgments leads to a loss of taste for explanations."[9] This holds true however broad the criteria of evaluation, including moral evaluation, because as stylistic analysis presupposes that design products ought to have an aesthetic visual impact, the moral point of view recommends a certain state of human affairs. In both cases the presuppositions may be irrelevant to the period under discussion, which suggests that the acceptance of the task of evaluating, of "criticizing" past design products by the design historian, may be invalid unless a universal standard of evaluation is proven to exist. This holds true for either stylistic or moral criticism.

In order to analyse in depth the design process involved in, for example, the production of the eastern facade of the Louvre during the reign of Louis XIV, one must explore it in the context of the external conflicts of the absolutist regime and of the internal conflicts and coalitions that involved the nobility, the court, the mercantile class, the guilds and the peasantry. To appraise the actions of any of these groups as morally good or bad impedes any further explanation of

the social relations, events or objects in question. An evaluation of this type is not very different from measuring the design of the Louvre in terms of any other evaluative standard, such as meeting the specifications of 'structural efficiency, economic construction, micro-climatic control, the compositional criteria of the Beaux Arts or Marcel Duchamp, the ideals of the socialist revolution, or humane values with respect to the small number of workers it mobilized. This can be an absorbing type of exercise, but it can hardly inform us as to why the Louvre was designed the way it was and what its erection meant to the contemporary society. By getting involved with evaluations of past products, historians of design have committed the fallacy classified by David Fischer as "false analogy."[10] They have looked at the decisions, the actions and the products of the past as answers to questions of the present. To borrow from a similar criticism, which Collingwood made of the anachronistic "realist" attitude of his colleagues in philosophy, it is comparable to objecting to the poor descriptions of steamers by the ancient Greek authors who were in fact, referring to triremes.[11]

In his intriguing essay on Gothic architecture, Erwin Panofsky did try to develop an analysis of design that was free of the evaluating predisposition of historical criticism. He compared the dominant scholastic writings of the period with the cathedrals, the "new style of building."[12]

He found a correspondence between the theological argumentation in the texts and architectural elements. Because the structures of both presented a similar development, he concluded that the modes of thinking and the habits of designing were shaped in a similar manner.

But the essay on Gothic architecture used as a base the false supposition that de- sign products are of the same nature as thoughts. For this reason, Panofsky's conclusions are limited – despite the fact that the material brought together is, as a result of Pan of sky's formidable erudition, bountiful and the pattern of correspondences striking. But if the presuppositions behind them are invalid, those elements cannot in themselves lead one to a valid conclusion. From the outset, Panofsky warned the reader of the pitfalls in the pursuit of such "parallels," but he was unable himself to resist the temptation of drawing inferences about "palpable and hardly accidental concurrence" from such analogies. As a result, the "unities" he established between design products have, at their best, a classificatory value; and the essay fails to provide a historical explanation for the genesis of the form that was true to the period.

One can also find efforts to establish analogies between texts and design products of the same period in discussions of content rather than formal characteristics. These studies describe texts and buildings as expressions of a common spirit of the epoch, a common worldview. A typical example of this approach to the history of design can be found in Pevsner's analysis of Renaissance architecture. "Architecture is not the product of materials and purposes – nor, by the way, of social conditions – but of changing spirits of changing ages. It is the spirit of an age that pervades its social life. ...The Gothic style was not created because somebody invented rib-vaulting, [it was] worked out because a new spirit required it."[13] Based on such assumptions, Pevsner arrived at the speculative conclusion that the "central plan" of the Renaissance church was "the symbol of worldliness" and of ' 'the spirit of Humanism." In fact, as other studies have factually demonstrated, expressing the spirit of the epoch was not a motive for architecture in either the Renaissance or the Gothic.

To study such anachronistic histories of design may be interesting and rewarding. Some designers may find in them stimulation for expanding their formal vocabulary. This is the purpose of a large number of courses around the world in the history of architecture. Such anachronistic

use of history – which we may call heuristic – helps students become more inventive by exposing them to a great variety of formal, spatial arrangements, which have been developed through time. But we have to be conscious that such use of works of the past, while it may produce fascinating typologies and intriguing *cabinets des curiosites* of architectonic objects, has strict limitations. Anachronistic history may easily lead us to think very much like those "German soldiers in 1914," written about by Bloch, who "envisioned ...as so many loopholes prepared for snipers ...the innocent contrivances of the masons ...on the fronts of a great many Belgian houses..." that, in fact, had been" designed to help the plasterers in setting up their scaffolding."

In the end, the findings of stylistic analysis and the conjectures about the formal expression of the spirit of the time can be applied only to those works, which have been conceived as stylistic compositions or as statements expressive of a period. Visual uniformities do form clusters at certain locations in space and certain periods in time, but such phenomena do not always arise from stylistic considerations and cannot always be explained through stylistic categories. To understand a design product, one must find the document that reveals its meaning, its real use.

In one of his most vivid passages, Emile Male recounts his chance discovery of Cesare Ripa's *Iconologia* from 1593 and, therein, of the key to Bernini's personification of Truth in the Villa Borghese and to much of the 17th century's allegorical representation.[14] Ripa's *Iconologia* is not unique. A large number of documents can be found in which meaning is matched with the design of physical objects, one of the most ambitious of these being Emanuel Tesauro's *Il Cannocchiale Aristotelico*. Borrowing concepts from Aristotle, Tesauro tried to build a general system to describe and prescribe the total artificial world as a universe of objects which are meant as carriers of meanings, as words of a discourse or, as it was called in the 17th century, an *Argutezza*. All objects, whether "Natural Bodies," "Artificial Bodies," or "Rhetorical Images," stood as "names" and "oracles." All compositions with those objects, served as "sentences" in a "language" subject to "interpretation." Design was seen as a process of coding. It is only with this conception of the man-made environment in mind – as a symbolic universe – that history of design can be envisaged as an activity of decoding.

This was the dominant direction taken by the Warburg Institute under the guidance and inspiration of Aby Warburg. In the first issue of the Institute's journal in 1937, Jacques Maritain sketched a program for the study of culture and its development through a "study of signs and symbols."[15] The work at the Institute echoed a contemporary construct of Ernst Cassirer, which interpreted and analysed culture exclusively as composed of "symbolic forms," a "system of signs," and a "world of symbols."[16]

Recent attempts to reduce the history of design to a history of signs and codes or to a history of relationships between the so-called signifier and signified should be seen as a generalization of previous efforts of the iconological approach.[17] This direction, under the name of semiology, having been substantially influenced by Saussurian linguistics, extended iconological analysis with the notion of syntax, grammar and other morphological characteristics of language in addition to the meaning.[18] But a history of design based exclusively on iconological documents and semiological considerations, although applicable to certain works, has its own limitations. It can relate only to products that have been constructed as symbolic objects, whose only purpose is to signify.

In the development of culture, a large number of man-made objects are not made simply in order to carry a meaning. In general, machines or instruments derive from decisions and conceptual systems, which are not to be found in manuals of iconology or any coding system.

Similarly with a factory, an airport, a regional plan, a camp, a bastion by Vauban, or the projects for a new *Hotel Dieu* designed by the *Academie des Sciences* just before the French Revolution – the decisions that shaped them, and the norms inside those decisions, destined them not for signification but for the production of utilities.

One must be careful not to confuse the case of a machine or an instrument used as a symbol, or as a signifier in a painting or as an *objet trouvé* on a podium in a gallery, with the case of the same machine or instrument performing productive operations. Similar confusions arise when a machine comes to signify the social or economic position of its possessor in addition to fulfilling its role as a producer of utilities. Neither of these signifying functions detracts from the fact that machines and instruments can be made to produce energy exclusively, and not significations. A similar argument can be made that ritual props of archaic societies are not pure signifiers but stand between signifiers and machines as ancestors to both, and are different from both.

After all that has been said about the limitations of the stylistic, iconological and semiological approaches, it is appropriate to recall the remark Wölfflin made in 1888: "We still have to find the path that leads from the cell of the scholar to the mason's yard." It appears that a more universal history of design is needed to accommodate the totality of design products: the machines, the objects of divination, the aesthetic objects and the icons. A broader range of documents must be explored, no matter what type of thinking they reveal and regardless of the use of the object to which they relate.

Editorial Note:
This article has been originally published as:
Tzonis, A., & Lefaivre, L. 1980. History is reurning to design, *JAE* 34(1), 7–10.
An earlier version was delivered as a paper presented at the Art History Institute, Utrecht, The Netherlands 16 May 1977.

Notes

1 Wilson (1975: 168)

2 Giedion, S (1941)

3 For an edifying discussion on the notion of style, see Shapiro, M (1963)

4 Nisbet, R (1969)

5 Winckelmann, (1764)

6 Wölfflin, (1888)

7 Wölfflin, (1952).

8 Riegl, (1908)

9 Bloch, (1949)

10 Fischer (1971).

11 Collingwood, (1939)

12 Panofsky (1951: 4)

13 Pevsner (1943: 17)

14 Male (1945).

15 Maritain (1937)

16 Cassirer (1923)

17 Schefer (1969); Jencks & Baird (1969).

18 Barthes (1967): Eco (1968: Saussure (1959)

Works cited

Barthes, Roland. 1967. *Elements of Semiology,* London: Cape.

Bloch, Marc. 1949. *Apologie pour I'Histoire, ou Metier d'Historie.*

Cassirer, Ernst. 1955. *Philosophe der symbolischen Formen, Berlin, 1923, reprinted as The Philosophy of Symbolic Forms.* translated by R Mannheim, New Haven: Yale University Press.

Collingwood, R.G. 1939. *An Autobiography.* London, Oxford University Press.

Eco, Umberto. 1968. *La Stuttura Assente.* Milano: BomPiani.

Fischer, David H. 1971. *Historian's Fallacies.* New York, Harper & Row.

Giedion, Sigfried. 1941. *Space, Time and Architecture.* Cambridge, Harvard University Press.

Jencks, Charles and Baird, Geoge. (eds.). 1969. *Meaning in Architecture.* New York, Braziller.

Mâle, Emile. 1945. *l'Art religieux du XIIe au XVIIIe siècle.*

Maritain, Jacques. 1937. Sign and Symbol, *Journal of the Warburg lnstitute* (1).

Nisbet, Robert. 1969. *Social Change and History.* New York: Oxford University Press.

Panofsky, Erwin. 1951. *Gothic Architecture and Scholasticism.* Latrobe: Archabbey.

Pevsner, Nikolaus. 1943. *An Outline of European Architecture.* London: Murray.

Riegl, Alois. 1908. *Die Enstehung der Barockkunst in Rom: Vorlesungen aus 1901-1902.* Wein: A Schroll.

Riegl, Alois. 1901. *Die spätrömische Kunstindustrie nach den Funden in Österreich-Ungarn.* Wien: Osterr Staatsdruckerei.

Saussure, F. 1959. *Course in General Linguistics.* London: P Owen.

Schefer, L. 1969. *Scenographie d'un Tableau.* Paris: Editions du Seuil.

Shapiro Meyer. 1963. Style, *Anthropology Today, ed. A L Kroeber.* Chicago: University of Chicago Press.

Wilson, E.O. 1975. *Sociobiology.* Cambridge: Harvard University Press.

Winckelmann, J. 1764. *Geschichte der Kunst des Altertums.* Leipzig.

Wölfflin, H. 1952. *Classic Art.* London: Phaidon.

Wölfflin, H. 1888. *Renaissance und Barock.* Miinchen.

Leonardo da Vinci's architectural designs as thought experiments: the sources and influence of his ideas

Estelle Alma Maré
Department of Architecture, Tshwane University of Technology, Pretoria
E-mail: mare_estelle @ fastmail.fm

It is argued that Leonardo da Vinci's architectural designs are uniquely original due to his ability to connect ideas derived from a wide range of sources and his own empirical researches. This attempt at understanding Leonardo's visual thinking that is the basis of his architectural designs commences with a reference to his decorative knotted puzzle, entitled *Concatenation*, that symbolises a map of the universe, reminiscent of Aristotle's world view, as expressed by Dante Alighieri. Leonardo's empiricist approach to scientific research and artistic creativity also relates to Aristotle's insight into matter, form and growth patterns. His creative process in art and design was inspired by thought experiments in which his mastery of *disegno* enabled him to express the mutation of living forms into mechanical and architectural forms, and *vice versa*, to imbue the latter with a life force. His representation of fictive buildings in his paintings is surveyed, followed by a review of his architectural sketches of which his designs of centralised and longitudinal domed churches are evaluated in some detail, taking into account his varied sources as well his influence. Emphasis is placed on Leonardo's originality as an architectural designer, especially with reference to notable domed churches on octagonal plans with side chapels that approximate fractal designs.

Key words: Leonardo da Vinci's architectural designs, thought experiments, *disegno*, domed churches, fractal design

Leonardo da Vinci se argitektoniese ontwerpe as gedagte-eksperimente: die bronne en invloed van sy idees

Dit word aangevoer dat Leonardo da Vinci se argitektoniese ontwerpe op 'n unieke wyse oorspronklik is vanweë sy vermoë om idees wat van 'n wye verskeidenheid bronne en sy eie empiriese navorsing verwerf is, met mekaar in verband te bring. Hierdie poging om Leonardo se visuele denke wat die grondslag van sy argitektoniese ontwerpe is, te begryp, begin met 'n verwysing na sy dekoratiewe, geknoopte raaisel, genaamd *Samekoppeling*, wat 'n kaart van die heelal simboliseer en herinner aan Aristoteles se wêreldbeeld, soos deur Dante Alighieri verwoord. Leonardo se empiriese benadering tot wetenskaplike navorsing en kunsskepping hou ook verband met Aristoteles se insig in materie. vorm en groeipatrone. Sy skeppingsproses in kuns en ontwerp is geïnspireer deur gedagte-eksperimente waarin sy meesterskap van *disegno* hom in staat gestel het om voorstellings te doen van die mutasie van lewensvorms in meganiese en argitektoniese vorms, en omgekeerd, ten einde laasgenoemde met 'n biologiese vormingskrag te vervul. Sy voorstellings van denkbeeldige geboue in sy skilderye word nagegaan, gevolg deur 'n oorsig van sy argitektuursketse, waaronder sy ontwerpe van gesentraliseerde en langwerpige koepelkerke meer gedetailleerd ontleed word, met inagneming van sy gevarieerde bronne sowel as sy invloed. Klem word geplaas op Leonardo se oorspronklikheid as 'n argitektoniese ontwerper, veral met verwysing na die uitsonderlike gesentraliseerde koepelkerke op agthoekige planne wat by benadering as fraktaalontwerpe bestempel kan word.

Sleutelwoorde: Leonardo da Vinci se argitektoniese ontwerpe, gedagte-eksperimente, *disegno*, koepelkerke, fraktaalontwerp

Thought experiments are devices of the imagination used to investigate the nature of things (Brown 2011: 1).

The logical pattern of the creative process [...] consists of the discovery of hidden similarities (Koestler 1970: 27).

Leonardo da Vinci's architectural designs have been taken seriously as part of the history of architecture by various researchers who have dedicated and continue to dedicate books, chapters in books and scholarly articles to the subject, but few have noted the extensive range of varied ideas incorporated into his designs.[1] It is therefore the purpose of this article to attempt to take into account his sources and influences, emphasising his originality as an architectural designer in connecting disparate ideas related to his own empirical researches.

Originality and creative thinking in both the realms of science and art is seldom combined in the researches and creative manifestations of one person, as in the case of Leonardo da Vinci (1452-1519). Since creativity as a symbolic activity is sustained by the imagination, the geometrical obsessions that dominated Leonardo's last years (Kemp 1996: 186) were the product of a fervent imagination experimenting with forms that would represent visual symbols – some of which are architectural designs, dealt with in this article. The objective of this research is to explicate how such symbols reflect a world view, and furthermore to analyse how a range of thought processes connecting in the various expressions of Leonardo's architectural designs, prove the postulate that "the logical pattern of the creative process [...] consists of the discovery of hidden similarities" (Koestler 1970: 27).

Leonardo's *Concatenation* as a symbolic map of the universe

This analysis of Leonardo's visual thinking as an empiricist and creative artist commences with an analysis of a decorative knotted puzzle, entitled *Concatenation*, that he designed as a logo (probably executed by his pupils), intended to be his "hieroglyphic signature" (Goldscheider 1959: 12). Since knotted designs pervade Leonardo's oeuvre it is important to focus on the meaning of this symbolic puzzle that takes on the form of a circular pattern, consisting of a single unbroken white line meandering on a black background, containing the words *Academia Lionardi Vici* in the centre, with four angle ornaments (probably derived from Medieval and Renaissance maps) in the form of knots (figure 1).

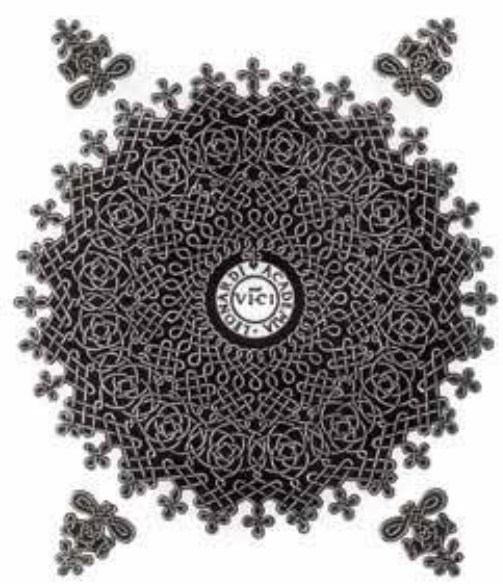


Figure 1
Leonardo da Vinci, *Concatenation*, engraving, *circa* 1499-1500, British Museum, London (source: http://www.nordicneedle.com).

The form of Leonardo's *Concatenation* design may have various precedents. It could be derived from nature in which the sunflower produces a centralised spiralling pattern. Leonardo illustrated his observation that "Water struck by water forms circles around the point of impact",[2] showing in each swirl the calm eye around which the water expands and contracts as representing the still place where dynamic opposites meet in a gravitational centre, similar to the central "eye" in the *Concatenation* (figure 2). Leonardo most probably also studied the rose window of the Cathedral of Santa Maria del Fiori, Florence, with its centralised pattern. He may also have been aware of Muslim designs that display a remarkable geometry that often encloses a centre in an intricate pattern.

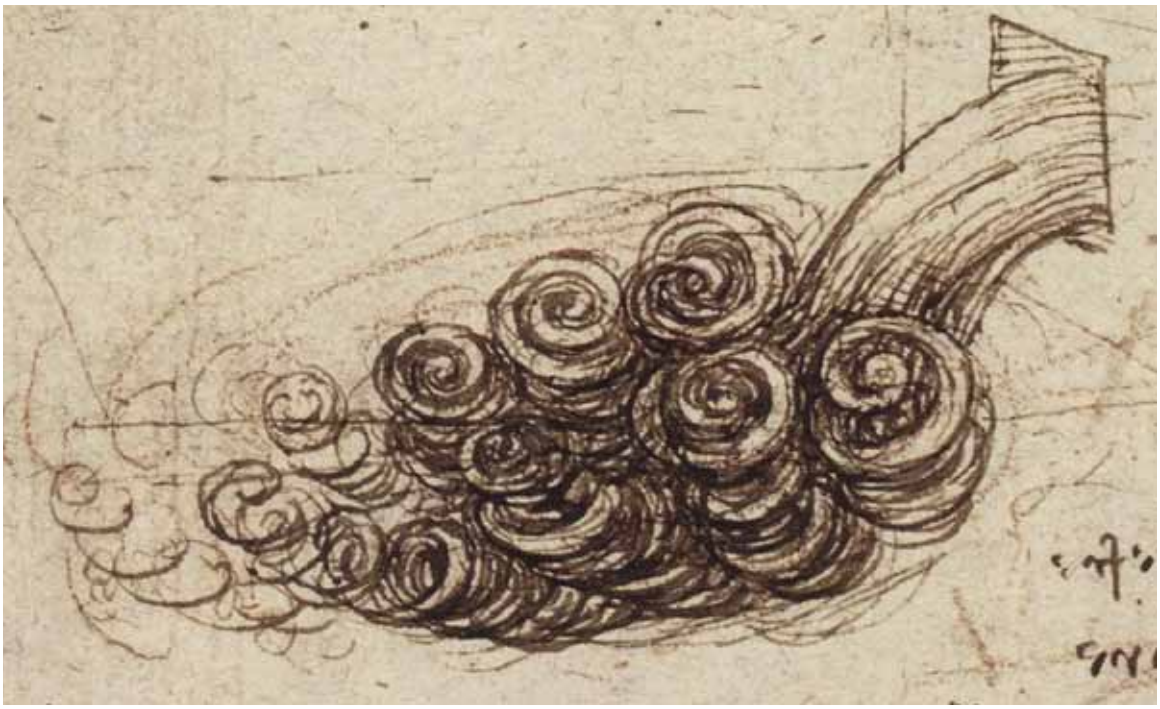


Figure 2
Leonardo da Vinci, detail from a page of sketches of swirling water, 1507, Royal Library, Windsor Castle, no. 12662r (source: Zöllner: 443).

The first art historian to point out a probable literary influence on Leonardo's *Concatenation* was Ananda Coomaraswamy (1944: 114). He postulated that it represents a map of the universe in the precise terms of Dante Alighieri's (1265-1321) lines in *Paradiso* XXIX: 31-6:

> Concreto fu ordine e construtto
> e la sustanze; e quelle firon cima
> del mondo in che puro produtto;
>
> pura potenza tenne la parte ima;
> nel mezzo strinse potenza con atto
> tal vime, che già mai non si divima.
>
> (At the same time as substances were created, was their order [hierarchy] created and firmly established. And those were placed in the highest rank which possess pure act [intelligence]; those who possess potentiality [matter] occupy the lowest station; in the middle part [i.e. between die lowest – the sublunar, and the highest – the Empyreum], a bond, which can never be loosened, conjoined act with potentiality [to form the heavens].)

Since the bond – a knot – between the hierarchy of substances can never be loosened, Dante states in *Paradiso* XXXIII: 58-60:

> Si li tuoi non sono a tal nodo
> sufficienti, non è maraviglia;
> tanto per non tentare è fatto sodo!
>
> (If your [Beatrice's] fingers are not skilful enough [to unravel] such a knot, it is no wonder; it has become so tight, since no one has attempted [to unravel] it.)

The following lines, from *Paradiso* XXXIII: 91-3, may also have influenced Leonardo's thinking:

> La forma universal di questo nodo
> credo ch'io vidi, perché più di largo
> dicendo questo, mi sento ch'i godo.
>
> (This universal form of the knot [closely knit bond] I think I saw; for while I am saying this, I feel I experience such a deep joy.)[3]

The implication in Dante's lines is that a puzzle is like a knot that defies unravelling. This idea would have appealed to Leonardo whose artistic oeuvre abounds in ambiguity and multiple meanings. A connection can be made between the *Concatenation*, if it is interpreted as the plan of a metaphysical map representing his world view, and Dante's idea that God is He who draws the earth and unites it to himself (notwithstanding the poet's confession that he does not understand the different elements' circular movements in the divine and terrestrial spheres). Thus, Leonardo's design has three parts, corresponding to Dante's "highest" (the summit), "middle", and the "lowest", of which the first and last are white. The dark background in the engraving represents earth, with angle ornaments most probably meant to be indicative of the cardinal directions, like on a map. Seen from below the knotted tissue broadens out below and contracts above, forming a design of seemingly self-creating unity. The knot as a puzzle is most probably a motif that reveals Leonardo's invocation of the power of problem solving by means of thought experiments: formulating puzzles and solving them visually, always with the end in view "to investigate the nature of things" (Brown 2011: 1), especially in his architectural designs that most often also have three parts.

Also in Leonardo's creative work knots are found, for example along the upper edge of the sitter's black bodice in Leonardo's *Mona Lisa*[4] where the artist drew countless knotted cloverleaf patterns in a wickerwork design. Since wickerwork is *vinco* in Italian, the artist most probably intended the knots as a reference to Vinci, his birthplace.[5] Also in the ceiling decoration in the Sforza Palace in Milan knots proliferate (figures 3-4), echoing his "hieroglyphic signature".

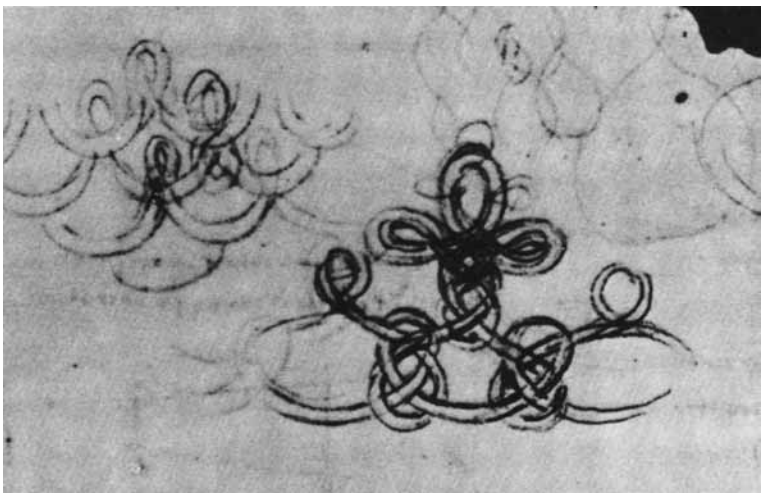


Figure 3
Leonardo da Vinci, study of knots, red chalk on paper,
Royal Library, Windsor Castle (source: Reti 1974: 37).

Figure 4
Leonardo da Vinci, fresco decoration in the Sala delle Asse,
Sforza Palace, Milan 1496-97 (source: Reti 1974: 37).

Even though there is an innovative strangeness in Leonardo's visually expressed world view, it is rooted in knowledge of his time, albeit restructured by his scientific enquiry into reality. The *Concatenation* is symbolically bound by a cosmology of circular and precisely unified forms that may imply erroneously that Leonardo, like Dante, had not progressed from the concept of a closed universe, as postulated by Aristotle (384-322 BCE), to an infinite universe (Koyré 1969). However, the self-creating unity of his design, mentioned above, is, according to D. Wade (1991: 276), more characteristic of the present view of the cosmos as "dynamic, self-creating, self-influencing" than of Leonardo's time. Furthermore, Leonardo affirmed the value of perspective: "Perspective, which shows how linear rays differ according to demonstrable conditions, should therefore be placed first among all the sciences and disciplines of man, for it crowns not mathematics so much as the natural sciences."[6]

Matter and form

In Classical Greek philosophy the problem of motion hangs together with the opposition of oneness of being and the multiplicity of existence. J. Marías (1967: 71) explains Aristotle's thinking as follows: "Moving and changing is a coming to be and a ceasing to be. Motion is [...] the realization of the possible in so far as it is possible." In short, motion implies the passing of one mode of being to the other.

Leonardo's understanding of matter and form as "the structure of things" was derived from Aristotle's *Metaphysics* (written 350 BCE) in which it is claimed that substance is a composite of two elements: "Form is the act of the matter, the perfection by which matter is something" (McCue 1962: 3). Matter is that of which a thing is made; form is that what makes a thing what it is. Form is that which confers being, for example the form of a table can be imposed on wood. Matter is simply possibility; it is potential that can be actuated.[7] By analogy, this insight has relevance for Leonardo's art and architectural concepts, especially when considered in relation to the expression of the motion that shapes organic growth patterns.

In the greater part of Leonardo's oeuvre as a designer, his thought experiments involved the mutability of forms, expressed by means of his mastery of *disegno*.

Disegno

Leonardo's search for an optimal solution for innovative design forms is expressed by means of *disegno*. This term is not the exact equivalent of "design" in English, but refers to the sketch, the drawing or exploratory phase of a visual work of art, including architectural and engineering designs.[8] All Italian Renaissance artists were draftsmen, first and foremost. However, *disegno* was not only related to the delineation of forms, but the planning of entire compositions. However, this procedure was not identical for all the arts. Leon-Battista Alberti (1988) noted that the architect, compared with the painter, "desires his work to be judged not by deceptive appearances but according to certain calculated standards."

So important was *disegno* or creative drawing that characterises the working method of Renaissance artists, that the concept acquired Neoplatonic connotations. The concept of creativity as the realisation of an Idea is Neoplatonic, a philosophy derived from Plotinus (204-70 CE), based on Platonic ideas. According to Federico Zuccaro (1541-1609), the sixteenth-century Italian painter and theorist, it actually meant "the sign of God in us" – that is in the artist. Indeed, it was believed that Renaissance artists, such as Leonardo, Raffaello Sanzio (called Raphael in English,1483-1520) and Michelangelo Buonarroti (1475-1564), were endowed with

geniality and divinely inspired. Giorgio Vasari (1511-74) actually called these artists divine (*divino*). The Italian humanists of the early Renaissance and sixteenth century established Neoplatonism as the norm and reconciled it with Christian beliefs that influenced artists. A case in point is Michelangelo, who in the figures called *Slaves* for the tomb of Pope Julius II (1513-16), depicted their spiritual struggle against the inertia of matter. However, this kind of expression was foreign to Leonardo's vision of reality. Even though he alluded to Neoplatonic ideals, Martin Kemp (1981: 106) quotes his assertion, "All our knowledge has its foundation in our sensations", as an assertion strongly flavoured by Aristotelian empiricism. Kemp (1981: 128) also states: "The Platonists' introverted quest for truth within man's soul was denounced as vigorously as possible by Leonardo – he believed fervently that 'knowledge' which the Platonists claimed to possess could never be verified against objective truth, because their 'knowledge' could only 'begin and end in the mind'."

Leonardo was basically an empiricist and indebted to Aristotle in his scientific thinking. In his artistic theory he echoes Dante's insight, that "art must begin in the mind before it can issue through the hands" (Leonardo 1956: 35). In this he followed an essentially Aristotelian view of art, as expressed by Dante in his treatise *De monarchia* (2.2): "Art exists in three degrees: in the mind of the artist; in the instrument as technique; in the material potentiality as informed substance." However, in Codex Urbino (folio 50r and 116r), Leonardo emphasises the unique quality of *disegno*: "Design [*disegno*] is of such excellence that it not only studies the works of nature but is more infinite than those made by nature [...] and, on account of this, we conclude that it is not only as science but a divine power."9 Moreover: "[*Disegno*] surpasses nature because the basic forms of nature are finite and the works that the eye demands of the hands are infinite."[10] In Leonardo's scientific thought *disegno* enabled him to be a "tireless inventor of new things", as his one-time collaborator, Luca Pacioli (1446/7-1517), characterised him.[11]

Disegno in Renaissance visual arts relates mainly to form, in contrast to *invenzione* which deals with content.[12] However, "The imagination of the painter gives life to a new *invenzione* with the help of *disegno"* (Zwijnenberg 1999: 25). The practice of *disegno* moreover encompasses the "total configuration of a painting without connections of colour. By implication, form in this broad sense included the individual form of all components of the painting" (Poirier 1976: 28), and – by extension – of a building. There is a dynamism and dialectic of opposites, of reality and fantasy, in Leonardo's manner of practising *disegno* in the creation of a work of art. An example is the calm serenity of the posed figure in the foreground of the *Mona Lisa*, compared with the powerful, almost volcanic backdrop.

Indeed, Leonardo seems to have been preoccupied with the dialectic between various forms and their mutability. In his fresco depicting the *Battle of Anghiari* (figure 5) the head of a horse, represented in an attacking mode with bared teeth, is comparable to a ferocious human face. Mutability of a pattern is also seen in various sketches, for example of swirling water (figure 2) and plaited hair. Some of Leonardo's flying machine designs look like bat wings, while Kemp (1987: 131-2) notes that others resemble his drawing of a skeletal human hand. His idea of redesigning Milan as a healthy city by creating more space between buildings for wider roads is an anatomically based "circulatory system".[13] Leonardo also envisaged a colossal bridge over the Golden Horn in Istanbul, reminiscent in form of the arched body of a man supporting himself on his outstretched arms and legs (figure 6).[14]

Figure 5
Leonardo da Vinci, detail of the *Battle of Anghiari*, 1503-5, a detail copied by Peter Paul Rubens, black chalk and white highlights, Royal Library, Windsor Castle (source: http://www.wga.hu/support/viewer/z.html).

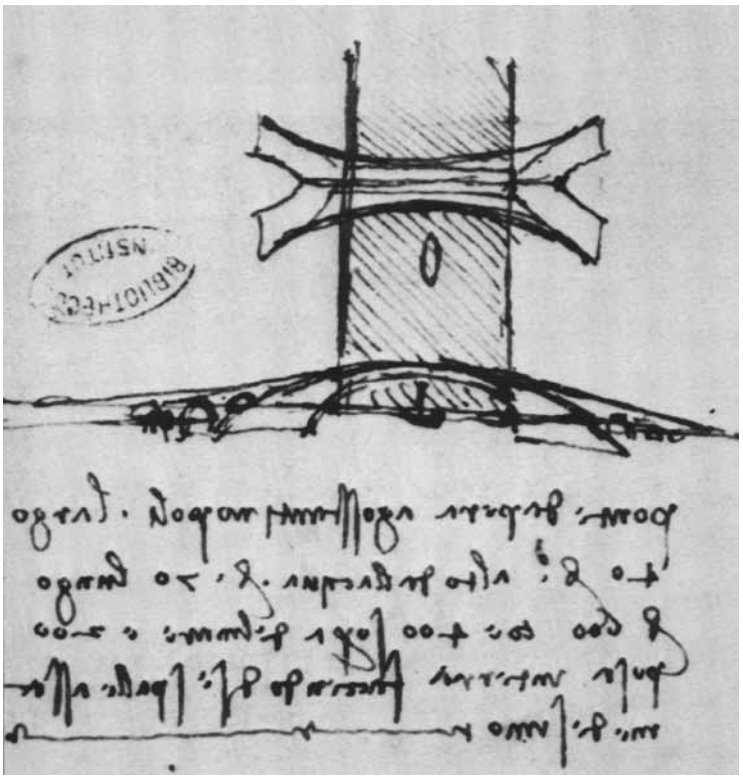


Figure 6
Leonardo da Vinci, design for a bridge over the Golden Horn, Istanbul, *circa* 1502, manuscript L, folio 66 *recto* (source: Reti 1974: 266).

As will be noted below, his anatomical studies and architectural sketches, as well as the proportions of the human body and that of a building have the same quality of mutability. Leonardo's *disegno* skills enabled him to transmute the pattern of one basic form into a series of more diverse forms that has the quality of a scientific formula in the progression from the simple to the intricate. Thus, Leonardo was an empiricist who made no real division between his researches into science and art, resulting in an oeuvre characterised by his ability to mutate living forms into design forms such as machines and buildings.

Fictive architecture in Leonardo's paintings and his use of perspective

In his paintings Leonardo left a legacy of architectural representation that broadens our understanding of his design ideals. Practising architects of his day may well have learnt from the way in which he applied perspective to architectural compositions as settings for human figures and their actions.

Though not displaying a full facade, or even a distant view of a complete structure, the architectural backdrop behind the Virgin in the *Annunciation*, an early painting (*circa* 1472-5), reveals a most intricate wall that has no parallel in Florentine Renaissance palace architecture (figure 7). The most impressive architectural details in the wall structure are the massive quoins rendered in dressed ashlar or marble that defines the dimension of the wall. Both the partially glimpsed doorway and the angled corner framing the Virgin are set in an otherwise unarticulated wall surface with its smooth, painted stucco finish, forming a strong contrast with the quoins.

Figure 7
Leonardo da Vinci, *Annunciation*, 1472-75, tempera on wood, 98x 217 cm
(source: http:www.wga.hu.index1.html).

In the painting the quoins have a direct relevance for its perspective structure. If continued, their horizontal lines converge in a vanishing point in the painting's background. Compositionally the architectural treatment contributes to the creation of an orderly setting in which the positions of the figures of the angel and the Virgin as well as every surrounding and background element are fixed. This implies that the plan of the palace, of which but a small part is revealed in the composition, can be accurately plotted.

The overall treatment of the fictive wall in the *Annunciation* is not found in buildings by Filippo Brunelleschi (1377-1446) or Leon Battista Alberti (1404-72), who often used heavily rusticated quoins to frame a rusticated wall. Leonardo's treatment of his depicted wall would seem to prefigure the use of quoins in buildings by Giacomo da Vignola (1507-73) and later Baroque architects who likewise contrasted the stone texture of the quoins with the smooth surface of stuccoed walls.

The architectural setting for the Bible narrative relating to the arrival of the Magi at the place of Jesus's birth in the *Adoration of the Magi* is complex (figure 8). The preparatory sketch actually shows multiple stairways built over arched passageways that ascend to an upper terrace, crowded with spectators. In the unfinished painting this space is rendered as a blank wall

connected to a series of broken arches and vaults. The scale of the wall, its prominent location and enigmatic function seem to have a purpose in the perspective construction of the painting in which each figure and object has a fixed place on a reconstructed plan. However, the overall impression is of a dialectic of movement, of people and animals amidst architectural structures transmuted into ruinous, jagged and somewhat purposeless forms.[15]

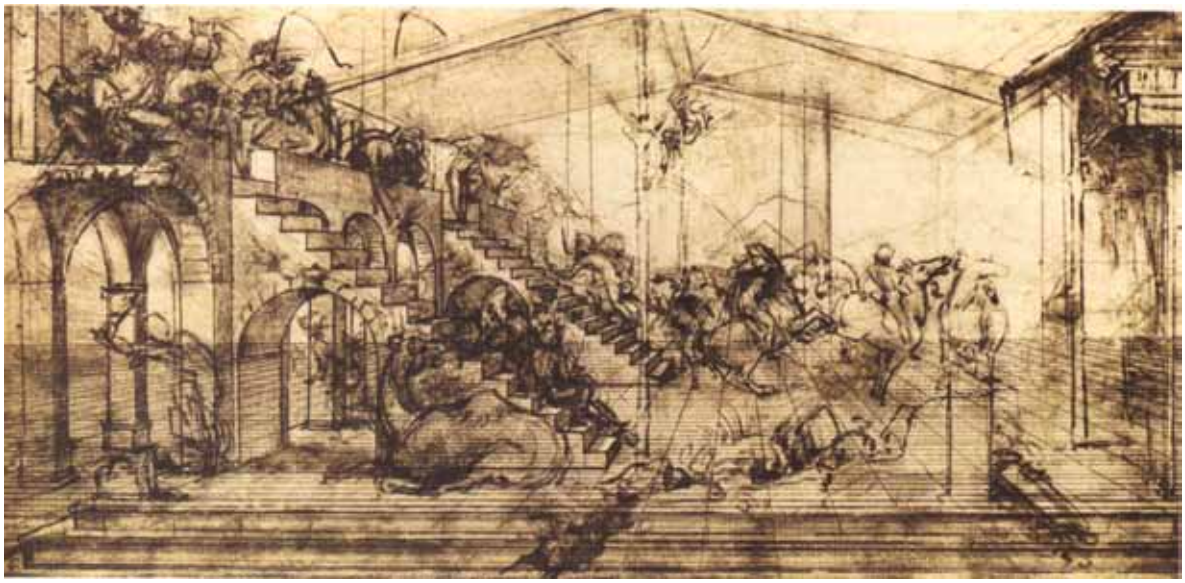


Figure 8
Leonardo da Vinci, preparatory sketch for the background of the *Adoration of the Magi*, *circa* 1481, metalpoint reworked with pen and brown ink, brush and brown wash on light brown prepared paper, 16,3x29 cm, Galleria degli Uffizi, Florence (source: http://www.wga.hu/index1.html).

If the setting of the *Annunciation* seems unreal and ambiguous, Leonardo painted a perfectly proportioned interior in the *Last Supper*[16] in the refectory of San Ambrogio, Milan during the years 1495-97. The upper room, as an illusionary extension of the refectory in which the *Last Supper* is represented. As befitting his status, the figure of Christ is placed in the precise centre of the composition that is mathematically set out according to a perspective formula about which scholars have differences of opinion. The inclining side walls of the Last Supper room that are a continuation of the side walls of the refectory, are divided by four evenly spaced rectangular panels depicted on the side walls and three openings in the rear wall, the central one larger than the sidelights whose lintels are set somewhat below the level of the side wall panels. The central window is crowned by a segmental pediment that also serves as a sort of half-halo behind Christ's head. This geometric precision that results in a kind of classical, formal purity is different from the somewhat chaotic setting of the sketch for the *Adoration of the Magi*.

Summing up Leonardo's representations of fictive architectural structures and space in his paintings, D. Fricelli (1993: 510) refers to "the protean nature of his architectural imagination, which seems to encompass [...] the development of Italian architecture from Bramante through Palladio".[17]

A summary of Leonardo's civic designs

Kemp (1996: 194) describes Leonardo's architecture as " in the spirit of Brunelleschi, combining a reverence for the proportional principles of antique buildings (as expounded by Vitruvius [80-

70 BCE-after 15 BCE]) with a relatively undogmatic use of the classical vocabulary and an inventive ingenuity in matters of engineering". Leonardo's approach to architecture was not only aesthetic, that is with emphasis on the formal appearance of the composition of the building, but his sketches also suggest an understanding of structure. No better example can be quoted than Leonardo's definition of arch as "a force originated by two weaknesses, for the arch in buildings is composed of two segments of a circle, each of which being very weak in itself tends to fall; but as each opposes the tendency in the other, the two weaknesses combine to form one strength" (Richter 1880: 778). Even though this is not an original insight, Leonardo searched for qualitative insights into the nature of building construction. His enquiring mind initiated new methods of structural research, albeit by means of thought experiments, summed up by George Winter (1963: 303): "It is the method of approach of Leonardo's investigations which marks the turning point from traditional art to scientific structural engineering. His subjects included beams, columns, arches, trusses, wires. Toward all of them he had a dual approach: investigation by experiment, and an application of the science of mechanics to structural problems in an attempt at quantitative calculation."

Leonardo was not a practising architect; however, he produced sketches of a large number of building plans and elevations, urban schemes, proposals for architectural details, as well as for monumental constructions, which are best interpreted as "units of his creativity" (Dorn: 1998: 523). Most notable are the sketches for longitudinal and domed churches with chapels (to be dealt with in the next section), public buildings, a palace, fortifications, the architectural regulation of entire regions, a garden and a pavilion. It is doubtful if any of his schemes were ever executed and it is also difficult to trace his exact influence on other architects. It is nevertheless apt to refer to Leonardo's architectural schemes as "his inquiry into the possibilities offered by architecture, both as an art and a science" (Fricelli 1993: 509).

In 1487 Leonardo was in Milan where he prepared a model for the *triburio* over the crossing of the city's vast Gothic cathedral. He attempted to devise a structure with affinities to the Gothic ribs of the cathedral, but the project was never executed. This design was clearly indebted to the crossing structure Brunelleschi devised for Florence Cathedral. However, it is most interesting that in his submission to repair a structurally defect cathedral he refers to the healing of a sick person who suffers from a lack of maintenance of "a parity and concordance of the elements [that] maintains it",[18] thus linking the wellbeing of a person with the soundness of a physical structure.

Fricelli (1993: 509) points out that in the expression of his architectural ideas, "Leonardo spoke not the language of the Florentine Renaissance of Brunelleschi and Alberti, but rather the fully developed, classically inspired language of the High Roman Renaissance of Bramante."[19] In a proposal for a church facade Leonardo not only anticipated Michelangelo's design for the elevation of San Lorenzo Cathedral, Florence, but also the facades of later churches by Andrea Palladio (1508-80), as well those by the Baroque architects Carlo Maderno (1556-1629) and Gian Lorenzo Bernini (1598-1680). In civil architecture Leonardo's plan for a palace facade anticipated not only Donate Bramante's (1444-1514) Roman palace style, but that of Raphael as well.

As an engineer Leonardo envisaged a circular fortress consisting of concentric rings of fortifications and moats around a central citadel, with four outposts arranged equidistant around the periphery (figure 9). This innovative design of an enclosed and protective military building echoes the circular form of the *Concatenation* with its four angle ornaments.

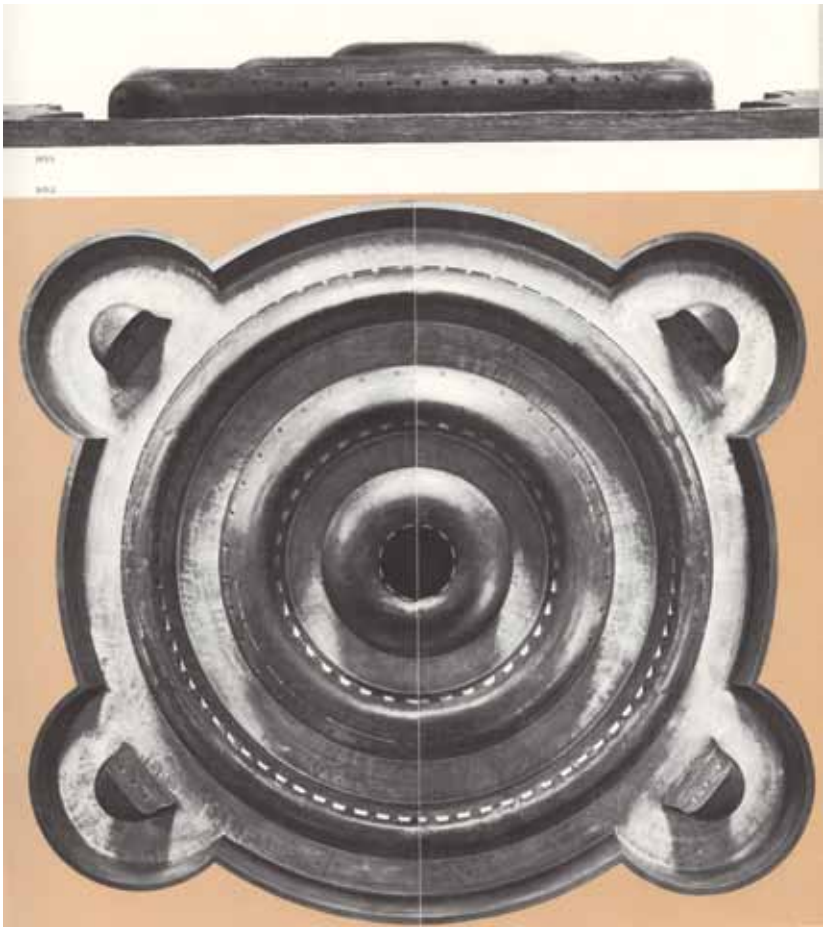


Figure 9
Leonardo da Vinci, model of a fortress with concentric rings, based on a sketch in Codex Atlanticus, folio 48 *recto-b* (source: Reti 1974: 165).

Urban planning as the extension of architecture into the larger environment, was well understood by Leonardo. His proposed scheme for the redevelopment of the area of Florence between San Lorenzo and San Marco would have created a rectangular city space centred on the Medici palace. This scheme was later reinterpreted by Vasari for the urban renewal of the area between the Palazzo Vecchio and the Arno River that resulted in the creation of the Uffizi building and its courtyard passageway, the present Galleria del Uffizi.

Leonardo spent the last three years of his life as guest of Francis I (François Ier, 1494-1541), King of France, who called on him to design an entire new city at Romorantin as a royal residence (figure 10). During his last years at Amboise, Leonardo produced schemes for the new city and an imposing palace. According to Carlo Pedretti (1972) the project was Leonardo's last dream that was, unfortunately, abandoned after his death. However, if it had been built according to Leonardo's designs, it would have been what Karel Vereycken (2010: 53) calls a "first modern city". Its most remarkable feature is its total regularity, parallel streets, intersected at right angles by short, wide cross streets. Leonardo's innovative plan introduced the use of urban canals as part of the city's gridded street system. A long, straight canal bisects the city, while shorter canals, following the cross-streets, cross it at right angles, connecting the central canal to a system of canals that encircle the city as a defensive moat. This clearly articulated urban scheme, being both "utilitarian and salubrious" (Fricelli 1993: 509), anticipated not only the water-gardens of the Italian and French Baroque, but is also reminiscent of the street and canal system of Amsterdam, planned some 200 years later.

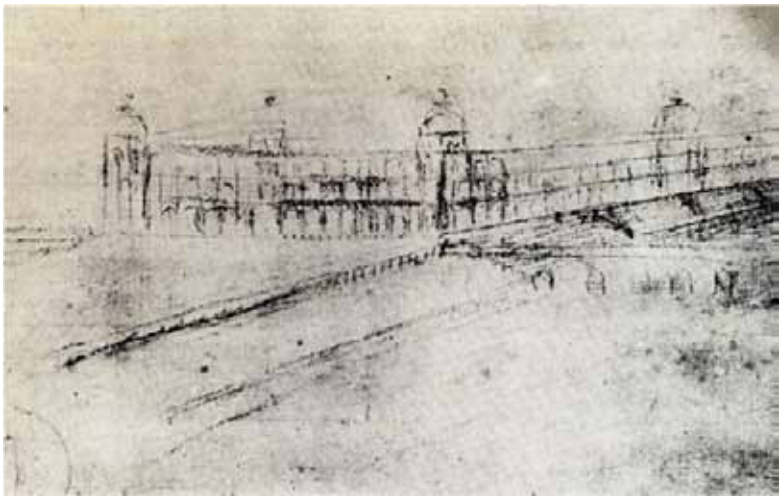


Figure 10
Leonardo da Vinci, sketch for the proposed city of Romorantin
(source: Pedretti 1985: 264).

It has been suggested that Leonardo may have designed the Château de Chambord in the Loire Valley for Francis I, since the structure of the remarkable double helix staircase at its centre points to an extraordinary architect (figure 11).[20]

Figure 11
Attributed to Leonardo da Vinci, double helix staircase,
Château de Chambord, 1519-47 (photograph: the author).

The spiral staircase at the Château de Blois is also attributed to Leonardo since its mathematical calculation of a spiral growth pattern structure also points to an extraordinary architect (figure 12).[21]

Figure 12
Attributed to Leonardo da Vinci, spiral staircase, Château de Blois, rebuilt by Francis I from 1515-19 (photograph: the author).

Leonardo's sketch for a city centre is on two levels, with a series of tunnels below ground level carrying wagon, cart and horse traffic, as well as serving as a conduit for waste material, and an upper level consisting of a series of arcaded structures framing an interconnected public square and pedestrian sidewalks (figure 13). This novel urban design in which Leonardo envisaged a city that would be practical, aesthetic, and hygienic to promote the well-being of inhabitants in the overcrowded Italian cities of his day, seems to be an urban extension of the traditional Renaissance palace as an architectural unit with its services on the ground level, and the *piano nobile* for luxurious living on the upper floor. Only in the twentieth century in the West did town planners apply similar ideas to separate services, vehicular traffic and pedestrian movement.

Figure 13
Leonardo da Vinci, project for a city centre on different levels, pen, ink and black chalk, manuscript B, folio 39 *recto* (source: Baroni 1956: 251).

Leonardo cannot be assessed as an architectural and urban planner in terms of actual structures, because he left no such legacy. Rather, some of his proposals for civic structures, churches, a palace, a harbour, and fortifications found somewhat modified expression in the architecture of his contemporaries, notably Bramante, as well as architects of the High Renaissance, both in Italy and later also abroad.

Leonardo's church designs

Continuing the tradition begun by Bramante in the Greek cross design of St. Peter's Basilica in Rome, of which the cornerstone was laid in 1503, Leonardo's thought experiments include a large number of central-plan churches. He envisioned a series of variations on the theme of a church composed of a geometrically regular domed octagonal central hall with side chapels ringing the central area. In these centralised plans the dome, placed on an octagonal base that can be geometrically inscribed in a circle while retaining the suggestion of a circular format, is mostly pointed, ribbed and crowned with a lantern, with much smaller similarly domed side chapels placed on the exterior sides of the octagonal plan (figure 14).

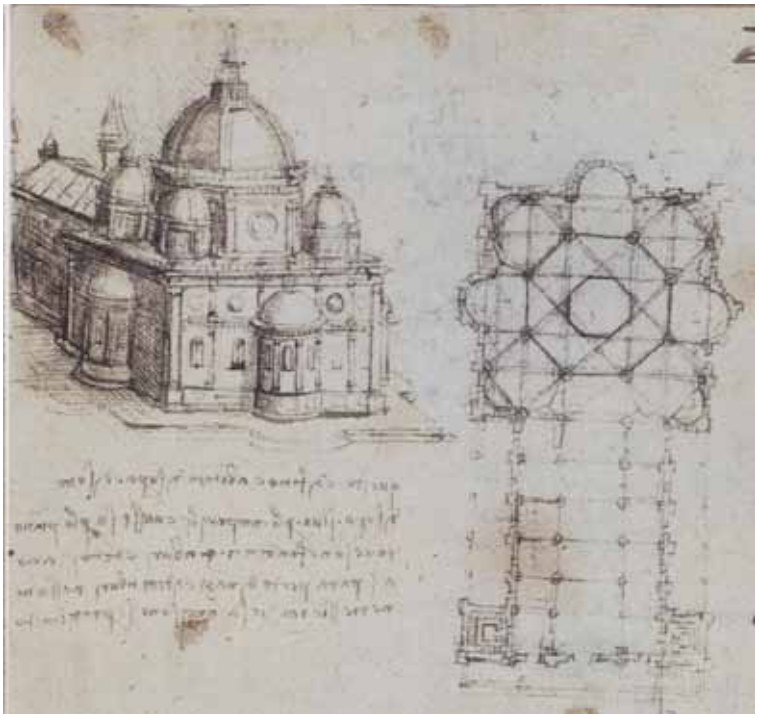


Figure 14
Leonardo da Vinci, plan and elevation of a longitudinal domed church with a central octagonal plan and surrounding domed chapels, manuscript B, folio 24 *recto*, pen, ink and black chalk (source: Chierici 1956: 236).

A variation of the domed central church is a Greek-cross plan with an octagonal central area, surrounded by eight side chapels of different forms, crowned on the flat roof structure with alternate turrets and small domes, entered with a stairway on the outside to a second level (figure 15). The corner turrets are more pronounced in a similar type of plan in the lower half of figure 19.

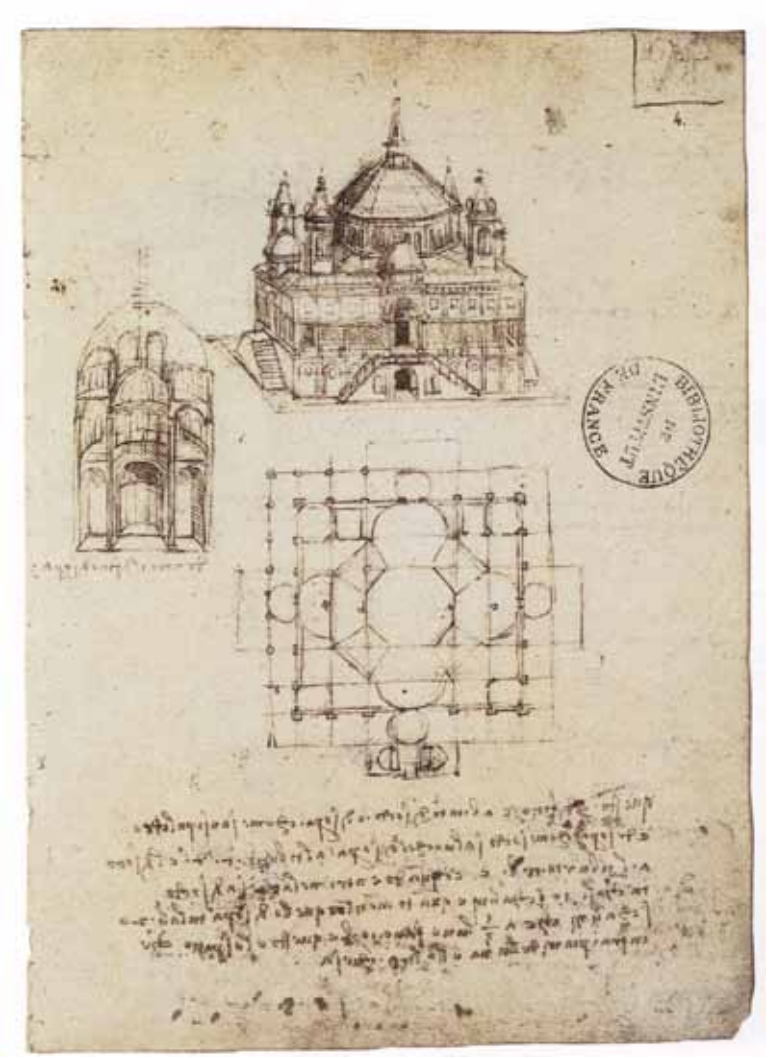


Figure 15
Leonardo da Vinci, plan and elevation of a domed Greek-cross plan church with alternating chapels and bell towers, pen, ink and black chalk, Bibliotèque de l'Institut de France, Ashburnham 2037, folio 4 *recto* (source: Chierici 1956: 235).

Notwithstanding the variations in planning and patterning, the basic themes of Leonardo's designs are reasonably simple. Plans are incorporated in a square set in a circle, set in a Greek cross, or a circle set in intersecting squares forming an octagon. His proposed churches include some on two levels, with a lower crypt, a central hall, and an upper dome. In his designs the multiplication of domes, half-domes, turrets and towers, apses, niches and the complex patterning of the walls in which all surfaces are covered with excressences recall the Italo-Byzantine churches of Padua and the Veneto and San Vitale at Ravenna. Fricelli (1993: 510) even suggests references to Byzantine churches of Russia and mosques in Turkey. In a sense these various sacred buildings represent a summary of past architectural accomplishments.

Leonardo's evolving sketches of various types of churches narrates his search for an understanding of the limits of the possible of specific structural forms. In a visual manner Leonardo eloquently celebrates architecture by filling sheet after sheet with sketches which, in serial form, seem to become arguments leading to the most convincing conclusion to specific formal, iconic and structural types. In this serialisation Leonardo reveals his preoccupation with mutability: that his *disegno* skills enabled him to transmute the pattern of one basic form into a series of more diverse forms.

It is certainly true that "only trivialities permit but one interpretation."[22] Since Leonardo most probably did not design the domed structures for any specific setting, the Kim Veltman (1986: 139-40) postulates that he availed himself in systematic play in designing ground plans for churches, evolving in complexity by an additive method and arriving at new shapes.

By definition play happens within accepted rules, which allows for the freedom of imagination, but not unlimited fantasy. In his imaginative play with domed church plans Leonardo follows Bramante's design for St. Peter's Basilica, Rome, an essentially a quincuncial plan that can be defined as a cross-in-a-square plan in which the central and four angular ones are domed to form a quincunx pattern. Since Leonardo's imaginative play with this basic church form was not intended for any practical purpose, his sketches are manifestations of a series of thought experiments.

Fricelli (1993: 510) furthermore suggests that Leonardo "may have been experimenting, as he did with so much else, with the problem of uniting the material and the spiritual by the integration of 'perfect' geometric forms, the circle and the square". These forms are clearly recognizable in many of his designs. They have had, since time immemorial, the symbolic connotations of heaven and earth, to which the ideal human form is also subject. According to a medieval drawing knowledge of ideal human proportions is probably based on revived Pythagoreanism[23] of the fifteenth century in which Nicolaus Copernicus (1473-1543) and Galileo Galilei (1564-1642) were deeply immersed. These astronomers applied direct observation and, most importantly, mathematics to reveal the structure of our solar system. Galileo (1957: 295) expressed his scientific credo as follows: "Philosophy is written in that vast book that stands forever open before our eyes; but cannot be read until we have learnt the language and become familiar with the characters is which it is written. It is written in mathematical language and the letters are triangles, circles and other geometrical figures, without which means it is humanly impossible to comprehend a single word."

Leonardo was equally inspired by the forms that Galileo later mentions, especially in his designs for cruciform churches in which geometric forms are the basis of structure as well as symbolic meaning. He may also have been influenced by Francesco di Giorgio Martini (1439-1507) who worked as an architect and engineer in Urbino, since Leonardo posessed one of his architectural manuscripts, *Trattati di achitettura ingegneria e arte militari*.[24] Indeed, Leonardo's sketch of a longitudinally planned church resembles that by Francesco (figure 14).

The idea that beauty is a quantifiable phenomenon derives from Vitruvius, and his illustration of the well-known "Vitruvian Man", inscribed into a circle and a square "seems to encapsulate the belief, deeply attractive to the Renaissance, that both man and the cosmos were structured according to regular geometry".[25] This idea must have appealed to Leonardo since it combined geometry with a living form. Likewise, Leonardo's domed churches unite heaven and earth in a geometric formula. The circles and squares he applied to his compositions metaphorically represent the realms of God and human beings. In this he follows the lead of other Italian designers of churches, most notably the Church of Santa Maria della Consolazione at Todi by Cola da Caprarola (1494-1507), built after 1508, with Baldassare Perruzzi (1481-1537) as advisor (figure 16).

Figure 16
Cola da Caprarola and Baldassare Perruzzi,
Santa Maria della Consolazione, Todi, after 1508 (source: internet).

Leonardo's most renowned designs of centralised domed churches on an octagonal plan

Leonardo's most renowned design is of an octagonal domed church with side chapels (figure 17), seemingly following the design pattern of the threefold *Concatenation* corresponding to the summit or dome, the middle of the interior, and the crypt below. It is postulated is that its integrated knotted design concept may also be recognised in Leonardo's architectural sketches of centralized domed churches with integrated secondary domed chapels. They echo the *Concatenation's* circular, rotating form with a static centre whose "pattern can be seen as circles around a centre" (Zwijnenberg 1999: 183). Similarly, Leonardo's domed churches have circular, rotating forms with static centres. The centralization of various of his church designs enhances the manner in which the parts, such as the dome and side chapels, interact dynamically in structural support of each other, furthermore suggesting a cosmic orientation by anchoring the plan in the four directions of a square.

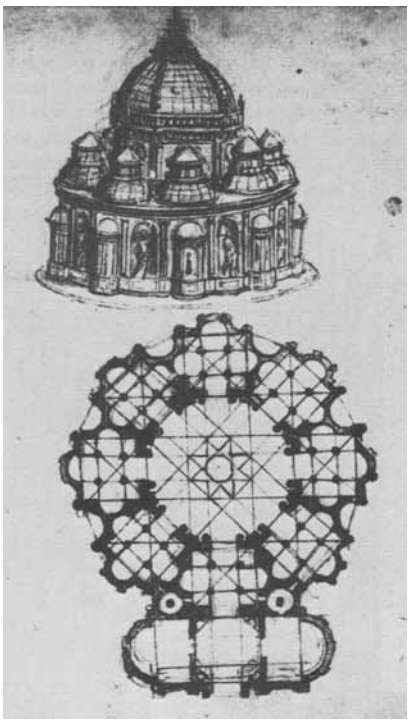


Figure 17
Leonardo da Vinci, plan and elevation of a domed church based on an octagonal central space with eight side chapels, *circa* 1488, 14x19 cm, pen, ink and black chalk, Bibliotèque de l'Institut de France, Ashburnham 2037, folio 5 *verso* (source: Chierici 1956: 234).

Most striking is the resemblance between Leonardo's ball bearing ring and the octagonal plans of centralised domed churches (figure 18). In a sheet of sketches with plans and elevations the octagonal ring marking the centres of the surrounding chapels in the upper right hand corner is clearly reminiscent of the ball-bearing race with eight sections and the plan of the domed octagonal church in figure 17 (figure 19). Analysing this phenomenon one may surmise that Leonardo envisaged the circle that can be drawn through the centres of the chapels as a moving ring, that serves, according to Veltman (1999: 140) "to illustrate his process of addition and multiplication of forms". The composite pattern of central hall and side chapels could be extended with further surrounding rings at decreasing distances linking decreasing chapels, but that would, however, render the architecture unfunctional.

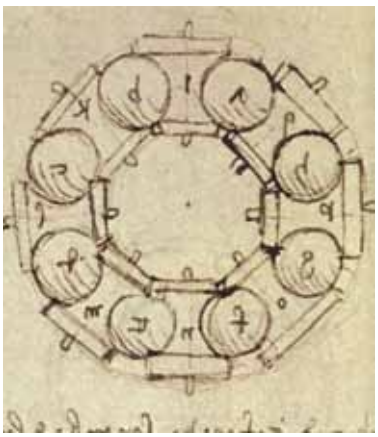


Figure 18
Leonardo da Vinci, design for a ball-bearing race, Codex Madrid, folio 20 *verso* (source: Reti 1974: 286).

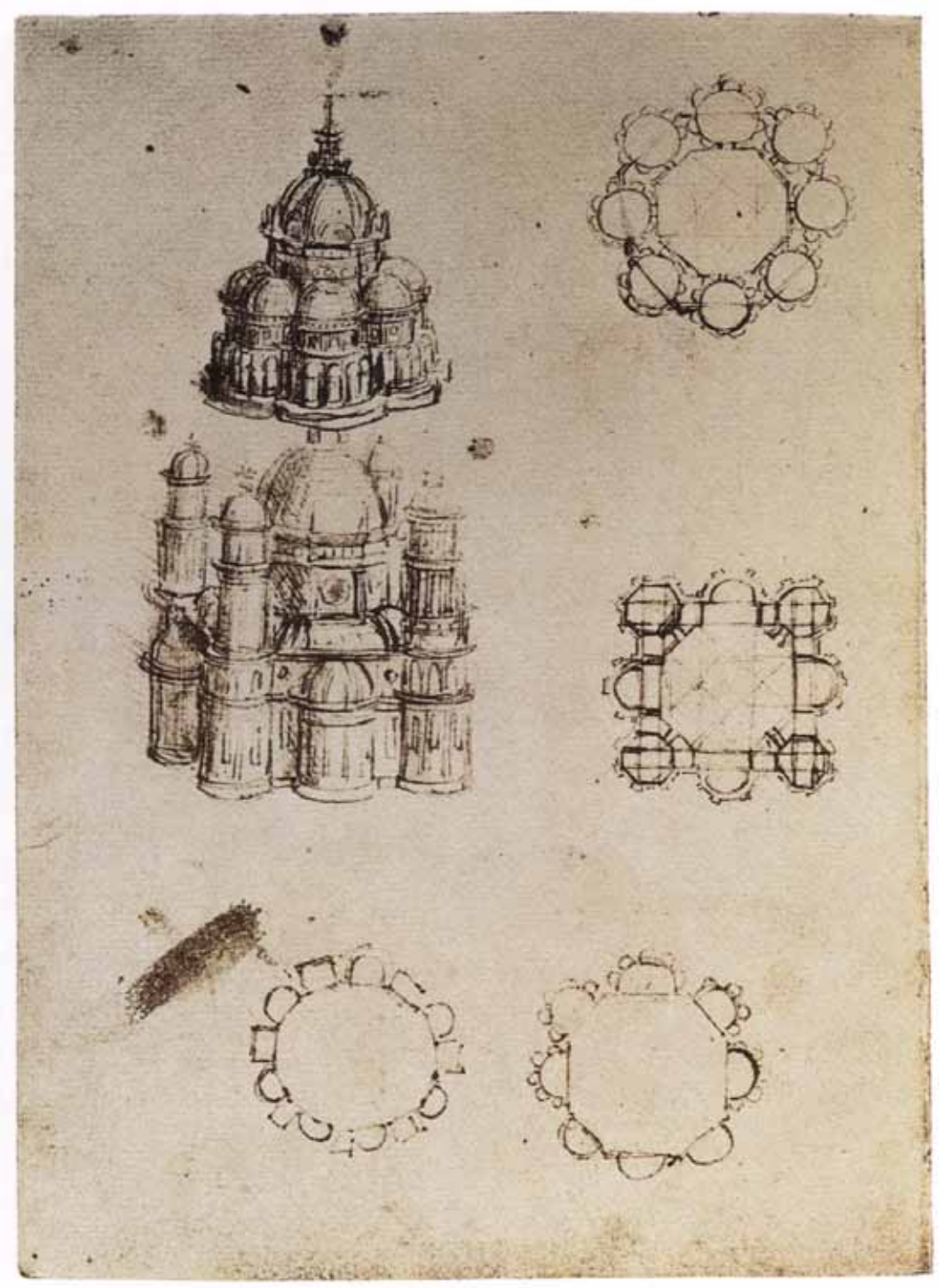


Figure 19
Leonardo da Vinci, sketches of plans and elevations of domed churches with octagonal central spaces, respectively with eight surrounding domed side chapels and four domed chapels and four corner minarets, pen, ink and black chalk, manuscript B, folio 25, *verso* (source: Chierici 1956: 235).

The plans of the surrounding chapels and their small domes in figures 17 and 19 are clearly similar to that of the main hall and its large dome, a pattern that approximated a fractal design.[26] This is the most outstanding of Leonardo's designs with the design of the octagonal main hall and side chapels following a repetitive, approximate self-similar pattern on a different scale. One may surmise that Leonardo had this idea of a growth pattern in mind. Thus the pattern

of the domed church with its exact geometrical layout may be extended from the core to the periphery, like the branching of the schematic tree which he sketched (figure 20). These unique designs are the culmination of an idea that a building is a "live" structure and that live structures follows a geometric growth pattern. Thus, in principle, the chapels may generate another series of smaller chapels, if that could in any sense be functional. However, Leonardo actually ventured to experiment with a designs of domed churches on an octagonal plan surrounded by eight domed chapels extended by eight more smaller domed spaces (figure 21).

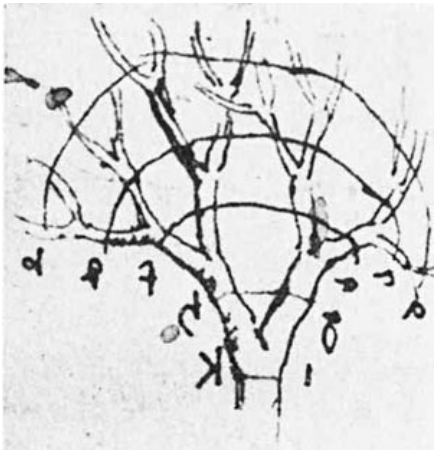


Figure 20
Leonardo da Vinci, analysis of the growth pattern of a tree, pen and ink,
(source: http://whattheheckisart.blogspot.com/2012/01/physorg-more-than-500-years-ago.html).

The same fractal-like pattern can be observed in the plan and elevation of the church in the upper section of figure 19.

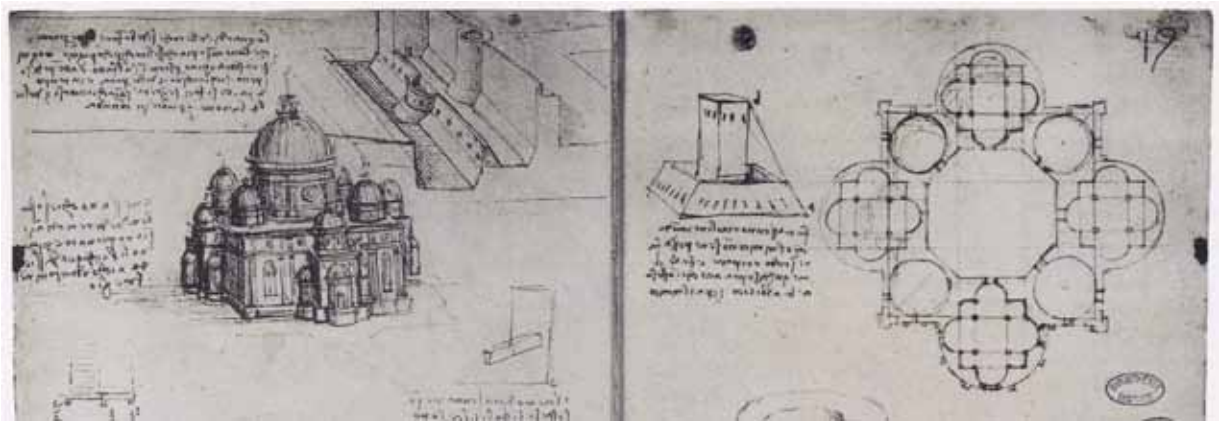


Figure 21
Leonardo da Vinci, sketches of plans and elevations of a domed church with the central space and eight domed side chapels based on an octagonal pattern extended by eight smaller domes, pen, ink and black chalk, manuscript B, folio 18 *recto*
(source: Chierici 1956: 236).

Leonardo's influence

Leonardo's treatment of domed and other structures may have influenced later writers on architecture, most notably Sebastiano Serlio (1475-1554). His architectural drawings, together with those of Francesco di Giorgio Martini and Giuliano Sangallo (1443-1516), are among the earliest known, since no drawings exist of this early date by Bramante, who worked in Milan

as court architect together with Leonardo for nineteen years. Leonardo's drawings are therefore crucial in illustrating the evolution of High Renaissance and even the Baroque architecture.

It may be said that Leonardo seldom aimed at the real; his imagination most often roamed in the realms of pure invention. Proof for this statement is that, if built, this church with a high dome as central compositional element, ringed by eight smaller domes all set on drums upon a square base, would have been of enormous size. The piers that would have been needed to support the superstructure would have completely invaded the space below the dome. This kind of structural problem became real for Bramante when he constructed the piers of the new St. Peter's Basilica, Rome. His Greek cross design is reminiscent of plans proposed by Leonardo for a cruciform church with a central domed crossing (figure 14), as well as his plan (figure 21) that shows the repetition of smaller Greek-cross-shaped chapels around a central space at the crossing of a large, domed Greek-cross plan. Also Bramante's monastic church of Santa Maria della Pace, Rome, reveals Leonardo's influence. However, Leonardo had not set goal to construct any of his designs. According to Fricelli (1993: 509) Leonardo had an "immense, if concealed influence". It is suggested that Bramante was aware of Leonardo's architectural thinking and copied his Il Tempietto in Rome (figure 22) from his centralised church designs.[27] Raffaello Sanzio, not only a painter but also a renowned architect, placed a centralised church, inspired by Leonardo and Bramante, in the background of his *Marriage of the Virgin* (figure 23). The greatest homage of all is paid to Leonardo by Andrea Palladio in his Villa La Rotunda, Vicenza (figure 24).

Figure 22
Donate Bramante, **San Pietro in Montorio, called Il Tempietto, Rome**, ***circa*** **1502**
(source: http://www.wikipedia.org/wiki/San_Pietro_in_Montorio).

Figure 23
Raffaello Sanzio, *Marriage of the Virgin*, 1504, oil on roundheaded panel, 170x118 cm, Pinacoteca di Brera, Milan
(source: http://www.wikipedia/wiki/The_Marriage_of_the_Virgin_Raphael).

Figure 24
Andrea Palladio, Villa Almerico Capra, called La Rotunda, Vicenza, built 1566-7, completed in 1591 (photograph: the author).

Leonardo's approach to design was to set himself problems and as Klein (210: 222) succinctly remarks, he demonstrated with his creative combinations "how far a person can take research that has no set goal". Leonardo's thought experiments with architectural plans enhanced his ability to mutate living forms into design forms such as machines and buildings.

The influence of Leonardo's anatomical studies on his architectural designs

The way in which Leonardo composed a building is comparable to the way in which he analysed human and animal anatomy because he saw analogy in the forms of nature and the artefacts he designed. Peter Murray (1969: 109) points out that Leonardo's scientific approach to anatomy has its counterpart in his numerous architectural drawings, in that he evolved different stages of planning and formal analysis, analogous to the way in which his anatomical diagrams are based on different stages of dissection (figure 25). As discussed above, Leonardo method of design was to take a number of centrally planned forms and evolve more and more complex elevations from the first simple shape. In these architectural sketches Leonardo seems to be seeking for an optimal solution to whatever form or structure he enquired into. In this search one may recognise a dialectic between various modes of being or manifestations, such as architecture and anatomy, matter and form, and oneness and multiplicity of form.

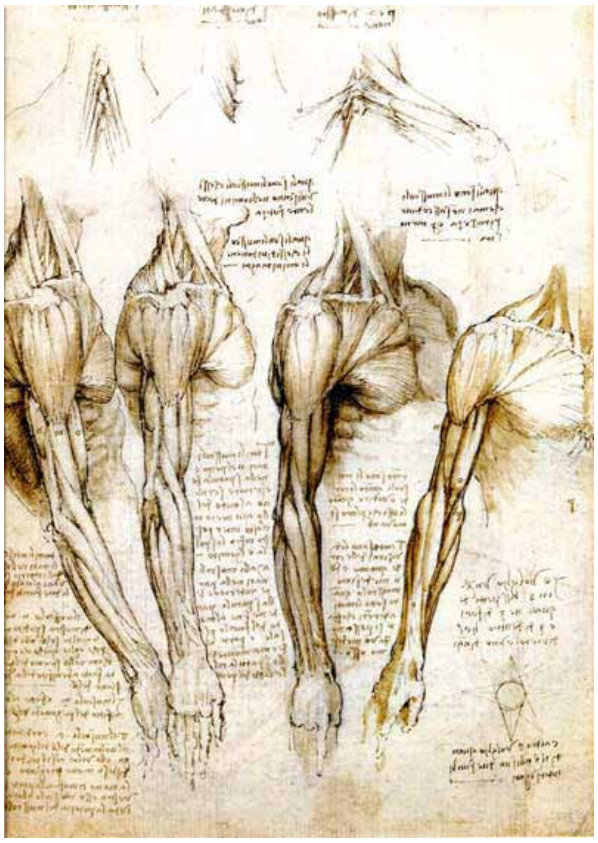


Figure 25
Leonardo da Vinci, muscles of the right shoulder and arm, 1510. pen and ink, Royal Library, Windsor Castle
(source: http://www.italian-renaissance-art.com/leonardo-drawings.html).

Even more important is the fact that Leonardo did not consider the terms "mechanical" and "organic" as opposites, as Mary Garrard (2010: 143) explains:

> [F]or Leonardo [these terms] were intimately linked. When he analyzed the movements of animals as "mechanical", he meant that they exemplify dynamic motion – of organically moving parts, not metal robots. He analyzed buildings as if they were functioning machines: as Paolo Galluzzi put it, "not merely static structures based on precise proportions, but living organisms in dynamic equilibrium."[28] [...] Brunelleschi's breakthrough had been to mechanize the organic, but Leonardo's contribution was to organize the tectonic.

Like living bodies or organisms, Leonardo's projected domed forms have a life of their own; like the human body.[29] His architectural designs approximate coherent microcosms, an idea summarised by Jonathan Jones (2010: 146): "In all his scientific work Leonardo remained loyal to the medieval idea of microcosm and macrocosm. In this traditional view of the cosmos, everything is a token of everything else: the same elements that compose a human being, compose a tree, and unexpected analogies can be discerned by the knowledgeable mind in things apparently quite different from one another."

Unexpected analogies can be found between knots, anatomy and architecture in Leonardo's oeuvre. His anatomical studies and architectural sketches, as well as the proportions of the human body and that of a building have the same quality of mutability. His creativity flourished by forging perceptual connections between design disciplines and natural phenomena.

Leonardo's classical and anti-classical, sacred and secular designs

In Leonardo's designs of architectural structures, both in his sketchbooks and in his paintings, he consistently subjected architectural mass to geometric form. He employed the classical orders as defined by Alberti and others, but not in a classical way. He never placed the orders as structural elements in a classical way between regulated intervals, but in an ambiguous way against walls, thus complicating both the orders and the walls.

Fricelli (1993: 511) also notes that a separation can be made between Leonardo's secular and sacred architectural designs: "His imagination tended toward the practical and the utilitarian in matters secular, and toward the theoretical and speculative in matters sacred." However, one may argue that the "theoretical and speculative" remained in the realm of the secular, since Leonardo's interest in architecture remained that of an engineer whose main interest in church architecture was not liturgy, but the mechanics involved in construction, referring also to natural forms. In all his researches Leonardo seems to have oscillated between practical empiricism and the alternative visual world of his imagination. He projected the latter in metaphors of cosmic correspondence, of which the *Concatenation* is an example. Even though the plans of Leonardo's centralised churches are imaginary he nevertheless evoked his world view in an architectural vocabulary that echoes Aristotelian cosmology. In this sense these designs were apt metaphors for the world view of the Roman Catholic Church. However, it should be postulated that Leonardo's knowledge of perspective – with its implicit postulate of infinity – meant that he did not subscribe to the closed cosmos in scientific terms.[30]

Rhetorical qualities of Leonardo's architectural designs

Leonardo's exploratory manner as expressed by means of his *Concatenation* design and architectural sketches have the quality of visual rhetoric – that is a mental way of seeking or devising a "vocabulary" and "syntax" with which to envision possible forms and structures. This exploratory attitude, of searching for originality, is referred to as *innovatio* in classical rhetoric. The preparatory stage of an orator's speech is inventiveness that is necessary to ensure a convincing speech or end product. Architecture, however, is a visually expressive medium and a building's rhetorical qualities can be found in the way its diverse parts are articulated and synthesized into a totality. The architect skilled in Classical rhetoric – of which Leonardo was certainly aware – composes visually to achieve the effect of *energeia*[31] that implies unique and purposive form, as found in his church designs. This ideal calls to mind Plotinus's assertion in *On Beauty* (*Ennead* 1, 6): "Only a compound can be beautiful, never anything devoid of

parts; and only a whole; the several parts will have beauty, not in themselves, but only working together to give a comely total."

One may draw an analogy with Leonardo's imaginary buildings by comparing the writing of history and fiction. History writing should be true in the sense that whatever is described actually happened, while fiction implies an author's freedom to use literary devices to persuade the reader to take the imaginary world in which fictitious events occur seriously. His scientific enquiry into anatomy by means of dissection was expressed in precise terms in anatomical drawings, while his architectural sketches of churches may be interpreted as works of fiction in which he expresses their mediating function between human beings and an infinite cosmos that – in his era – could only be symbolically understood.

Coda

A thirteenth-century mystic, Jalaluddin Rumi, once wrote:

> We are addicted to subtle discussions;
> we're very fond of solving problems.
> So that we may tie knots and then undo them,
> we constantly make rules for posing the difficulty
> and for answering the questions it raises.[32]

How else can one interpret Leonardo's architectural endeavours – indeed all of his artistic enterprise – than as the tying of knots, that is of the creating and solving of problems. His enquiring mind and hand skilled at *disegno* embodied his fondness of solving problems as evidenced in his logo design, the *Concatenation*. Moreover, Leonardo the creator and scientific researcher not only had a predilection for tying knots and unravelling them, but in an exemplary manner his architectural designs show their parts tied together coherently in wholes seemingly endowed with a life force, while being simultaneously functional structures integrated into an aesthetic totality.

Notes

1 The following scholarly works that deal with Leonardo's architectural designs are the most notable: Baroni (1956), Chierici (1956), Pedretti (1962), Reti (1974), Kemp (1981), Pedretti (1982), Pedretti (1985), Veltman (1986), Galluzzi (1987), Zwijnenberg (1999), Zöllner (2007), Klein (2010).

2 Leonardo, manuscript H 67r, quoted from Reti (1974: 295).

3 The theme of "the knot of body and soul" in Dante's thought is treated by Shapiro (1998).

4 Leonardo, *Mona Lisa*, 1505-14, Louvre, Paris.

5 See Klein (2010: 17).

6 Leonardo, Atlanticus 203r-a, Quoted from Reti (1974: 294). As will be argued later, Leonardo's insight into perspective defies the postulate of a closed cosmos (see note 20).

7 This philosophical insight is borrowed from Marías (1967).

8 For a survey of the meaning and application of *disegno*, see (Quek 2010).

9 Quoted from Kemp (1987: 131-32).

10 Quoted from Kemp (1987: 131-32).

11 Quoted from Kemp (1987: 131-32).

12 Inventiveness (*invenzione*) resulted in added internal *variet* which Bull (1965: 250) defined as a component of spontaneity that Vasari understood "enables the artist to enhance his works by adding innumerable inventive details, and, as it were, a pervasive beauty to what is merely artistically correct".

13 Phillips and Priwer (2012).

14 A Swiss scientist, D.F. Stüssi, calculated that Leonardo's design was technically feasible and constructed the model housed in the National Museum of Science and Technology in Milan.

15 It may be postulated that Leonardo prefigured some enigmatic architectural ambiguities in Mannerist paintings, such as the dangerously twisting dysfunctional flight of stairs going nowhere in Giacomo Pontormo's (1494-1557) *Joseph in Egypt*, 1518, 44x49 cm, National Gallery, London.

16 Leonardo da Vinci, *Last Supper*, 1495-97, refectory of San Ambrogio, Milan.

17 There is evidence of Leonardo's association with Bramante (Pedretti 1973).\

18 Quoted from Kemp (1981: 107).

19 See the sheet illustrating civic buildings in Codex Atlanticus, folio 395 *recto*-b. See also Guillaume (1974).

20 Leonardo illustrated his skill in designing double staircases with square plans (Manuscript B, folio 68 *verso*, and Manuscript B, folio 47 *recto*) and also a double spiral staircase on a circular plan (Manuscript B, folio 69 *recto*).

21 Tanaka (1992: 85).

22 Quoted from Neugebauer (1954: 2).

23 Pythagoras of Samos (*c.* 570-*c.* 495 BCE) was an Ionian Greek philosopher and mathematician. There is little reliable information about him since his life and works were only recorded centuries after his death.

24 See http://www.omifacsimiles.com/brochures/francesco.html.

25 Quoted from Rogers (2010), who acknowledged Wittkower (1962) as the exponent of this idea.

26 The word "fractal" was coined in 1975 by Benoit Mandelbrot (died 1910), a Polish-born mathematician. Fractals are geometrical objects that are self-similar when the distance at which they are viewed is changed. The only reference found referring to "Leonardo's fractal designs" was accessed on 2012/02/02 at http://classes.yale.edu/fractals/panorama/Architecture/DaVinci.The author's name is not mentioned. His brief text reads: "Why did Leonardo propose fractal designs? Perhaps because his careful drawings of flowers and water vortices made him aware of repetition across scales in nature."

27 Pedretti (1973: 227) states that Leonardo's "possible participation in the conception of Bramante's *Tempietto*, or even that of the new S. Peter's, must remain conjectural".

28 Galluzzi (1987: 101).

29 Kemp (1981: 117-8) quotes Leonardo's insight into man as a "lesser world" or microcosm:"By the ancients man was termed a lesser world and certainly the use of the name is well bestowed, because, in that man is composed of water, earth, air and fire, his body is an analogue for the world...".

30 The discovery of perspective in the Renaissance is an important aspect of the demise of the finite, closed, Medieval, Aristotelian cosmos. Euclidian space is infinite clearly seen in the "parallel postulate": given any straight line and any point not on that line, there is precisely one straight line through the point and parallel to the given line – i.e., continuously equidistant from, never meeting the given line. The conclusion may be drawn that the relationships between three disparate systems – infinite, three-dimensional Euclidian space, a finite flat physical surface, and human vision – are discovered and bound together as representation.

31 The term *energeia* is derived from Aristotle's *Poetics,* iii. 111.1-2.

32 Quoted from Helminski (1990: 204).

Works cited

Alberti, Leon-Battista. 1988. *On the Art of Building in Ten Books*.Translated by Joseph Rykwert *et al.* Cambridge, Mass.: MIT Press.

Aristotle. 1951. *The Poetics*, translated by S.H. Butcher as *Aristotle's Theory of Poetry and Fine Art*. New York: Dover.

Aristotle. 1953. *Metaphysics,* translated by W.D. Ross. Harvard: Loeb Classical Library, Harvard University Press.

Baroni, Costantino. 1956. Leonardo architetto, in *Leonardo da Vinci I,* Novara: Instituto Grafico de Agostini: 238-59.

Bull, George (ed.). 1965. *Lives of the Artists*. Harmondsworth: Penguin.

Brown, James Robert. 2011. Thought experiments, *Stanford Encyclopedia of Philosophy,* http://plato.stanford.edu/entries/thought-experiment: 1-32.

Chierici, Gino. 1956. L'architettura a cupolo, in *Leonardo da Vinci I,* Novara: Instituto Grafico de Agostini: 233-7.

Coomaraswamy, Ananda K. 1949. The inconography of Dürer's "knots" and Leonardo's "concatenation", *Art Quarterly* 7(2, Spring): 109-27.

Dante Alighieri. 1904. *De monarchia,* edited and translated by Aurelia Henry. Boston & New York: Houghton Miflin and Co.

Dante Alighieri. 1963. *La divina commedia,* edited by F. de Sanctis. Rome: Editrice Italiana di Cultura.

Di Giorgio Martini, Francesco. 1482. *Trattato di architettura, ingegneria e arte militare.* Biblioteca Medicea Laurenzina, Firenze, manuscript 282.

Dorn. Harold. 1989. Book review of Paolo Galluzzi (ed.), *Leonardo da Vinci: Engineer and Arcitect. (Catalogue of an* Exhibition at the Montreal Museum of Fine Arts, 22 May-8 November1987), *Isis* 80(3, September): 522-4.

Fricelli, D. 1993. Leonardo da Vinci, in R.J. van Vynckt (ed.), *International Dictionary of Architects and Architecture 1.* Detroit: St. James Press: 508-11.

Galileo, 1957. *Il saggiatore, Q. 6, in Augustine to Galileo, translated* and edited by A.C. Crombie. Chicago: University of Chicago Press.

Galluzzi, Paolo (ed.). 1987. The career of a technologist, *Leonardo da Vinci, Engineer and Architect*. Montreal: Montreal Museum of Fine Arts: 41-109.

Garrard, Mary D. 2010. *Brunelleschi's Egg: Nature, Art, and Gender in Renaissance Italy.* Berkeley/Los Angeles/London: University of California Press.

Goldscheider, L. 1959. *Leonardo da Vinci: Life and Work, Paintings and Drawings.* London: Phaidon.

Guillaume, Jean. 1974. Léonardde Vinci et l'architecture française. I. Le problème de Chambord, *Revue de l'Art* 25: 71-84.

Helminski, C. & K. 1990. *Rumi: Daylight. Putney: Threshold.*

Jones, Jonathan. 2010. *The Lost Battles: Leonardo, Michelangelo and the Artistic Duel that Defined the Renaissance.* London: Simon and Schuster.

Kemp, Martin. 1981. *Leonardo da Vinci: The Marvellous Works of Nature and Man.* London: J.M. Dent and Sons.

Kemp, Martin. 1987. The inventions of nature and the nature of inventions, in Paolo Galluzi (ed.), *Leonardo da Vinci, Engineer and Architect.* Montreal: Montreal Museum of Fine Arts: 131-44.

Kemp, Martin. 1996. Leonardo da Vinci, in J. Turner (ed.), *Dictionary of Art 19.* London: Macmillan: 180-99.

Klein, Stefan. 2010. *Leonardo's Legacy: How Da Vinci Reimagined the World, translated from the German by Shelley Frish.* Philadelphia: Da Capo Press.

Koestler, Arthur. 1970. *The Act of Creation.* London: Pan Books.

Koyré, A. 1969. *Von der geschlossen Welt zum unendlichen Universum.* Frankfort am Main: Sührkamp Taschenbuch.

Leonardo da Vinci. 1956. *Treatise on Painting (Codex Urbinas Latinus 1270),*edited by A.P. McMahon. Princeton: Princeton University Press.

Marias, J. 1967. *History of Philosophy,* translated from the Spanish by A. Appelbaum and C.C. Stowbridge. New York: Dover.

McCue, James F. 1962. Scientific procedures in Aristotle's *De Caelo, Traditio* 18: 1-24.

Murray, Peter. 1969. *The Architecture of the Renaissance.* London: Thames and Hudson.

Neugebrauer, O. 1945. The history of ancient astronomy: problems and methods, *Journal of Near Eastern Studies* IV (1, January): 2-38.

Pedretti, Carlo. 1962. *A Chronology of Leonardo da Vinci's Architectural Studies After 1500.* Genève: Librairie E. Droz.

Pedretti, Carlo. 1972. *Leonardo da Vinci: The Royal Palace at Romorantin.* Cambridge, Mass.: Harvard University Press.

Pedretti, Carlo. 1973. Newly discovered evidence of Leonardo's association With Bramante, *Journal of the Society of Architectural Historians* 32: 223-7.

Pedretti, Carlo. 1982. Leonardo da Vinci, *Macmillan Encyclopedia of Architects 2,* edited by Adolf K. Placzek. London: Collier Macmillan: 676-85.

Pedretti, Carlo. 1985. *Leonardo Architect,* translated from the Italian by Sue Brill. New York: Rizzoli.

Phillips, Cynthia and Priwer, Shana. 2012. Leonardo da Vinci: he built this city, retrieved on 7 January 2012 from http:www.netplaces.com/leonardo-da-vinci/architecture/he-built-this-city.htm.

Plotinus, 1930. *On Beauty*, in *The Enneads,* translated by S. MacKenna and revised by N. Page. London: Faber & Faber.

Poirier, M.G. 1976. *Studies on the Concepts of "Disegno", "Invenzione", and "Colore" in Sixteenth-century Italian Art and Theory.* Ann Arbor, Michigan: Xerox University Microfilms.

Quek, Raymond. 2010. Excellence in execution: *disegno and the parallel of* eloquence, *Working Papers on Design* 4, edited by Grace Lees-Maffei, retreived on 16 April 2012 from http://sitem.herts.ac.uk/artdes_research/papers/wpdesign/index.html.

Reti, Ladislao (ed.). 1974. *The Unknown Leonardo.* London: Hutchinson.

Richter, Jean Paul (ed.). 1880. *The Notebooks of Leonardo da Vinci XIII: Theoretical Writings on Architecture.* New York: Dover.

Rogers, Mary. 2010. Beauty and concepts of the ideal, in Linda Kalof and Willian Bynum (eds.), *A Cultural History of the Human Body in the Renaissance.* Oxford and New York: Berg: 125-48.

Shapiro, Marianne. 1998. *Dante and the Knot of Body and Soul.* London: Palgrave Macmillan.

Tanaka, Hidemichi. 1992. Leonardo da Vinci, architect of Chambord? *Artibus et Historiae* 13(25): 85-102.

Vasari, Giorgio. 1906. *Le vite de' più eccellenti pitturi, scultori, ed architettoni,* in Gaetano Milanesi (ed.), *Le opere di Giorgio Vasari*. Florence: Sansoni.

Veltman, Kim and Keele, Kenneth D. 1986. *Studies in Leonardo da Vinci I: Linear Perspective and the Visual Dimensions of Science and Art.* Münich: Deutsche Kunstverlag.

Vereycken, Karel. 2010. Romorantin: Leonardo da Vinci imagines the first modern city, *EIR Culture* (20 August): 53-55.

Wade, D. 1991. *Crystal and Dragon: The Cosmic Dance of Symmetry and Chaos*

in Nature, Art and Consciousness. Rochester, Vermont: Destiny Books.

Winter, George. 1963. Architectural engineering, *Encyclopedia Britannica 2*. London: William Benton: 301-5.

Wittkower, Rudolf. 1962. *Architectural Principles in the Age of Humanism.* London: Triani.

Zöllner, Frank. 2007. *Leonardo da Vinci 1452-1519: The Complete Paintings and Drawings.* Köln: Taschen.

Zuccaro, Federico. 1607. *L'idea de' pittori, scultori et architetti.* Torino.

Zwijnenberg, Robert. 1999. *The Writings and Drawings of Leonardo da Vinci: Order and Chaos in Early Modern Thought,* translated by Caroline A. van Eck. Cambridge: Cambridge University Press.

Estelle Alma Maré holds the position of Professor Extraordinaire in the Department of Architecture, Tshwane University of Technology, Pretoria, and is the present editor of the *SAJAH*.

Le Corbusier's town-planning ideas and the ideas of history

Gerald Steyn
Tshwane University of Technology
E-mail: steyngs@tut.ac.za

Since Le Corbusier so forcefully propagated a new urban and architectural dispensation, there is a misconception that he disregarded history and that he conceptualised projects rationally and without preconceived ideas. Focusing on his town-planning schemes, this article provides substantiation that Le Corbusier's urban ideas are intrinsically connected to ideas essentially derived from historical sources.
Key words: Le Corbusier, urbanism, modernist town-planning

Le Corbusier se idees aangaande dorpsbeplanning en geskiedkundige idees
Aangesien Le Corbusier so kragdadig gepropageer het vir 'n nuwe stedelike en argitektoniese bedeling, heers daar 'n wanbegrip dat hy geskiedenis verontagsaam het en dat hy projekte sonder vooropgestelde idees rasioneel gekonseptualiseer het. Met 'n fokus op sy dorpsbeplanningskemas bied hierdie artikel stawing dat Le Corbusier se stedelike idees wesenlik gekoppel is aan idees wat hoofsaaklik aan geskiedkundige bronne ontleen is.
Sleutelwoorde: Le Corbusier, stedelikheid, modernistiese dorpsbeplanning

Le Corbusier (1887-1965) was one of the most prominent architects of the 20th century. He was also a self-proclaimed town-planner, but whereas his building designs are certainly entrenched and celebrated in architectural history and theory, his critics have been considerably less flattering in their comments on his city planning. In fact, Le Corbusier is frequently blamed for the monotonous, single use zoning and car-dependent developments immediately after the Second World War.

Baker (1996: 294, 303) writes that "the inadequacies of Le Corbusier's town-planning strategies are now well known" and speaks of his city schemes as "excruciatingly boring" and "regimental". That judgment is particularly puzzling considering the astonishing scope, diversity and volume of his urban projects and their associated architectural forms. One reason is that, whereas his buildings are being subjected to continuous rigorous assessment, evaluations of his urban projects are rare and mostly highly subjective. This could be because his buildings can be experienced in situ, while Chandigarh, his only realised city, is not a common traveller's destination. Another reason is that his critics are mostly fixated only on his early projects (Contemporary City, Plan Voisin and Radiant City).

This article hopes to contribute to the journal's editorial theme by exploring the connections between Le Corbusier's town-planning ideas and the ideas he derived from historical sources and, by implication, precedent. It focuses simplistically and narrowly on shape and form and for that purpose twelve of the most geometrically distinctive plans were selected (figure 1).

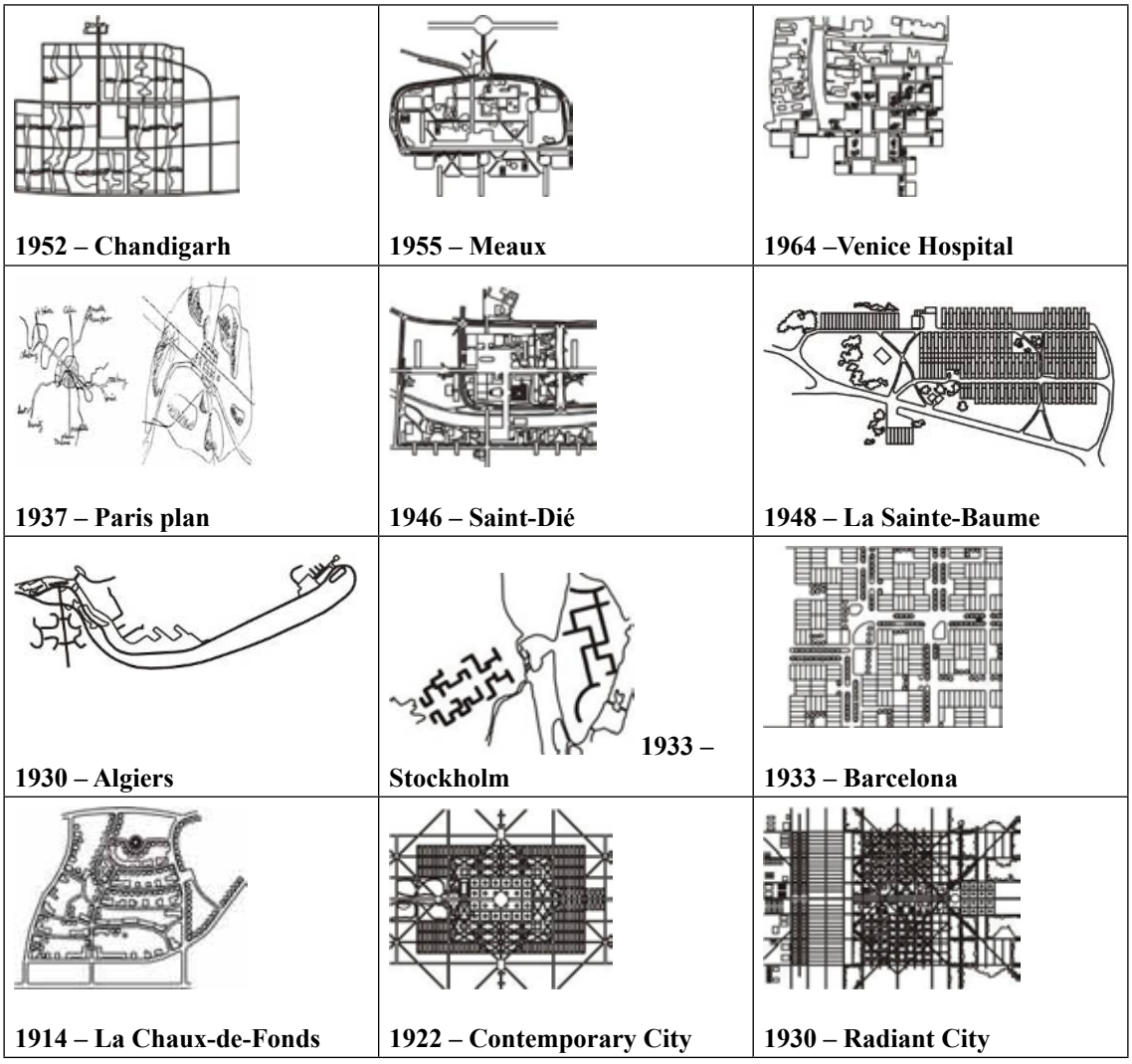


Figure 1

A selection of Le Corbusier's urban typologies (drawing by the author, not to scale).

As the undisputed leader of the Modernist Movement there is a perception that he rejected ideas from history. His Purist work (1917-1929) especially seems to have had no historical connections, but he writes during that period that "there is no reason why we should bury Old Europe" (1929: xxvii). He makes his position quite clear (1929: 39):

> So, to begin with, man [sic] needs a dwelling and a town. The dwelling and the town will result from the spirit of today, the modern spirit, this irresistible force, overflowing and uncontrollable now, but derived from the slow efforts of our forefathers.

And concludes (1929: 264): "Past history provides us with innumerable and forceful examples. Foresight and control are essential". Both his first seminal books are testimony to his appreciation of the past. In *Towards a new architecture* (1927) he allocates 70 out of 289 pages, about 25 per cent, to historical issues, a proportion that increases to nearly 30 per cent, or 85 out of 300 pages, in *The City of Tomorrow* (1929).

Curtis (1986: 228) suggests that "along with nature and geometry, Le Corbusier's other great inspiration was tradition … [trying] to penetrate to the generating principles". Tzonis and Lefaivre (1985: 7) are blunter: "Le Corbusier plundered history and the work of his contemporaries in order to grasp, control and transform the given modern reality. He searched

constantly for those elements with which one would have to construct the appropriate urban instrument".

Early influences

Le Corbusier was born Charles-Edouard Jeanneret in the small Swiss town of La Chaux-de-Fonds. By 1905 he had started his architectural training under the mentorship of a local architect. He was an avid reader and a keen observer, and two years later he also became an enthusiastic and life-long traveller. His travels, especially to the Mediterranean, South America, North Africa and the United States, exercised a number of profound influences on his views of architecture and town planning. First, while touring the Mediterranean he became profoundly impressed by Greek, Roman and Turkish aesthetic and spatial ideals. Second, after visiting Brazil he adopted curvilinear, geometrically less precise forms. Third, from North Africa he learned about the rougher vernacular of the Maghreb and about Arab architecture in particular. Fourth, the United States reinforced his belief in freeways, tall buildings and larger street blocks.

The Carthusian monastery of Ema in Tuscany (figure 2) made a lasting impression on him. He would later admit that his "basic measures of urbanism, determination of the cellular [dwelling] unit, the network of roads and transportation lines" were all part of "a process of fundamental architectural organization which he had already experienced … at the Charterhouse of Ema", notable for its "individual freedom and collective organization" (1951: 28). He visited the monastery again in 1911.

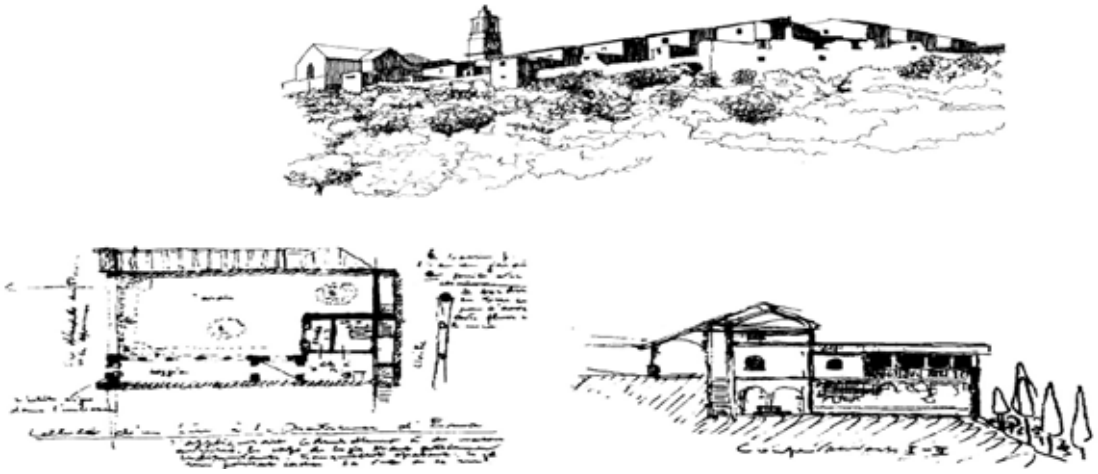


Figure 2
Le Corbusier's sketches of the Carthusian monastery of Ema in Tuscany
(source: Baker 1996: 75).

Although his initial physical experiences were the famous sites of Greek and Roman antiquity, together with the architecture of Byzantium monasteries and that of Istanbul (then part of the Islamic Ottoman Empire), as a devoted reader, his knowledge reached much further than these venues.

In *The city of tomorrow* he notes two types of city structures. One is "a progressive growth, subject to chance, with resultant characteristics of slow accumulation and gradual rise".

The other is "the construction of a city as the expression of a preconceived and predetermined plan embodying the then known principles of the science" (Le Corbusier 1929: 92). He evidently recognises a clear distinction between organic and planned cities. Examples of the former in his books include a few irregularly shaped medieval cities, and of the latter – which he thereafter vehemently propagated – regular planning examples such as Khorsabad, the Forbidden City in Beijing, Timgad, a French bastide, a fortified Renaissance town and Washington. He also illustrated his narrative with illustrations of monumental French buildings like the Place des Vosges, the Louvre and Versailles.

Le Corbusier worked for six months under Josef Hoffman in 1907 in Vienna, and intermittently for Auguste Perret from July 1908 to November 1909 in Lyons (where he also met Tony Garnier), as well as attending a history course at the Ecole des Beaux-Arts in Paris. He travelled extensively inside Germany in 1909 and 1910, also working for Peter Behrens for five months. During that period he met Mies van der Rohe and Walter Gropius.

La Chaux-de-Fonds (1914)

Back in his home town Le Corbusier designed a number of houses in what can be roughly termed a tempered Classical idiom. In 1912, at age 25, he directed the courses in architecture and furniture design at the Art School of La Chaux-de-Fonds. In 1914 he designed a village of 120 freestanding and attached houses just outside La Chaux-de-Fonds. Since he admired the British garden suburbs of Letchworth and Hampstead at that stage (Baker 1996: 132-3), designed by Barry Parker and Raymond Unwin in 1902 and 1906 respectively, it is reasonable to assume he would use them as a precedent, adhering to the principles of symmetry and the central park (figure 3). But the plan form is fundamentally different, and resembles an organic vernacular village on a sloping site more than it does a planned garden city. In that regard it seems as if he, instead, adopted Ruskin's aesthetic philosophy, with which he was familiar.

The village was never built, and it is perhaps noteworthy that Le Corbusier makes no mention of this project in his *Oeuvre complete.* It nevertheless demonstrates an early ability to interpret the unselfconscious historical building traditions of the region and an appreciation for context, rather than be seduced by the formalism of Ebenezer Howard's diagram, which was so popular at that time.

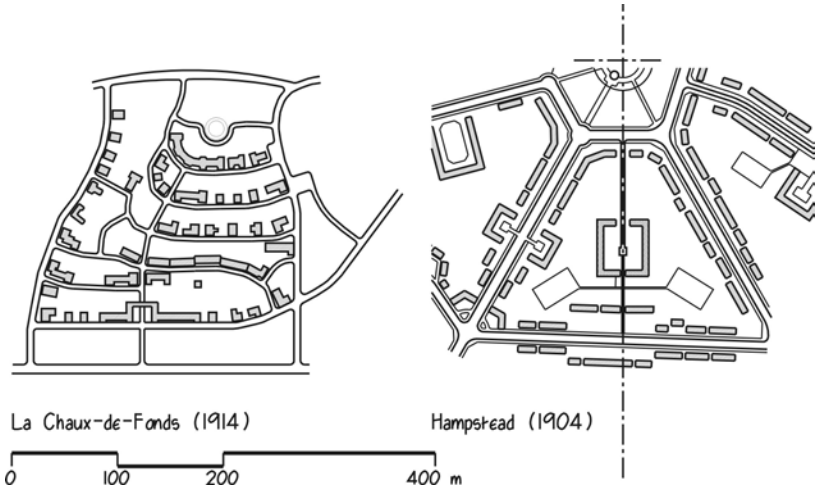


Figure 3
La Chaux-de-Fonds compared (drawing by the author).

Contemporary City (1922)

His admiration for Ruskin and Sitte, garden cities and medieval towns underwent a change soon after he settled in Paris in 1917. Whereas La Chaux-de-Fonds was a prosperous watch-making town in the Jura region of Switzerland, Paris – similar to most Western cities after the First World War – was obliged to face two serious issues: A severe housing shortage and an increase in the use of private vehicles in cities designed for horse-drawn traffic. Densities in Paris were as high as 1,070 persons per hectare (Rowe 1993: 50). Teige (1932: 52) describes the overcrowding which prevailed in most European cities in a particularly grim manner:

> A room whose dimensions are suitable for accommodating one to two persons becomes occupied during the night by six to ten persons with children. People in these hovels sleep in two shifts just as they work two shifts in the factory, and beds crowded with two to three persons never cool down: after the night shift has left the bed, the day shift arrives to get its sleep.

Le Corbusier's response (1927: 17): "The time has therefore come to put forward the problem of the house, of the street and of the town, and to deal with both the architect and the engineer". He stresses that "modern life demands, and is waiting for, a new kind of plan both for houses and for the city" (1927: 45). Curtis (1986: 29) suggests that Paris "gave him so many of the elements of his later urbanism – classical vistas, parks with curving paths, transportation lines on different levels (figure 4). It formed his very idea of urbanity".

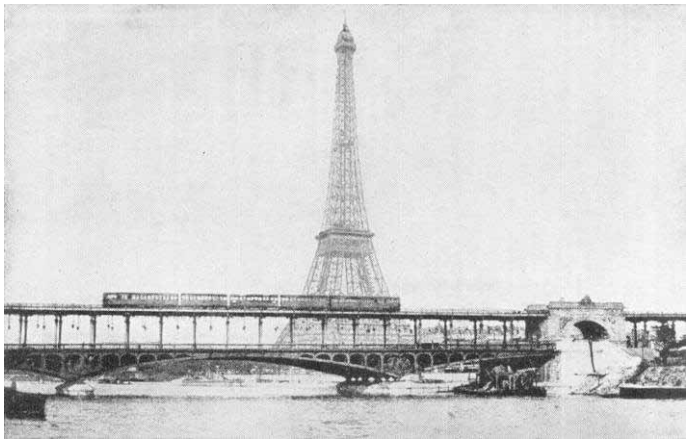


Figure 4
Elevated transport in Paris (source: Le Corbusier 1929: 50).

Le Corbusier was obviously profoundly influenced by Tony Garnier. He describes Garnier's *Cité Industrielle* (translated as *Industrial Quarter*) as "an attempt at an ordered scheme and a fusion of utilitarian and plastic solutions" (1927: 53). He notes that the social dispensation – "not yet brought to pass" – would provide a house for each family. Since fences would not be allowed, "the town could be traversed in every direction, quite independently of the streets, which there would be no need for a pedestrian to use. The town would really be like a great park" (figure 5).

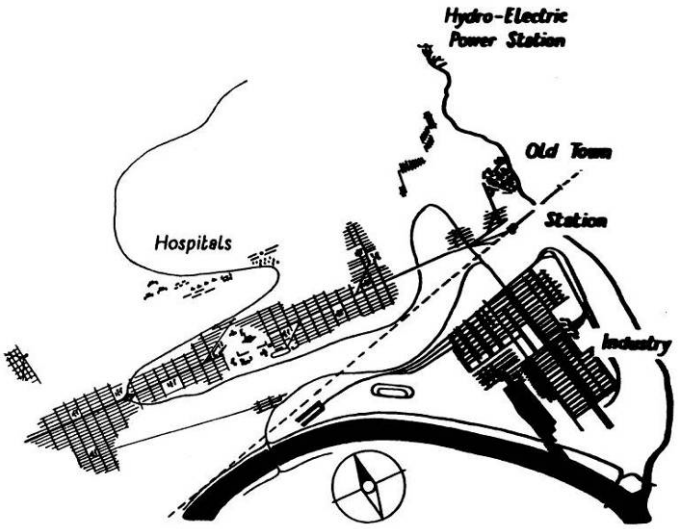


Figure 5
1904 – Toni Garnier's Cité Industrielle for 35,000 (source: Calthorpe 1986: 201).

Against this background Le Corbusier exhibited his project for *Ville Contemporaine* (a Contemporary City of Three Million Inhabitants) in 1922 (figure 6), complete with a regional framework. It was certainly a polemical manifesto as Moughtin (2003: vii) suggests, but also a marketing scheme – at that stage Le Corbusier was unknown and struggling. He admitted that his solution was "a rough one and completely uncompromising" (1929: 163). It was nevertheless worked out in considerable detail: a monocentric city with a symmetrical Baroque street layout. Interestingly, the city itself was planned for 600,000 inhabitants, while two million or more were to be housed in surrounding garden cities, serviced by an extensive suburban railway network.

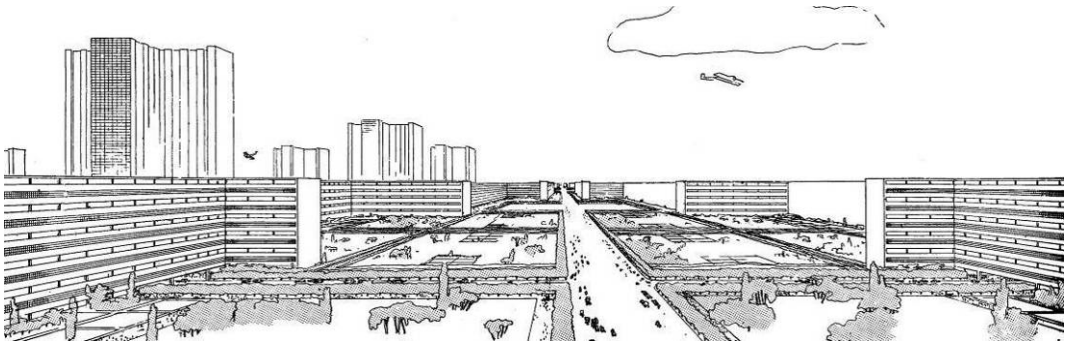


Figure 6
1922 – Le Corbusier's panoramic view of the Contemporary City (source: Le Corbusier 1960: 64).

The Contemporary City of 1922 clearly fuses Garnier's zoning with the Baroque town plan of Pierre L'Enfant of Washington in 1791 (figure 7), which was in turn inspired by the "self-centring" of Versailles (Morris 1994: 354). The perimeter blocks were intended to emulate the great squares of Paris, while the indented blocks show a conceptual similarity to Fourier's "phalanstery" (figure 8). Furthermore, the typical L-shaped apartment unit, of which a prototypical version

was showcased as the Pavillon de L'Esprit-Nouveau at the international exposition in 1925 in Paris, was clearly inspired by a monk's quarters in the Carthusian monastery of Ema. Hence, it seems as if at least four distinctly different historical sources provided ideas that informed the basic design.

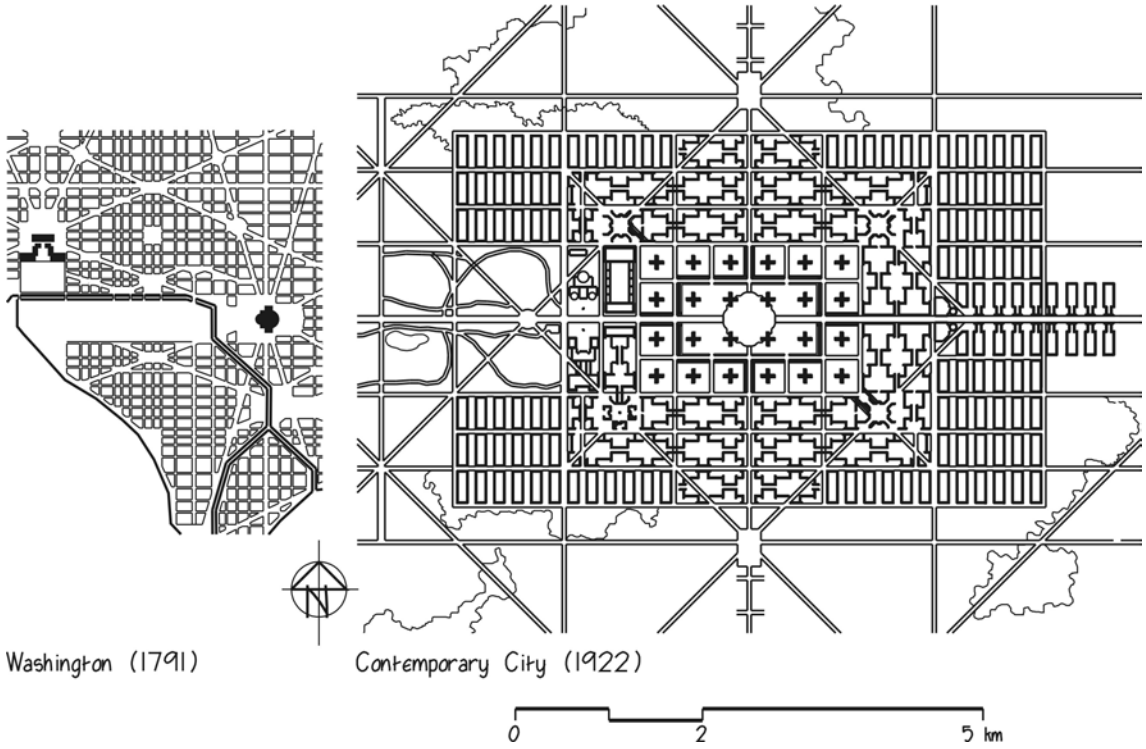


Figure 7
Contemporary City compared with Washington
(drawing by the author).

Figure 8
1848 – Francois Fourier's proposed new town for 1, 600 people (source: Calthorpe 1986: 192).

Radiant City (1930)

Risebero (1997: 241) states that from 1917 to 1932 "Russian artistic ideas were among the foremost in the world". Many new towns were built to support industrialisation, with most following Garnier's principles of zoning. The most prominent planning theorist of the time, however, was Nicolai Miliutin (1889-1942), whose proposals for the expansion of Magnitogorsk (1929), Stalingrad and Gorki were based on a linear scheme that evolved from Soria y Mata's work.

The Spanish transport engineer, Arturo Soria y Mata, had proposed his Ciudad Lineal in 1882, "a continuous pattern of urban growth stretching through the countryside on either side of a rapid-transit spine route, incorporating both old and new urban centres" (figure 9).

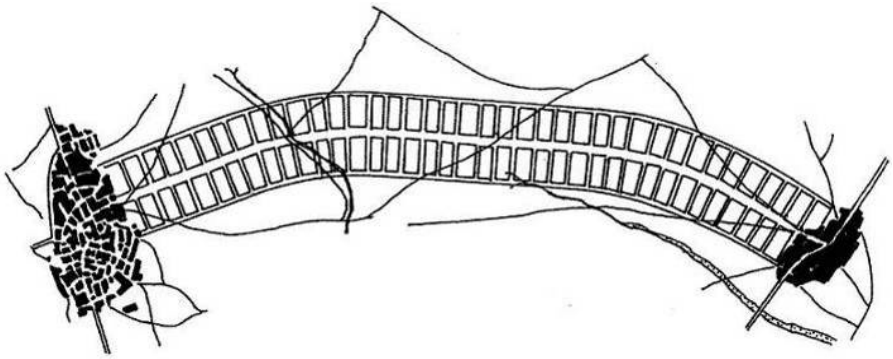


Figure 9
1882 – Linear city by Soria y Mata (source: Moughtin 2003: 198).

Miliutin's concept consisted of "narrow, parallel strips of land running through the countryside, incorporating the old town centres where they occurred: a railway zone, a factory, workshop and technical college zone, a green belt with a main highway, a residential zone, a park and sports area, and a wide belt of farmland" (Risebero 1997: 241). Not only Miliutin's plan, but also the envisaged social system of collectivism and egalitarianism became entrenched in avant-garde European schemes as well. As Teige (1932: 320) writes: "The linear city … has no centre and no business district. The linear city supersedes the concentric form of the capitalist city. It represents a new, higher type of city".

Towards the end of the 1920s, Le Corbusier had extensive contact with other planners – especially in Germany and the Soviet Union – mainly through congresses and the *Congrès Internationaux de l'Architecture Moderne* (CIAM) founded by Le Corbusier, Sigfried Gideon, Walter Gropius and others in 1928. While the Radiant City was presented at a CIAM congress focusing on middle- and high-density housing, a number of authors have suggested that the actual purpose of the scheme was to solicit work in the Soviet Union, as many of his contemporaries were doing at that time.

Both Mata and Miliutin's ideas could have served as precedents for Le Corbusier's basic concept for the Radiant City, and an unmistakable anthropomorphic analogy was then superimposed to refine the layout (figure 10). The final plan is deceptively simple, but Le Corbusier's writing confirms the vast body of empirical research that underpins it.

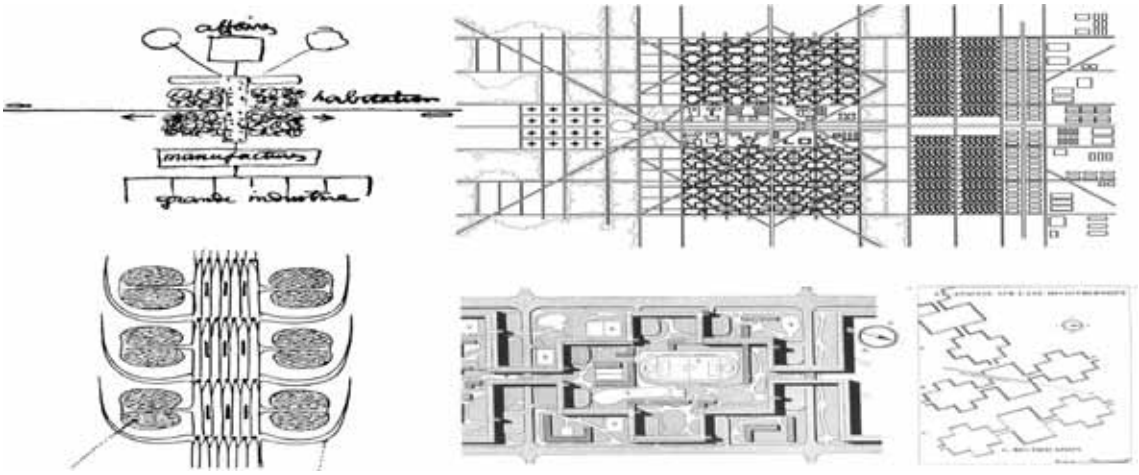


Figure 10
1930 – Radiant City. Diagram by Le Corbusier and the city plan (redrawn by the author).

Algiers (1930)

That same year, he visited Algiers for the first time. In Le Corbusier's own words, he devoted 12 years to "uninterrupted study of Algiers and its future" (1960: 50), which produced "seven great plans" for the city, which he claims "are well known in professional circles in every country" (1960: 102). These were each called Plan Obus (an explosive shell) and given a number. Plan A proposed a new business district in an area designated for demolition and a new residential quarter on rocky, unused land. The two were linked by an elevated road about 100 metres high with dwellings for 180,000 people below (Boesiger et al. 1967: 327). Jencks (2000: 202) suggests that Obus A was "by far the most idealistic". It was also the most refined of Le Corbusier's building-aqueduct-highway designs (figure 11).

Figure 11
1930 – Plan Obus A (drawing by the author, after *Oeuvre complète* 2: 140).

Figure 12
A close-up view of the 23-storey apartments underneath the elevated roadway (source: Le Corbusier 1964: 247).

The building-aqueduct-highway typology first emerged in 1929 when Le Corbusier published sketches of what Curtis calls "quixotic urbanistic studies" for some existing South American cities, including Buenos Aires, São Paulo, Montevideo, and Rio de Janeiro (figure 13). The common concept was "based on linear viaducts treated as vast landscape sculptures" (Curtis 1986: 108, 120). These would provide "large automobile routes in the inextricable cities, while creating a considerable amount of building cubage for habitation" (Boesiger et al. 1967: 324). Besides the housing beneath the elevated highway, one of Le Corbusier's sketches of Rio also shows a number of Cartesian skyscrapers for the first time. He claimed that his proposal for Rio was "something completely radical" (1960: 124):

> A second town of unprecedented form, carried on pilotis [nearly 40 metres] high with the lower groups of existing buildings radiating from each bay and passing beneath. And, [90 metres] up, a level motorway [25 metres] wide, linking all the hill tops, and creating order in the plan and townscape of Rio.

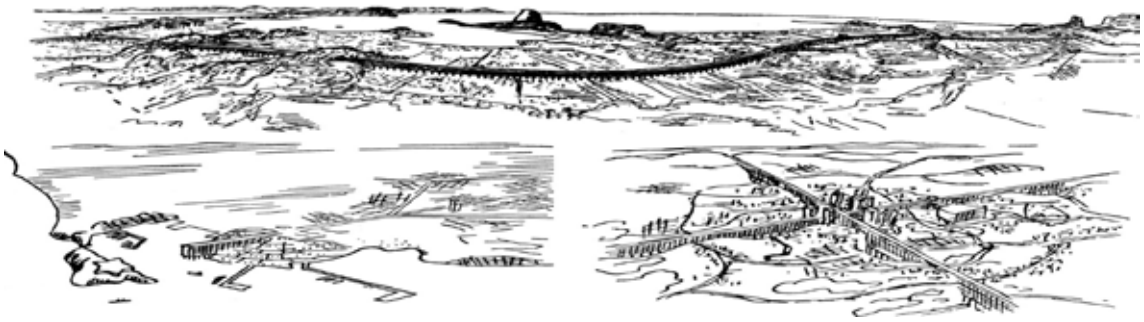


Figure 13
1929 – Rio de Janeiro. Sketch by Le Corbusier (source : *Oeuvre complète* 2: 138).

Not only the layered transport lines of Paris, but also the elevated highways of American cities such as New York and the Roman aqueducts of antiquity inspired Le Corbusier to imagine linearity in a totally innovative urban form (figure 14). As expected the imagery is bold – after all, of the Roman aqueduct at Valens he writes (1929: 67): "An immense horizontal running through the surrounding country and forming a rigid backbone along the Seven Hills".

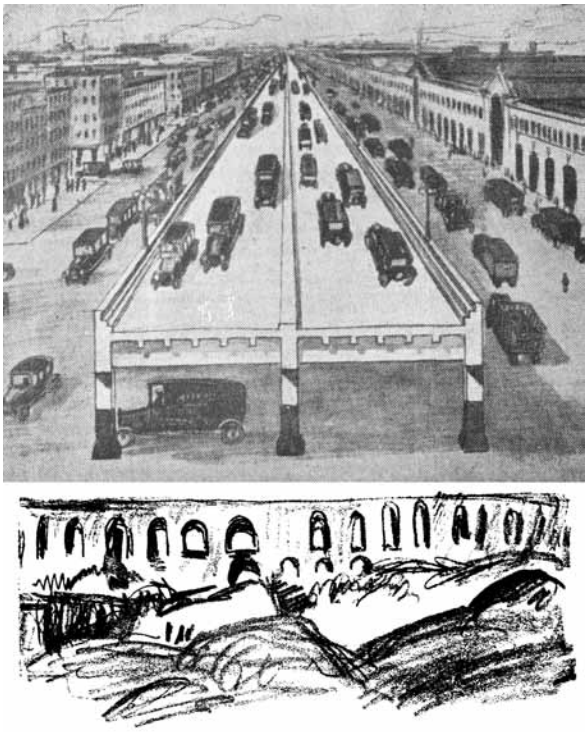


Figure 14
Top: An elevated highway in New York (source: Le Corbusier 1929: xiii).
Bottom: Le Corbusier's sketch of the Roman aqueduct in Valens (source: Le Corbusier 1929: 63).

In the case of Algiers, Zeynep Çelik (1997: 33-4) offers a more direct relationship, arguing that a boulevard on the waterfront in Algiers, designed by French architect Charles-Fréderick Chassériau and completed in 1866, was actually the precedent (figure 15). The boulevard formed the upper level of an arcade at embankment level, supported by high arches.

Figure 15
Chassériau's viaduct-like boulevard on the Algiers waterfront (source: Cresti 1985: 59).

Stockholm – 1933

The indented residential blocks, sometimes referred to as buildings with setbacks (or *Lotissements à redents* in French), which remind one so much of Fourier's "phalanstery" of 1848, were present in both the Contemporary City and Plan Voisin. In Obus A the type became free-form and sculptural in plan. Three years later Le Corbusier's plan for Stockholm would explore the *redent* typology fully, with irregular and curved forms. Le Corbusier envisaged accommodating 170,000 inhabitants in the northern part and 110,000 in the southern at a density of 1,000 per hectare in 50 metre high *redents* on columns, with all units facing "extensive" parks (Le Corbusier 1964: 297-9.

It is significant that he envisaged *redents* for most of his city plans, from the very first to the last (reconstruction of Berlin centre in 1961). During this time he experimented with every conceivable kind of modulation and counterpoint – all conceivably with the intention of enhancing urban aesthetics by a highly varied streetscape (figure 16). This is one instance where a historical idea remained incredibly resilient and guided Le Corbusier for nearly forty years.

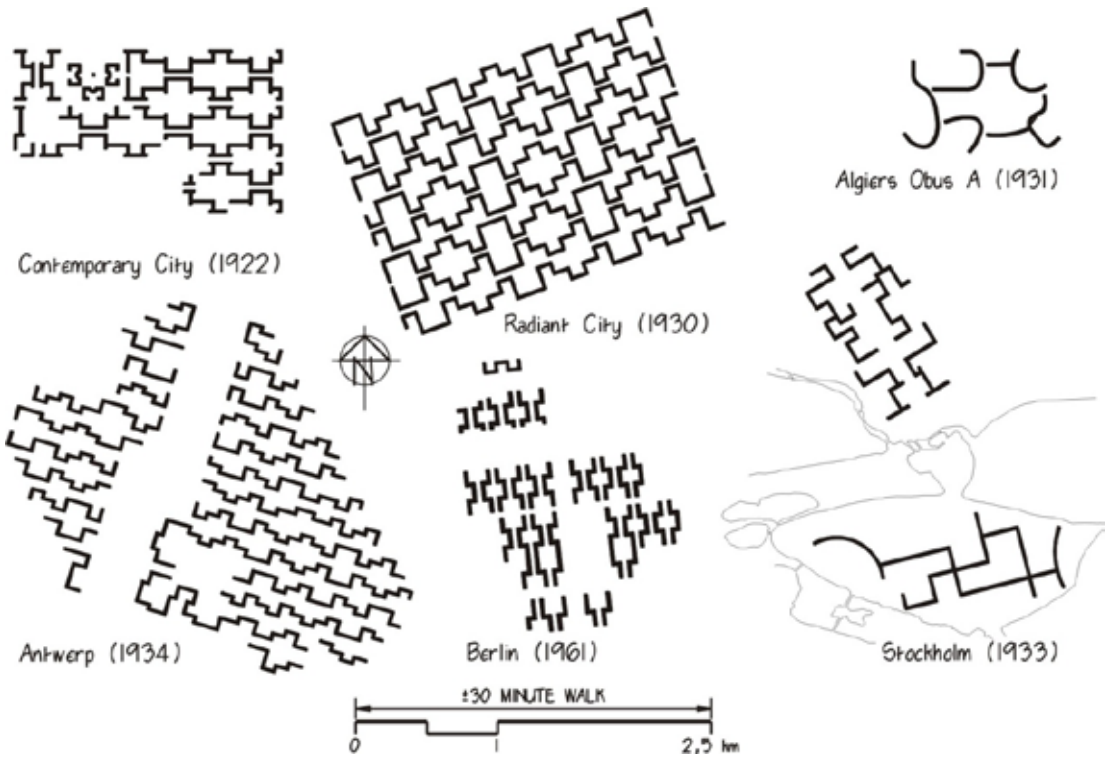


Figure 16
Indented building patterns compared (drawing by the author).

Barcelona (1933)

In 1932 Le Corbusier designed a master plan for the redevelopment of Barcelona. He proposed transforming Ildefons Cerdà, "Spanish square" as Le Corbusier (1964: 306) called the 113 x 113 streetblock, into a 400 x 400 street grid. Fortunately that remained unexecuted, but regrettably also the terrace housing he designed for workers (figure 17).

In this low-cost housing scheme he "organised his dwellings as a tight-knit modern version of a Kasbah, and treated the facades to moveable louvers, the roofs to thick turf protection" (Curtis 1986: 116). Le Corbusier (1964: 306) writes that each house "constitutes living conditions similar to those in the country" and each should have a tree in front: "The quarter would then become a delightful oasis of refreshing greenery" (1960: 110). At that stage Le Corbusier was totally enthralled with Arab architecture, and the site layout, while making provision for vehicles, certainly has all the characteristics of a vernacular Arab settlement, complete with a meandering pattern and dead-end lanes (figure 18). The housing units reflect Arab custom with a vertical privacy gradient. The courtyard is now on the roof, with small balconies behind the louvers reminiscent of the *musharabiya* (screened bay windows) found in North Africa and the Middle East. With a huge part of Spain having been occupied by Muslims from North Africa for centuries, deriving this idea from traditional Islamic architecture is not wholly inappropriate. In any case, he reworked it until the Arab inspiration is barely recognisable.

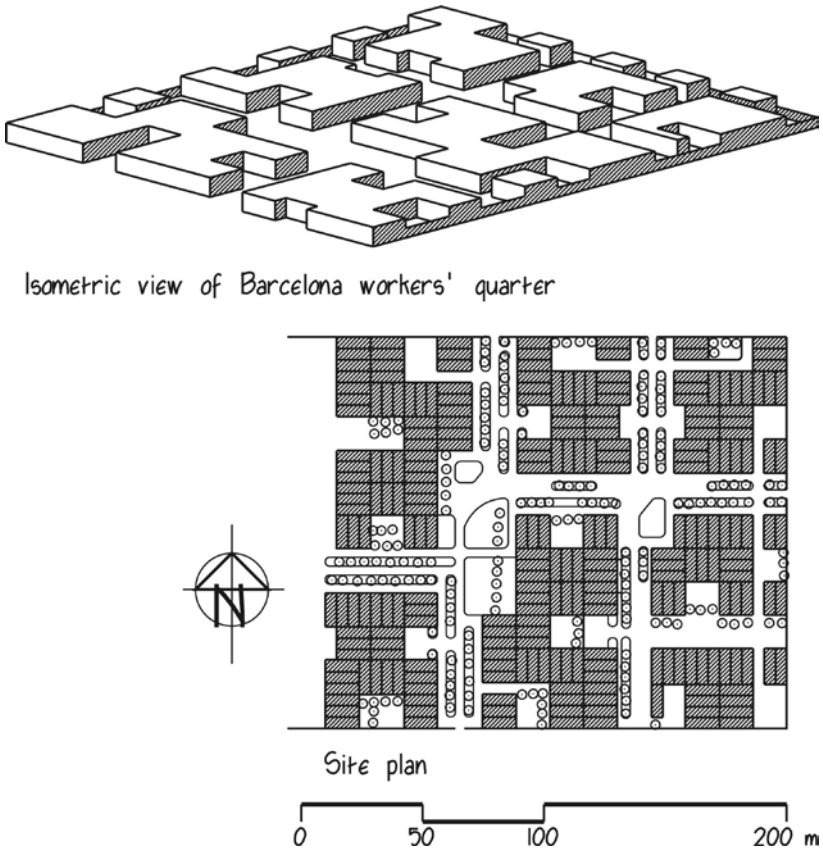


Figure 17
1933 – Site plan and isometric view showing massing (drawing by the author).

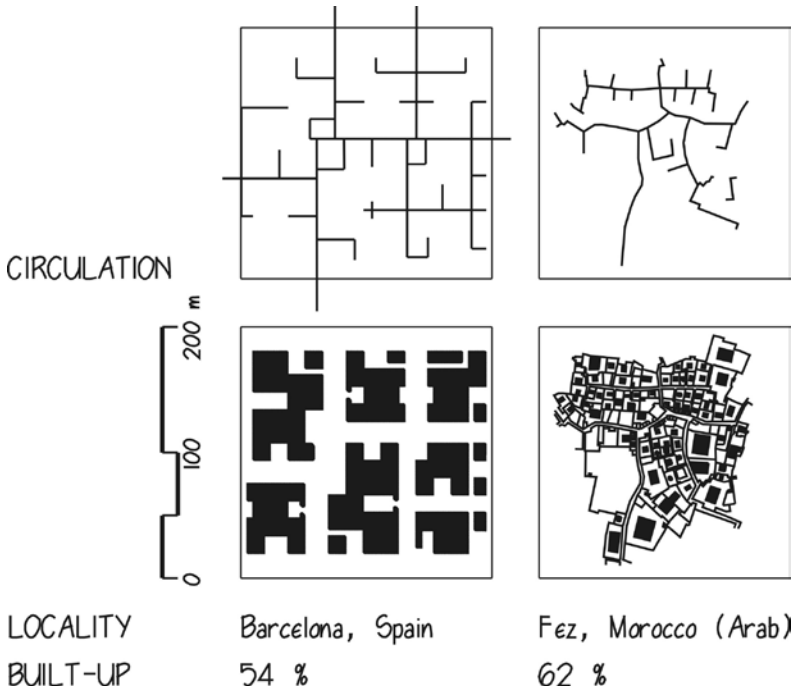


Figure 18
Barcelona quarter analysed (drawing by the author).

Paris plan (1935)

It is perhaps significant that Le Corbusier makes no reference to Plan Voisin in *My Work (1960),* but instead illustrates his Paris Plan 1937 (1960: 130-131). This plan is also mentioned in the very first sentence of his chapter entitled Urbanism in *The Modulor* (1951). Rather than the finned high-rise office buildings, first seen in the Contemporary City, he now proposes just four Cartesian skyscrapers, the retention of major streets and links with the existing, surrounding fabric, demonstrating respect for and responsiveness to the history of the site (figure 19).

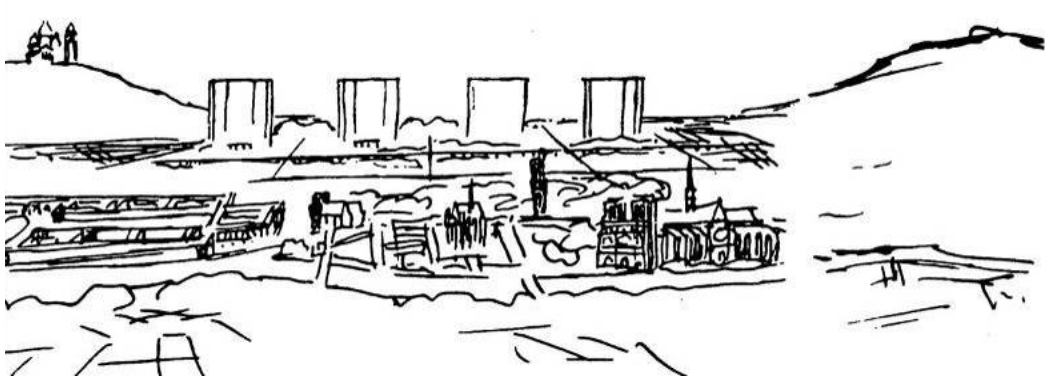


Figure 19
The Paris Plan of 1937 (source: Le Corbusier 1960: 131).

Saint-Dié (1946) and Meaux (1955)

Saint-Dié was a bomb-damaged small town in the east of France. Here, in 1946, Le Corbusier proposed five initial Unités flanking a civic centre, tourist facilities, restaurants, cafés and cultural institutions (figure 20). It was never built, but it was planned to accommodate about 10,500 people. Each Unité would house 1,600, and the balance would occupy single-family houses along the approach roads. Across the river were "Green factories" along a 1,200 metre spine (Boesiger et al. 1967: 338). Circulation was separated into roads for fast-moving vehicular traffic, local vehicular access and in the town centre, promenades and footpaths for pedestrians (Boesiger et al. 1967: 339). The project gave Le Corbusier the opportunity to explore "urban monumentality and enclosed civic spaces, two issues that had been underplayed in the Charter of Athens" (Curtis 1986: 163). Le Corbusier describes his design as "sheer architectural music in that mountain landscape" and "all in all, a truly modern plan" (1960: 148). Jencks (2000: 245) describes Saint-Dié as "Le Corbusier's first and most influential plan for reconstruction" in the Post-Second World War period.

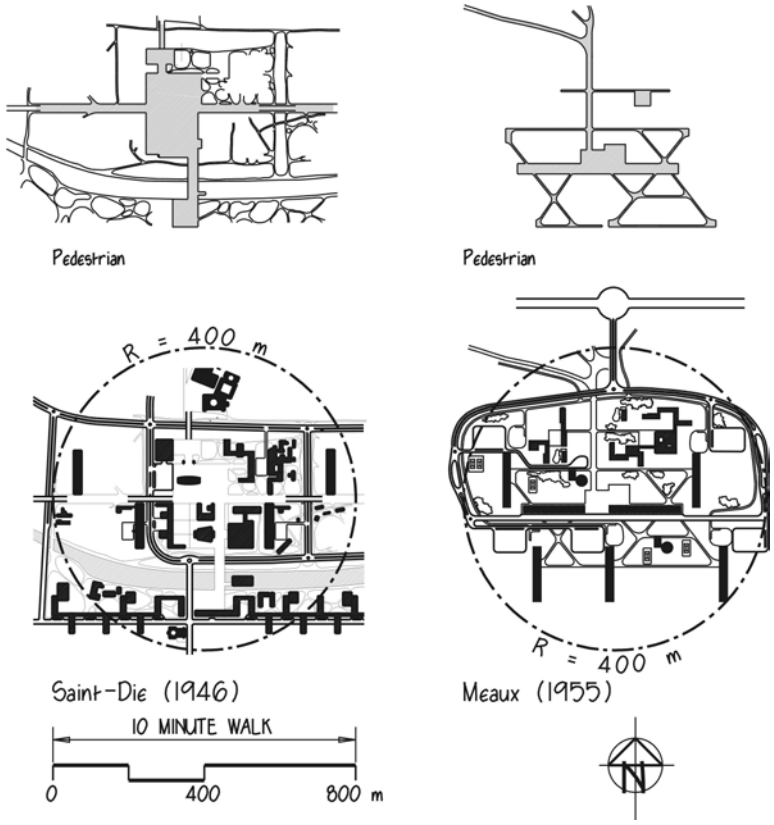


Figure 20
Saint-Dié and Meaux compared, showing pedestrian realms separately (drawing by the author).

Le Corbusier worked on the unbuilt design of Meaux from 1955 to 1960 (1960: 188). Very much like Saint-Dié a decade earlier, it was designed as a small town for 10,000 people, with five Unités but also with two tower blocks, one for single people and the other a hotel. Apart from rooftop facilities such as crèches and gyms, and shops half-way up each Unité, the town centre would have provided extensive recreational, educational and administrative

services. Cars and pedestrians are separated, with both networks connected to an envisaged "Linear Industrial Centre" (Le Corbusier 1960: 188).

It seems reasonable to assume that the concept for the "urban monumentality and enclosed civic spaces" is inspired by the Acropolis (figure 22). In *Towards a new architecture* (1927) he discusses the Acropolis extensively – more than any other building in any of his books – illustrated with nine drawings and eighteen photographs. As Le Corbusier (1927: 43) writes:

> The whole thing being out of square, provides richly varied vistas of a subtle kind; the different masses of the buildings, being asymmetrically arranged, create an intense rhythm. The whole composition is massive, elastic, living, terribly sharp and keen and domineering.

Further on he (1927: 54) quips that "The apparent lack of order could only deceive the unlearned". The Acropolis gave him the ideas for achieving the desired spatiality, massing, views, sense of place and enclosure in an irregular, asymmetrical but controlled way.

It is ironical that although Le Corbusier rejected Sitte and his picturesque towns, both architects shared an appreciation for the Acropolis. Actually, many of Le Corbusier's ideas for composing plazas (and public spaces in general) seem to be sourced from Sitte (1889).

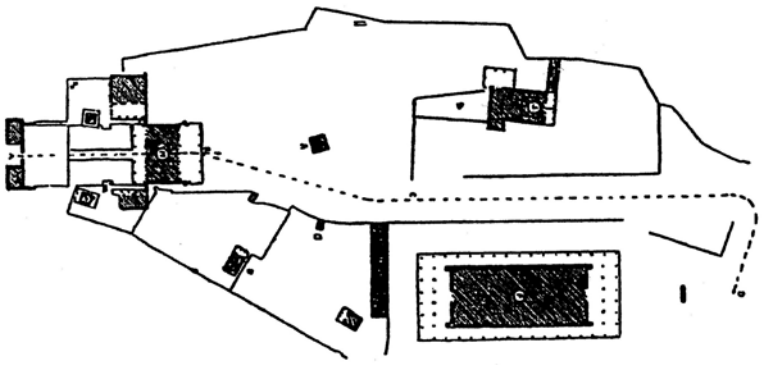


Figure 22
The Acropolis in Athens (source: Le Corbusier 1927: 52).

La Sainte-Baume (1948)

Another scheme that embraces both architecture and urbanism is a 188-unit housing project on the French Coast at a pilgrimage site called La Sainte-Baume ("Holy Cave") in Provence, about 17 kilometres inland (figure 23). Here he fused European open-plan unit layouts with forms and circulation patterns that remind one of North Africa.

The form is essentially the same 2:1 (section profile) deep, narrow module used in the Unités while the barrel vaulted roofs are the same as in the Monol housing of 1919 and the Weekend House of 1934, employing the same planted roof and rough exterior finishes as the latter.

In its specific context, on the shore of the Mediterranean, the concepts gleaned from the historical vernacular are more obvious. The morphology resembles not only Tunisian ghorfas

(figure 24) and houses with vaulted roofs on the Greek coast, but the narrow lanes which also access lanes parallel to the shore, the units stepping up the slope and incorporating courtyards are all designs from the Casbah in Algiers (figure 25).

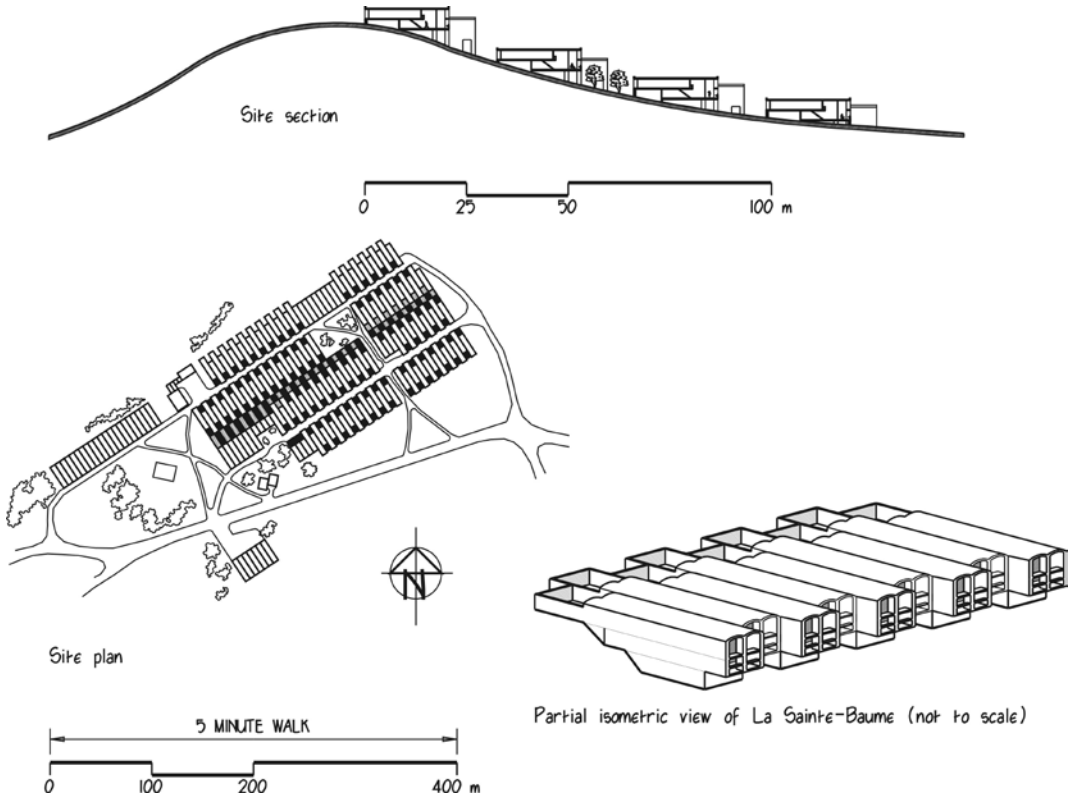


Figure 23
Site development (drawing by the author).

Figure 24
A Sainte-Baume model compared with Tunisian ghorfas (source: Goldfinger 1993: 18, 159).

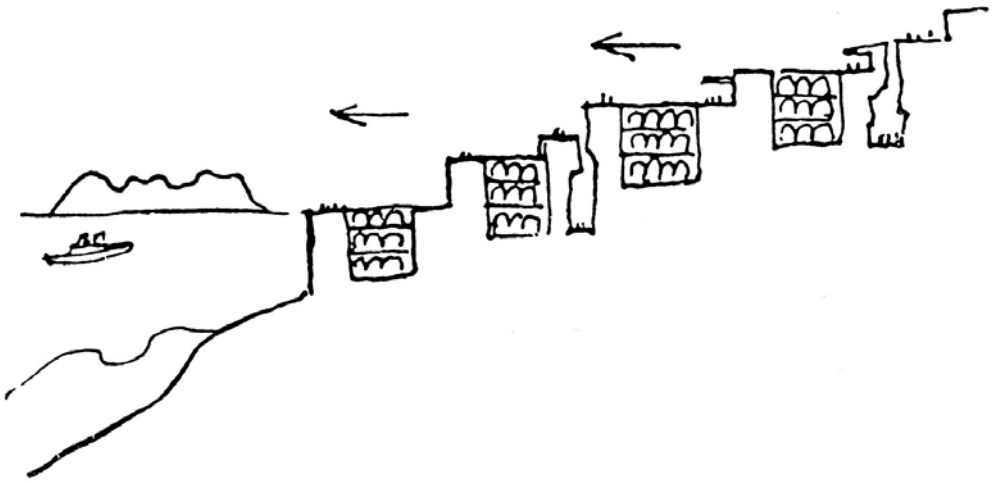


Figure 25
Section through Algiers' historic Casbah (source: Le Corbusier 1971: 122).

Chandigarh (1952)

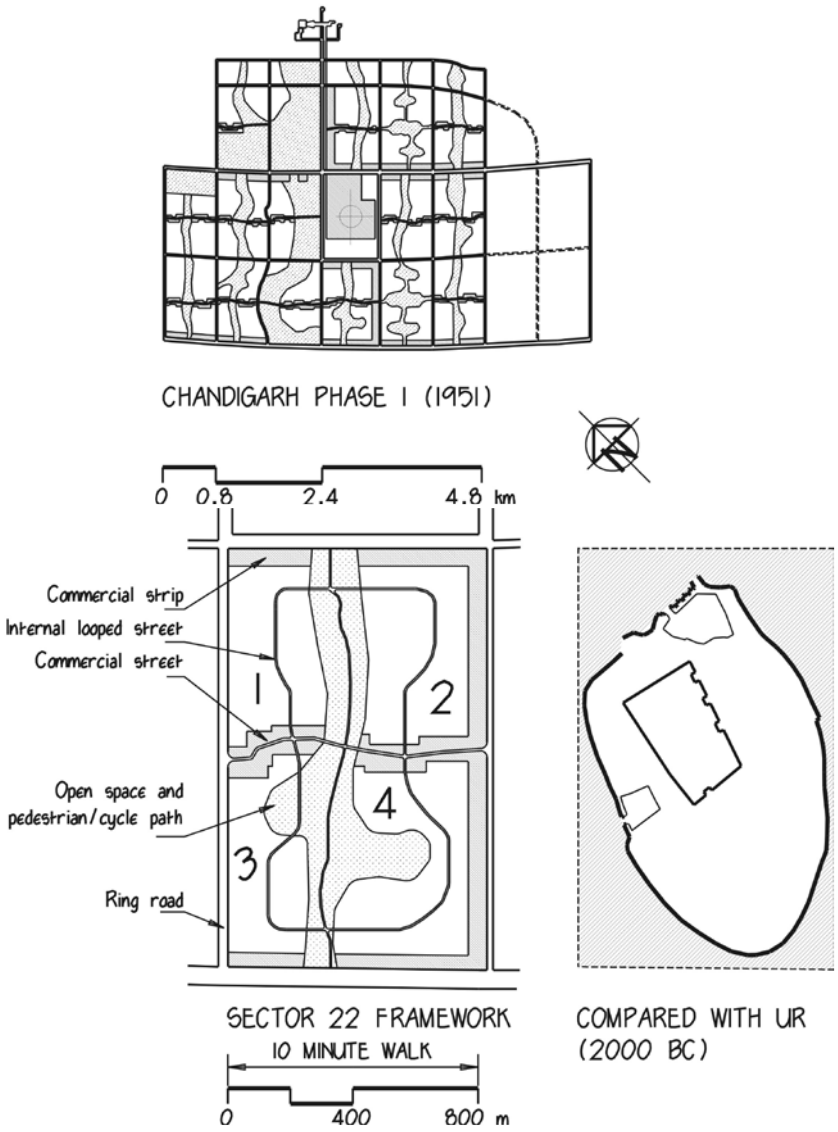
Chandigarh is located northwest of Delhi, just south of the Shivalik Mountains, foothills of the Himalayas. Matthew Nowicki and Albert Mayer designed the initial masterplan, a sensitive response to topography and climate. Le Corbusier was invited to participate after Nowicki died in a plane crash in 1950 and was appointed in 1951. His collaborators were Maxwell Fry, Jane Drew and Corbusier's cousin, Pierre Jeanneret, as well as a number of young Indian architects and planners.

It is true that Le Corbusier retained some key aspects of the Nowicki-Mayer leaf-shaped plan, especially spatial relationships between key elements (government, city centre, university and industries) and the superblock principle, but fundamentally his town planning was based on an unbuilt proposal for Bogota he executed in the previous year (Le Corbusier 1958: 210). There he again, as in Barcelona, consolidated the "Spanish Square" into larger superblocks, this time measuring 1,200 x 800 metres. But instead of a different geometrical pattern for pedestrians, he simply conceived a similarly dimensioned superimposed grid and shifted it half a module relative to the vehicular grid (figure 26).

It is clear that each residential sector was envisaged as a relatively self-contained urban village, consisting of four neighbourhood-sized quarters (24 ha) each bordering on a green strip with pedestrian paths running north-south, and a market street east-west. It offers the potential of accommodating different architectural and urban morphologies within a compact framework, offering all the diversity and neighbourhood interaction, overlap and connectivity considered desirable today. He allocated nearly 30 per cent of the city to parks and recreational areas.

Le Corbusier was certainly familiar with the first cities of the Fertile Crescent. Perhaps his choice of a 1,200 x 800 module, rather than his more usual 400 x 400 grid, was not coincidental, but an idea inspired by those first, compact, walkable cities!

Figure 26



Top: Chandigarh Phase 1.
Bottom: Sector 22 as plan and compared with Ur
(drawings by the author).

Venice Hospital (1964)

Finally, one of his "strongest ideas" was that for the Venice Hospital of 1964 (figure 27). Here he "respected the skyline of the city, conceiving the building as a series of low boxes matted together in a complex pattern of overlapping walkways, platforms and spaces, extending over the water on piers" (Curtis 1986: 214).

Curtis (1986: 214) writes that "both Venice Hospital and the Roq and Rob [morphologically very similar and contemporaneous with La Sainte-Baume] schemes were based on the readings of underlying typologies in existing towns in terms of both buildings and spaces between. These patterns of adaptation and memory were then translated into standardised modern systems of construction, arranged in a cellular fashion to evoke growth and change, as in the vernacular, or in the patterns of nature. Charles Jencks (2000: 325) asserts that the scheme for the Venice hospital, on which Le Corbusier was working when he died, "has many of the complex, urban aspects which his critics were asking for".

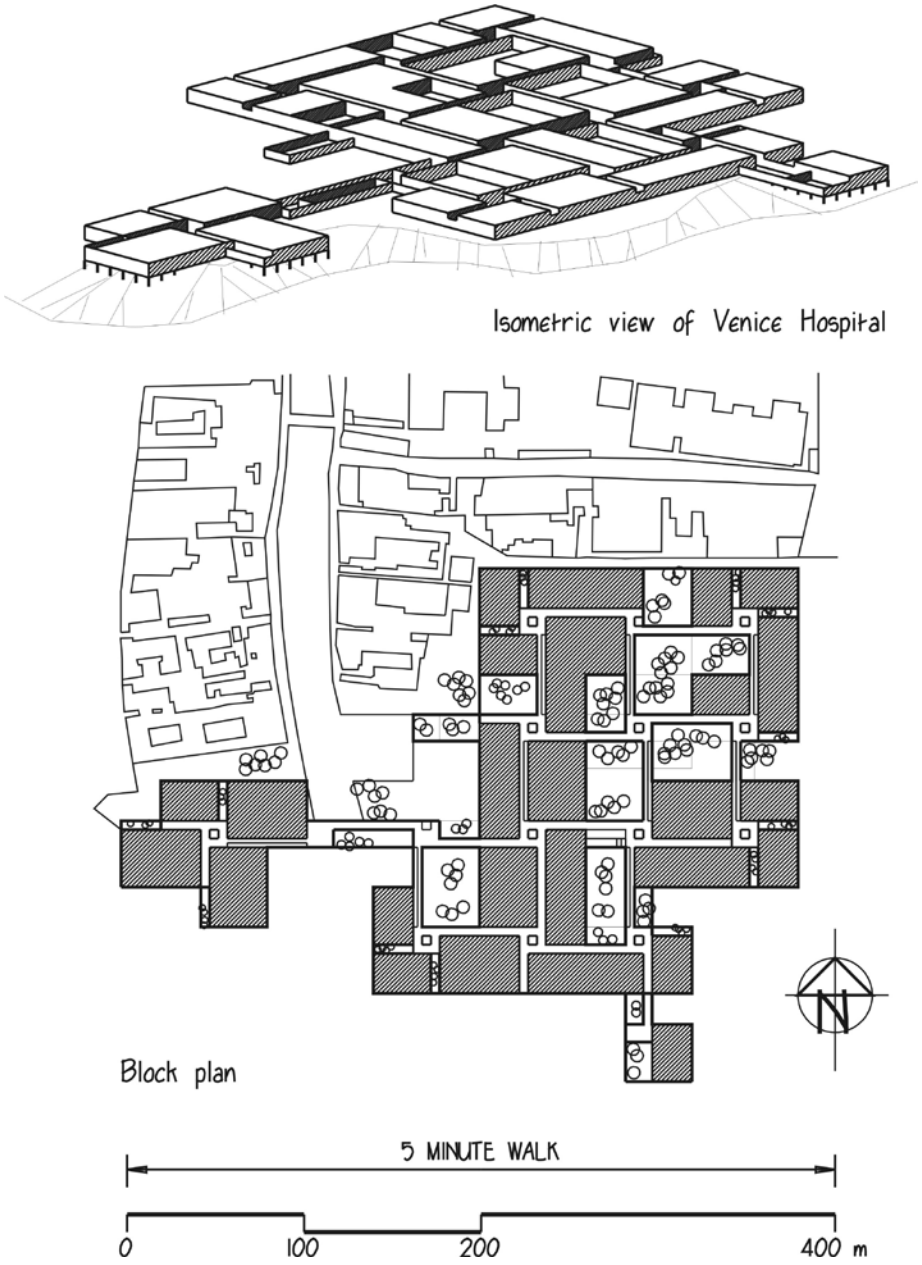


Figure 27
Venice hospital (drawing by the author).

Like the Barcelona Quarter and La Sainte-Baume, the Venice Hospital is an example of Critical Regionalism in every sense. It is a modern interpretation informed by the history of the place and the fabric. In this case a major inspiration could have been derived from the Roman garrison town of Timgad (first century AD). The 60 x 60 metre grid is exactly double that of Timgad (figure 28). What is even more intriguing is that the offset, pinwheel configuration at the nodes where corridors and ramps connect is described by Sitte, referring to piazzas in Ravenna, Pistoia, Mantua and Brescia, as an “ingenious system” (quoted in Collins et al. 1986: 172-173).

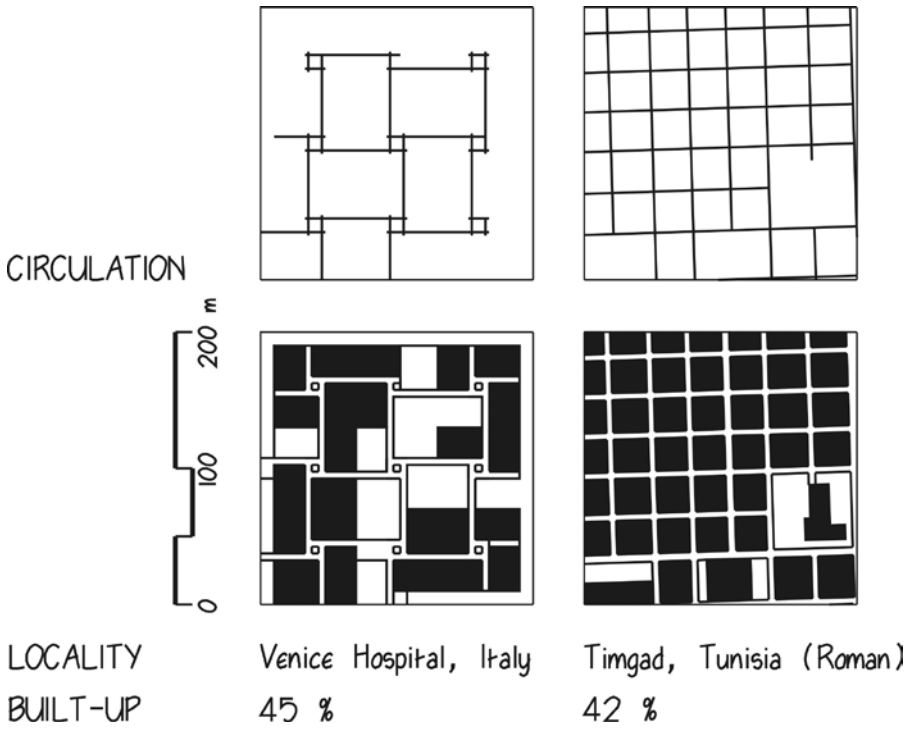


Figure 28
Venice hospital analysed (drawing by the author).

Creativity, synthesis of ideas and representation

Le Corbusier, except for a part-time course in history at the Ecole des Beaux-Arts in Paris, received no formal architectural or town-planning training at all. Garnier on the other hand, a major influence on 20th century town-planning, spent three years at the Lyon Ecole, ten at the Ecole des Beaux-Arts in Paris and a further four at the Academy in Rome (Anderson 1985: 3). Le Corbusier (1951: 29) declared that he "had always fled from formal teaching. He therefore had no knowledge of the canonical laws, the principles codified and dictated by the Academics. Being free from the academic spirit, he had an open mind and an alert eye". Clearly this also means receptiveness to the ideas of history.

The result was a remarkable and increasingly sophisticated body of theory and an oeuvre of urban designs – frequently of a pioneering, responsive and innovative nature. His urban concepts were embedded in a number of successive core ideas spanning four periods, although there is considerable overlap. In the beginning (up to 1916) he practised Regional Classicism and garden city picturesqueness. After moving to Paris (1917) he developed Purism, and conceived the Contemporary City as a Baroque-type grid. Then, just as Modernism became the International Style, Le Corbusier abandoned Purism and started to explore hybrid and vernacular architectural forms. During this period (1929-1945) he also abandoned the symmetrical grid after releasing Radiant City, and explored a large number of urban typologies during the next 15 years. These included juxtaposed nets with different geometries for vehicles and pedestrians, often based on curvilinear and trigonometric forms. Thereafter, in the post-war years until his death (1946-1965) his buildings reflected a Mediterranean vernacular and were mostly heavy, monumental and sculptural. His urbanism of that period focussed on the Unités in a number of urban settings, as well as Chandigarh, Berlin and Venice Hospital. His peers, including Hilberseimer and others, never developed residential typologies beyond simple slabs and towers, and urban typologies beyond CIAM urbanism (figure 29).

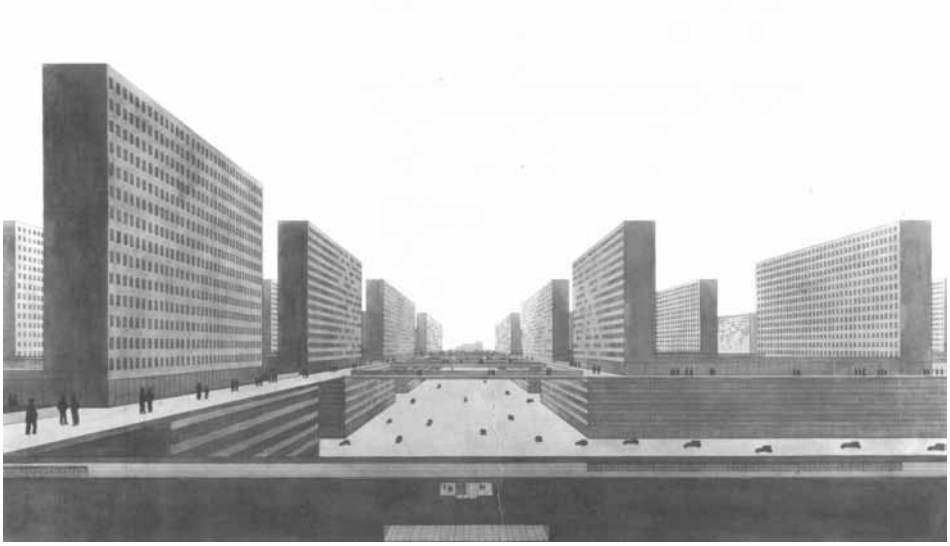


Figure 29
Ludwig Hilberseimer, Vertical City, 1924 (source: Van Lent 2008).

Le Corbusier (1927: 51-52) insists that "The plan carries in itself the very essence of sensation." Fawcett (2003: 20) reminds us that the true meaning was lost in translation from French and that "the three-dimensional organisation is the generator" would have been more realistic. Besset (1992: 174) also points out that Le Corbusier's town-planning went beyond the purely functional, embracing, like Sitte, the "art of building towns". He clearly considered a town not as a two-dimensional plan, but as a site and a landscape organised in three dimensions. Regarding the integration of architecture and town-planning Le Corbusier (1927: 51-52) is quite adamant: "Towns must be conceived and planned throughout their entire extent in the same way as were planned the temples of the East and as the Invalides or the Versailles of Louis XIV were laid out."

Today, most commentators would experience difficulties with that statement. Jencks (2000: 326) for instance observes: "As to his city planning, it was undoubtedly flawed in ... the assumption that a city is a total work of art and not a piecemeal growth responding to countless economic forces and decisions".

Edmund Bacon (1968: 79) found that towns in medieval times were generally perceived as organic entities. Guido Francescato (2001) believes that this approach, propagated during the Renaissance by Leon Battista Alberti (1404-1472), saw the city as a large building. Cynically, Francescato states furthermore that the Albertian model was adopted by architects towards the end of the 19th century, because they began "to claim jurisdiction over the entire built environment, not just over the individual buildings and urban fragments that traditionally had been the focus of their work"! Le Corbusier, like most of his peers for that matter, was simply continuing a long tradition of representing the city.

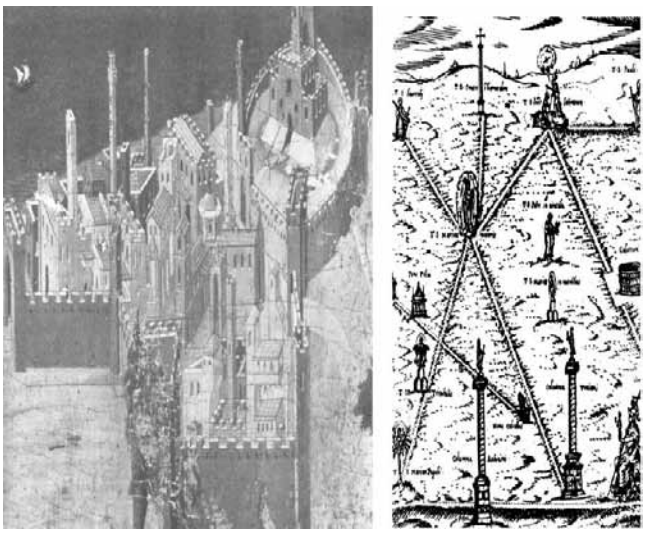


Figure 30
Hill town in Tuscany, painted by Ambrogia Lorenzetti in ca. 1340 (source: Bacon 1968: 79).

Conclusion

Whereas Le Corbusier's architectural models are well-defined and generally accepted, his urban ideas have not been so neatly packaged and defy chronological delineation, simply because there is so much overlap. We find that ideas were not only transferred between urban typologies, but also between the three streams of urbanism, neighbourhoods and building complexes, and individual buildings. Throughout his career these streams variously diverged, converged and crossed. There is a very clear trajectory of seminal ideas that were conceived in one of these streams and then transferred to another, as well as of a leapfrogging of concepts. It is also obvious that Le Corbusier modified and continuously refined a number of particularly robust conceptual ideas.

From his very first writings Le Corbusier readily shared his ideas and steadily expanded on his body of theory by means of guidelines, principles, hypotheses, polemic and manifestos. Reading reveals that a complex universe of ideas from fields as disparate as history, biology, geometry, arithmetic, nature, politics and the Zeitgeist variously influenced his designs. This article, however, postulates that – once the exigencies of a project have been identified – history and precedent were often the main sources of ideas for Le Corbusier's core urban concepts, and that the other fields provided ideas for shaping and refining them.

Works cited

Anderson, L. 1987. Tony Garnier. Places 3:3-13.

Bacon, E. 1968. Design of cities. New York: Viking.

Baker, G. 1996. Le Corbusier: The Creative Search. New York: Van Nostrand Reinhold.

Besset, M. 1992. *Le Corbusier: To Live with the Light.* London: Architectural Press.

Boesiger, W. and Girsberger, H. 1967. Le Corbusier 1910-65. London: Thames & Hudson.

Calthorpe, P. 1986. A short history of twentieth century towns, S. van der Ryn and P. Calthorpe (editors). *Sustainable Communities: A New Design Synthesis for Cities, Suburbs, and Towns.* San Francisco: Sierra: 189-234.

Çelik, Z. 1997. *Urban Forms and Colonial Confrontations: Algiers under French Rule.* Berkeley: University of California Press.

Collins, R. and Collins C. 1986. *Camillo Sitte: The Birth of Modern City Planning* (with a translation of the 1889 Austrian edition of his *City Planning According to Artistic Principles*). New York: Dover.

Cresti, F. 1985. The Boulevard de l'Impératrice in Colonial Algiers (1860-1866), *Environmental Design: Journal of the Islamic Environmental Design Research Centre* 1: 54-59.

Curtis, W. 1986. *Le Corbusier: Ideas and form.* Oxford: Phaidon.

Fawcett, P. 2003. *Architecture Design Notebook.* Oxford: Architectural Press.

Francescato, G. 2001. City as home and city as network: contrasting paradigms in history, 32nd Annual Conference of the Environmental Design Research Association, Edinburgh, Scotland.

Goldfinger, M. 1993. *Villages in the Sun: Mediterranean Community.* Architecture. New York: Rizzoli.

Jencks, C. 2000. *Le Corbusier and the Continual Revolution in Architecture.* New York: Monacelli.

Le Corbusier. 1927. Towards a New Architecture. London: John Rodker.

Le Corbusier. 1929. The City of Tomorrow and its Planning. London: John Rodker.

Le Corbusier. 1951. *The Modulor.* London: Faber & Faber.

Le Corbusier. 1958. *Modulor 2*. Cambridge, Massachusetts: MIT Press.

Le Corbusier. 1960. *My Work.* London: Architectural Press.

Le Corbusier. 1964. The Radiant City. New York: Orion.

Le Corbusier. 1971. *Looking at City Planning*. New York: Grossman.

Le Corbusier, Pierre Jeanneret, et al. 1995. *Oeuvre compl*ète, edited by B. Boesiger. Basel: Birkhäuser: 1-8.

Morris, A.E.J. 1994. *History of Urban Form Before the Industrial Revolution.* London: Prentice Hall.

Moughtin, C. 2003. *Urban Design: Street and Square.* New York: Elsevier.

Risebero, B. 1997. The Story of Western Architecture. London: Herbert.

Rowe, P. 1993. *Modernity and Housing.* Cambridge, Massachusetts: MIT Press.

Teige, K. 1932. The Minimum Dwelling, Translated by Eric Dluhosh in 2002. Cambridge, Mass.: MIT Press.

Tzonis, A. and Lafaivre, L. 1985. Syncretism and the critical outlook in Le Corbusier's work, *Drawings From the Le Corbusier Archive,* edited by A. Tzonis, *Architectural Design Profile* 60(Jul/Aug): 7-8.

Van Lent, R. 2008. The Rise and Fall of CIAM Urbanism. www.roelvanlent.com/essays [accessed 4 Oct 2011].

Gerald Steyn is Research Professor at the Department of Architecture of the Tshwane University of Technology. He holds B Arch and M Arch degrees from the University of the Free State and a PhD from the University of Pretoria. His academic and research interests include settlement dynamics and vernacular African architecture, with a special focus on African urbanism, affordable housing and good neighbourhoods.