

# Articulating Space Through Architectural Diagrams

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## Abstract

This paper is directed to the use of architectural diagrams. Whenever architectural designers are confronted by a design task the beginning solution process entails a visualization of possible design solutions. The relationship between aspects of the beginning of the design process, the usage of architectural diagrams and the physical building as the final product of the design process is highlighted and discussed from the author's practical design experience as an trained architect. Significant techniques and categories of architectural diagrams are analyzed and exemplified with respect to their usage in design practice. Finally, two different architectural design methods, namely object-oriented and context-oriented design are characterized and comparatively discussed. The information presented is based on observations, literature, and personal experience in architectural design practice.

## Sketching as an Instrument of Thought

We sit in an office and we draw things for a building that might be twenty times, hundred times bigger than the paper we drawn on. And the relation between the drawing, and the big reality is fascinating: How could you imagine a fifty-story building when you are working on a three-foot by six-foot desk?

Stern (as cited by Herbert, 1993) characterized the complex relationship between the building on the paper and the building in reality. The architect' role is to be a creator of form, a design specialist who will initiate and lead a (building) design process. Thus, sketching and drawing play a central role in architect's work. Tigerman (as cited by Herbert, 1993) questions:

A drawing has distance from the building, so what is the building? The drawing isn't the building. The drawing informs about the building, but does it really?

As an instrument of thought, sketches, diagrams and drawings have a eminent influence on not only on the early phases of the architect's working process, but also on the

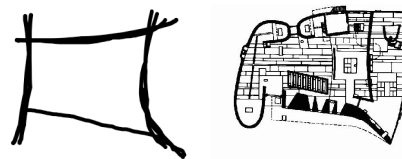
next phases concerning construction, and thus on the buildings that are the final goal of architectural design.

## The Building in the Architect's Mind

To articulate architectural elements is to clearly distinguish the parts that constitute the whole, especially at the points of their connection. Imagination generates a spatial concept, which is seeing in the architect's mind's eye as a discontinuous, nondimensional image (Porter, 1997), and must be seen in respect to the multifaceted decision space of the design process (Bertel et.al, 2004). Somewhere a long the way, a colleague of mine characterized this phenomenon in respect to the drawing practice of other architects by saying:

Most people sketch with images in their head. I think architectural designers have images, preconceived mental images, and drawings are materialization of these visual images.

Le Corbusier viewed sketching as subordinate to the mental images within the design process. He explained this view at the beginning of the architectural design of his well-known chapel Ronchamp by memorizing project data, shapes and spatial information for a few weeks, but not making any sketches (Pauly, 1982). But after the long time of saving there was the 'spontaneous birth ... of the whole project, all at once and all of sudden' (Pauly, 1982). However, it is hard to believe that when he produced the drawings of Ronchamp for the first time he had a mental image of all the complex spatial configuration, distances, and relations to the topological building context. Further, Pauly (1980, p.34) precisely described the procedure one of Le Corbusier's earliest sketches of Ronchamp:



**Figure 1:** left: (author after Le Corbusier, 1950): One of the earliest sketches of Le Corbusier defining the spatial layout of the chapel Ronchamp. right: the final ground plan of the building.

With only four lines he finds the plane of the chapel: two curved lines, one toward the south, the other toward the east. The space between the convexities of these two lines is closed by two straight lines meeting at an obtuse angel.

This rough sketch articulates the general design of the building project as it was some years later developed. But, none of the lines is produced as a single stroke, so that with any starting point and technique he chose, his sketching steps were not a verification of a preconceived mental image of the whole building. It is more likely to show that the sketch is developed graphically step by step and each line marks the beginning of the next line. Quite contrary to his own description, Le Corbusier used his sketches as dynamic and active parts in his design thinking and not simply as a medium for recording complete mental images. As shown in the brief analysis of the drawing, it is important to identify that the sketching process is embedded within a step-by-step design loop of interpretation, and redrawing. The possibility of using mental images as an architectural design tool will be discussed later on.

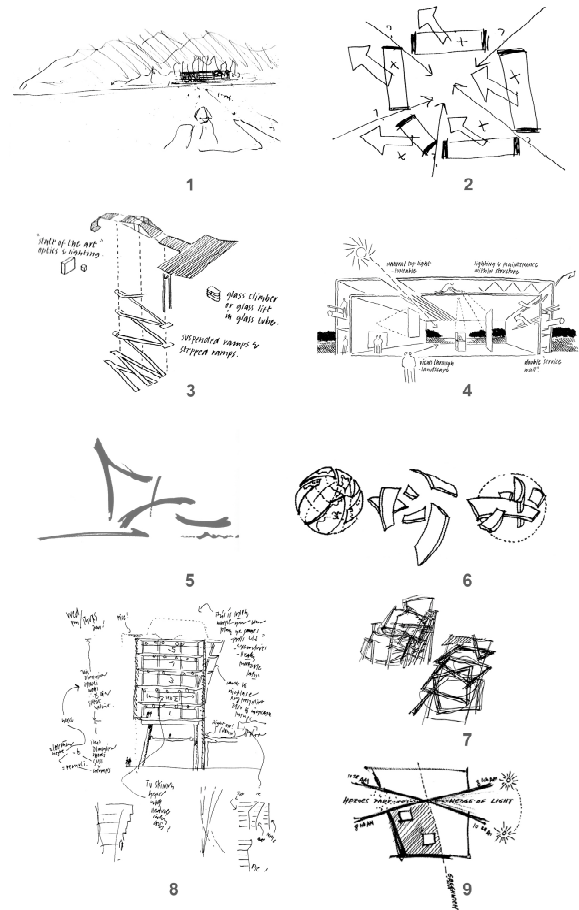
## Spatial Codes in Architectural Diagrams

Sketching and drawing play a central role in architect's work. Every architectural design has started on a blank sheet of paper and with a scribble mostly both in words and lines. Architects make use of diagrams to help develop and formulate conceptions. They draw to think about design and to remind themselves of possible design alternatives. Even though drawing styles may differ, many architects acknowledge the use of diagrams as an essential part of their design process (Do, 2002).

## Structuring Spatial Design Thoughts with Diagrams

Spatial design thoughts can become extremely complex; complex enough so that they can no longer be enclosed in the architect's mind, but rather have to be externalized. More than a few kinds of representation, technique, and medium are necessary within the architectural design process. In addition to three-dimensional representations (i.e. tangible models) two-dimensional representations are the most essential way of clarifying, articulating, and communicating spatial ideas (Lawson, 1980). It is a significant moment in the processing of every architectural design concept when ideas are carried over from architect's mind to his sketch-paper. Thus, the architect has to formulate diverse and multi-faceted kinds of abstractions to represent his thoughts. To speak from one of's my experience, a variety of diagrams (each explains different aspects, i.e. forces, flows, functions, etc.) seem to be most effective to generate and illustrate spatial information.

Diagrams could be seen as powerful graphic representations for structuring. For better understanding the role of diagrams in architectural design process and architect's working life we should examine widely-used categories of architectural diagrams.



**Figure 2:** Sketches of Foster (1,2,3,4,8) and Libeskind (5,6,7,9) illustrating design codes of the following projects: 1. Hongkong & Shanghai Bank, Hongkong; 2. Hammersmith Centre, London; 3. Carré d'Art, Nimes; 4. Sainsbury Centre for Visual Arts, Norwich; 5. Imperial War Museum, Manchester; 6. Imperial War Museum, Manchester; 7. Victoria & Albert Museum, London; 8. Hammersmith Centre, London; 9. World Trade Center, New York

**Iconic diagrams.** Generally, buildings or particular parts (i.e. details) of buildings can be represented by a graphic image. Iconic diagrams have no fixed scale or dimension and are used as symbols or identifying marks of the building. An icon can be seen as an extract, denoted by just a few lines and may also reflect a multifaceted three-dimensional silhouette of the building (i.e. see Figure 2.5). In the mind, the iconic diagram and the building often fuse into an iconic image.

**Conceptual diagrams.** Operating with this category of diagrams, architects aim for creating ideas for viable architectural solutions in general, for producing spatial, functional and aesthetical compositions, and for taking up concrete topological entities of the environment. Conceptual diagrams are regarded as a preliminary stage of dimensioned diagrams precisely because they should reveal central configurations, proportions and dimensions always in connection to the particular architectural conception (i.e. see Figure 2.9 and 2.8).

**Operational and Functional Diagrams.** Operational diagrams are mechanical variants of conceptual diagrams aimed at elements and their orientation each other (i.e. see Figure 2.3). When using operational diagrams in the design process, one has to illustrate chronological changeovers, particularly constructional concepts, i.e. how does each element relate to the other. To categorize principles of environments, neighborhoods, and the relative mass of activities within them, architects mostly make use of functional diagrams. A variety of shapes represent different functional areas and openings (typically completed by arrows) their connecting points.

**Flow Diagrams.** Similar to the operational diagram, those kinds of diagrams visualize changes over time, that is for example movement (often pedestrian), air, transport, or traffic flows within a designed environment (i.e. see Figure 2.2). They are often used to examine directions, conflicts and problems within a high-frequented area.

**Analytical Diagrams.** Analytical diagrams are extremely useful in visually identifying and relating design constraints that have an influence on an evolving conception. When architects use analytical diagrams, they make an effort to formulate and identify the orientation of the building close to its spatial entities of the existing situation, to its environmental context, and to its functional organization (i.e. see Figure, 2.4).

## Diagrams in Architect's Working Life

Perhaps as little as fifteen or twenty percent of an architectural office's overall working time on a building project are allocated to conceiving and developing the building's design – that is, to producing sketches, diagrams and drawings.

One of the things about sketching on the move is that it forces you to distill the essence of a spatial situation,

says Foster on the essential role of sketching in architect's everyday life (Foster and Blaser, 1994). In every early stage of architectural design problems, diagrams and sketches are central and important for both producing spatial knowledge and handling with spatial knowledge.

Architects produce maybe hundreds of sketches, scribbles, and diagrams (within the whole design process) before starting presentation drawings. But for all that one can assume that the more there is in the diagram the easier it is to build. In spite of their significance and importance in the very early phases of architectural design problems, diagramming constitutes just a fraction of the architect's duties. Architects make use of diagrams as communication tools, both to clarify their thoughts to other architects, engineers or clients and to be in an internal dialog (Goldschmidt, 1991) with their own diagrams

## Communication with Diagrams

Sketches and diagrams are frequently intended for a private and personal audience (such as meeting or office audience), architects draw them often in loose formats, on sketch-paper, at the bottom of larger drawings, or on scribbling paper, newspaper, envelopes, or whatever is at hand (who was ever sat with an architect in a restaurant knows very well that not only at the office it is common for trained architects to scribble alongside when discussing or explaining a spatial situation but also at every place and on every paper like material – primarily on table napkins).

As a mnemonic aid, a form of dialogue as well as a visual guideline, the drawing serves as both the subject of conversation and the object of architect's endeavor. Sketches to great extent also serve to frame and structure the social interaction architects have among each other. So, Foster describes (Foster and Blaser, 1992) that he uses sketches and diagrams additionally for 'communication about design issues to the office stuff'.

## Private vs. Public Audience

Architectural sketches have a private, inward focus (Gross, 1996). Foster characterizes the in some ways emotional relationship to his sketches (as cited by Foster and Blaser, 1994) as follows:

The majority of the sketches, contained in hundreds of black bound books, which had accumulated over the years, were a kind of naïve private shorthand.

This inward focus implies a private and perhaps semi-private audience of insiders, compared with the public audience outside of the working group. Typically, an architectural designer uses sketches to conduct an internal graphic dialog about the design issues at hand (Goldschmidt, 1991, 1994). Or, a more sizeable project, several designers may communicate and coordinate their work within a (small) group by means of sketches and diagrams.

Because architects are addressing a limited, internal (office) audience, diagrams often contain idiosyncratic notations made up on the spot. Public drawings, aimed at an external and often anonymous audience, necessarily rely on a widely shared system of conventions and symbols for communication. The focus of diagrams is continuously

changing during the design process, between a private (the designer is sketching by himself), a semi-private (the designer is collaborating with a small group), and a public audience (the designer is presenting his ideas and concepts to a client).

**Architect vs. Diagram.** While designers are sketching by themselves it seems that there is an internal dialog between the diagram and the designer (Goldschmidt, 1991). The process of discovering shapes and outlines within the own diagram and redrawing them is a powerful method for developing architectural designs (Suwa and Tversky, 1997). This interactive process involves a number of idiosyncratic characteristics and individual preferences of sketching.

**Architect vs. Diagram vs. Architect.** Sketching and drawing always accompanied these discussions and were used to communicate or record conceptions and ideas as they are brought up in the conversation. Foster describes a phenomenon that applies to both visual and the verbal communication with a small group of architects (Foster and Blaser, 1993):

Over the years a kind of private language has evolved in the office to communicate certain ways of working, negotiating, exploring, and cajoling. We use expressions, which are clear to us, but they would be quite incomprehensible outside our small community.

As a result, Stern precisely lets us know what he regards as a good and useful sketch (Stern, 1977):

The definition of a good study drawing from a point of view of its utilities in the office is that can I convey what I have in mind to someone else who will have to draw it up, develop it one step further.

**Architect vs. Diagram vs. Public.** Addressing the public audience for a project is the purpose of presentation and construction diagrams and drawings. Presentation diagrams, for example, tell architect's client how spaces will be related within the building and what it will look like. Construction drawings provide technical information for material suppliers and construction crews.

## Notes on Architectural Diagrams

Drawing with pencil allows the architect to explore spatial concepts, ideas, situations and arrangements more effortlessly and rapidly than constructing computational drawings. Architects are qualified to operate with paper and pencil to create conceptions and to communicate their thinking through the act of drawing. Design thinking relates to both form and function and must be seen as a kind of visual and spatial reasoning. Thus, the role of sketches and drawings is not a passive recording but an active participation in formulating the design. Architectural

sketches are always incomplete, fragmented and contingent. They are made mark by mark within the design process that evolves in real time, and are always poised between an unresolved past and an unpredictable future. The interactive process of sketching in architect's work may be understood through a number of properties about architectural diagrams.

## Conventions on Diagrams

Architects must be able to assume for example, that "lines mean edges" and know that others throughout the architectural profession will make the same assumptions. These shared assumptions are necessary so that everybody can go on with the work.

Design proposals will be coded into a certain graphic conventions such as plans, sections, elevations, etc. (for a good overview see Neufert, 1936). These conventions will be available to incorporate further from other drawings or from remembered images that have been coded to these conventions and may be interpreted similarly by other architects. Each of these conventions prescribed certain types if lines and a range of possible interpretations of these lines.

**The Connotation of Lines.** Lines are assumed to be both ambiguous and variable. For example, Foster makes use of at least three types of lines (i.e. see Figure 2. 4): those that are intended to represent objects that would be cut by a horizontal or vertical plane at a particular height, such as the lines that were afterwards transferred into constructions or walls; Those that represent edges of objects, and those that stand for abstract forces, such as the arrow at the walls. So, architects must be able to assume for example, that specific lines mean boundaries and know that other architectural designers will make the same assumptions. These common pre-conditions are necessary so that anyone can keep on with the work.

**Sketching the Right Dimension.** From my own graphic experience it seems that architectural designers have a preference for small sketches and diagrams sizes. Almost certainly small diagrams are faster to produce (and speed is a important criteria of the production of diagrams), but also from a perceptual point of view the message area of the diagram could be held in the architect's visual focus. Generally, the term message area refers to the central meaning of a graphic work, i.e. the particular zone, from which the meaning of the diagram is communicated. From cognitive perspective a small diagram has an absolute advantage, because it allows concentrating on the idea of the diagram with out visual switching from one side to the other. Thus, concentrating is better than searching.

**Sketching in Layers.** Sketching in layers relates to 'redrawing', as a very common characteristic of a designer's sketching actions, (Do, 2001) in which the designer continually outlines a focal point of the drawing, e.g. as to outline the final shapes of a building (see Fig. 3).

The combination of redrawing techniques with sketch paper as a medium serves as a efficient design method to the experienced designer.



**Figure 3:** The shape is defined layer-by-layer. As a result the sketch both contains and exemplifies the diagrammatical history of the emergence of the final outline.

## Discussion

Hence, my colleague's belief of preconceived mental images in the architectural design process is to a certain extent justified: It could be true that designers may have perhaps a few mental images that they aim to realize, but this images comes out not to be as complete as he think it they are and, they have to be manipulated graphically. Finally, while the process of manipulating, architects discover things in their own sketches that they never expect (Goldschmidt, 1994). Sometimes the sketches show more than the finished perspective. And Eisenman (as cited by Herbert, 1993):

what I do is set up a series of ideas or rules or strategies, and draw into them... trying to find some form in those ideas. In other words, my drawings are rather more haptic or circumstantial and in them I find things that I wouldn't have found if I had said 'This is what I want' to start with.

It becomes obvious that architects produce spatial information during they are operating with sketching that they use as a dynamic instrument of thought. One has seen that some architectural designers describe their own design methods by means of 'images in mind' or 'mental images' (for example Le Corbusier, in Pauly 1982) that is to say they imagine the whole building design in their mind' eye without externalizing and recording it on physical media. To discuss those reports it is a crucial point to distinguish between buildings as stand-alone-objects and as contextualized-objects (see Rowe and Koetter, 1978).

### Object vs. Context Concerning Pictorial vs. Spatial

Is there a difference in design thinking when architects have to develop a building on a blank sheet or within a complex context? One could argue that buildings always are created within a present context (that means that there are always environmental constraints to respect), but also from my own experience speaking nevertheless there is a visible dissimilarity in building design.

**Buildings as Stand-Alone-Objects.** Most buildings as stand-alone-objects (also known as *solitaire*) are in some way isolated from their environment, for example in the central point of squares, on the top of hills, or in open landscapes. One of the most significant characteristics is that these buildings were not only perceived and experienced as an object that one can circumvents from all sides, but that architects can design them as well as a single object, as a separate thing, or as a big architectural sculpture.

**Buildings as Contextualized-Objects.** Buildings are contextualized-objects, if they are surrounded and encircled by a number of other buildings, urban paths, grouped areas, or arranged objects, and thus an integrated part of a complex and dynamic network. To create a building design in respect to all these environmental aspects and constraints is substantially more complex and complicated. One experiences buildings as contextualized-objects rarely as objects, but always close to the existing entities that surround it. A number of existing buildings represent a combination of both, especially in inner-city situations.

However, these two approaches of designing buildings have not only a strong influence on architect's mental images and thoughts, but also on the use of architectural diagrams during the design process. Frequently the decision is regarding to client-specific constrains.

**Pictorial or Spatial?** The question if there is a relation between the characteristic of the architectural design process and the object-context dissimilarity is to all intents and purposes validly. As stated above, there is not only a difference in categorizing the close building-environment relation, but also in the process of designing them. From my own experience, architects imagine the building as a stand-alone-object more pictorially, in contrast to the building as contextualized-object, which is imagined more spatial, causal to the environmental complexity and thus to the strong (interactive) relation to diagrams (Goldschmidt, 1994). This interrelation (object-pictorial and context-spatial) could be based on the difference of one's particular experience and view of this two categorizes of buildings.

When I generally have a 'mental image' of a building as stand-alone-object, I am looking from a perspective view to the building. This perspective view allows the architect to understand its appearance from its shapes, outlines and form and to get an overall picture of the building. When architects want to contextualize a building within a design existing arrangement, i.e. find the right position in relation to other alignments, they are always working on plans and maps that give them an overview about the environment.

But, could it be possible to utilize this 'cognitive preference' for developing a design method? With the statement of Le Corbusier (about the 'spontaneous birth' of the building shape of Ronchamp) in mind, and considering

some of Libeskind's most well-known existing buildings, namely the Imperial War Museum (Manchester), the Jewish Museum (Berlin), and the Victoria & Albert Museum (London), it becomes obvious that all these buildings are designed as architectural objects, without respecting the context not greatly. Further, the design of the Imperial War Museum is based on the concept of fragments of a globe, the design of the Jewish Museum rest upon a deformed Star of David, and finally the V&A Museum's design concept represents a walkable helix (for good overview see Libeskind, 1997, 1999, 2005). I remember that all these buildings are designed as objects, symbols or icons (that means that they could easily be imagine in the architect's mind), they should represent an architectural metaphorical mark, and their shapes are not emerge from interactive sketching, but from passive recording from the architect's mind (occasionally following by a modification with both diagrams and physical models). To work with preconceived images one has to operate with existing forms and recognizable shapes. So, it means that one is imaginably mapping i.e. the shape of the helix into the existing building plot. Thus, in the mind, the iconic diagram and the building outline are merging into an iconic image of the building. Libeskind's buildings and his design process could be classified as object-oriented. Furthermore, Libeskind frequently is using iconic diagrams (i.e. see Figure 2.5, 2.6, 2.7) to explain both his design concept and the final form of the building. Foster is designing more spatially and context-oriented and makes use of iconic diagrams rarely. It seems difficult to bring Foster' buildings in to mind without integrating particular entities of their context and environment.

Regarding to the use of diagrams in architectural design one could say that if architects are designing more pictorially, they use diagrams simply for recording the preconceived idea of the building. But if they are scribbling and interact with their diagrams one could say that they are designing more spatially.

To come back to Eisenman's question at the beginning: the ability of architects seems to be that, depending on the particular design problem solving process they use architectural diagrams in many-sided and numerous ways to articulate and communicate spatial qualities and elements. Thus, diagrams and the activity of diagramming generally seem to bring a quality to the architectural design process that nothing else can perform.

### Notice

Most information presented and discussed in this paper is based on the author's personal working experience as an architectural designer in both design offices, Studio Daniel Libeskind and Foster and Partners. All sketches presented on Figure 2 are copyrighted by Foster & Partners and Studio Daniel Libeskind. The right sketch in Figure 1 is copyrighted by the Le Corbusier Foundation.

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### References

- Bertel, S., Freksa, C., & Vrachliotis, G., 2004, Aspectualize and conquer in architectural design, in Gero, J., Tversky, B., Knight, T., (eds.) *Proceedings of the 3rd Conference at Visual and Spatial Reasoning in Design 04*, Key Center for Design Computation and Cognition, University of Sydney
- Cross, N., 1999, Natural intelligence in design, *Design Studies* 20, 25-39
- Do, E. Y. and Gross, M. D., 2001, Thinking with diagrams in Architectural Design, in *Artificial Intelligence Review* 15, Kluwer Academic Publishers, Netherlands, pp. 135-149.
- Do, E. Y.: 2002, Drawing marks, acts, and reacts: Toward a computational sketching interface for architectural design, in *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, Cambridge University Press, pp. 149-171
- Eisenman, P., 1988, Architecture as a second language: the texts of between, *Threshold: Journal of the School of Architecture, University of Illinois at Chicago* 4
- Foster, N., 1997, *Norman Foster: selected and current works of Foster and Partners*, Mulgavre, Vic.: Images Publishing
- Foster, N., and Blaser, W., 1993, *Norman Foster Sketch Book*, Basel, Birkhauser Verlag
- Foster, N., and Blaser, W., 1992, *Norman Foster: Sketches*, Basel, Birkhauser Verlag
- Goldschmidt, G.: 1991, The dialectics of sketching, *Creativity Research Journal* 4, 123-143.
- Goldschmidt, G., 1994, On visual design studies thinking: the vis kids of architecture, *Design Studies* 15, 2
- Goldschmidt, G.: 1995, The designer as a team of one, *Design Studies*, 16, 189-209.
- Herbert, D., 1993, *Architectural Design Drawings*, London
- Lawson, B.: 1980, *How designers think – the design process demystified*, Architectural Press Ltd., London.
- Lawson, B.: 1994, *Design in Mind*, Architectural Press Ltd, London.
- Le Corbusier: 1965, *Texte und Zeichnungen zu Ronchamp*, Oeuvres de Notre-Dame du Haut, Ronchamp.
- Libeskind, D., 1997, *Radix-Matrix: Architecture and Writings*, München; New York, Prestel
- Libeskind, D., 2005, *Breaking Ground*, Verlag Kiepenhauser and Witsch, Köln
- Libeskind, D., and Binet, H., 1999, *Jewish Museum Berlin*, G and B Arts International

- Stern, R., 1977, Drawing towards a more modern architecture, in *Threshold – Journal of the School of Architecture, University of Illinois*
- Suwa, M., and Tversky, B., 1997, What do architects and students perceive in their design sketches? A protocol analysis, *Design Studies*, 18, 385-403
- Neufert, E.: 1936, *Bau- Entwurfslehre*, Bauwelt-Verlag, Berlin.
- Pauly, D., 1980, Ronchamp. Lecture d'une Architecture, Paris
- Pauly, D., 1982, The Chapel of Ronchamp as an example of Le Corbusier's creative process. The Le Corbusier Archive, in Vol. 20, Ronchamp, Maisons Jaoul, and other Buildings and Projects, New York
- Porter, T., 1997, The Architect's Eye – Visualization and depiction of space in architecture, Hong Kong
- Rowe, C., and Koetter, F., 1978, *Crisis of the Object: Predicament of Texture in Collage City*. The MIT Press, Cambridge, MA