

# Starting with a Cube as the Perfect Guide to Sketch Geometry in Design and Architecture

Albert Schmid-Kirsch

*Institute of Creative Design and Architectural Drafting, Leibniz University Hannover  
Herrenhaeuser Str. 8, D-30419 Hannover, Germany  
email: schmid-kirsch@aida.uni-hannover.de*

**Abstract.** This paper deals with the role of traditional sketching in times of computer aided design. Sketching is still an essential skill for artists, designers and architects and maybe some others. Sketching in the early stage of the design process means to explore forms, connections and space. But how to teach these skills in times of highly developed sophisticated computer renderings? The authors answer is a special course in freehand sketching called “Unplugged Drafting”.

*Key Words:* Descriptive Geometry, graphics education, sketching, architecture  
*MSC 2000:* 51N05

## 1. Introduction

While Dresden hosted the 13th International Conference on Geometry and Graphics in Beijing China the CCTV building (Fig. 1, left) was finished. The design of the building is done by Dutch architects Rem KOOLHAAS and Ole SCHEEREN. Having a look at their preliminary studies and first sketches on the project (Fig. 1, middle) one can realise that the main idea is very simple. The huge building follows the edges of a cube, the uprising parts slightly inclined. The same design idea can be found in smaller scale in the door handle (Fig. 1, right) on the front door of a shop in Vienna on the opposite side of the MAK, the museum of applied arts. Not every simple idea is good design but good design ideas often are simple and born with the help of sketches.

## 2. To draw is to see

The basis of writing is verbal literacy, the basis of sketching is visual literacy. Donis A. DONDIS emphasizes in her Primer of visual Literacy [3]: “Visual information is the oldest record of human history. The cave paintings represent the oldest preserved report on the

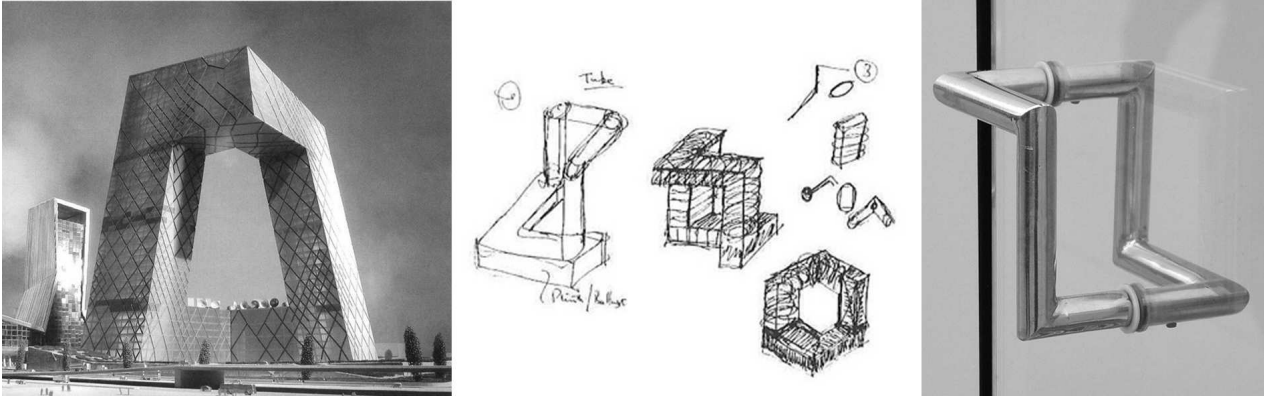


Figure 1: CCTV Beijing, Rendering, Preliminary studies, Door Handle in Vienna

world as it was seen some 30.000 years ago.” Verbal literacy is generally accepted, visual literacy is not yet. To become verbally literate we established schools. To become visually literate is often thought to be a windfall or innate.

In order to teach these skills at the faculty of architecture the author established a special course in freehand sketching called *“Unplugged Drafting”*. Francis D.K. CHING says in [1]: “The drawing of things we see before us has traditionally been fundamental training for artists and designers.”

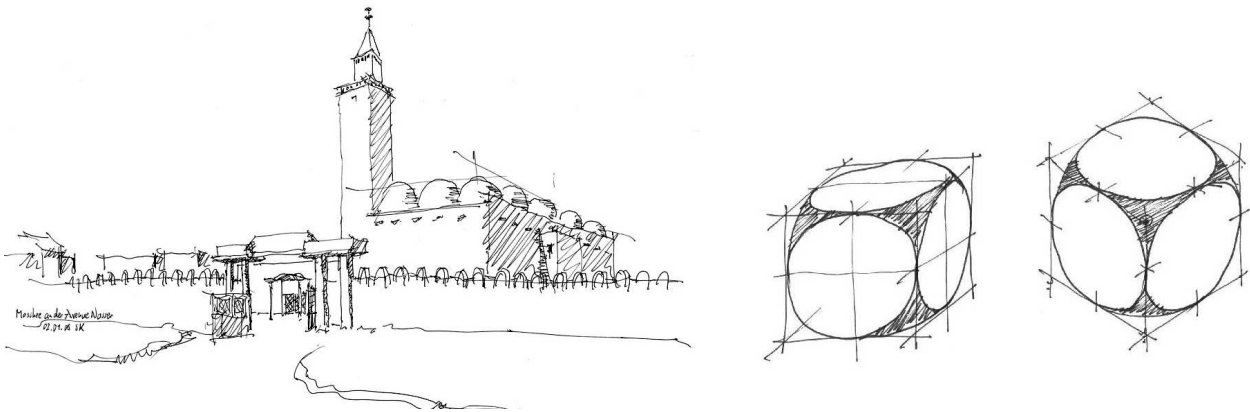


Figure 2: Left: Mosque in Nouakchott, Mauretania; Right: Cube in oblique projections

Drawing from observation like the mosque in Nouakchott, Mauretania by the author as shown in Fig. 2 develops the eye-mind-hand coordination and fosters the capability of seeing. A self drawn object or scene is hard to forget. The aim is not to produce a piece of art but to train perception as well as drawing skills. In this context the sketching hand is an extended part of the brain. Sketching in the early stage of the design process means to explore forms, connections and space. This sketching is not a survival of times before computer rendering was possible. It is the essence of non verbal information mankind ever used to use as close to our thoughts and visual thinking as spoken words and writing.

### 3. Unplugged Drafting

#### 3.1. Projection methods

This course enables students of architecture to explore and describe their design ideas with a pencil on a sheet of paper. Neither electricity nor other device is needed. To start with a design process there is no better tool than a sketch or a series of sketches, see [2]. The basics of this course are pure descriptive geometry. And there is no better object to study all the possible projections than the cube. The cube is the backbone. Every child knows the cube or at least his relative the dice (Fig. 2). Like no other object the cube represents our three dimensional world and the Cartesian coordinate system. So we start to compare the three common projection methods like orthographic, axonometric and perspective projection (Fig. 3).

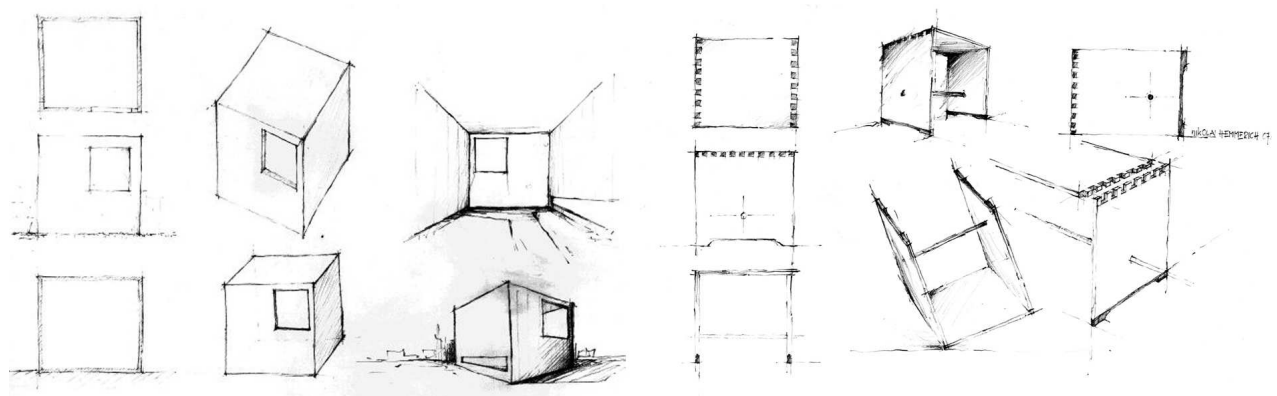


Figure 3: Cube (left) and *Ulmer Hocker* (right) in different projections

#### 3.2. Differences in projection methods

While sketching we realize that there is a difference between axonometric and perspective drawings. Axonometric drawings show us the threedimensional nature of the drawn subjects but have a certain amount of analysis. We can compare dimensions and proportions. Perspective drawings require a point of view, a line of vision and a distance and show us objects in the subjective way we see them. The draftsman has to make his choice according to his aims. We can also distinguish the different kinds of axonometric drawings by sketching the cube in plan oblique, elevation oblique, Isometric and Dimetric. If students are able to draw a cube in every possible projection, they are also able to draw furniture like the famous *Ulmer Hocker* (Fig. 3) designed by Max BILL (1908-1994) and Hans GUGELOT (1920-1965) in the year 1955 on the Hfg Ulm (Hochschule fuer Gestaltung = Ulm school of design) in Germany. In order to be aware of these differences between the different projection methods, almost all the following examples are drawn in more than one of these three main methods: multiview drawings (plan, section, elevation), axonometric and perspective drawings.

#### 3.3. Stairs, different points of view

We study perspective with a straight flight of eight steps inspired by the stairs of Luis BARAGAN (1902–1988) in his own house in Mexico City and draw it from different points of view. Vanishing points of sloping lines, e.g., the handle are introduced. Turning the sheet of paper

upside down and even 90 degrees clockwise and anticlockwise shows us all the possibilities of making a choice.

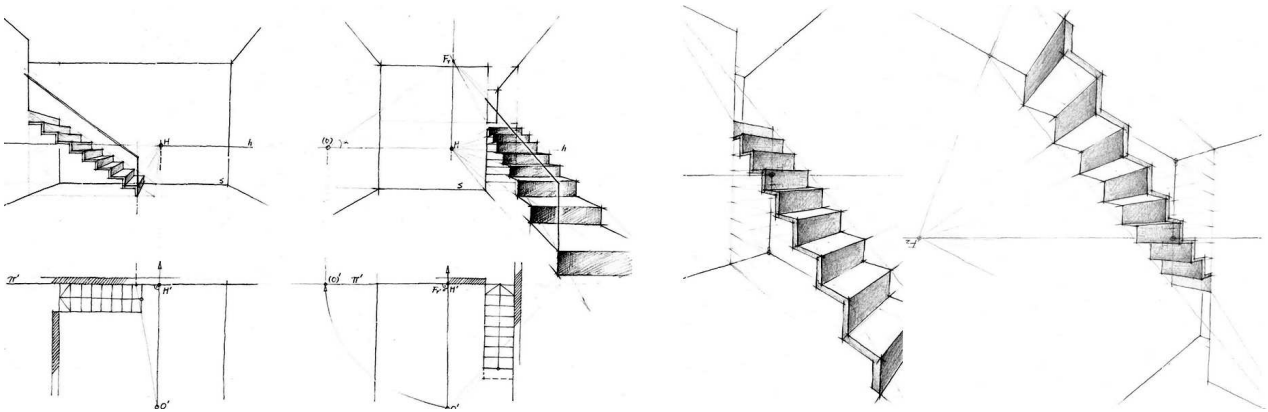


Figure 4: A flight of stairs, different points of view and upside down (right)

### 3.4. Circles, ellipses

Not all examples of furniture design are rectangular as the *Ulmer Hocker*. Drawing the table of Gerrit RIETVELD (1888–1964) needs knowledge about circles and ellipses (Fig. 5). With the circles inscribed in the quadratic sides of the cube it is possible to draw circles, conic sections and other curved lines using the centre of the four edges, the edges itself as tangents on the curve in the centre points. If the centre of the circles coincide with the centre of the cube we have three circles (equator and two main meridians) that represent a sphere (Fig. 6). The circle shaped stairs of Heinz BIENEFELD (1926–1995) can be drawn in any desired projection. The commonnesses and differences in different projections become conscious (Fig. 6).

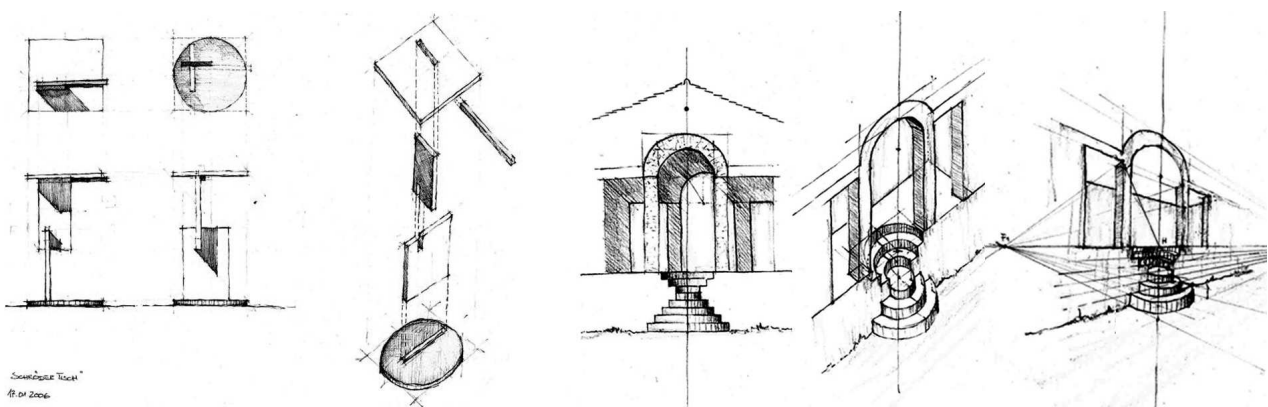


Figure 5: Left: RIETVELD Table; Right: Rounded stairs with conic shape

The loudspeaker *BeoLab2* of Danish brand Bang and Olufsen (Fig. 6) is an example for a classic geometrical form, the combination of cube and sphere. It is the form of the dice and the pendentif vault ore the Roman capital in architecture. In architecture it is used as transition from square to circle.





Figure 6: Shere, Pendentif Vault (sketch), Loudspeaker, Pendentif Vault (Foto)

### 3.5. Spheres, freeformes and bubbles

As seen already in Fig. 6 it is possible to analyse and draw spheres. Freeform surfaces like the *Kunsthau Graz* (Museum of art) by British architects Peter COOK and Colin FOURNIER need another concept. It is the concept of sections in fixed distances like the ones we know from maps. These parameter lines are also used in CAD and in medical diagnosis. Contour lines also are useful. Almost all we can think in terms of descriptive geometry we can draw and sketch. But we can only succeed when we learn in terms of descriptive geometry and keep on training. We have to use both, body and brain and we get aware that they belong together. That's not a little thing in times of increasing TV consumption and children sitting in front of their playing consoles for hours and hours. The benefits of freehand drawing are the simple tools needed and the quick results arising.

### 3.6. Shade and shadow

In Fig. 7 the graphic concept of shade and shadow already appears. Besides points and lines tonal values are important graphic tools to express three dimensional space and depth in two dimensional drawings. It's the author's experience over twenty years of teaching that students of architecture are not able to draw cast shadows right before being told how to do it. The author came to learn that in order to express depth and three dimensions in twodimensional drawings shade is more important than cast shadow. Shadows change in time over day and

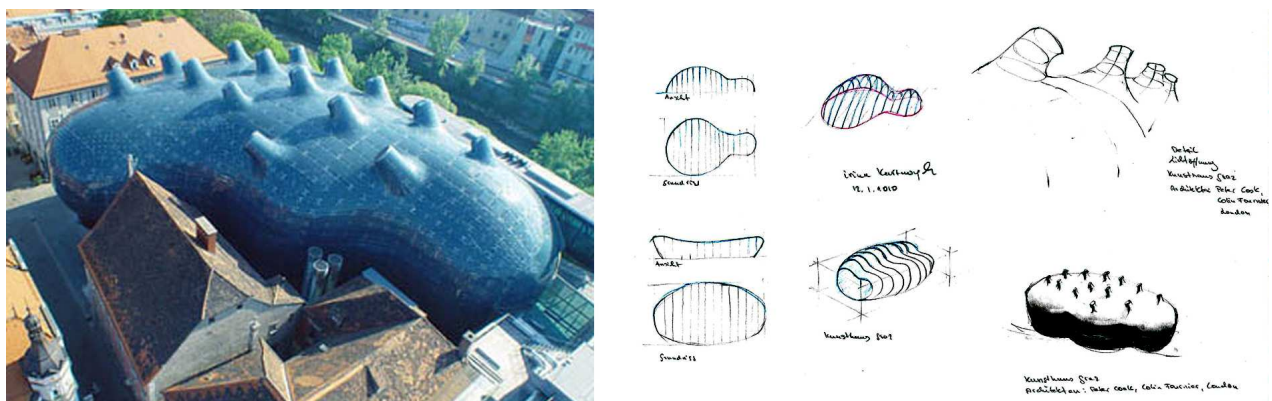


Figure 7: *Kunsthau Graz*, aerial view and sketches

year but objects will always have a lighter and a darker side in the presence of light. While teaching students of architecture it is very important not only to draw what you see but to draw what you know. And that includes besides visible or invisible edges lines of special meanings like centrelines, grids, rays of light, tangents and so on. This way sketching will still be a strong tool in the hands of designers, artists and architects.

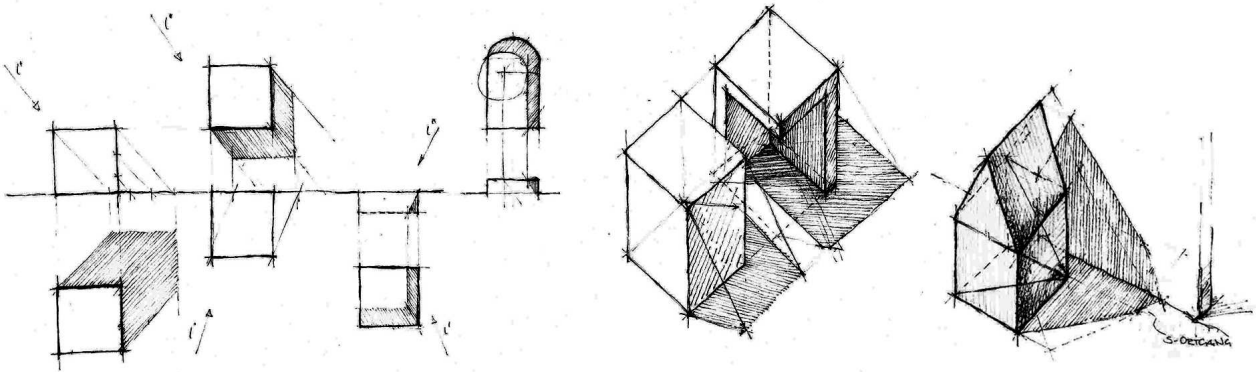


Figure 8: Shade and shadow

### 3.7. Concepts, new ideas

Sketches are the easiest, shortest and most economic way to enable communication on new design ideas. This is demonstrated with the so called House of today by German architects ALLMANN, SATTLER, WAPPNER in 2004 in Munich, Germany. An axonometric look up in the three individual rooms as well as an perspective look down in the living room upstairs helps to understand the concept of the house.

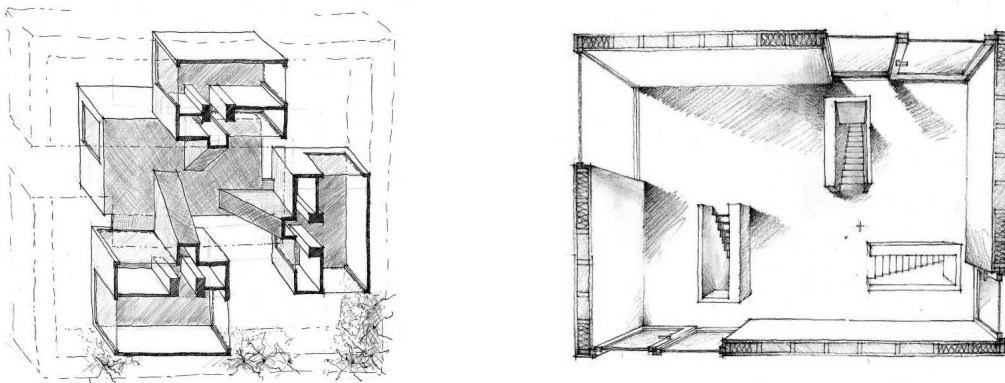


Figure 9: House of today, axonometric looking up, perspective looking down

### 3.8. Drawing the invisible

A photo takes a scene as a whole and can not emphasize only a special part. A sketch brings up the concept of Rudolph M. SCHINDLER's (1887–1953) own house in California only with a few lines as clear as possible. A sketch can express ideas and thoughts in short time like Frank O. GEHRY's sketch for the Museum of Art *MARTa* in Herford, Germany. GEHRY's

concept sketch is not a simple plan of the first floor. It can be read as the traces of visitors moving towards and through the museum.

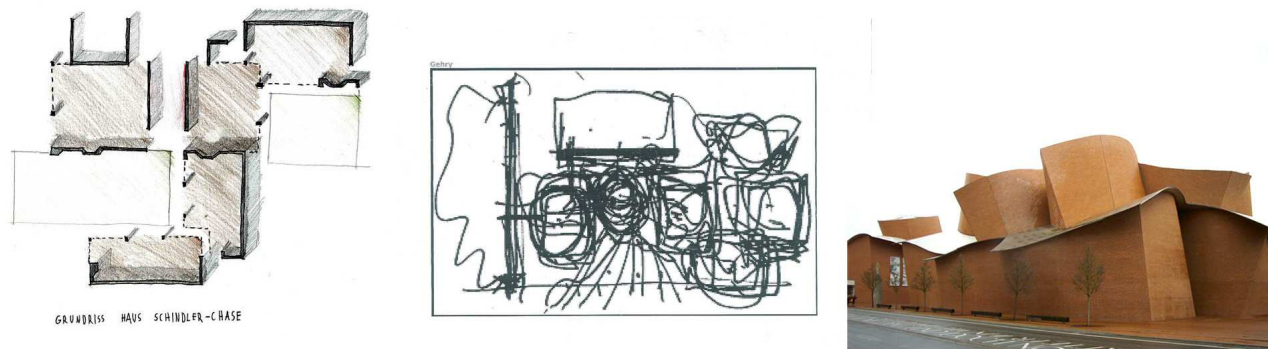


Figure 10: SCHINDLER's house, concept sketch and Museum *MARTa* in Herford, Germany

#### 4. Conclusion and Acknowledgement

Drawing is more than presentation. Drawing is the closest connection between brain, eye and hand. Drawing stimulates thinking and seeing. Drawing is a tactile experience, a kind of formfinding laboratory. It can only be learned by doing. While sketching and drawing visual literacy is acquired. The sketches of this paper are results of the course “Unplugged Drafting”. The course started first in the winter term 2005/06 and is now going in the 8th term.

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