国外高等院校土建学科基础教材（中英文对照）

工程制图
TECHNICAL DRAWING

[德] 贝尔特·比勒费尔德
[西] 伊莎贝拉·斯奇巴　编著

吴寒亮 何玮珂　译

BASICS

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著作权合同登记图字：01－2007－3336 号

图书在版编目（CIP）数据

工程制图/（德）比勒费尔德，（西）斯奇巴编著；吴寒亮、何玮珂译.
北京：中国建筑工业出版社，2009
国外高等院校土建学科基础教材（中英文对照）
ISBN 978-7-112-11582-2

Ⅰ. 工… Ⅱ. ①比…②斯…③吴…④何… Ⅲ. 工程制图－高等学校－教材－英、汉 Ⅳ. TB23

中国版本图书馆 CIP 数据核字（2009）第 209814 号

责任编辑：孙　炼
责任设计：郑秋菊
责任校对：袁艳玲　赵　颖

国外高等院校土建学科基础教材（中英文对照）
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［德］贝尔特·比勒费尔德
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*

中国建筑工业出版社出版、发行（北京西郊百万庄）
各地新华书店、建筑书店经销
北京嘉泰利德公司制版
北京密东印刷有限公司印刷

*

开本：880×1230 毫米　1/32　印张：4¼　字数：136 千字
2010 年 2 月第一版　2010 年 2 月第一次印刷
定价：**15.00** 元
ISBN 978－7－112－11582－2
（18811）

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序

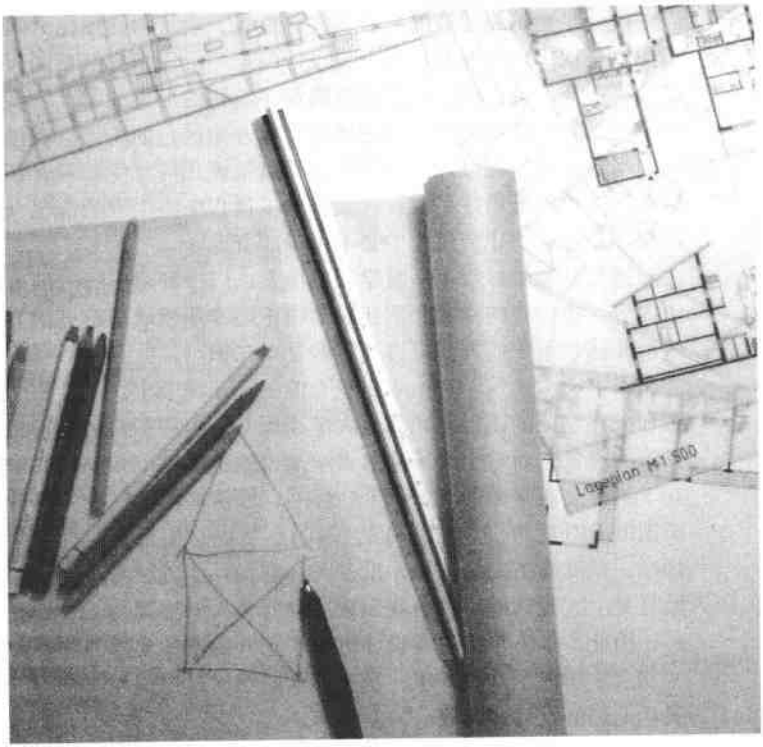
设计是建筑物建造的必需条件。首先，建筑物必须在方案图和施工图上呈现出来。通常情况下，设计的第一阶段是方案草图设计，如设计简图或者透视图，其目的是确定建筑物的形式和设计方案。本书介绍的内容是在第一阶段已完成之后才开始进行的工作。在接下来的时间里，首先是将设计简图转化成具有精确几何比例的设计图：工程图纸。工程图纸描述了在设计或者施工过程中将出现的情况及其详细过程，是建筑物建造过程中必不可少的资源。

这套基础教材旨在从教学目的出发，以一种适应练习的方式来给出内容。我们将向读者介绍建筑学中不同专业领域的培训内容，并以一种简洁、系统的方式来讲述这些基础知识。

本书面向建筑学和土木工程专业的低年级学生，以及初学建筑制图和工程制图的读者，尤其是大学课程对工程制图要求进行相关基础知识的准备，而学生必须通过自学来得到这些基础知识。其中的难点在于规范建筑制图的大量的 ISO 标准，而这些国际标准大部分是基于德国的 DIN 标准（例如纸张的版式）。然而，如果不注意这些通常的规则，就没有正确的途径来准备和开展设计或者制图工作。建筑制图始终是个人设计的一种自我表现，具有个人的格调。

因此，本书给出了在设计过程中不同的设计类型和制图方式的基本要求。掌握了这些要求，学生们就能够通过建筑制图快速、自信地展示他们的设计和思路。

编者：贝尔特·比勒费尔德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FOREWORD

Buildings are not erected without plans, but must first be presented in plans and construction drawings. As a rule, the first steps consist of free presentations like sketches or perspective drawings, intended to establish the form and design of the building. This book begins at the point when these ideas have been developed, and the first sketches are turned into geometrically precise scale plans: technical drawings. These drawings provide an image of what will emerge in terms of design or construction, and their detailing process is thus an essential resource on the way to a finished building.

The "Basics" series of books aims to present information didactically and in a form appropriate to practice. It will introduce students to the various specialist fields of training in architecture, and transmit the basics in a compact and systematic way.

The "Technical Drawing" volume is directed at those commencing studies in architecture and civil engineering, and trainees in construction drawing and technical drawing. University courses in particular often require basic knowledge for the preparation of technical drawings, which students have to acquire laboriously for themselves. The difficulty lies in the large number of ISO standards that regulate construction drawings – the German DIN standards were largely the basis for international standards (e.g. for paper formats). Regardless of these general rules, however, there is no one correct way of preparing and creating a design or working drawing. Construction drawings always an act of self-expression by the person preparing them; they have a personal touch.

This book therefore provides the fundamentals required for the various plan types and drawings in the planning process – so that students are enabled to present their designs and ideas quickly and confidently through construction drawings.

Bert Bielefeld
Editor

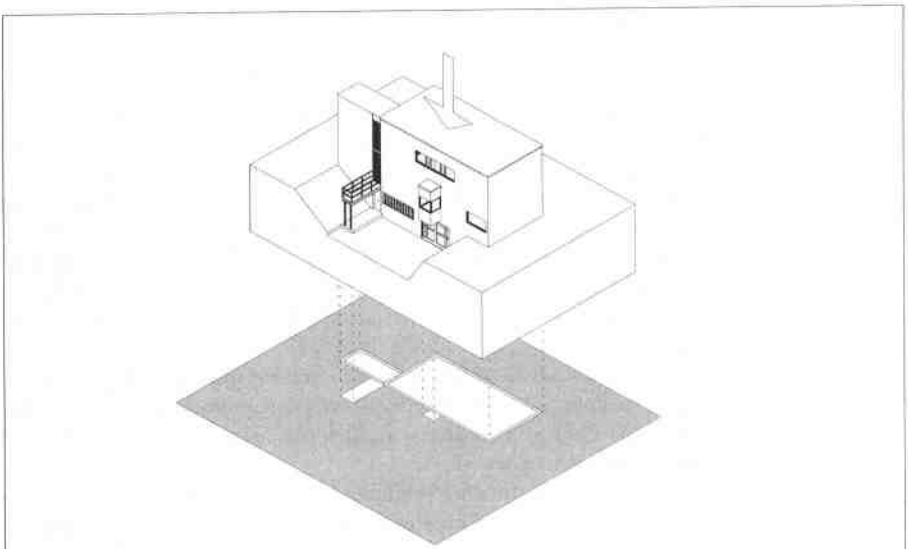

Fig.1:
Top view principle

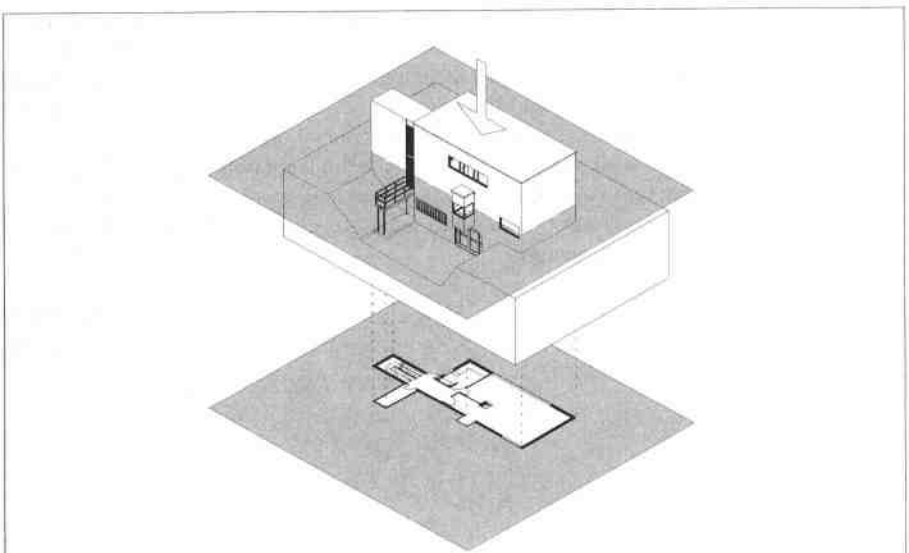

Fig.2:
Plan view principle

PROJECTION TYPES

Buildings are drawn in the form of sketches and free perspectives, but also using various structural drawing approaches. A fundamental distinction is made between top view and elevation for the exterior, and between plan view and section when drawing the interior of a building.

TOP VIEW (OR ROOF PLAN)

Top view drawings present a view or projection of the building seen from above. A top view (also often called roof plan) is important for the location plan, for example, which defines the building's position on the plot.

PLAN VIEW

In the same way, a plan shows a single floor of the building. Here a section is taken through the building at a height of about 1 to 1.5 m above the floor, to include as many apertures (doors, windows) in the masonry as possible. To make the drawing comprehensive, the heights of all the relevant structural sections (sill to floor height, aperture height, ground level, floor height) are given, as well as all the relevant horizontal dimensions. The height of the horizontal section may be changed to illustrate as many special features of the design as possible and to represent any windows that may, for example, be higher. (The different position of the window is then clarified by giving the sill to floor height.) For the direction of the plan, there are two basic possibilities:

- The downward direction of view used in architects' plans (top view), which makes it possible to record room structures, form and size.
- The reflected plan views from below showing construction elements that lie above the horizontal section level. – Structural engineers prefer this view, which shows the loadbearing construction elements in the ceiling above. › see chapter Specialist planning

Designating plan views

Plan views are generally designated according to the floor they apply to, e.g. cellar floor plan view, ground floor plan view, 1st floor plan view, attic floor plan view etc. If it is not possible to identify floors clearly in a design, e.g. when floor levels are offset, the obvious thing to do is to name the plan views after particular levels: e.g. level -3 plan view, underground car park.

\\Hint:
As a rule, plans with top and plan views are "northed", in other words, north is at the top edge of the plan and is indicated by a north arrow.

ELEVATION

Elevations (also called views in the ISO standards) show the outside of the building with all its apertures. Views of the cubature of a building provide information about its relationship to its environment, its form and proportions, and the construction type and material qualities where applicable. Along with the plan views and sections, elevations complete the overall design.

Elevations are parallel projections, seen from the side, onto a building façade. The projection lines run at right angles to the projection plane, so offset sections are not shown in their true size.

An elevation generally shows the immediate surroundings, with the lie of the terrain and links to any existing building development where appropriate.

Designating elevations

Elevations are identified according to their position on a point of the compass. The north arrow on the location plan and on the plan views defines the orientation of the building. Hence, the following designations are used for each of the four elevations: view north, south, east and west (or northeast, southwest etc.). If only two elevations are visible (as in terraced houses), they can also be defined in relation to the building's position on the plot, or the position of the development as a whole. But this means that only two sides are fixed unambiguously, e.g. the garden or courtyard side and the street side. The labelling of the elevations must be clear for anyone – even if they are not familiar with the area.

SECTION

A section is created by making a vertical cut through a building and considering this as a view in parallel projection. Sections are intended to provide information about floor heights, material quality and the building materials to be used for the planned building.

The section line must be entered on the plan view or all plan views. It is identified by a thick dash-dot line and the direction of view. Arrows and two capital letters of equal size fix the direction and the designation of the section. The section is taken in such a way that all the information

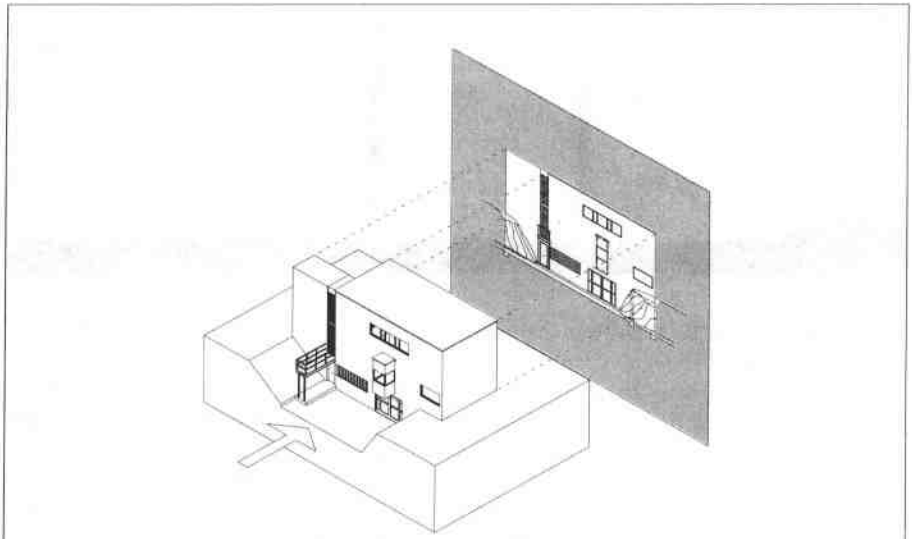

Fig. 3:
Elevation principle

relevant to the building can be recorded, which means that the section line may deviate occasionally. This deviation must be at right angles, and must be identified in the plan view.

Elements of a section

Important elements shown in a section include the structure of the roof, the floors and ceilings, the foundations, and the walls with their apertures. The section should also show access to the building via stairs, lift, ramp etc.

Designating sections

Sections taken parallel through a main axis of the building are called longitudinal and cross sections. A longitudinal section cuts the building along the longer side and the cross section along the shorter. If more than two sections are taken, they are usually designated by capital letters or numbers. As the section lines on the plan views are identified by the same letters on both sides, the section designations are, correspondingly, section A–A, section B–B or section C–C etc.

THREE-DIMENSIONAL VIEWS

Axonometric projections

Axonometric projections are plan views or views with a third plane added – height. They are generally used as three-dimensional views at the planning stage, and give a spatial impression of the building. They are

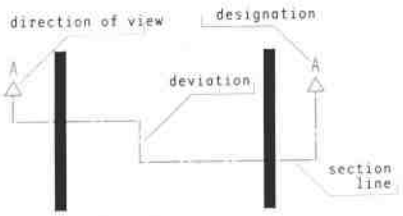

Fig.4:
Section line

used for construction plans only in exceptional cases, for example to show the design of a corner.

It is easy to develop three-dimensional views from a two-dimensional drawing. A distinction is made between different projections (even though the term "projection" is misleading here):

- The "military projection", where the plan view is rotated through 45° at one corner and completed vertically by adding the heights.
- The "architects' projection", where the plan view is again rotated at one corner – through 30° or 60°.

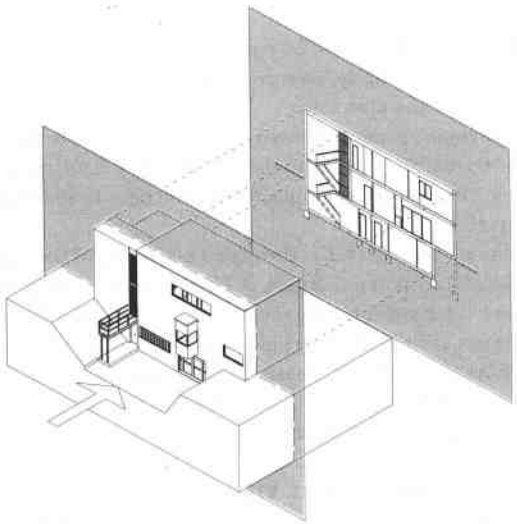

Fig.5:
Section principle

_ The "cavalier projection", where an elevation or section acquires a third dimension by the addition of lines at an angle of 45°.

Isometric and dimetric projections

It is possible to create a better three-dimensional impression by moving away from the right angle as a base. Isometric and dimetric projections are used to do this.

Isometric drawings place each of the two plan view axes at an angle of 30° to the horizontal base line, and the height axis is plotted onto the plan view axes. This means that the object represented is not so distorted as in the three methods given above, but the drawing must be constructed more elaborately.

For a dimetric projection the two plan view axes are placed at angles of 7° and 42°. The line lengths of the latter should be shortened by factors of 0.5 or 0.7.

Perspective drawings

Perspective drawings differ from axonometric, isometric and dimetric projections in that they do not present the lines lying on an axis as parallel, but in perspective. Since perspective drawings are not generally used as construction plans, but only for presentation purposes, they fall into the field of descriptive geometry and are not examined further here.

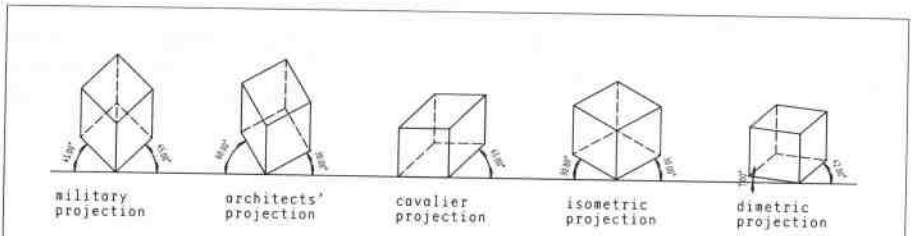

Fig. 6:
Axonometric, isometric and dimetric projections

AIDS

Basically there are two different methods for producing construction plans:

_ Hand drawing
_ CAD

Drawing tables

Hand drawing is carried out either at special drawing tables fitted with a pair of sliding rulers set at right angles, which can be adjusted; or using drawing rails, which are screwed onto an existing desk-top and slid vertically on stretched wires. Both variants make it possible to draw lines parallel or at right angles.

Pens and pencils for hand drawing

Hand drawings are usually made with pencils or ink pens. Pencils are available in various hardness grades, which affect the thickness and visual effect of a line: the harder the pencil, the finer the line, because little lead is rubbed off onto the paper. So various grades of pencil are needed for drawings, to be able to make lines of different widths.

Ink pens exist in various forms (e.g. with or without cartridges) and nib widths. The nibs mentioned in the chapter on lines are available individually.

Rulers and set squares

A variety of rulers, protractors, triangles, set squares and stencils are available to make drawing simpler. Rulers, triangles and adjustable set squares are used to draw in the geometrical dimensions. Lengths on plans

\\Tip:
Pencils ranging from grade B (soft) via F (medium) to H to 3H (various degrees of hardness) are used for construction plans. Harder pencils should be used first, to avoid smudging the softer, thicker lines.

\\Tip:
Ink pens come with and without cartridges in various colours. The latter are cheaper in throwaway versions, but more expensive if a lot of drawing is to be done. The thinner the line produced by an ink pen, the greater is the danger that the pen may dry up if stored for a long time. Sometimes the pigments in the nib of the pens can be moistened in a bath of water. If lines that have already been drawn need to be removed, special ink erasers can be used. But careful scratching with a razor blade is quicker.

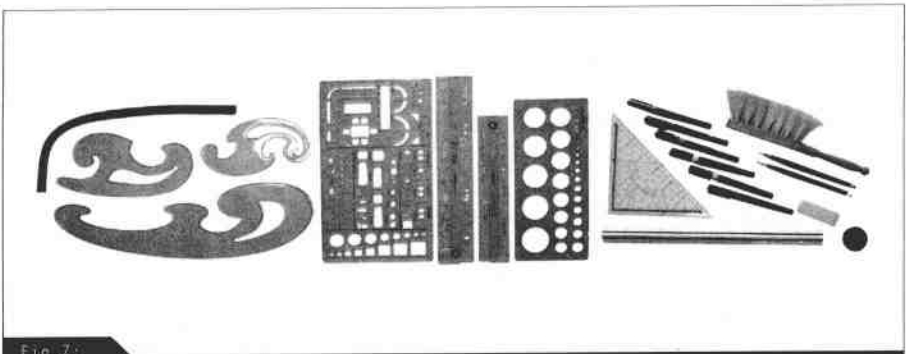

Fig.7:
Typical aids

are generally measured with a set square, a triangular ruler including six different scales with a length scale for each.

Stencils

Stencils are available for almost all typical drawing symbols (e.g. for furniture, electrical connections or bathroom facilities). There are also stencils for standard typefaces. All stencils are dependent on line thickness and scale.

CAD programs

CAD drawings are made using a computer. You need a CAD (Computer Aided Design) program intended specially for construction drawing. Various programs are available on the market, but they differ considerably in ease of use, performance and price. Almost all providers offer student and school versions.

\\Important:
It makes sense to look at what several providers offer before working your way into a program. Prices vary considerably even between the student versions, and it is also important for fellow students or colleagues to use the same program, so that working experiences can be shared.

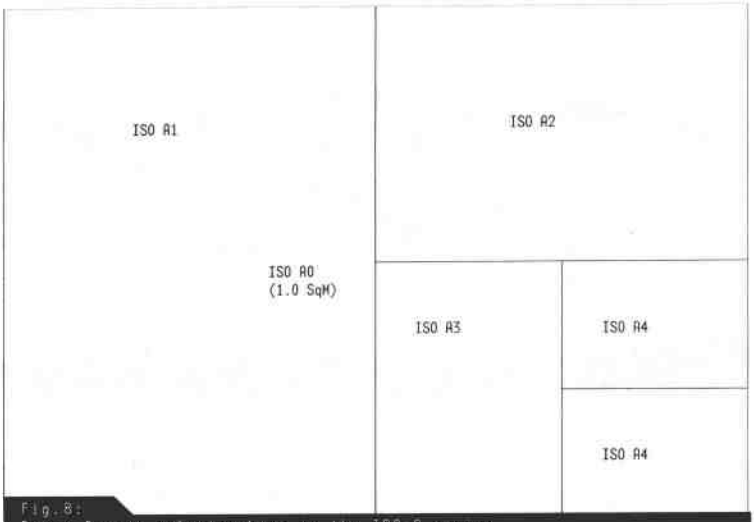

Fig. 8:
Paper format relationships in the ISO-A series

PAPER FORMATS AND PAPER TYPES

Paper formats

DIN 476-1 or ISO 216 define various paper formats based on a page ratio of 1:√2. The advantage of this page ratio is that a large sheet can always be divided into smaller formats without waste.

There are various series within the DIN or ISO standards; the DIN-A or ISO-A series is generally used for plans.

As losses occur when cutting to size and folding, sheet formats distinguish between trimmed and untrimmed sheets. There are also format categories like DIN A3 Plus on the paper market, but these were created by printer manufacturers and are not further standardized.

Table 1:
ISO/DIN series A-E (mm×mm)

	A–	B–	C–	D–	E–
2-0	1189×1682	1414×2000			
0	841×189	1000×1414	917×1297	771×1091	800×1120
-1	594×841	707×1000	648×917	545×771	560×800
-2	420×594	500×707	458×648	385×545	400×560
-3	297×420	353×500	324×458	272×385	280×400
-4	210×297	250×353	229×324	192×272	200×280