国外高等院校土建学科基础教材（中英文对照）

计算机辅助设计
CAD

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\\建筑设计 DESIGN

建筑表现 FUNDAMENTALS OF PRESENTATION

\\构造施工 CONSTRUCTION

\\项目管理 PROJECT MANAGEMENT

\\执业实践 PROFESSIONAL PRACTICE

\\建筑物理与建筑设备 BUILDING PHYSICS AND BUILDING SERVICES

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序

如果没有电脑的帮助，我们无法想像今天的设计制图工作将会是什么样子。在复杂的工程项目中，各个专业之间顺畅的数据交换和设计修改统筹都在电脑的介入帮助下得以最终实现。在过去的几十年里，计算机辅助设计（CAD）已经成为设计师的必备工具。不管结构复杂的设计还是简单的设计，CAD 工具都可以帮助设计师创建出完整全面的设计资料。CAD 也可以模拟显示状态以及提供详尽的参数信息。目前，几乎所有的建筑及规划单位都在应用 CAD 工具，各个大学里也有很多此类工具用于教学及研究。

目前市面上可以买到很多关于 CAD 工具功能及使用的手册，而这些书籍对 CAD 工具的基本原理却很少详细说明，而恰恰是这些基于基本原理且看似简单的说明和小窍门更能够帮助初学者免于养成很多日后难以纠正的不良习惯——本书极具趣味性地向初学者讲解了 CAD 工具的功能、流程及构成等方面。本书的主要目标读者群为建筑学、工程、园林设计以及室内装潢等专业大学一年级的学生，同样，刚刚进入建筑制图或工程制图领域且今后必将以 CAD 为主要生产工具的人们亦在其列。

编者：贝尔特·比勒费尔德（Bert Bielefeld）

FOREWORD

Creating design and construction drawings would be inconceivable today without the help of computers. The complexity of major building projects has made it necessary for all participants to be able to exchange data smoothly and to modify layouts regularly in the process of creating the drawing that will ultimately be implemented. Over the past few decades, computer-aided design (CAD) has evolved into a universal tool for planners. CAD programs make it possible to create all documentation, from simple designs to complex construction drawings. They can also display photorealistic depictions or information on quantities and components. Nowadays nearly all architectural and planning offices use the full range of CAD features, and it has become a firm fixture in university studies as well.

Whereas it is possible to buy handbooks and publications that describe the functions of specific CAD programs, what is lacking is a general survey of the basic principles of CAD. Many tips and tricks would be particularly helpful for CAD beginners, keeping them from making basic mistakes that require time-consuming corrections. This is the gap that the Basics student series intends to fill with *Basics CAD*, which provides a fundamental understanding of the functions, processes and structures that all programs share. *Basics CAD* targets first-year students in disciplines such as architecture, engineering, landscape design and interior architecture, as well as trainees in the fields of construction drawing and technical drawing who will work with CAD programs in their later professional environments.

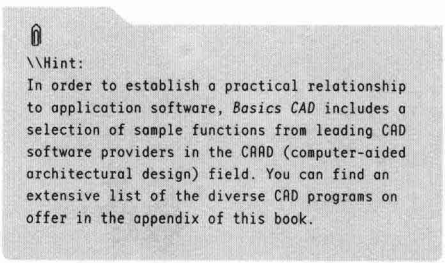
Bert Bielefeld, Editor

CAD: MEANING AND FIELDS OF APPLICATION

CAD – short for computer-aided design – is the catchword for drawing and designing with the help of a computer. A wide selection of both simple and complex CAD computer programs (software) makes it possible to create two- and three-dimensional drawings using input devices such as the keyboard, mouse and other tools. These drawings are displayed by output devices such as monitors and printers. The CAD field of IT plays an important role in many areas including engineering. It is used in automotive and plant engineering, as well as in structural engineering and architecture – the focus of this book. Aside from creating technical drawings, CAD programs can be used to develop powerful virtual models that provide a basis for a wide range of simulations. CAD programs can generate photorealistic visualizations of buildings, as well as climate and light simulations. With the right CAD software, users can also design load and fluid flow simulations in addition to simplifying development and production processes.

The first CAD programs were developed in the 1960s and were used primarily in aeroplane construction. With the breakthrough of personal computing and the lower costs of computer workstations in the 1980s, these programs became available to a larger number of users. The powerful, standardized computing systems developed in the early twenty-first century has led to efficient, relatively inexpensive CAD systems that meet a wide range of requirements.

Although nearly all the programs have a similar foundation, they differ significantly at times in terms of operation and use. There is a great deal of literature on CAD on the market – so much that it is nearly impos-



sible to keep track of – but most of it deals with particular CAD systems. By contrast, the book *Basics CAD* offers a general approach to learning CAD. It contains basic, application-oriented knowledge and is designed to assist the novice in selecting a suitable CAD system.

THE VIRTUAL DRAWING BOARD

When you draw with CAD, the sheet of paper is replaced by the computer monitor, the pencil by the mouse and keyboard. Lines and shapes are created by mouse clicks and keyboard entries, and the whole process is supported by functions that simplify drawing. › **Chapter Drawing elements**

Screen scale

The objects in CAD drawings are usually created on a scale of 1:1 – that is, at their real size. This means that a 10 m wall is drawn with a length of 10 m. To display the entire length of the wall on the screen, you must choose a smaller scale since the space would otherwise not be sufficient to show it. Screen scale describes the ratio between the real size of drawn objects and their depiction on the computer monitor. It changes automatically when the size of the screenshot changes. The actual representational scale that you follow when drawing on paper is created only in the output process in CAD (e.g. printing), but you must always bear it in mind when doing your drawing.

Reference scale

In a CAD drawing on the monitor, this representational scale is referred to as the reference scale. It describes the scale in which the drawn object is likely to be printed (e.g. 1:20, 1:100 or 1:500). Since some of the elements in a drawing, such as lettering, are independent of building components and must be displayed in an appropriate size in subsequent prints, they are not based on a drawing scale of 1:1, but on the probable scale of the printout. This means that, in the drawing operation, the software illustrates on screen the size ratio between the typeface and other elements, including the actual drawn object. › **Chapter Printing and plotting**

\\Tip:
Screen scale must be the same as the reference scale if you wish to view and evaluate the real size of the printout on the screen. Some CAD programs show the screen scale as a percentage of the reference scale: when set at 100% it thus shows the real size of the print. It is also advisable to create sample prints during the work process in order to evaluate the effects of the scale drawing.

\\Hint:
In addition to the mouse and keyboard, you can use a variety of other input devices, including sketchpad and SpaceMouse. However, these play a minor role in architecture-related CAD (see Chapter Hardware).

Measurement units

When technical drawings are made, architects use common units of length so that their work is comprehensible to everyone. In Central Europe, these units are millimetres, centimetres and metres. Some English-speaking countries continue to use feet and inches as units of length, but due to the need for standardization in managing international projects, even these countries are increasingly using the more easily convertible units favoured in Central Europe. You are free to select the units on which you wish to base your CAD drawing. The smallest units can be millimetres, centimetres or metres, or inches or feet.

USER INTERFACE

CAD user interfaces consist of special building blocks that we will explain briefly below by elucidating their underlying concepts.

The various tools of the CAD program are displayed by symbols and menus on the user interface. › Fig. 1 You can generate a drawing on the computer using the usual entry devices such as the mouse and the keyboard.

Drawing area

The drawing area is the most important part of the user interface. It allows you to draw and modify objects in either a two-dimensional field or in a space defined in three dimensions. Generally speaking, the CAD drawing area is comparable to a piece of paper. The main difference is that it is a virtual workspace that offers far-ranging options and various virtual tools.

Selection and drawing tools

The computer mouse is a commonly used pointing device. A pointing device controls the cursor on the user interface and functions as a virtual selection and drawing tool. It is represented by an arrow, crosshairs or some other symbol, according to the CAD program in question. This symbol generally changes when you use different selection and drawing options in the drawing operation to indicate the function you are currently using.

Electronic pens

CAD programs allow you to customize electronic pens and specify various line widths, line types and colours. › Fig. 2 You can define line properties before you begin to draw a line, or you can modify them retroactively. This brings greater clarity to both the drawing process and the methodology, since different lines emphasize and illustrate different elements of a drawing. Since many CAD programs link line colours to specific line widths, you can immediately see which elements have been drawn with a specific line width even in complex drawings. In this way, the different elements of a drawing are prepared for subsequent printing based on their

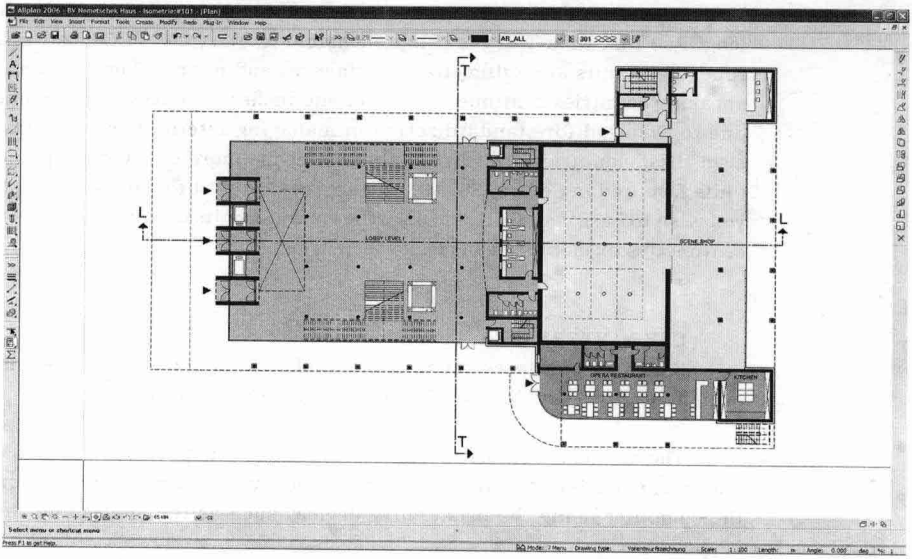


Fig.1:
Example of a CAD interface (Nemetschek Allplan)

screen depiction. › Chapter Printing and plotting The depiction of the pen line represents the subsequent result in the printout.

In addition, many CAD programs allow you to show true-to-scale line widths on the screen. In the corresponding screen scale, the line widths are shown just as they appear in a printout and give an impression of what the print will actually look like. Electronic pens can also be assigned other virtual properties that are important for the visualization of structures. › Chapter Visualization

Menu bar

The menu bar is located above the drawing area and displays the software options in interactive lists. For instance, as is generally the case with Windows-based applications, you can use the "File" menu to create new drawings, open existing ones or store drawing files. Via the menu bar, you can also custom-configure the user interface and activate all software commands and functions by means of the mouse and the keyboard.

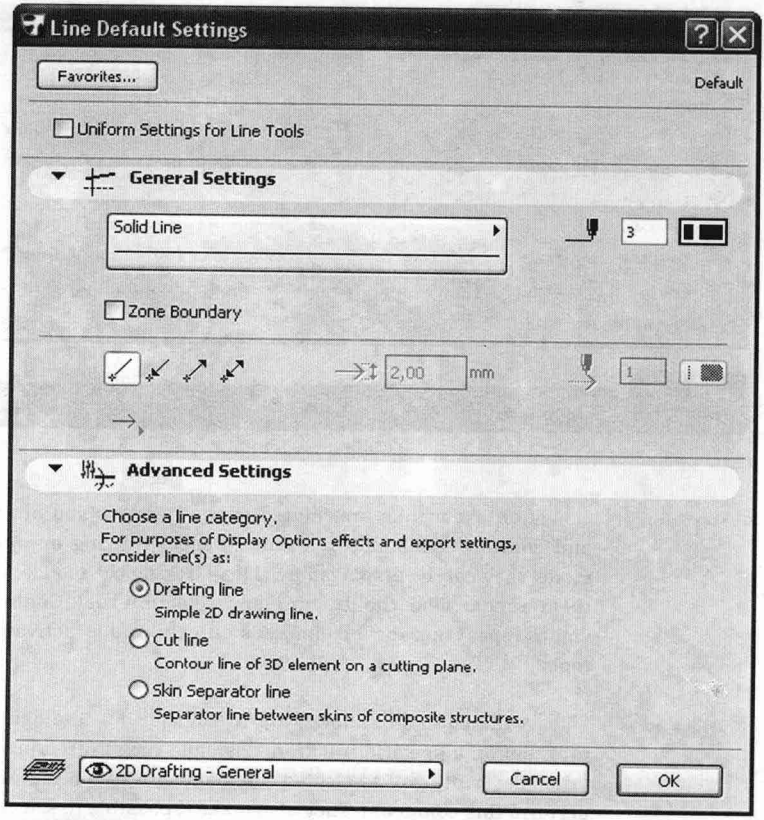


Fig. 2:
You can customize the width, type and colour of the lines drawn by electronic pens (Graphisoft ArchiCAD).

Toolbox

The toolbox buttons display symbols of the drawing and tool functions available. They are activated by selection with the virtual selection tool. › Fig. 3 If you move the selection tool to a symbol, the software will usually display the name of the corresponding function. When you use a CAD program for the first time, the user interface will contain default functions that can be configured individually and shown or hidden according to your needs.

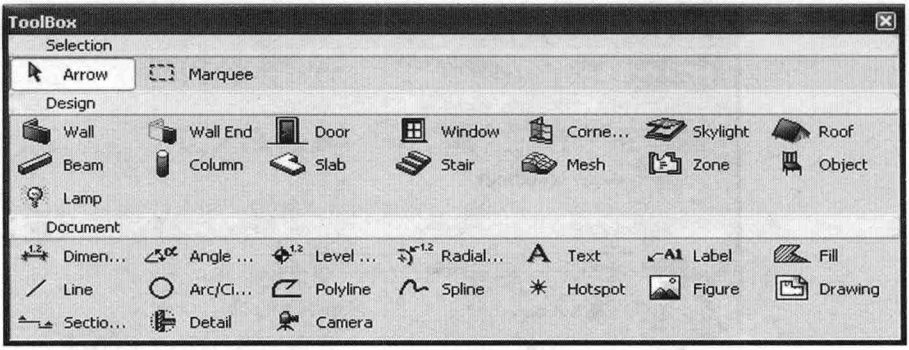


Fig.3:
Example of a toolbox with various functions (Graphisoft ArchiCAD)

Context menu

Context menus are related to the function you are currently using and contain commands relevant to each drawing operation. In default mode, they can be displayed by right-clicking the mouse, which will make them appear near the drawing and selection tool. Context menus allow you to repeat or cancel commands quickly, and to activate other drawing tools.

Dialogue boxes

A dialogue box allows you to engage in a "dialogue" with the CAD program on a specific function. Dialogue boxes often provide a more detailed description of a selected command, or explain the steps necessary to perform this command. They also make it possible to select special options

\\Tip:
The toolboxes can be displayed in a vertical or horizontal column on the edge of the user interface, or they can be positioned alongside or within the drawing area. An intelligent setup will enlarge the working area and allow you to work more efficiently. Once you have gained some experience of drawing with CAD, you will learn which functions you use frequently, and can then arrange the required toolboxes on the interface so that you can access them quickly.

\\Hint:
Cartesian coordinates are not the only available system. One alternative is the polar coordinate system, in which a point is described by a radius and an angle instead of by X and Y axes.

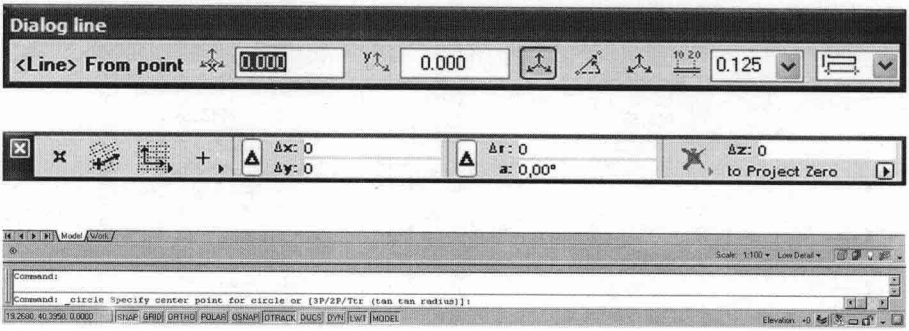


Fig.4:
Communicating with CAD software through dialogue boxes (Nemetschek Allplan, Graphisoft ArchiCAD, Autodesk Architectural Desktop)

or to enter numerical values via the keyboard. The boxes are part of the various drawing and tool functions, and they open automatically on the user interface when you activate the commands. › **Fig. 4**

COORDINATE SYSTEMS

The basic geometric reference system in CAD software is a coordinate system that defines the virtual drawing area as a construction plane. This construction plane can be thought of as a piece of graph paper divided by horizontal and vertical lines. Points on a plane, which are specified as coordinates, are thus clearly mapped out within the CAD system and can be used to define the location and shape of drawing elements. › **Chapter Drawing elements**

The Cartesian coordinate system, which is used most commonly, is based on two perpendicular axes (X and Y) in two-dimensional space. These axes describe the distance between any given point and the zero point of the system. › **Fig. 5**

Imaginary lines parallel to the X and Y axes intersect within the coordinate system and define the position of any given point.

Going one step further, we can define a line in geometric terms as the connection between two points. This is also how both endpoints of a line are specified in the Cartesian coordinate system. › **Fig. 6**

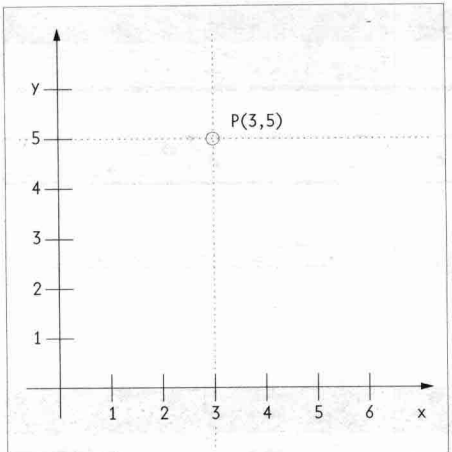


Fig.5:
The point P(3,5) is described by lines parallel to the X and Y axes.

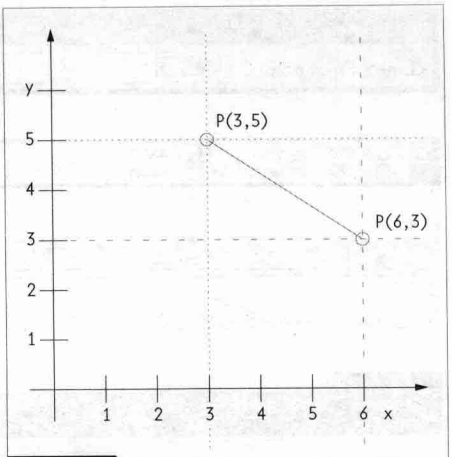


Fig.6:
Both endpoints of a line are defined as two individual points.

Absolute coordinates

Absolute coordinates are based on the above-mentioned zero point of the drawing, at which the X and Y axes intersect. It makes sense to use absolute coordinates when the exact X and Y values of the coordinates you wish to define are known.

User-defined coordinate system

It would be disadvantageous to enter only absolute coordinates together with an absolute, fixed zero point since this would make large drawings particularly difficult to generate using the keyboard.

This is one of the main reasons that most CAD programs allow you to move and thus redefine the point of origin within the coordinate system

\\Hint:
A coordinate system like the one introduced in Figs 5 and 6 is not usually visible on the screen and serves only as an imagined or virtual basis for drawing. In some CAD programs, symbols appear in one corner of the drawing area for orientation purposes and to show the directions of the coordinate axes. They are, however, an exception.

\\Example:
Apartment walls can be drawn on one layer of a floor plan, the interior furnishings on another. Both levels can be viewed separately, edited or, if necessary, combined (see Fig. 8).