QCAD

An Introduction to Computer-Aided Design (CAD)

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Part I

Introduction

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Chapter 1

Introduction

QCAD is a computer application for technical drawings such as mechanical plans or floorplans. The CAD in QCAD stands for Computer-Aided Drafting or Computer-Aided Design. QCAD is one of many applications on the market that provides this kind of functionality. However, if you have tried other popular CAD systems before, you will likely have realized that these systems are usually very complex, difficult to learn and for most private users and small businesses almost unaffordable. This is because CAD has long been a technology that was only used by major industrial companies, universities and governments and most CAD manufacturers still exclusively target these groups of users.

QCAD is an alternative solution that is available to everyone who is interested in CAD. QCAD is not only a lot easier to use than other traditional CAD systems, it also runs on most modern operating systems including Windows, macOS and Linux. This means that with QCAD you are not locked in on any particular system and you can share your drawings with friends and companies who happen to use another system. Despite all these advantages, QCAD is also one of the most affordable complete CAD packages on the market today.

Although QCAD is easy to use compared to other CAD solutions, using a CAD system in general is not as trivial as using a word processor or as browsing the Internet. Simply learning how to use the various tools and features of QCAD is not enough to create professional looking technical drawings. You also have to become familiar with the fundamental concepts of technical drafting in general and with some CAD specific concepts such as layers, blocks and precision tools. These concepts are what separates a CAD system from a simple drawing or presentation software.

This book will not only help you to get started with QCAD immediately, it will also teach you the basics of technical drafting and CAD along the way.

Target Audience

It is only natural to feel insecure about starting to use a CAD system. CAD systems have been used to design some of the most complex machines and buildings of our

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time. However, there is no reason to think that CAD systems are for experts only. QCAD in particular was designed with beginners, students and home users in mind. This book targets the same audience. It will help you to get started with CAD and QCAD even if you have a non-technical background and technical drafting and CAD are both new to you.

What you do need are some basic computer skills before you get started with this book. It helps if you already know how to use other applications on your computer and you should be familiar with the basic concept of folders and files on the operating system of your choice.

QCAD is a generic CAD system which means that it can be used for any type of technical drawing. QCAD is not specialized in mechanical drafting, architecture, landscaping, geographical information systems, schematics or any other specific area of use. This book provides examples from various different backgrounds in which CAD systems can be used.

Structure of This Book

This book is divided into several parts that are meant to be studied or worked through in sequence.

Part IV describes the most common construction and editing tools of QCAD in detail with step by step instructions and examples. You might just want to skim read through this part to get an idea about the tools QCAD has to offer. You can always come back to these chapters later and use them as a reference while using QCAD in your projects.

The following is a brief overview of what is contained in each part.

Part II: First Steps with QCAD

In this part you will install QCAD on your computer and start it for the first time. You will learn how to use and adjust the application window and you will already create and print your first simple drawing.

Part III: Basic CAD Concepts

This part introduces the fundamental CAD concepts you will be confronted with whenever you work with a CAD system. You will learn how to navigate in your drawing, understand what coordinates are and work with layers to organize your

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drawing. Along the way you will get to know some first drawing and modification tools and learn how QCAD supports you to create precise drawings.

Part IV: Drawing and Editing with QCAD

In this part all drawing and editing tools are described in detail. This part also covers the wide range of selection tools QCAD offers to select entities before changing them.

Part V: Blocks

Groups of entities are called *blocks* in QCAD. This part introduces blocks and explains when and how to use them. The part library (or symbol library) is also introduced in this part.

Part VI: Import, Export and Printing

This part shows ways how you can import and export data with QCAD for example to embed your drawing in your favorite word processor or presentation program or to share drawings with other people over the Internet. This part also explains the printing tools of QCAD in detail.

Part VII: Projections

Unless you are drawing mainly schematics with QCAD, your drawings will most likely show two-dimensional views of three-dimensional objects. This part guides you through the process of creating two-dimensional drawings that provide enough information to describe three-dimensional objects.

How to use this Book

This book offers hands-on study material for many topics. When working through the examples, make sure that you have a computer at hand to try out things and to experiment beyond the scope of the examples.

Prerequisites

The most important prerequisite for this basic course is your own motivation to learn how to use a CAD system and how to handle QCAD. A specific project which you are planning to realize is probably the best motivation to keep you going. If you don't have such a project in mind, you might want to define one right now. This can be anything from designing a bird house to drawing a floorplan of your house.

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Software Requirements

To follow the examples you will of course also need the QCAD software. Fortunately, QCAD is one of the most economic CAD packages available. For information about QCAD, a price list and free downloads, please refer to its website at: http://www.qcad.org

Hardware Requirements

QCAD runs on any reasonably modern hardware configuration. Having a screen of 17" or above is desirable but not a minimum requirement.

The only thing that leaves you with a real disadvantage is a mouse with only one button or one without a mouse wheel. In QCAD you can use the mouse wheel to quickly navigate around in the drawing. If your mouse does not have a wheel you will still be able to follow along but you will not be as efficient. A two or three button mouse with a mouse wheel is therefore strongly recommended if you are to become a regular QCAD user.

If you are using a Macintosh computer, you might not be used to a three button mouse since Apple mice traditionally come with only one button. Nevertheless, three button mice with mouse wheels also work fine under macOS and generally increase your productivity, not only when working with QCAD.

Instead of a mouse, you can also use a graphics tablet with a pen. Most CAD users find a tablet more efficient or ergonomic than a mouse. Since you can access all features of QCAD with a tablet and pen, a mouse is not required in this case.

From Manual Drafting to CAD

If you have experience in manual drafting you might wonder what this book has to teach to you. Any prior experience with technical drafting will give you a head start. But note that although the end products of manual drafting and CAD are usually almost the same, there are some fundamental differences between the two approaches. The most important ones are outlined below.

Modifications

Every draftsman knows the fear of making a mistake in an otherwise perfect drawing. The more complex the drawing becomes, the more frustrating such a mistake can be. But even once the drawing has been finished there is no guarantee that there will not soon be a request for modification. Figure 1-1 shows how a drawing might need to

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be modified. In manual drafting the part at the top would most likely have to be re-drafted to create the new drawing at the bottom. In a CAD system, this modification is easily done in a few seconds using the stretch tool.

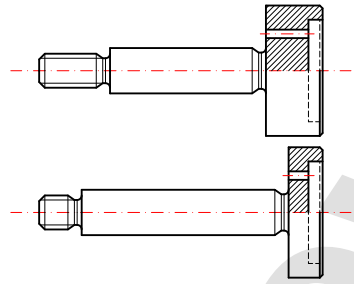

Figure 1-1: Changing existing drawings is one of the strengths of a CAD system. The drawing at the top can be changed into the one at the bottom with a few clicks.

Precision

Manual drawings are never 100% precise. This is not really a problem since the precise measurement is contained as textual information in the dimensions of the drawing. A dimension is a drawing element that indicates the exact measurement of something in the drawing, for example how long a part is. A dimension might indicate that a line is 100mm long even if it is only 98mm long on the paper. When working with a CAD system there are no such arbitrary errors. The geometry of every element of a drawing is exactly defined. This is something beginners often struggle with. You might think that if a line on your computer screen looks horizontal it must be horizontal. This is far from true. A horizontal line on paper might serve its purpose if it looks horizontal to the viewer, but CAD systems deliver far better precision. A horizontal line in a CAD system is truly horizontal. Similarly, if two lines form a corner, they form exactly a corner. That means that there is no gap between the end points of the lines. This is where CAD also differs from most other computer applications you might have used so far. In a painting program, presentation application or word processor you are usually satisfied if the result looks good on the screen or in the printout. The precision of a CAD drawing goes far beyond that.

There are many reasons for the extreme precision of CAD systems like QCAD, but the most important one for you at this point is that lack of precision leads to bad results which are hard to correct. Creating a precise drawing from the start is far less tedious and saves you a lot of work in the end.

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While CAD systems support you to create precise drawings, they do not prevent you from creating imprecise drawings. You will know that you are about to work imprecisely when you are trying really hard to position the mouse pointer "exactly" at a certain position or if you move your face very close to the screen to check if your drawing looks precise. These are signs that you are doing something wrong and you should find out how the CAD system can support you in what you are trying to achieve.

Especially if you are a perfectionist, you will very soon appreciate the precision of a CAD system. In fact, being a perfectionist is a good qualification for any CAD draftsperson.

Drawing Scale

In manual drafting, you would usually work with a fixed drawing scale. To fit the floorplan of your house on paper you could for example define a drawing scale of 1:100. This means that an object that is one meter (about 3.3 feet) long would be drawn on paper as an object that is one centimeter (about 0.4 inch) long, i.e. 100 times smaller. On the other hand, a very small object such as a mechanical part of a wrist watch could for example be drawn at a scale of 10:1 to make sure that every detail of it is well visible on paper.

In CAD there are no such drawing scales. In other words, the drawing scale is always 1:1 or real size. No matter how small or big the object is you are drawing, you will always construct it exactly in its original size. In a CAD system you can create a plan of our universe in real size. One reason for that is that in a CAD system you are not restricted to a particular paper size. Your drawing area is virtually unlimited.

Of course when you print your drawing on paper, the CAD system can scale it up or down for you so it fits on the paper size your printer uses.

Repetitive Work

With a CAD system, you will never have to draw the same thing twice. For example to draw the rotationally symmetric part shown at the right in Figure 1-2, the part shown at the left can be rotated twice by 120 degrees to produce the rest of the drawing.

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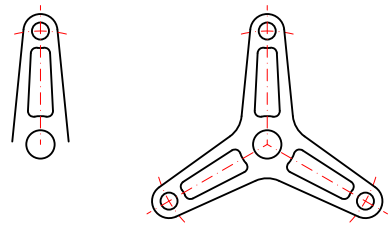

Figure 1-2: A CAD system helps you to avoid repetitive work. In this example, the drawing at the right can be easily created from the part at the left.

Many CAD systems go even one step further and allow the user to create entire drawings fully automatically. The example drawing shown in Figure 1-2 could be created automatically based on a few parameters given by the user. In QCAD this can be done using the very powerful and complete QCAD scripting interface. The scripting interface offers a programming language to automate the construction of drawings. It is mainly interesting for programmers and advanced users and therefore not covered by this book for beginners.

Auxiliary Lines

A similarity between manual drafting and CAD is the use of auxiliary lines. In Figure 1-3, both the auxiliary construction at the left and the final drawing at the right can be constructed without having to calculate any positions. Auxiliary lines often visualize how the edges and corners of an object are defined.

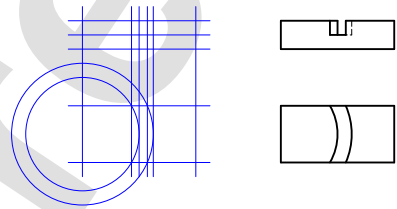

Figure 1-3: Auxiliary construction lines at the left and the final drawing at the right.

In a CAD system, auxiliary lines are usually not deleted after they have served their purpose. Instead they can be easily hidden when they are not needed, for example for the final printout.

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Efficiency

As a beginner you might find that using a CAD system at first is far less efficient than using pen and paper. It takes some practice to become faster with a CAD system than by hand. The more complex and repetitive the drawing you are creating, the more the use of a CAD system will pay off. A rectangle can be drawn very quickly by hand. If that rectangle is filled with a simple pattern, a CAD system is already much more efficient. Now imagine that there is a circle inside the rectangle which is not filled and make that two rectangles that are mirrored as shown in Figure 1-4. This simple drawing will already take significantly longer to create manually than with a CAD system. And the quality of the manual drawing will most likely not be a match for the printout from the CAD system.

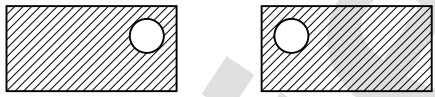

Figure 1-4: Even simple drawings like this one are more efficient to draw with a CAD system. For the computer, filling an area with a pattern or mirroring a drawing only takes fractions of a second.

Planning

To become an efficient CAD user, you will have to plan your drawings before you start. Try to identify identical, nearly identical or symmetrical parts early and don't hesitate to create auxiliary lines that help you to define points and shapes.

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Hands-on: Auto Zoom

Menu:	View > Zoom > Auto Zoom	
Keycode:	ZA	

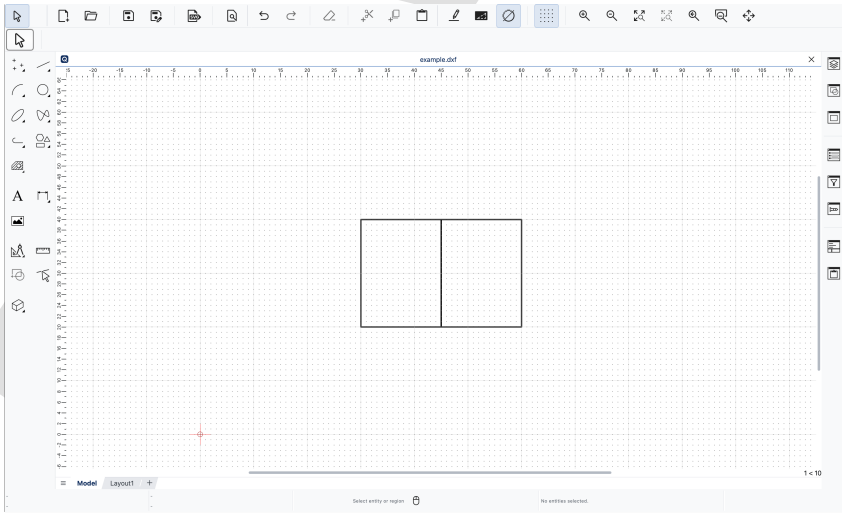
Click the *Auto Zoom* button in the viewing toolbar or press the keys Z and then A. Just like after opening the drawing, QCAD automatically fits the whole drawing at the maximum possible scale into the drawing view.

Hands-on: Window Zoom

Menu:	View > Zoom > Window Zoom	
Keycode:	ZW	

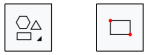
Sometimes you will want to show exactly a certain area of your drawing to work on. The tool you are going to use now allows you to choose a rectangular area (or *window*) of your drawing and magnify that area.

1. Make sure that you zoom in or out so that your rectangle drawing has about the size as shown below:



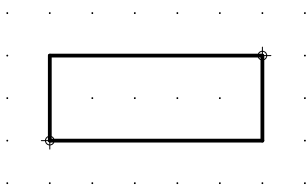
2. Click the button *Window Zoom*:

2. Choose the drawing tool for drawing a rectangle:

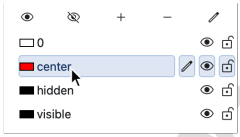


3. Activate the grid snap:

4. Adjust the scale of the drawing area so that you can see a space of about 100 units horizontally. To do this, keep an eye on the rulers that QCAD displays at the top and at the left. Check the bottom right corner of the drawing area to make sure that the grid is currently shown with a spacing of 10 units (the text 10 / 100 is shown).
5. Draw a rectangle that is 50 units wide and 20 units high using the grid.
   Set the first corner at any grid point in the drawing and set the second corner 5 grid points to the right and 2 grid points to the top of the first corner:

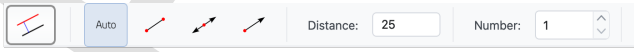


6. We will now create the vertical center line in the middle of the rectangle. We can use the parallel tool for that, but first we need to switch the active layer to *center*. Click on the layer *center* in the layer list to activate it:



7. Choose the drawing tool for drawing parallel lines:

8. The options toolbar for parallels is shown at the top. Enter 25 for Distance and make sure that *Number* is set to 1:

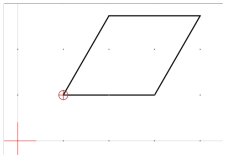


9. Move the mouse pointer close to the left side of the rectangle, just slightly to the right of it. QCAD gives you an immediate preview of where the parallel will be placed. This should look like this:

Preview

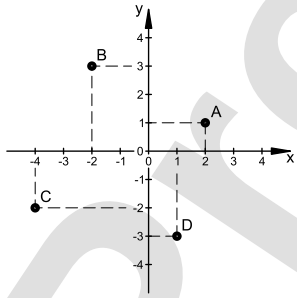
Since QCAD still expects you to enter a Cartesian coordinate, you need to click the button for entering polar coordinates first.
QCAD shows now the options toolbar for entering polar coordinates. Enter the radius (distance) 20 and the angle 0 in the options toolbar and tick the check box for relative coordinates:

6. Click the green tick button.
7. Repeat this for the next two coordinates (@20<60) and (@20<180). For the last coordinate that closes the rhombus (10,10) you will have to switch back to absolute Cartesian coordinates again.
8. Your drawing should now look like this:



Exercises

1. What are the four different types of coordinates that are supported by QCAD?
2. Write down the absolute Cartesian coordinates of the four points A, B, C and D using the notation (X,Y).



3. Write down the absolute polar coordinates of the three points A, B and C using the notation (Radius<Angle).

Preview

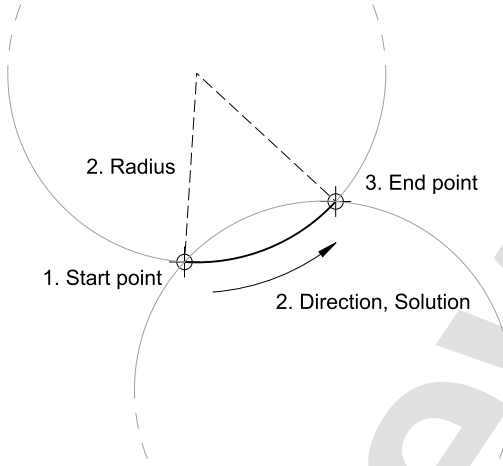
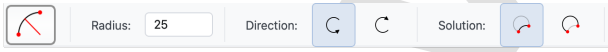


Figure 9-15: Arc from two points and a radius.

Usage

1. Click the start point of the arc.
2. Enter the arc radius and choose the arc direction (counterclockwise or clockwise) and which solution you want (shorter or larger arc):



   For the example in Figure 9-15 the direction was chosen as counterclockwise and the solution.
3. Click the end point of the arc.
   If the end point is a distance of at least two times the radius away from the start point, a half circle is drawn with the given radius.
4. Terminate the tool by clicking the right mouse button or by hitting the Escape key on your keyboard.

Arc from Two Points and Angle

Menu:	Draw > Arc > 2 Points and Angle	
Keycode:	A2	

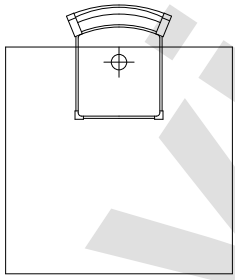
This is the second tool to draw an arc from its start point and end point. With this tool you can specify the angle that is covered by the arc and the arc direction. Figure 9-16 shows the two points with the four possible solutions in gray and the chosen solution in black.

Preview

The selection is now stored on the clipboard and the drawing has no selected entities anymore.

3. You can paste the clipboard contents into any drawing anytime later on. Note that the clipboard contents is lost if you quit the QCAD application.
   To paste the clipboard contents, click the paste tool:

4. Other applications usually paste the clipboard contents in the same position from where it was cut or copied or anywhere in a drawing. QCAD chooses a more flexible approach and allows you to precisely position the pasted entities with the mouse or by entering a coordinate.
   In this example, we want to place the chair at the table as shown below. Click the left mouse button to place the chair in this position:

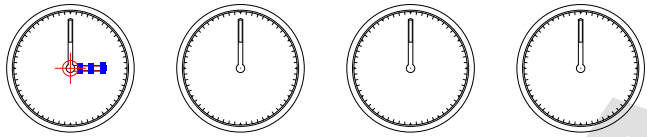


5. You can directly continue to paste the clipboard contents multiple times and if desired with different rotation angles, scales, etc.
   In our case, we want to place another copy of the chair at the opposite side of the table.
6. This time, type a rotation angle of 180 into the options toolbar at the top:

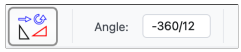
7. The chair is rotated by 180 degrees and you can place it now by clicking the left mouse button at the lower position:

Preview

3. Click a reference point for moving the entities. This is also the center for the rotation.
   We choose the reference point at the center of the clock:

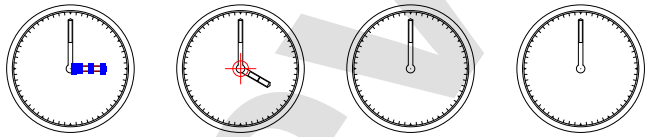


4. Enter the rotation angle in the options toolbar. This step is optional since you can also adjust the rotation angle later in the dialog, but entering it at this point allows you to display the correct preview and detect any potential errors already. For our clock example, we enter the angle -360/12 or -30:

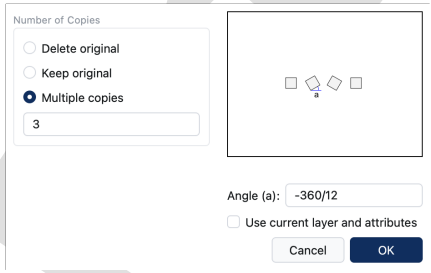


   Note that positive angles rotate counterclockwise and negative angles clockwise.

5. Move the mouse cursor to the center of the second clock and check if the correct preview is shown for the rotation. If that is not the case, correct the angle in the options toolbar.
   In the clock example, the preview looks like this:

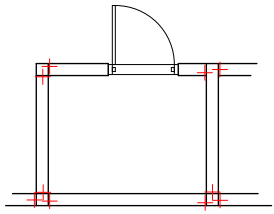


6. Click the left mouse button to set the target point for the first copy.
7. QCAD shows the dialog with the options for this tool:

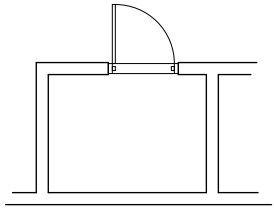


   The choices for the number of copies, attribute usage and layer usage are the same as for previous tools.
   We choose the option *Multiple copies* and enter 3 for the number of copies. This will create three copies of the hour handle. The angle has already been entered before and does not need to be adjusted anymore.

Preview



5. The final drawing without the unwanted segments:



Splitting up Entities into Equal Parts

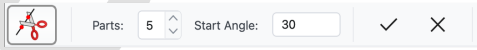
Menu:	Modify > Split Entities	
Keycode:	MS	

This tool breaks entities up into a given number of equal parts. It can for example convert a line into three equally long smaller lines.

Usage

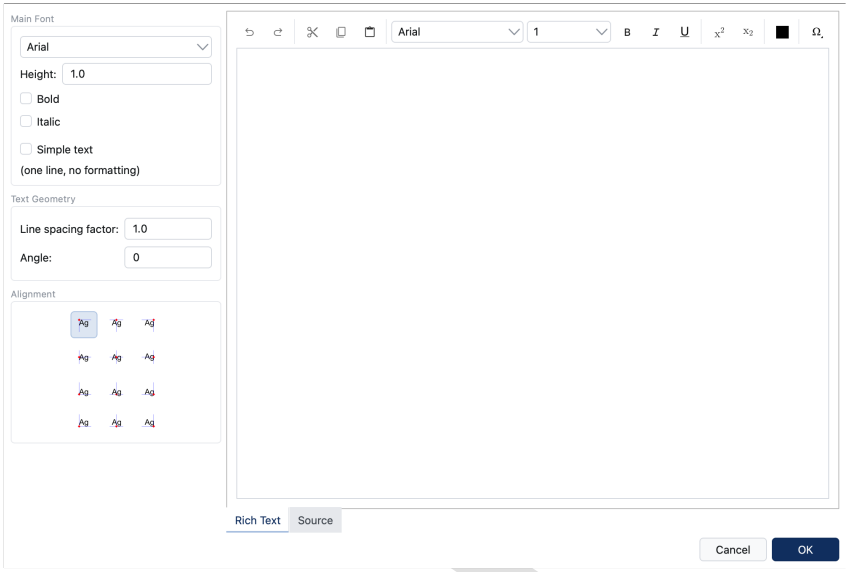
1. Select the entities you want to split up. Supported entities are lines, arcs and circles.
2. Start the split up tool:

3. Enter the number of equal parts to create in the options toolbar:



4. If you are splitting up any circles, enter the start angle of the split up process. The circles will be first split at that angle.
5. Click the green tick button at the right in the options toolbar to split up the selected entities. Unsupported entities are ignored.

Preview



2. Choose a font for the text entity.
   There are two types of fonts available in QCAD:
   CAD fonts with letters that consist of lines and arcs. They are shown at the top of the font list. If you are creating a text using a CAD font, the font *standard* is usually a good choice:

   Sample text in CAD font 'Standard'

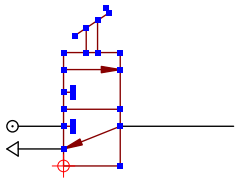
   System wide fonts are shown below the CAD fonts. These fonts create texts in which the letters are displayed as filled areas rather than lines and arcs. If you are planning to share your drawing, keep in mind that other users might not have the same fonts installed on their systems as you. The font 'Arial' is usually a safe choice for a system font as it is available on most systems:

   Sample text in font 'Arial'

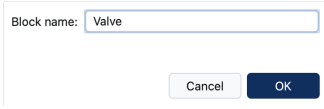
3. Enter the height of your text by following the notes about drawing scale above. Texts that are too small on paper (smaller than about 2.5mm) are hardly readable while large texts might get in the way of the actual drawing elements.
   The text height is measured from the bottom line of the text to the top of a capital letter.
   The height that is chosen is the initial height for your text entity. You may also change the text height anywhere in the text using the text editor at the right.

Preview

4. Click a reference point for the block. This point should be a significant point of the block. It will be used later when positioning references of that block.
   In our example, we use the left bottom corner as reference point:



5. QCAD shows a dialog to enter a name for the block. Enter a unique name that helps you to later identify the block.
   For this example block, we enter *Valve*:

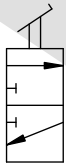


   For real drawings you might want to choose a more descriptive name than this by including a measurement or type number in the block name. Good block names are for example *Table 100x200* for a table that measures 100x200 or *DIN85 M4x16* for mechanical element of that type.

6. Click OK. QCAD creates the block and adds the name to the block list:

   Note that QCAD did not only create the block, it also created a block reference of the block at the exact position of the original entities. In other words: your selection has been replaced by a block reference of the block you have just created. You can easily verify this by clicking on one of the lines that make up the symbol. Instead of only that line, the whole symbol is selected.

7. The block *Valve* that has been created looks as shown here:



Preview

Figure 18-1: Photograph of a stone wall. The image is stored as a bitmap (small dots with different colors).

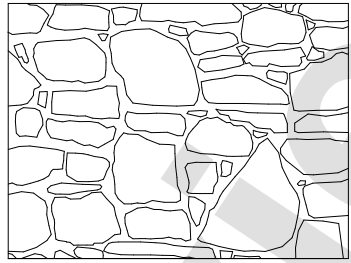


Figure 18-2: Vector graphic of the same stone wall. Vector graphics are stored as geometrical elements.

When to Use a Bitmap

There are only a few but nonetheless important uses for bitmaps in a CAD system:

- To include a company logo or something similar in a drawing.
- To show a photograph that helps to understand the drawing or has a connection to the drawing.
- Bitmaps can be displayed in the background of a drawing for vectorization. Vectorization is the process of converting a bitmap into a vector (CAD) drawing. This is often used for drawings that don't need to be very precise. For example to trace art designs from a scan or photograph or to vectorize the boundaries of a geographical feature from a satellite picture. A convenient way to create the vectorized stone wall pattern in Figure 18-2 would be to display the bitmap in Figure 18-1 and trace the stones with the line, polyline or spline tool of QCAD.

Inserting Bitmaps into a Drawing

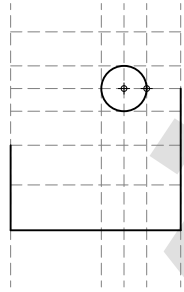
Menu:	Draw > Insert Bitmap	
Keycode:	IM	

Preview

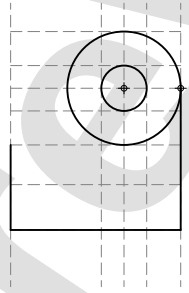
Note that for the sake of brevity the illustration above only shows that part of the drawing that is going to contain the front view.

10. Choose the tool for drawing circles with a given center and a given point on the circle line:

11. The circle tool lets you choose the center of the circle first and then a point on the circle line. To draw the circle for the drilling, set the center point at the intersection of the vertical center line with the horizontal center line. Set the point on the circle line at the intersection at the right or left of the center:



12. With the same tool, create also the larger circle around the same center.



13. For the next step we need to create a tangent from the loose end at the left to the larger of the two circles. QCAD offers a special tool for creating a tangent from a given point to a circle.

14. The tool asks you first for the point. Click the end point of the loose end at the left (1).

Preview