Introduction to AutoCAD 2010

2D and 3D Design

Autodesk Authorised Author

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Preface

The purpose of writing this book is to produce a text suitable for students in Further and/or Higher Education who are required to learn how to use the CAD software package AutoCAD® 2010. Students taking examinations based on computer-aided design will find the contents of the book of great assistance. The book is also suitable for those in industry wishing to learn how to construct technical drawings with the aid of AutoCAD 2010 and those who, having used previous releases of AutoCAD, wish to update their skills to AutoCAD 2010.

The chapters in Part 1 – 2D Design, dealing with two-dimensional (2D) drawing, will also be suitable for those wishing to learn how to use AutoCAD LT 2010, the two-dimensional (2D) version of this latest release of AutoCAD.

Many readers using previous releases of AutoCAD will find the book's contents largely suitable for use with those versions, although AutoCAD 2010 has considerable enhancements over previous releases (some of which are mentioned in Chapter 21).

The contents of the book are basically a graded course of work, consisting of chapters giving explanations and examples of methods of constructions, followed by exercises which allow the reader to practise what has been learned in each chapter. The first 11 chapters are concerned with constructing technical drawings in two dimensions (2D). These are followed by chapters detailing the construction of three-dimensional (3D) solid drawings and rendering them. The two final chapters describe the Internet tools of AutoCAD 2010 and the place of AutoCAD in the design process. The book finishes with two appendices – a list of tools with their abbreviations and a list of some of the set variables upon which AutoCAD 2010 is based.

AutoCAD 2010 is a very complex computer-aided design (CAD) software package. A book of this size cannot possibly cover the complexities of all the methods for constructing 2D and 3D drawings available when working with AutoCAD 2010. However, it is hoped that by the time the reader has worked through the contents of the book, he/she will be sufficiently skilled with methods of producing drawings using the software to be able to go on to more advanced constructions and will have gained an interest in the more advanced possibilities available when using AutoCAD.

Alf Yarwood

Salisbury

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Part 1

2D Design

Chapter 1

Introducing AutoCAD 2010

AIM OF THIS CHAPTER

The contents of this chapter are designed to introduce features of the AutoCAD 2010 window and methods of operating AutoCAD 2010.

Opening AutoCAD 2010

Fig. 1.1 The **AutoCAD 2010** shortcut icon on the Windows desktop

AutoCAD 2010 is designed to work in a Windows operating system. In general, to open AutoCAD 2010, either *left-click* on the **AutoCAD 2010** shortcut in the Windows desktop (Fig. 1.1). Depending on how details in **Initial Setup…** in the **Options** dialog (Fig. 1.20, page 16), the **Initial Setup** dialog (Fig. 1.2) may appear. This dialog is in three pages, two of which are shown in Fig. 1.2. The settings shown in Fig. 1.2 are for most of the 2D drawings in **Part 1** of this book.

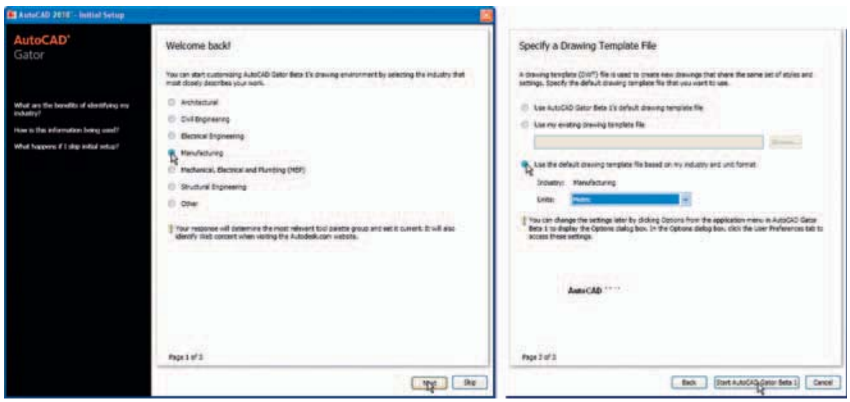

Fig. 1.2 Settings in **Page 1** and **Page 3** of the **Initial Setup** dialog

When working in education or in industry, computers may be configured to allow other methods of opening AutoCAD, such as a list appearing on the computer in use when the computer is switched on, from which the operator can select the program he/she wishes to use.

When AutoCAD 2010 is opened a window appears, which depending upon whether a **3D Modeling**, **Classic AutoCAD** or a **2D Drafting & Annotation** workspace has been set as the **QNEW** in the **Options** dialog. In this example the **2D Drafting & Annotation** workspace is shown and includes the **Ribbon** with **Tool panels** (Fig. 1.3). This **2D Drafting & Annotation** workspace shows the following details:

- **Ribbon**: which includes tabs, each of which when *clicked* will bring a set of panels containing tool icons. Further tool panels can be seen by *clicking* the appropriate tab. The panels in the ribbon can be changed to previous AutoCAD releases using the **Customer User Interface** dialog if desired (see page 25).
- **Menu Browser** icon: A *left-click* on the arrow to the right of the **A** symbol at the top left-hand corner of the AutoCAD 2010 window causes the **Menu Browser** menu to appear (Fig. 1.4).

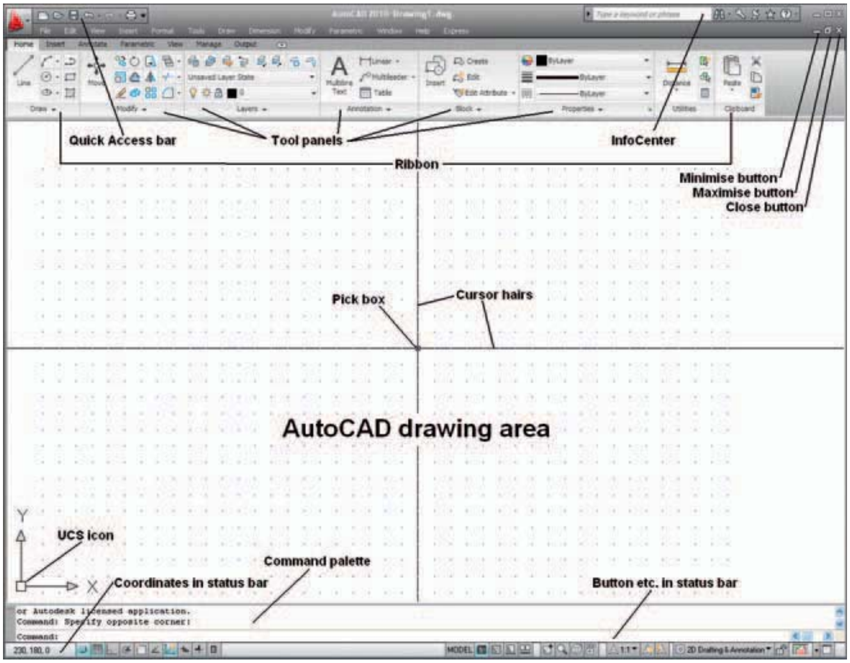

Fig. 1.3 The AutoCAD 2010 **2D Drafting & Annotation** workspace

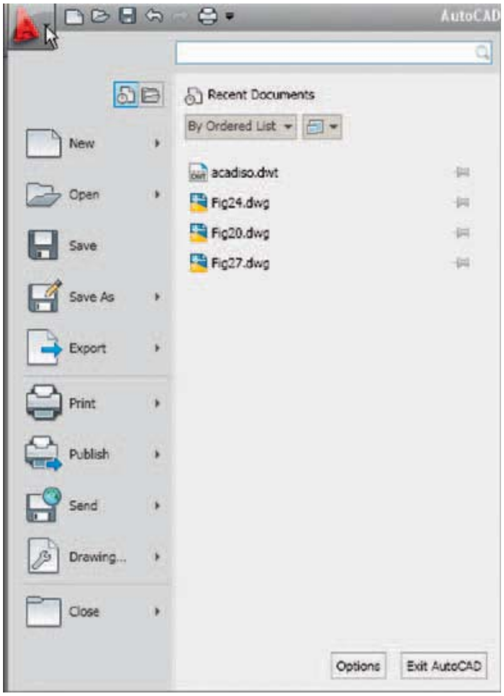

Fig. 1.4 The **Menu Browser**

- **Workspaces Switching** menu: appears with a *click* on the **Workspace Switching** button in the status bar (Fig. 1.5).
- **Command palette**: can be *dragged* from its position at the bottom of the AutoCAD window into the AutoCAD drawing area, when it can be seen to be a palette (Fig 1.6). As with all palettes, an **AutoHide** icon and a right-click menu is included:

Fig. 1.5 The **Workspace Switching** pop-up menu

Fig. 1.6 The command palette when *dragged* from its position as the bottom of the AutoCAD window

- **Tool panels**: each shows tools appropriate to the panel. Taking the **Home/Draw** panel as an example, Fig. 1.7 shows that placing the mouse cursor on one of the tool icons in a panel brings a tooltip on screen showing details of how the tool can be used. Two types of tooltip will be seen. In the majority of future illustrations of tooltips, the smaller version will be shown. Other tools have pop-up menus appearing with a *click* . In the example given in Fig. 1.8, a *click* on the **Circle** tool icon will show a tooltip. A *click* on the arrow to the right of the tool icon brings a pop-up menu showing the construction method options available for the tool.

- **Quick Access toolbar**: The toolbar at the top right of the AutoCAD window holds several icons, one of which is the **Open** tool icon. A *click* on the icon opens the **Select File** dialog (Fig. 1.9).

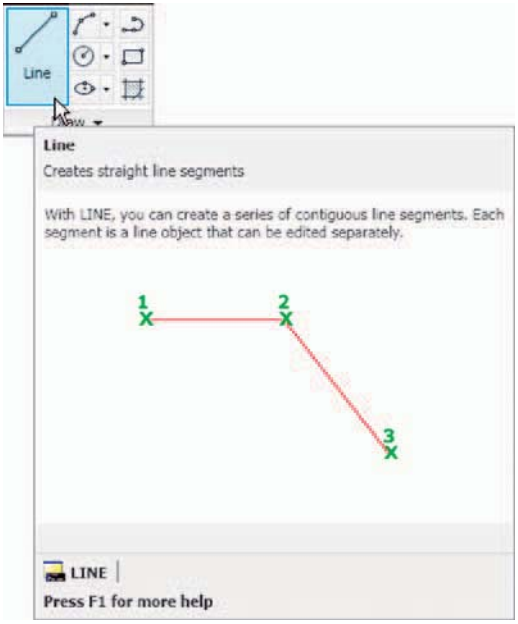

Fig. 1.7 The descriptive tooltip appearing with a *click* on the **Line** tool icon

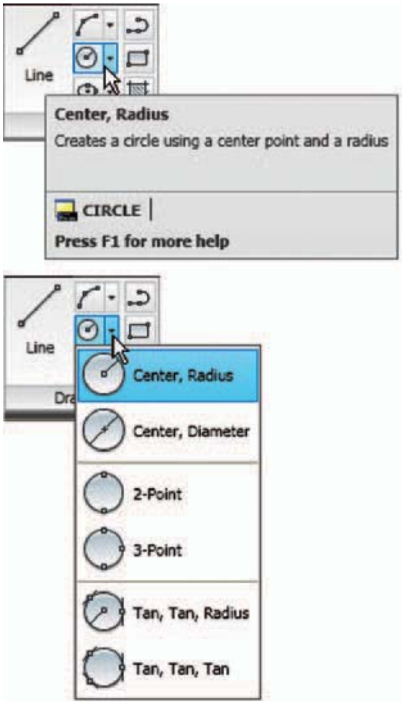

Fig. 1.8 The tooltip for the **Circle** tool and its pop-up menu

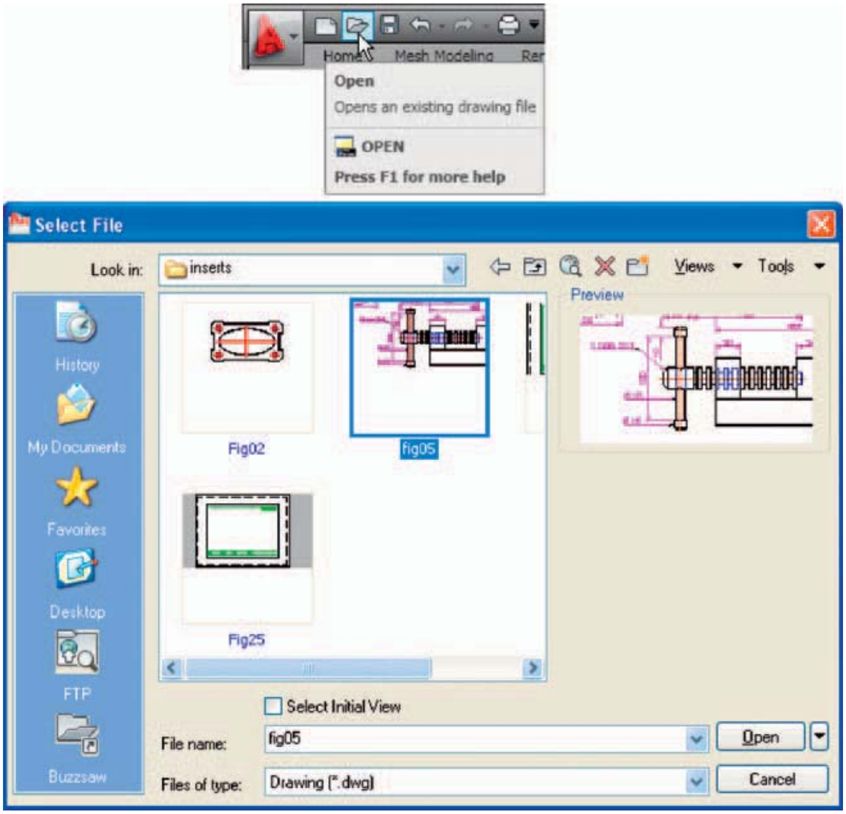

Fig. 1.9 The **Open** icon in the **Quick Access** toolbar brings the **Select File** dialog on screen

The mouse as a digitiser

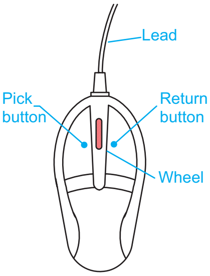

Fig. 1.10 A two-button mouse

Many operators working in AutoCAD will use a two-button mouse as a digitiser. There are other digitisers which may be used – pucks with tablets, a three-button mouse etc. Fig. 1.10 shows a mouse which has two buttons, and a wheel.

To operate this mouse pressing the **Pick button** is a *left-click*. Pressing the **Return** button is a *right-click*. Pressing the **Return** button usually, but not always, has the same result as pressing the **Enter** key of the keyboard.

When the **wheel** is pressed drawings in the AutoCAD screen can be panned by moving the mouse. Moving the wheel forwards enlarges (zooms in) the drawing on screen. Move the wheel backwards and a drawing reduces in size.

The pick box at the intersection of the cursor hairs moves with the cursor hairs in response to movements of the mouse. The AutoCAD window as shown in Fig. 1.3 includes cursor hairs which stretch across the drawing in both horizontal and vertical directions. Some operators prefer cursors hairs to be shorter. The length of the cursor hairs can be adjusted in the **Display** sub-menu of the **Options** dialog (page 13).

Palettes

A palette has already been shown – the **Command** palette. Two palettes which may be frequently used are the **DesignCenter** palette and the **Properties** palette. These can be called to screen from icons in the **View/ Palettes** panel.

- **DesignCenter** palette: Fig. 1.11 shows the **DesignCenter** palette with the **Block** drawings of building symbols from Fig. 9.1 from which the file **Third type of chair** block has been selected.

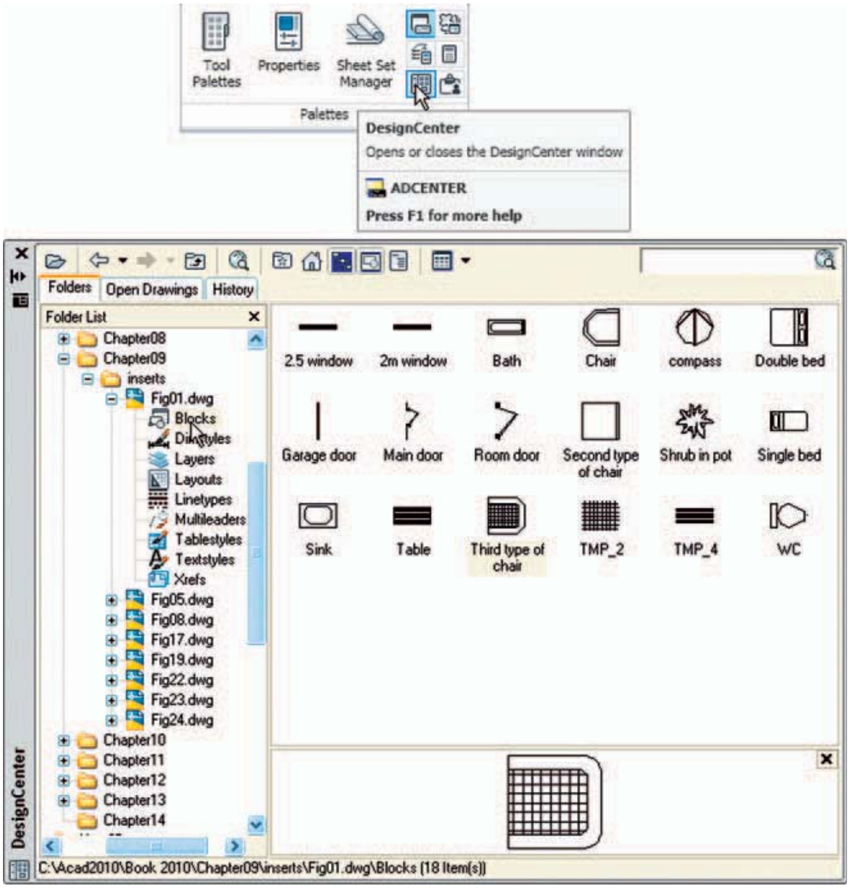

Fig. 1.11 A *left-click* on the **DesignCenter** icon brings the **DesignCenter** palette to screen

- **Properties** palette: Fig. 1.12 shows the **Properties** palette, called from the **View/Palettes** panel, in which the general and geometrical features of a selected line are shown. The line can be changed by the *entering* of new figures in parts of the palette.

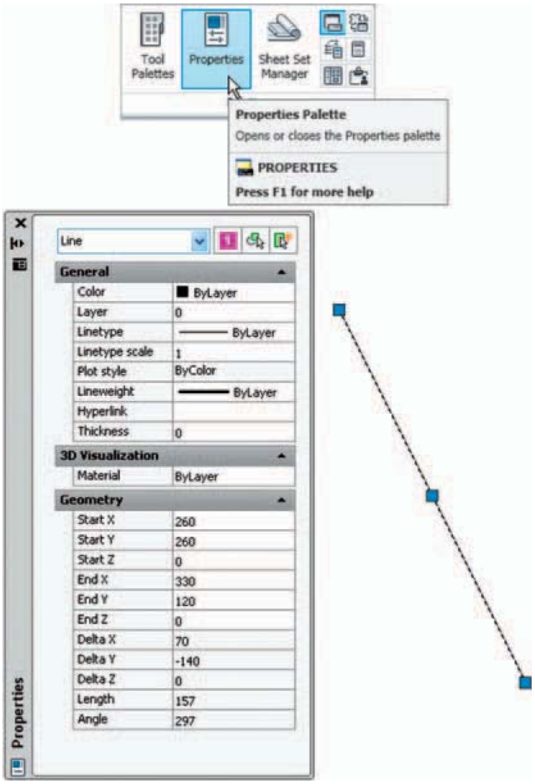

Fig. 1.12 The **Properties** palette

Tool palettes

Click on **Tool Palettes** in the **View/Palettes** panel and the **Tool Palettes – All Palettes** palette appears (Fig. 1.13).

Right-click in the title bar of the palette and a pop-up menu appears. *Click* on a name in the menu and the selected palette appears. The palettes can be reduced in size by *dragging* at corners or edges, or hidden by *clicking* on the **Auto-hide** icon, or moved by *dragging* on the **Move** icon. The palette can also be *docked* against either side of the AutoCAD window.

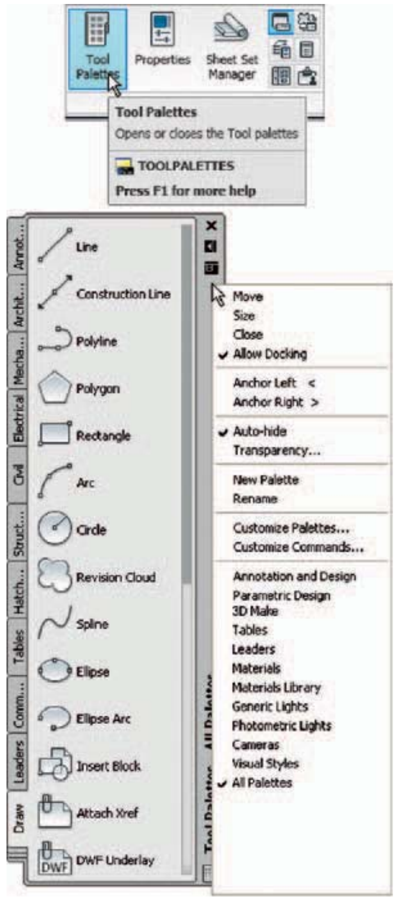

Fig. 1.13 The **Tool Palettes – All Palettes** palette

Notes

Throughout this book tools will often be shown as selected from the panels. It will be seen in Chapter 3 that tools can be "called" in a variety of ways but tools will frequently be shown selected from tool panels although other methods will also be shown on occasion.

Dialogs

Dialogs are an important feature of AutoCAD 2010. Settings can be made in many of the dialogs, files can be saved and opened and changes can be made to variables.

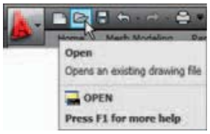

Fig. 1.14 Opening the **Select File** dialog from the **Open** icon in the title bar

Examples of dialogs are shown in Figures 1.15 and 1.16. The first example is taken from the **Select File** dialog (Fig. 1.15), opened with a *click* on **Open …** in the **Quick Access Toolbar** (Fig. 1.14). The second example shows part of the **Options** dialog (Fig. 1.16) in which many settings can be made to allow operators the choice of their methods of constructing drawings. The **Options** dialog can be opened with a *click* on **Options …** in the *right-click* dialog opened in the command palette.

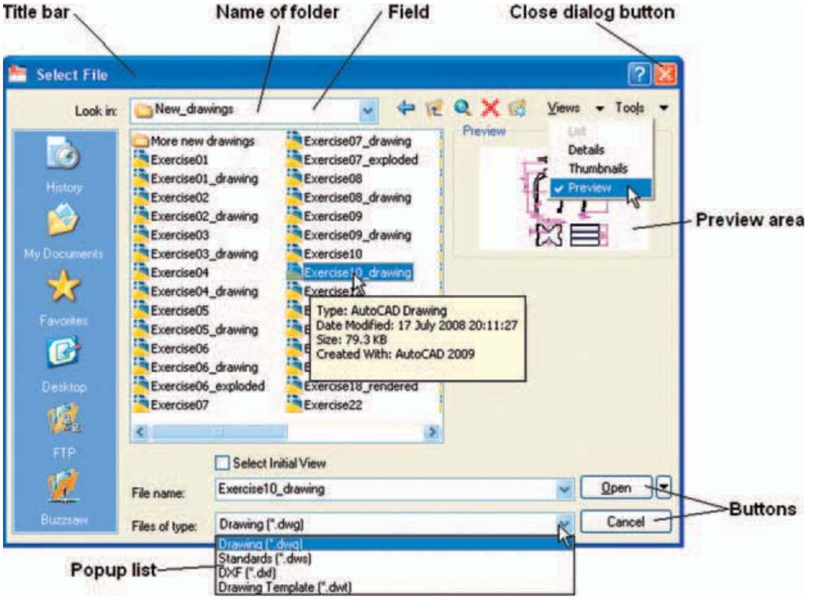

Fig. 1.15 The **Select File** dialog

Note the following parts in the dialog many of which are common to other AutoCAD dialogs:

- **Title bar**: showing the name of the dialog.
- **Close dialog button**: common to other dialogs.
- **Pop-up list**: a *left-click* on the arrow to the right of the field brings down a pop-up list listing selections available in the dialog.
- **Buttons**: a *click* on the **Open** button brings the selected drawing on screen. A *click* on the **Cancel** button, closes the dialog.
- **Preview** area: available in some dialogs – shows a miniature of the selected drawing or other feature, partly shown in Fig. 1.15.

Note the following in the **Options** dialog:

- **Tabs**: a *click* on any of the tabs in the dialog brings a sub-dialog on screen.
- **Check boxes**: a tick appearing in a check box indicates the function described against the box is on. No tick and the function is off. A *click* in a check box toggles between the feature being off or on.

- **Radio buttons**: a black dot in a radio button indicates the feature described is on. No dot and the feature is off.
- **Slider**: a slider pointer can be *dragged* to change sizes of the feature controlled by the slider.

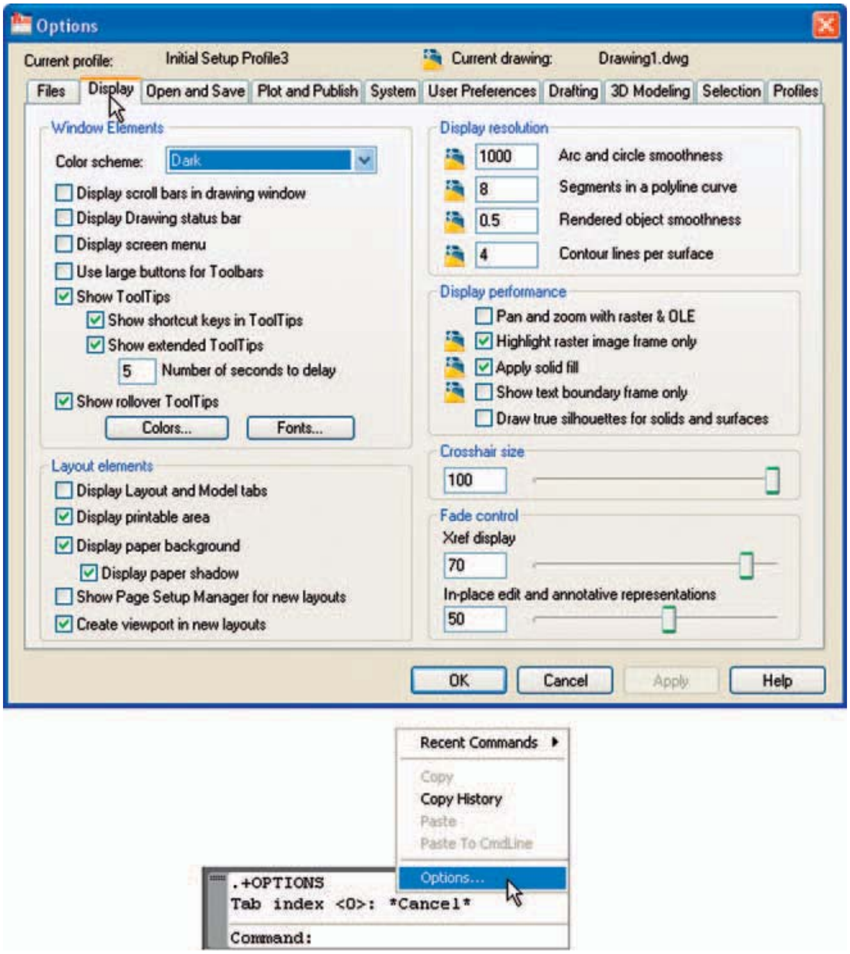

Fig. 1.16 Part of the **Options** dialog

Buttons at the left-hand end of the status bar

A number of buttons at the left-hand end of the status bar can be used for toggling (turning on/off) various functions when operating within AutoCAD 2010 (Fig. 1.17). A *click* on a button turns that function on, if it is off; a *click* on a button when it is on turns the function off. Similar results can be obtained by using the function keys of the computer keyboard (keys **F1** to **F10**).

- **Snap Mode**: also toggled using the **F9** key. When snap is on, the cursor under mouse control can only be moved in jumps from one snap point to another. See also page 56.
- **Grid Display**: also toggled using the **F7** key. When set on, a series of grid points appears in the drawing area. See also page 5.

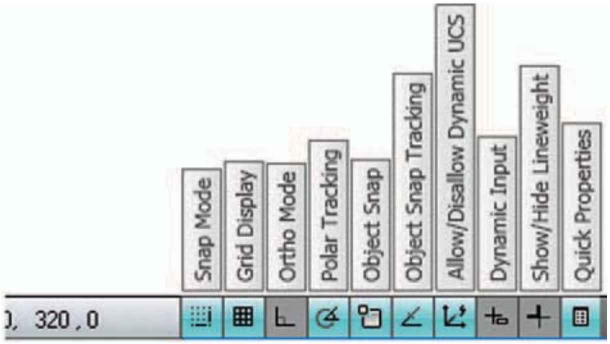

Fig. 1.17 The buttons in left-hand end of the status bar

- **Ortho Mode**: also toggled using the **F8** key. When set on, lines etc. can only be drawn vertically or horizontally.
- **Polar Tracking**: also toggled using the **F10** key. When set on, a small tip appears showing the direction and length of lines etc. in degrees and units.
- **Object Snap**: also toggled using the **F3** key. When set on, an osnap icon appears at the cursor pick box. See also page 57.
- **Object Snap Tracking**: when set on, lines etc. can be drawn at exact coordinate points and precise angles.
- **Allow/Disallow Dynamic UCS**: also toggled by the **F6** key. Used when constructing 3D solid models.
- **Dynamic Input**: also toggled by **F12**. When set on, the **x,y** coordinates and prompts show when the cursor hairs are moved.
- **Show/Hide Lineweight**: when set on, lineweights show on screen. When set off, lineweights only show in plotted/printed drawings.
- **Quick Properties**: a *right-click* brings up a pop-up menu, from which a *click* on **Settings…** causes the **Drafting Settings** dialog to appear.

Note

When constructing drawings in AutoCAD 2010 it is advisable to toggle between **Snap**, **Ortho**, **Osnap** and the other functions in order to make constructing easier.

Buttons at the right-hand end of the status bar

Another set of buttons at the right-hand end of the status bar are shown in Fig. 1.18. The uses of some of these will become apparent when reading future pages of this book. A *click* on the downward-facing arrow near the right-hand end of this set of buttons brings up the **Application Status Bar Menu** (Fig. 1.19) from which the buttons in the status bar can be set on and/or off.

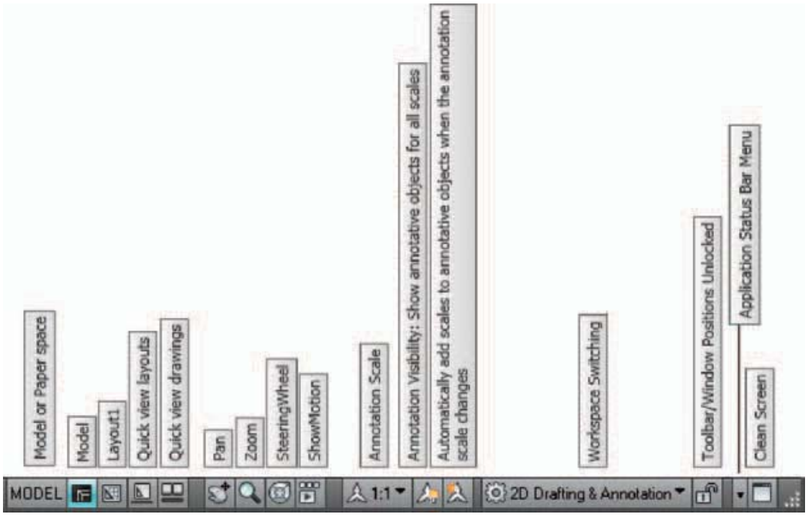

Fig. 1.18 The buttons at the right-hand end of the status bar

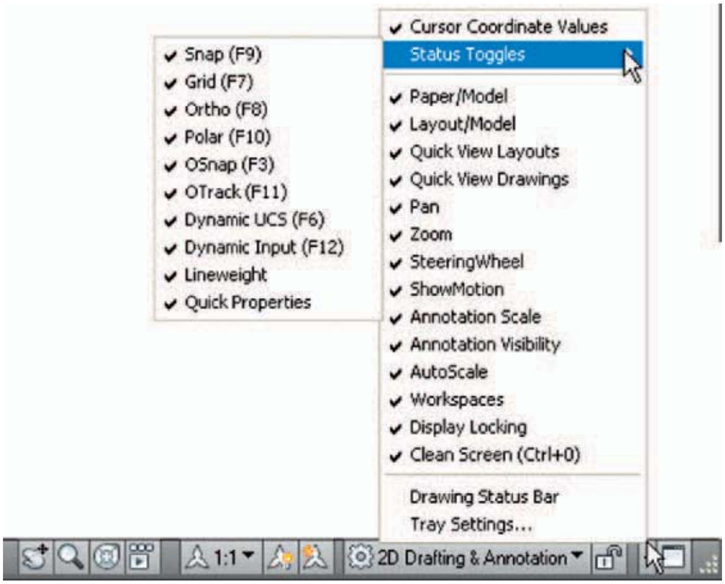

Fig. 1.19 The **Application Status Bar Menu**

The AutoCAD coordinate system

In the AutoCAD 2D coordinate system, units are measured horizontally in terms of X and vertically in terms of Y. A 2D point in the AutoCAD drawing area can be determined in terms of X,Y (in this book referred to as *x,y*). *x,y* = 0,0 is the **origin** of the system. The coordinate point *x,y* = 100,50 is 100 units to the right of the origin and 50 units above the origin. The point *x,y* = −100, −50 is 100 units to the left of the origin and 50 points below the origin. Fig. 1.20 shows some 2D coordinate points in the AutoCAD window.

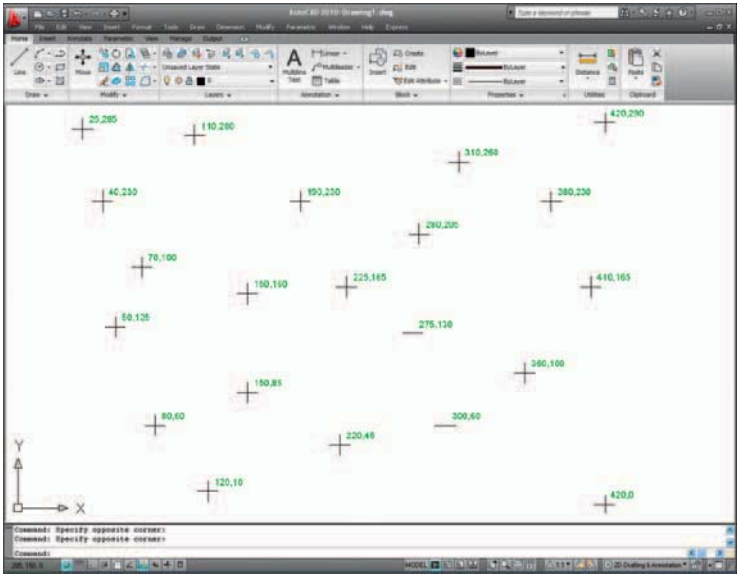

Fig. 1.20 The 2D coordinate points in the AutoCAD coordinate system

3D coordinates include a third coordinate (Z), in which positive Z units are towards the operator as if coming out of the monitor screen and negative Z units are going away from the operator as if towards the interior of the screen. 3D coordinates are stated in terms of *x,y,z*. *x,y,z* = 100,50,50 is 100 units to the right of the origin, 50 units above the origin and 50 units towards the operator. A 3D model drawing as if resting on the surface of a monitor is shown in Fig. 1.21.

Drawing templates

Drawing templates are files with an extension **.dwt**. Templates are files which have been saved with predetermined settings – such as **Grid** spacing, **Snap** spacing etc. Templates can be opened from the **Select template** dialog (Fig. 1.22) called by *clicking* the **New…** icon in the

Quick Access toolbar. An example of a template file being opened is shown in Fig. 1.22. In this example the template will be opened in Paper Space and is complete with a title block and borders.

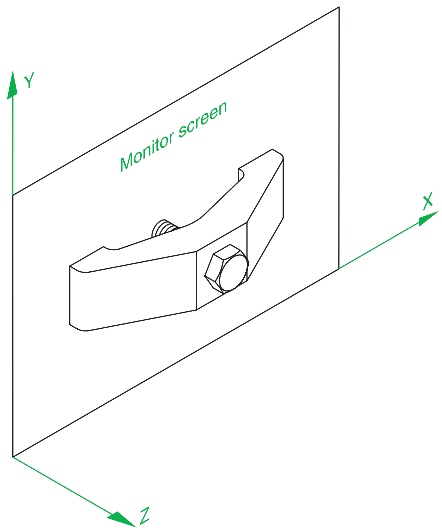

Fig. 1.21 A 3D model drawing showing the X, Y and Z coordinate directions

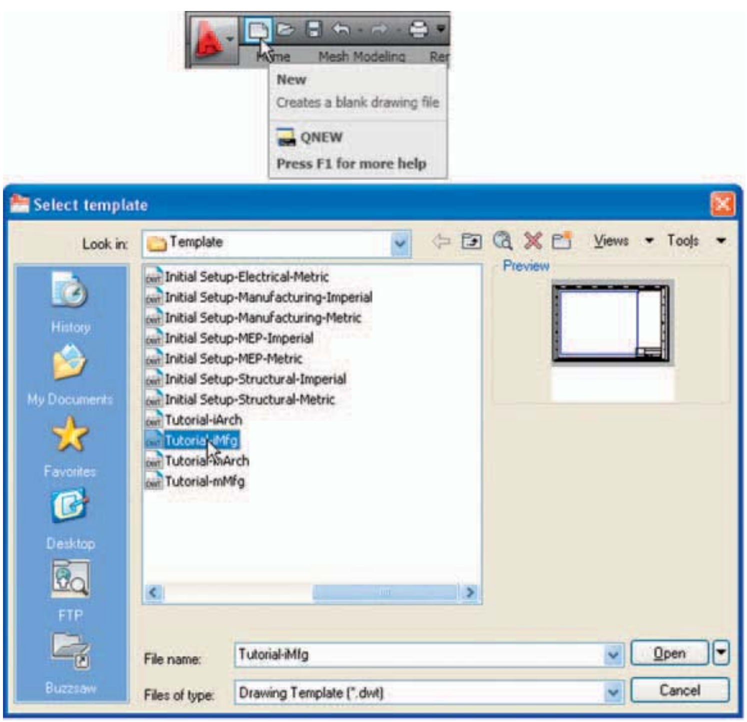

Fig. 1.22 A template selected for opening in the **Select template** dialog

When AutoCAD 2010 is used in European countries and opened, the **acadiso.dwt** template is that most likely to appear on screen. In this part (Part 1 – 2D Design) of this book, drawings will usually be constructed in an adaptation of the **acadiso.dwt** template. To adapt this template:

1. In the command palette *enter* (type) **grid** followed by a *right-click* (or pressing the **Enter** key). Then *enter* **10** in response to the prompt which appears, followed by a *right-click* (Fig. 1.23).

```
Command: grid
Specify grid spacing(X) or [ON/OFF/Snap/Major/aDaptive/Limits/
Follow/Aspect]<0>:  10

Command:
```

Fig. 1.23 Setting **Grid** to **10**

2. In the command palette *enter* **snap** followed by *right-click*. Then *enter* **5** followed by a *right-click* (Fig. 1.24).

```
Command: snap
Specify snap spacing or [ON/OFF/Aspect/Style/Type]<10>:5

Command:
```

Fig. 1.24 Setting **Snap** to **5**

3. In the command palette *enter* **limits**, followed by a *right-click*. *Right-click* again. Then *enter* **420,297** and *right-click* (Fig. 1.25).

```
Command: limits
Reset Model space limits:
Specify lower left corner or [ON/OFF] <0,0>:
Specify upper right corner <12,9>:420,297

Command:
```

Fig. 1.25 Setting **Limits** to **420,297**

4. In the command palette *enter* **zoom** and *right-click*. Then in response to the line of prompts which appears *enter* **a** (for All) and *right-click* (Fig. 1.26).

```
Command: zoom
Specify corner of window, enter a scale factor (nX or nXP), or
[All/Center/Dynamic/Extents/Previous/Scale/Window/Object] <real time>: a
Regenerating model.

Command:
```

Fig. 1.26 **Zooming** to **All**

5. In the command palette *enter* **units** and *right-click*. The **Drawing Units** dialog appears (Fig. 1.27). In the **Precision** pop-up list of the **Length**

area of the dialog, *click* on **0** and then *click* the **OK** button. Note the change in the coordinate units showing in the status bar.

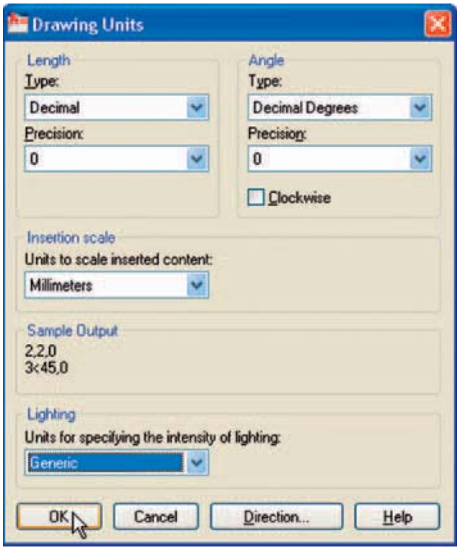

Fig. 1.27 Setting **Units** to **0**

Fig. 1.28 Click **Save**

6. *Click* the **Save** icon in the **Standard Annotation** toolbar (Fig. 1.28). The **Save Drawing As** dialog appears. In the **Files of type** pop-up list select **AutoCAD Drawing Template (*.dwt)**. The templates already in AutoCAD are displayed in the dialog. *Click* on **acadiso.dwt**, followed by another *click* on the **Save** button.

Note

1. Now when AutoCAD is opened the template saved as **acadiso.dwt** automatically loads with **Grid** set to **10**, **Snap** set to **5**, **Limits** set to **420,297** (size of an A3 sheet in millimetres) and with the drawing area zoomed to these limits, with **Units** set to **0**.
2. However, if there are multiple users of the computer, it is advisable to save your template to another file name – e.g. **my_template.dwt**.
3. Other features will be added to the template in future chapters.

Method of showing entries in the command palette

Throughout the book, when a tool is "called" usually by a *click* on a tool icon in a panel – in this example *picking* the **Navigation/Zoom** tool – the command palette will show as follows:

```
Command:_zoom right-click
Specify corner of window, enter a scale
  factor (nX or nXP), or [All/Center/Dynamic/
  Extents/Previous/Scale/Window/Object] < real
  time > :enter a (All)right-click
Regenerating model.
Command:
```

Note

In later examples this may be shortened to:

```
Command: _zoom
[prompts]:enter a right-click
Command:
```

Note

1. In the above *enter* means type the given letter, word or words at the **Command:** prompt.
2. *Right-click* means press the **Return** (right) button of the mouse or press the **Return** key of the keyboard.

Tools and tool icons

In AutoCAD 2010, tools are shown as names and icons in panels, in toolbars or in drop-down menus. When the cursor is placed over a tool icon a description shows with the name of the tool as shown and an explanation in diagram form as in the example given in Fig. 1.7 (page 7).

If a small outward-facing arrow is included at the right-hand side of a tool icon, when the cursor is placed over the icon and the *pick* button of the mouse depressed and held, a flyout appears which includes other features. An example is given in Fig. 1.8 (page 7).

Another AutoCAD workspace

Click **Workspace Switching** icon at the bottom right-hand corner of the AutoCAD window. In the menu which appears *click* **AutoCAD Classic** (Fig. 1.29). The **AutoCAD Classic** workspace appears (Fig. 1.30). This includes the **Draw** toolbar *docked* against the left-hand side of the window and the **Modify** toolbar *docked* against the right-hand side of the window with other toolbars *docked* against the top of the window. The menu bar is included in the example given in Fig. 1.30.

Other workspaces can be designed as the operator wishes. One in particular which may appeal to some operators is to *click* the **Clear Screen** icon at the bottom-right corner of the AutoCAD window (Fig. 1.31). This example shows a clear screen window from the **AutoCAD Classic** workspace. This allows more working space.

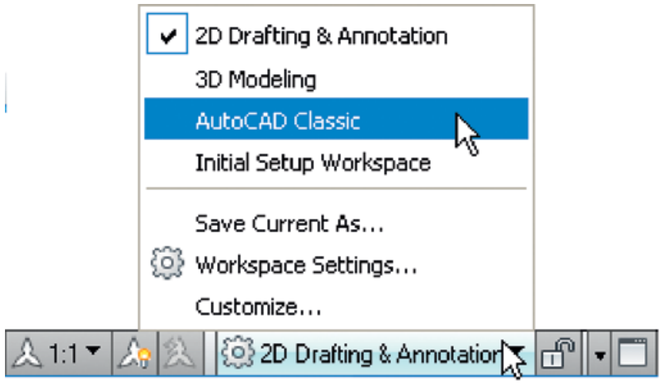

Fig. 1.29 Selecting **AutoCAD Classic** from the **Workspace Switching** menu

The Ribbon

The **Ribbon** contains groups of panels placed, by default, at the top of the AutoCAD 2010 window. There are, by default, 7 groups of panels called from **tabs** above the panels –**Home**, **Insert**, **Annotate**, **Parametric**, **View**, **Manage** and **Output**. Other groups can be added if wished by using the **Custom User Interface** dialog.

If a small arrow is showing to the right of the panel name, a *click* on the arrow brings down a flyout showing additional tool icons not included in the panel. As an example Fig. 1.32 shows the flyout from the **Home/ Draw** panel.

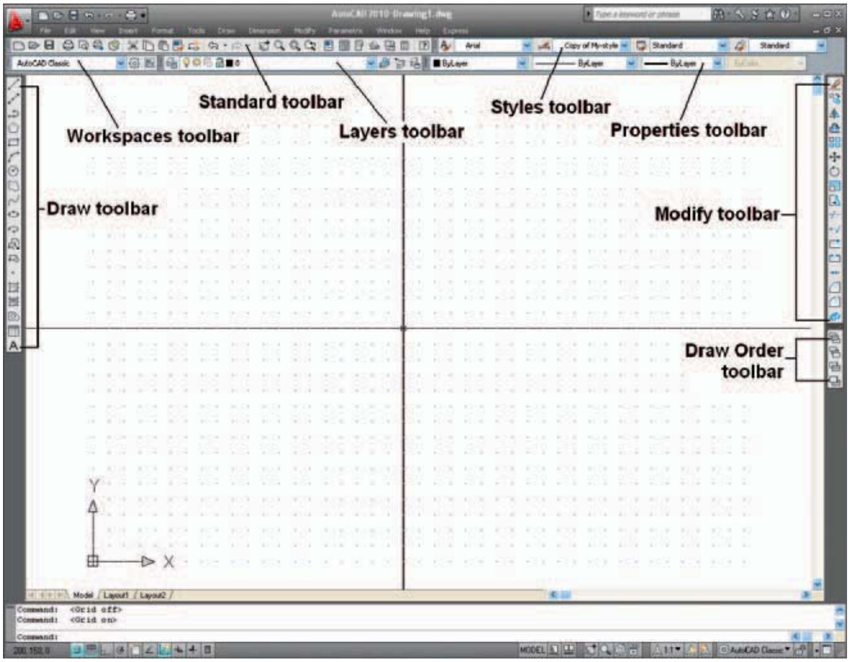

Fig. 1.30 The **AutoCAD Classic** window

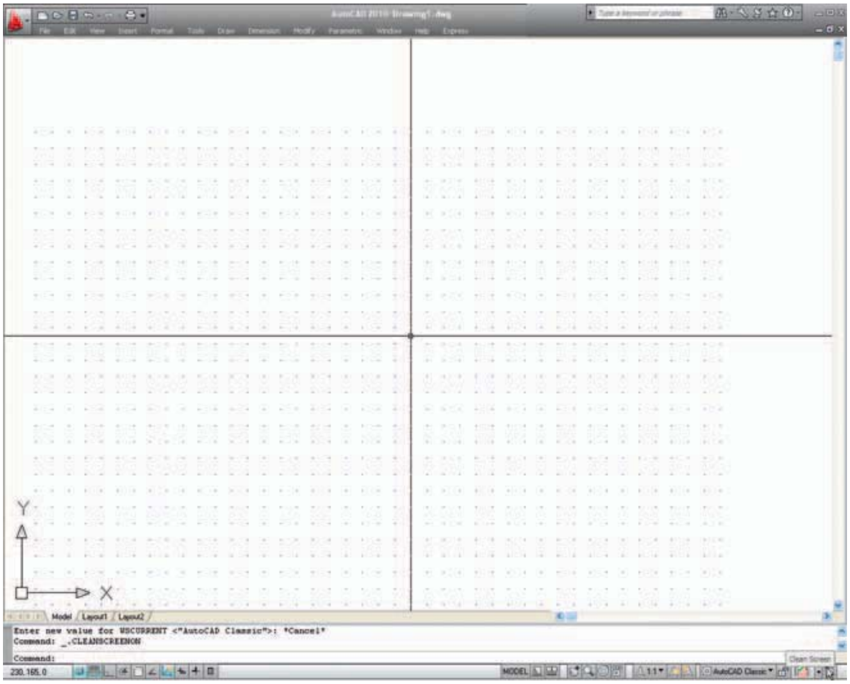

Fig. 1.31 The **AutoCAD Classic** workspace after the **Clear Screen** icon has been *clicked*

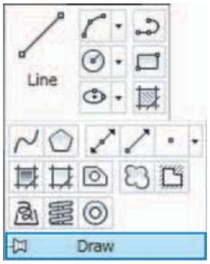

Fig. 1.32 The **Home/Draw** panel and its pop-up

A *right-click* on the **Minimise to Panel Titles** button brings down a menu – a *click* on **Undock** in this menu and the **Ribbon** becomes a palette (Fig. 1.33). A *right-click* menu in the palette shows that the palette can now be *docked* against either side of the window. Some operators will prefer selecting tools from a *docked* **Ribbon** because of the larger workspace obtained when it is so *docked*.

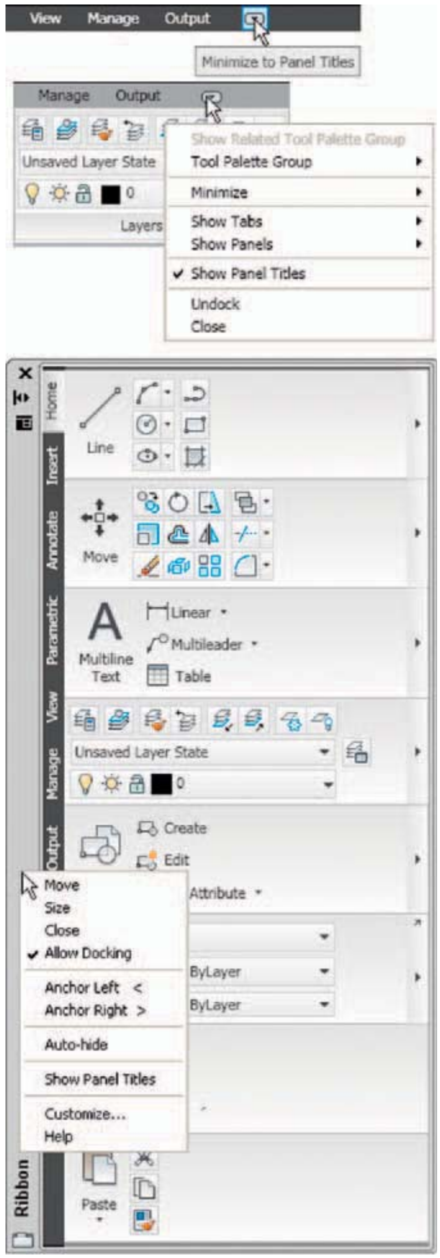

Fig. 1.33 The **Ribbon** as a palette with its *right-click* menu

A *left-click* on the **Minimize to Panel Titles** button causes the **Ribbon** panels to disappear leaving only the tabs showing, but each panel can then be selected from the panel tabs. Fig. 1.34 shows the AutoCAD window with the **Ribbon** minimised to tabs and with the **Home** tab selected, icons of the other panels appear. **Line** is then selected from the **Home/Draw** panel. When the **Line** tool comes into action the **Home** panels disappear again leaving a larger drawing area than before the panels were minimised.

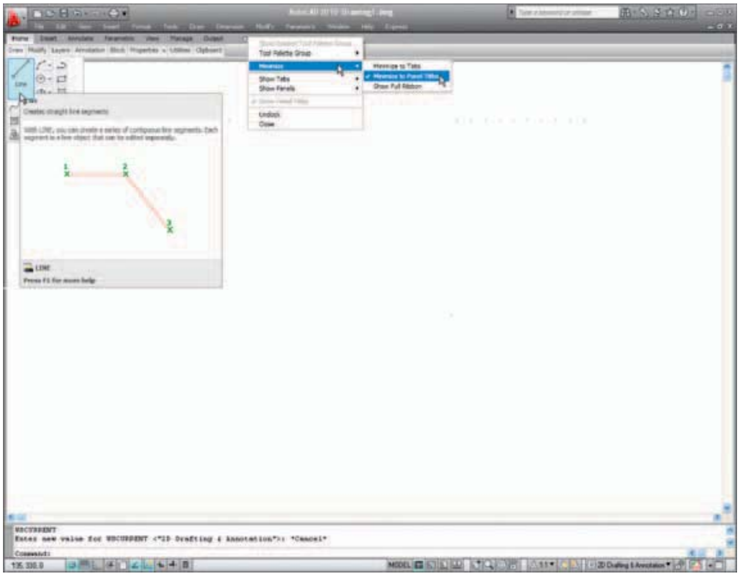

Fig. 1.34 The AutoCAD window with the panels minimised

The Quick View Drawings button

One of the buttons at the right-hand end of the status bar is the **Quick View Drawings** button. A *click* on this button brings miniatures of recent drawings on screen (Fig. 1.35). This can be of value when wishing to check back on features of recent drawings in relation to the current drawing on screen.

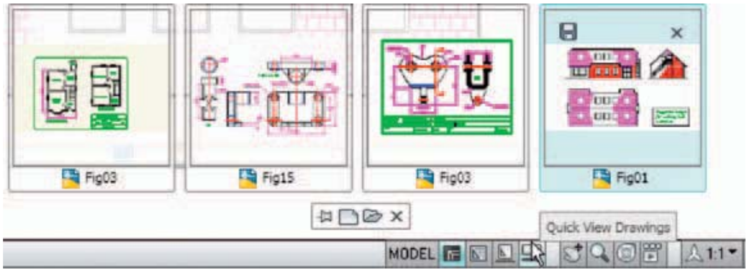

Fig. 1.35 The result of a *click* on the **Quick View Drawings** button

Customisation of User Interface

The AutoCAD 2010 workspace can be arranged in any format the operator wishes by making settings in the **Customize User Interface** dialog (Fig. 1.36) brought to screen from the *right-click* menu from the button in the **Quick Access** toolbar. The dialog can be opened using other methods such as *entering* **cui** at the command line, but using this *right-click* menu is possibly the quickest method. The dialog is only shown here to alert the reader to the fact that he/she can customise the workspace being used to suit their own methods of working. Page space in this book does not allow further explanation.

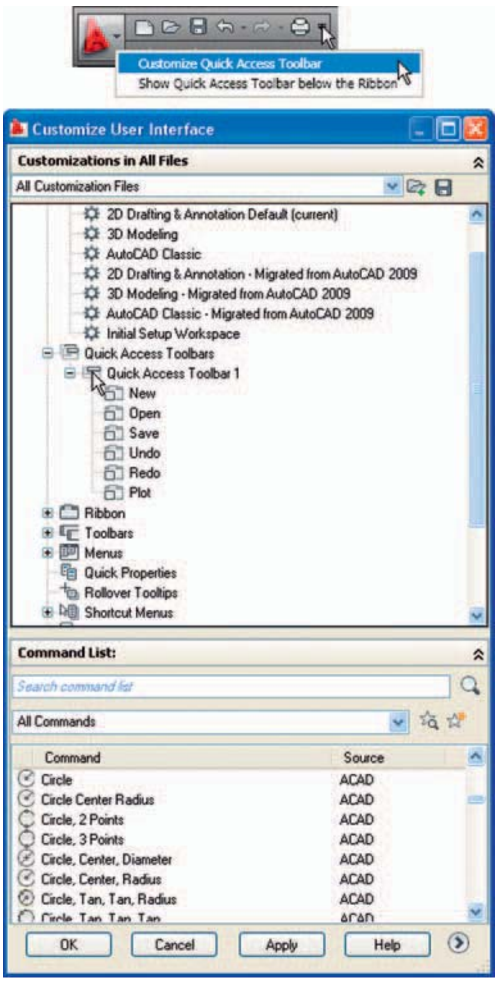

Fig. 1.36 The **Customize User Interface** dialog

REVISION NOTES

1. A *double-click* on the **AutoCAD 2010** shortcut in the Windows desktop opens the AutoCAD window.
2. There are three main workspaces in which drawings can be constructed – the **2D Drafting & Annotation**, **Classic AutoCAD** and the **3D Modeling** workspace. **Part 1, 2D Design** of this book deals with 2D drawings that will be constructed mainly in the **2D Drafting & Annotation** workspace. In **Part 2, 3D Design**, 3D model drawings will be mainly constructed in the **3D Modeling** workspace.
3. All constructions in this book involve the use of a mouse as the digitiser. When a mouse is the digitiser:
   A *left-click* means pressing the left-hand button (the **Pick**) button.
   A *right-click* means pressing the right-hand button (the **Return** button.)
   A *double-click* means pressing the left-hand button twice in quick succession.
   Dragging means moving the mouse until the cursor is over an item on screen, holding the left-hand button down and moving the mouse. The item moves in sympathy to the mouse movement.
   To *pick* has a similar meaning to a *left-click*.
4. Palettes are a particular feature of AutoCAD 2010. The **Command** palette and the **DesignCenter** palette will be in frequent use.
5. Tools are shown as icons in the tool panels.
6. When a tool is *picked*, a tooltip appears describing the action of the tool. Most tools show a small tooltip, followed shortly afterwards by a larger one.
7. Dialogs allow opening and saving of files and the setting of parameters.
8. A number of *right-click* menus are used in AutoCAD 2010.
9. A number of buttons in the status bar can be used to toggle features such as snap and grid. Functions keys of the keyboard can be also used for toggling some of these functions.
10. The AutoCAD coordinate system determines the position in units of any 2D point in the drawing area (**2D Drafting & Annotation** and **Classic AutoCAD**) and any point in 3D space (**3D Modeling**).
11. Drawings are usually constructed in templates with predetermined settings. Some templates include borders and title blocks.

Note

Throughout this book when tools are to be selected from panels in the ribbon the tools will be shown in the form e.g. **Home/Draw –** the name of the tab in the ribbon title bar, followed by the name of the panel from which the tool is to be selected.

Chapter 2

Introducing drawing

AIMS OF THIS CHAPTER

The contents of this chapter aim to introduce:

1. The construction of 2D drawing in the **2D Drafting & Annotation** workspace.
2. The drawing of outlines using the **Line**, **Circle** and **Polyline** tools from the **Home/Draw** panel.
3. Drawing to snap points.
4. Drawing to absolute coordinate points.
5. Drawing to relative coordinate points.
6. Drawing using the "tracking" method.
7. The use of the **Erase**, **Undo** and **Redo** tools.

The 2D Drafting & Annotation workspace

Illustrations throughout this chapter will be shown as working in the **2D Drafting & Annotation** workspace. In this workspace the **Home/Draw** panel is at the left-hand end of the **Ribbon** and **Draw** tools can be selected from the panel as indicated by a *click* on the **Line** tool (Fig. 2.1). In this chapter all examples will show tools as selected from the **Home/Draw** panel. However, methods of construction will be the same if the reader wishes to work in other workspaces. When working in the **Classic AutoCAD** workspace **Draw** tools can be selected from the **Draw** toolbar (Fig. 2.2) The **Draw** tools can also be selected from the **Draw** drop-down menu (Fig. 2.2) whether working in **2D Drafting & Annotation** or **Classic AutoCAD**.

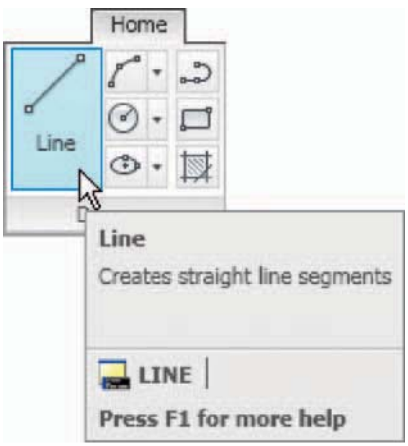

Fig. 2.1 The **Line** tool from the **Home/Draw** panel with its tooltip

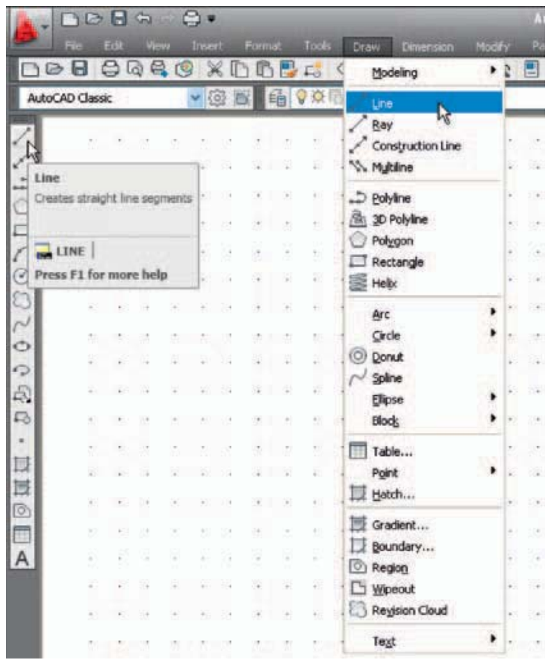

Fig. 2.2 Selecting the **Line** tool in the **Classic AutoCAD** workspace

Drawing with the line tool

First example – Line tool (Fig. 2.4)

1. Open AutoCAD. The drawing area will show the settings of the **acadiso.dwt** template – **Limits** set to **420,297**, **Grid** set to **10**, **Snap** set to **5** and **Units** set to **0**.

2. *Left-click* on the **Line** tool in the **Home/Draw** panel, in the **Draw** toolbar (Figs. 2.1 and 2.2) or *enter* line or **l** at the command line.

Notes

(a) The tooltip appears when the tool icon is *clicked*.

(b) The prompt **Command:_line Specify first point** appears in the command window at the command line (Fig. 2.3).

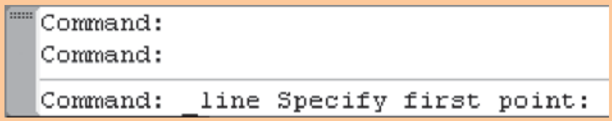

Fig. 2.3 The prompt appearing at the command line in the Command palette when Line is "called"

3. Make sure **Snap** is on by either pressing the **F9** key or the **Snap Mode** button in the status bar. <**Snap on**> will show in the command palette.

4. Move the mouse around the drawing area. The cursors pick box will jump from point to point at 5 unit intervals. The position of the pick box will show as coordinate numbers in the status bar (left-hand end).

5. Move the mouse until the coordinate numbers show **60,240,0** and press the *pick* button of the mouse (*left-click*).

6. Move the mouse until the coordinate numbers show **260,240,0** and *left-click*.

7. Move the mouse until the coordinate numbers show **260,110,0** and *left-click*.

8. Move the mouse until the coordinate numbers show **60,110,0** and *left-click*.

9. Move the mouse until the coordinate numbers show **60,240,0** and *left-click*. Then press the **Return** button of the mouse (*right-click*).

The line rectangle Fig. 2.4 appears in the drawing area.

Second example – Line tool (Fig. 2.6)

1. Clear the drawing from the screen with a *click* on the drawing **Close** button of the AutoCAD drawing area. Make sure it is not the AutoCAD 2010 window button.

Fig. 2.4 First example – **Line** tool

2. The warning window Fig. 2.5 appears in the centre of the screen. *Click* its **No** button.

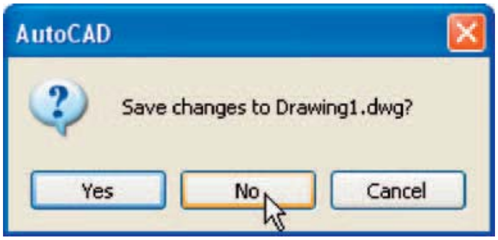

Fig. 2.5 The **AutoCAD** warning window

3. *Left-click* **New…** button in the **File** drop-down menu and from the **Select template** dialog which appears *double-click* on **acadiso.dwt**.
4. *Left-click* on the **Line** tool icon and *enter* figures as follows at each prompt of the command line sequence:

```
Command:_line Specify first point:enter 80,235
  right-click
Specify next point or [Undo]: enter 275,235
  right-click
Specify next point or [Undo]:enter 295,210
  right-click
Specify next point or [Close/Undo]:enter 295,100
  right-click
Specify next point or [Close/Undo]:enter 230,100
  right-click
Specify next point or [Close/Undo]:enter 230,70
  right-click
```

```
Specify next point or [Close/Undo]:enter 120,70
  right-click
Specify next point or [Close/Undo]:enter 120,100
  right-click
Specify next point or [Close/Undo]:enter 55,100
  right-click
Specify next point or [Close/Undo]:enter 55,210
  right-click
Specify next point or [Close/Undo]:enter c (Close)
  right-click
Command:
```

The result is as shown in Fig. 2.6.

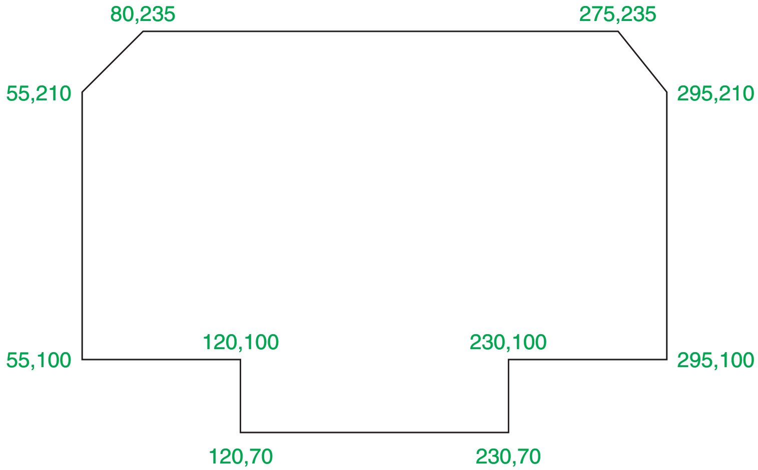

Fig. 2.6 Second example – **Line** tool

Third example – Line tool (Fig. 2.7)

1. Close the drawing and open a new **acadiso.dwt** window.
2. *Left-click* on the **Line** tool icon and *enter* figures as follows at each prompt of the command line sequence:

```
Command:_line Specify first point:enter 60,210
  right-click
Specify next point or [Undo]:enter @50,0
  right-click
Specify next point or [Undo]:enter @0,20
  right-click
Specify next point or [Close/Undo]:enter @130,0
  right-click
```

```
Specify next point or [Close/Undo]:enter @0,-20
  right-click
Specify next point or [Close/Undo]:enter @50,0
  right-click
Specify next point or [Close/Undo]:enter @0,-105
  right-click
Specify next point or [Close/Undo]:enter @-50,0
  right-click
Specify next point or [Close/Undo]:enter @0,-20
  right-click
Specify next point or [Close/Undo]:enter @-130,0
  right-click
Specify next point or [Close/Undo]:enter @0,20
  right-click
Specify next point or [Close/Undo]:enter @-50,0
  right-click
Specify next point or [Close/Undo]:enter c (Close)
  right-click
Command:
```

The result is as shown in Fig. 2.7.

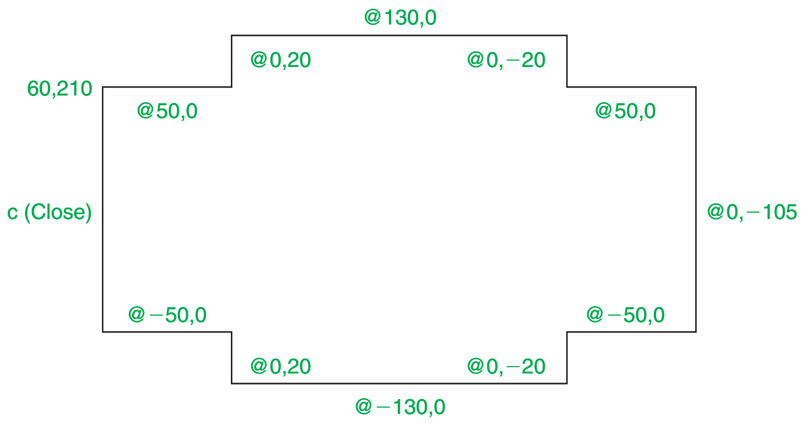

Fig. 2.7 Third example – **Line** tool

Note

1. The figures typed at the keyboard determining the corners of the outlines in the above examples are two-dimensional (2D) *x,y* coordinate points. When working in 2D, coordinates are expressed in terms of two numbers separated by a comma.

2. Coordinate points can be shown as positive or as negative numbers.
3. The method of constructing an outline as shown in the first two examples above is known as the **absolute coordinate entry** method, where the *x,y* coordinates of each corner of the outlines are *entered* at the command line as required.
4. The method of constructing an outline as shown in the third example is known as the **relative coordinate entry** method – coordinate points are *entered* relative to the previous entry. In relative coordinate entry, the @ symbol is *entered* before each set of coordinates with the following rules in mind:

   + ve x entry is to the right.

   − ve x entry is to the left.

   + ve y entry is upwards.

   − ve y entry is downwards.
5. The next example (the fourth) shows how lines at angles can be drawn taking advantage of the relative coordinate entry method. Angles in AutoCAD are measured in 360 degrees in a counter-clockwise (anticlockwise) direction (Fig. 2.8). The < symbol precedes the angle.

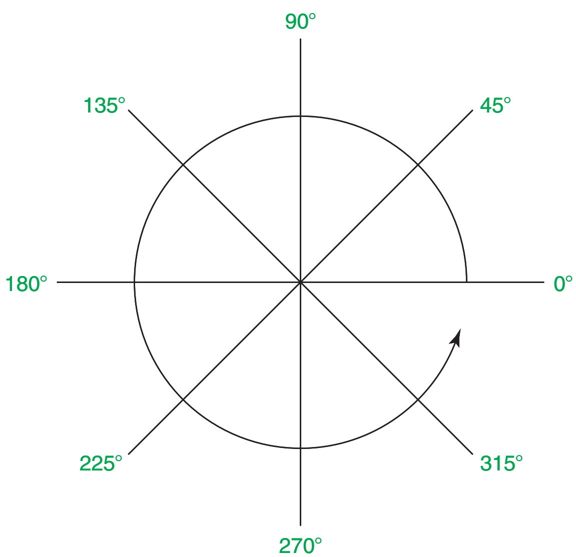

Fig. 2.8 The counter-clockwise direction of measuring angles in AutoCAD

Fourth example – Line tool (Fig. 2.9)

1. Close the drawing and open a new **acadiso.dwt** window.
2. *Left-click* on the **Line** tool icon and *enter* figures as follows at each prompt of the command line sequence:

```
Command:_line Specify first point:enter 70,230
Specify next point:right-click @220,0
Specify next point:right-click @0,-70
Specify next point or [Undo]:right-click
  @115 < 225
Specify next point or [Undo]:right-click @-60,0
Specify next point or [Close/Undo]:right-click
  @115 < 135
Specify next point or [Close/Undo]:right-click
  @0,70
Specify next point or [Close/Undo]:right-click c
  (Close)
Command:
```

The result is as shown in Fig. 2.9.

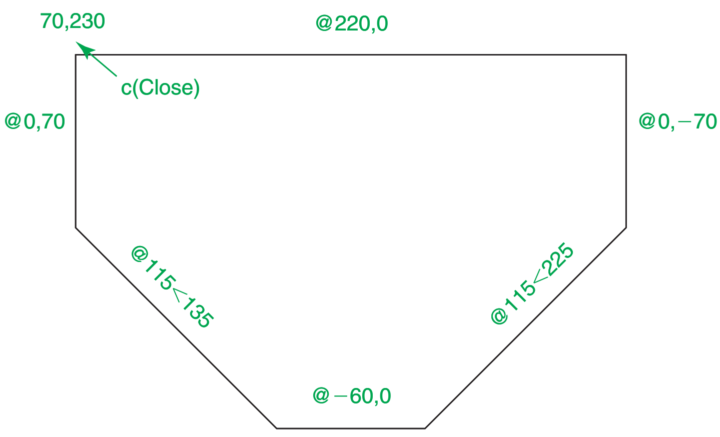

Fig. 2.9 Fourth example – **Line** tool

Fifth example – Line tool (Fig. 2.10)

Another method of constructing accurate drawings is by using a method known as **tracking.** When **Line** is in use, as each **Specify next point:** appears at the command line, a *rubber-banded* line appears from the last point *entered. Drag* the rubber-band line in any direction and *enter* a number at the keyboard, followed by a *right-click.* The line is drawn in the *dragged* direction of a length in units equal to the *entered* number.

In this example because all lines are drawn in vertical or horizontal directions, either press the **F8** key or *click* the **ORTHO** button in the status bar which will only allow drawing horizontally or vertically.

1. Close the drawing and open a new **acadiso.dwt** window.
2. *Left-click* on the **Line** tool icon and *enter* figures as follows at each prompt of the command line sequence:

```
Command:_line Specify first point:enter 65,220
  right-click
Specify next point:drag to right enter 240
  right-click
Specify next point:drag down enter 145 right-click
Specify next point or [Undo]:drag left enter 65
  right-click
Specify next point or [Undo]:drag upwards enter 25
  right-click
Specify next point or [Close/Undo]:drag left enter
  120 right-click
Specify next point or [Close/Undo]:drag upwards
  enter 25 right-click
Specify next point or [Close/Undo]:drag left enter
  55 right-click
Specify next point or [Close/Undo]:c (Close)
  right-click
Command:
```

The result is as shown in Fig. 2.10.

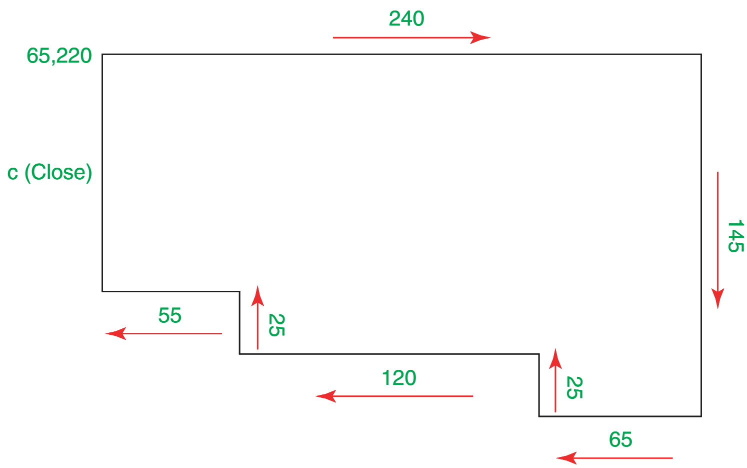

Fig. 2.10 Fifth example – **Line** tool

Drawing with the circle tool

First example – circle tool (Fig. 2.13)

1. Close the drawing just completed and open the **acadiso.dwt** template.
2. *Left-click* on the **Circle** tool icon in the **Home/Draw** panel (Fig. 2.11).
3. *Enter* a coordinate and a radius against the prompts appearing in the command window as shown in Fig. 2.12, followed by *right-clicks*. The circle (Fig. 2.13) appears on screen.

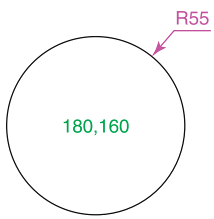

Fig. 2.13 First example – **Circle** tool

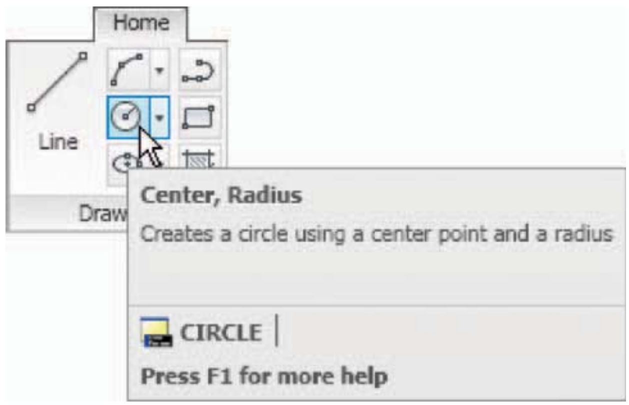

Fig. 2.11 The **Circle** tool from the **Home/Draw** panel

```
Command: _circle Specify center point for circle or [3P/2P/Ttr (tan tan
radius)]: 180,160
Specify radius of circle or [Diameter]: 55
Command:
```

Fig. 2.12 First example – **Circle**. The command line prompts when **Circle** is called

Second example – Circle tool (Fig. 2.14)

1. Close the drawing and open the **acadiso.dwt** screen.
2. *Left-click* on the **Circle** tool icon and construct two circles as shown in the drawing Fig. 2.14 in the positions and radii shown in Fig. 2.15.
3. *Click* the **Circle** tool again and against the first prompt *enter* **t** (the abbreviation for the prompt **tan tan radius**), followed by a *right-click*.

Command_circle Specify center point for circle or
  [3P/2P/Ttr (tan tan radius]:*enter* t *right-click*
Specify point on object for first tangent of
  circle: *pick*

```
Specify point on object for second tangent of
  circle: pick
Specify radius of circle (50):enter 40 right-click
Command:
```

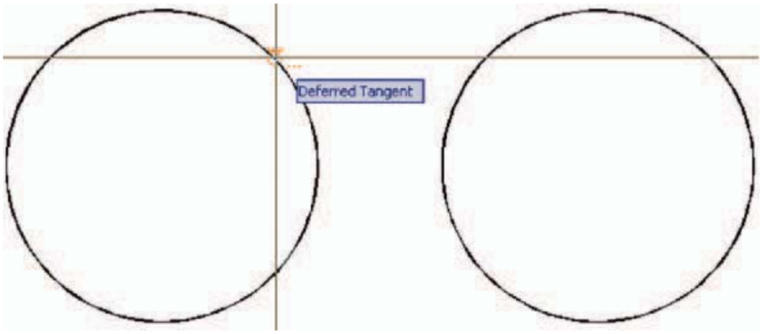

Fig. 2.14 Second example – **Circle** tool – the two circles of radius 50

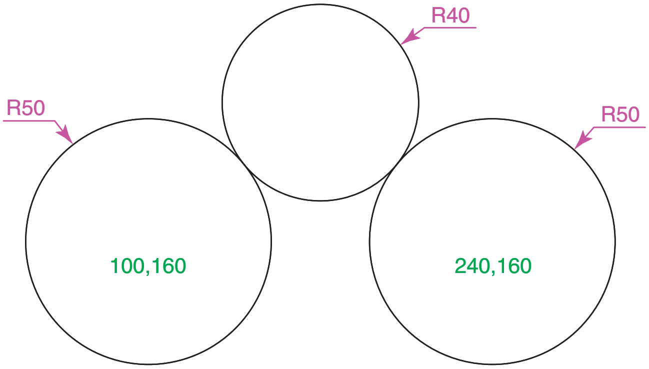

Fig. 2.15 Second example – **Circle** tool

The radius **40** circle tangential to the two circle already drawn then appears (Fig. 2.15).

Notes

1. When a point on either circle is picked a tip (**Deferred Tangent**) appears. This tip will only appear when the **Object Snap** button is set on with a *click* on its button in the status bar, or the **F3** key of the keyboard is pressed.
2. Circles can be drawn through 3 points or through 2 points *entered* at the command line in response to prompts brought to the command line by using **3P** and **2P** in answer to the circle command line prompts.

The Erase tool

If an error has been made when using any of the AutoCAD 2010 tools, the object or objects which have been incorrectly drawn can be deleted with the **Erase** tool. The **Erase** tool icon can be selected from the **Home/ Modify** panel (Fig. 2.16) or by *entering* **e** at the command line.

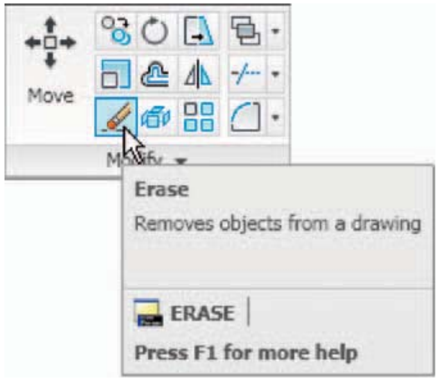

Fig. 2.16 The **Erase** tool icon from the **Home/Modify** panel

First example – Erase (Fig. 2.18)

1. With **Line** construct the outline Fig. 2.17.

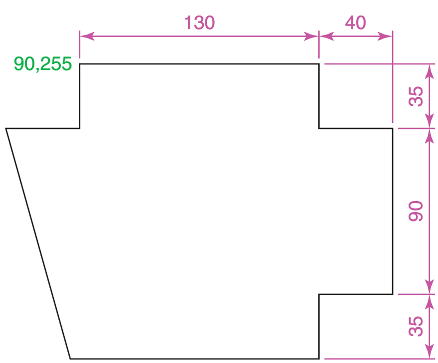

Fig. 2.17 First example – **Erase**. An incorrect outline

2. Assuming two lines of the outline have been incorrectly drawn, *left-click* the **Erase** tool icon. The command line shows:

```
Command:_erase
Select objects:pick one of the lines 1 found
Select objects:pick the other line 2 total
Select objects:right-click
Command:
```

And the two lines are deleted (right-hand drawing of Fig. 2.18).

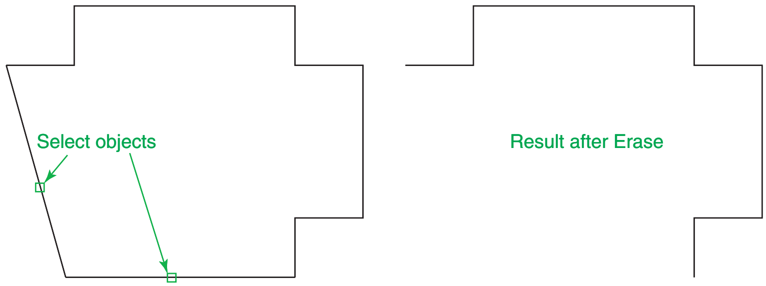

Fig. 2.18 First example – **Erase**

Second example – Erase (Fig. 2.19)

The two lines could also have been deleted by the following method:

1. *Left-click* the **Erase** tool icon. The command line shows:

```
Command:_erase
Select objects:enter c (Crossing)
Specify first corner:pick
  Specify opposite corner: pick 2 found
Select objects:right-click
Command:
```

And the two lines are deleted as in the right-hand drawing Fig. 2.19.

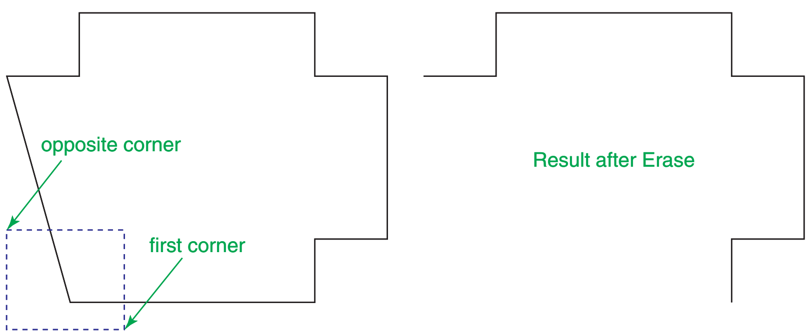

Fig. 2.19 Second example – **Erase**

Undo and Redo tools

Two other tools of value when errors have been made are the **Undo** and **Redo** tools. To undo the last action taken by any tool when constructing a drawing, either *left-click* the **Undo** tool in the **Quick Access** toolbar

(Fig. 2.20) or *enter* **u** at the command line. No matter which method is adopted the error is deleted from the drawing.

Fig. 2.20 The **Undo** tool in the **Title** bar

Everything constructed during a session of drawing can be undone by repeated *clicking* on the **Undo** tool icon or by repeatedly *entering* **u**'s at the command line.

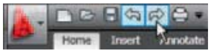

Fig. 2.21 The **Redo** tool icon in the **Title** bar

To bring back objects that have just been removed by the use of **Undo**'s, *left-click* the **Redo** tool icon in the **Quick Access** toolbar (Fig. 2.21) or *enter* **redo** at the command line.

Drawing with the Polyline tool

When drawing lines with the **Line** tool, each line drawn is an object in its own right. A rectangle drawn with the **Line** tool is four objects. A rectangle drawn with the **Polyline** tool is a single object. Lines of different thickness, arcs, arrows and circles can all be drawn using this tool, as will be shown in the examples describing constructions using the **Polyline** tool. Constructions resulting from using the tool are known as **polylines** or **plines**.

The **Polyline** tool can be called from the **Home/Draw** panel (Fig. 2.22) or by *entering* **pl** at the command line.

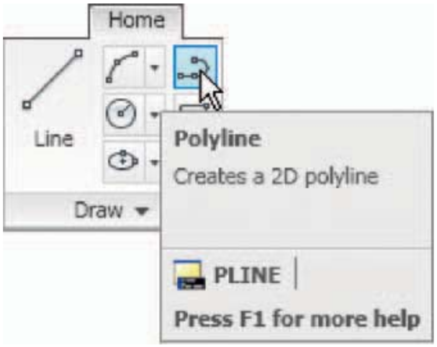

Fig. 2.22 The **Polyline** tool icon in the **Home/Draw** panel

First example – Polyline tool (Fig. 2.23)

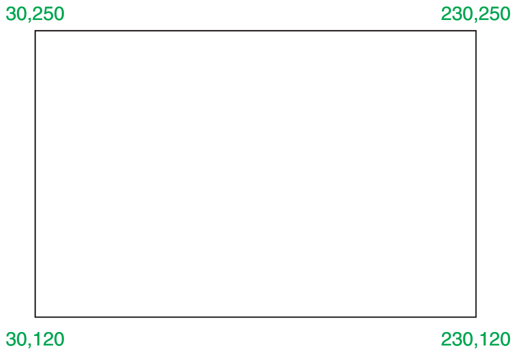

Fig. 2.23 First example – **Polyline** tool

Note

In this example *enter* and *right-click* have not been included.

Left-click the **Polyline** tool. The command line shows:

```
Command:_pline Specify start point: 30,250
Current line width is 0
Specify next point or [Arc/Halfwidth/Length/
  Undo/Width]: 230,250
Specify next point or [Arc/Close/Halfwidth/
  Length/Undo/Width]: 230,120
Specify next point or [Arc/Close/Halfwidth/
  Length/Undo/Width]: 30,120
Specify next point or [Arc/Close/Halfwidth/
  Length/Undo/Width]: c (Close)
Command:
```

Note

1. Note the prompts: **Arc** for constructing pline arcs; **Close** to close an outline; **Halfwidth** to halve the width of a wide pline; **Length** to *enter* the required length of a pline; **Undo** to undo the last pline constructed; **Close** to close an outline.
2. Only the capital letter(s) of a prompt needs to be *entered* in upper or lower case to make that prompt effective.
3. Other prompts will appear when the **Polyline** tool is in use as will be shown in later examples.

Second example – Polyline tool (Fig. 2.24)

This will be a long sequence, but it is typical of a reasonably complex drawing using the **Polyline** tool. In the following sequences, when a prompt line is to be repeated, the prompts in square brackets ([]) will be replaced by **[prompts]**.

Left-click the **Polyline** tool icon. The command line shows:

```
Command:_pline Specify start point: 40,250
Current line width is 0
Specify next point or [Arc/Halfwidth/Length/Undo/
  Width]: w (Width)
Specify starting width <0> : 5
Specify ending width <5> :right-click
Specify next point or [Arc/Close/Halfwidth/Length/Undo/
  Width]: 160,250
Specify next point or [prompts]: h (Halfwidth)
Specify starting half-width <2.5> : 1
Specify ending half-width <1> :right-click
Specify next point or [prompts]: 260,250
Specify next point or [prompts]: 260,180
Specify next point or [prompts]: w (Width)
Specify starting width <1> : 10
Specify ending width <10> :right-click
Specify next point or [prompts]: 260,120
Specify next point or [prompts]: h (Halfwidth)
Specify starting half-width <5> : 2
Specify ending half-width <2> :right-click
Specify next point or [prompts]: 160,120
Specify next point or [prompts]: w (Width)
Specify starting width <4> : 20
Specify ending width <20> :right-click
Specify next point or [prompts]: 40,120
Specify starting width <20> : 5
Specify ending width <5> :right-click
Specify next point or [prompts]: c (Close)
Command:
```

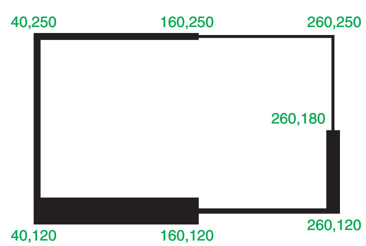

Fig. 2.24 Second example – **Polyline** tool

Third example – Polyline tool (Fig. 2.25)

Left-click the **Polyline** tool icon. The command line shows:

```
Command:_pline Specify start point: 50,220
Current line width is 0
[prompts]: w (Width)
Specify starting width <0> : 0.5
Specify ending width <0.5> :right-click
Specify next point or [prompts]: 120,220
Specify next point or [prompts]: a (Arc)
Specify endpoint of arc or [prompts]: s (second pt)
Specify second point on arc: 150,200
Specify end point of arc: 180,220
Specify end point of arc or [prompts]: l (Line)
Specify next point or [prompts]: 250,220
Specify next point or [prompts]: 260,190
Specify next point or [prompts]: a (Arc)
Specify endpoint of arc or [prompts]: s (second pt)
Specify second point on arc: 240,170
Specify end point of arc: 250,160
Specify end point of arc or [prompts]: l (Line)
Specify next point or [prompts]: 250,150
Specify next point or [prompts]: 250,120
```

And so on until the outline Fig. 2.25 is completed.

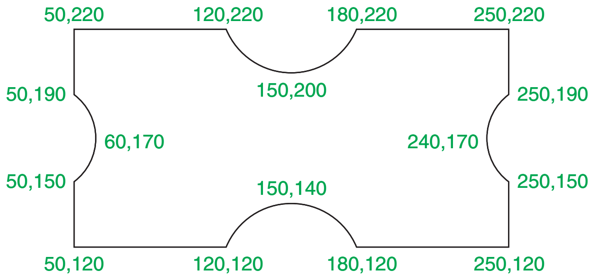

Fig. 2.25 Third example – **Polyline** tool

Fourth example – Polyline tool (Fig. 2.26)

Left-click the **Polyline** tool icon. The command line shows:

```
Command:_pline Specify start point: 80,170
Current line width is 0
Specify next point or [prompts]: w (Width)
Specify starting width <0> : 1
Specify ending width <1> :right-click
```

```
Specify next point or [prompts]: a (Arc)
Specify endpoint of arc or [prompts]: s (second pt)
Specify second point on arc: 160,250
Specify end point of arc: 240,170
Specify end point of arc or [prompts]: c (Close)
Command:
```

And the circle Fig. 2.26 is formed.

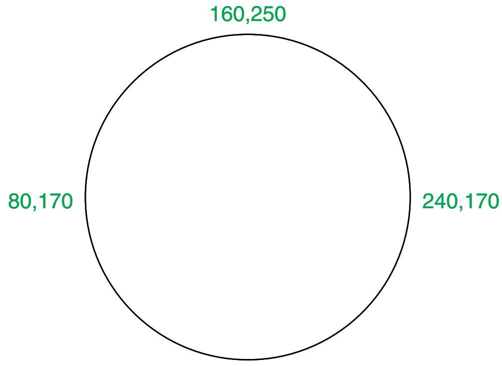

Fig. 2.26 Fourth example – **Polyline** tool

Fifth example – Polyline tool (Fig. 2.27)

Left-click the **Polyline** tool icon. The command line shows:

```
Command:_pline Specify start point: 60,180
Current line width is 0
Specify next point or [prompts]: w (Width)
Specify starting width <0> : 1
Specify ending width <1> :right-click
Specify next point or [prompts]: 190,180
Specify next point or [prompts]: w (Width)
Specify starting width <1> : 20
Specify ending width <20> : 0
Specify next point or [prompts]: 265,180
Specify next point or [prompts]:right-click
Command:
```

And the arrow Fig. 2.27 is formed.

Fig. 2.27 Fifth example – **Polyline** tool

REVISION NOTES

1. The following terms have been used in this chapter:

   Left-click – press the left-hand button of the mouse.
   Click – same meaning as *left-click*.
   Double-click – press the left-hand button of the mouse twice.
   Right-click – press the left-hand button of the mouse – has the same result as pressing the **Return** key of the keyboard.
   Drag – move the cursor on to an object and, holding down the right-hand button of the mouse, pull the object to a new position.
   Enter **–** type the letters or numbers which follow at the keyboard.
   Pick **–** move the cursor on to an item on screen and press the *left-hand* button of the mouse.
   Return – press the ***Enter*** key of the keyboard. This key may also marked with a left facing arrow. In most cases (but not always) has the same result as a *right-click*.
   Dialog – a window appearing in the AutoCAD window in which settings may be made.
   Drop-down menu – a menu appearing when one of the names in the menu bars is *clicked*.
   Tooltip – the name of a tool appearing when the cursor is placed over a tool icon from a toolbar.
   Prompts – text appearing in the command window when a tool is selected which advise the operator as to which operation is required.

2. Three methods of coordinate entry have been used in this chapter:

   Absolute method – the coordinates of points on an outline are *entered* at the command line in response to prompts.
   Relative method – the distances in coordinate units are *entered* preceded by **@** from the last point which has been determined on an outline. Angles, which are measured in a counter-clockwise direction, are preceded by $<$.
   Tracking – the rubber band of the tool is *dragged* in the direction in which the line is to be drawn and its distance in units is *entered* at the command line followed by a *right-click*.
   Line and Polyline tools – an outline drawn using the **Line** tool consists of a number of objects – the number of lines in the outline. An outline drawn using the **Polyline** is a single object.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/978-1-85617-868-6

1. Using the **Line** tool construct the rectangle Fig. 2.28.

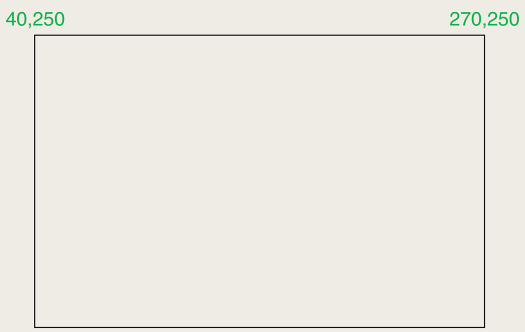

Fig. 2.28 Exercise 1

2. Construct the outline Fig. 2.29 using the **Line** tool. The coordinate points of each corner of the rectangle will need to be calculated from the lengths of the lines between the corners.

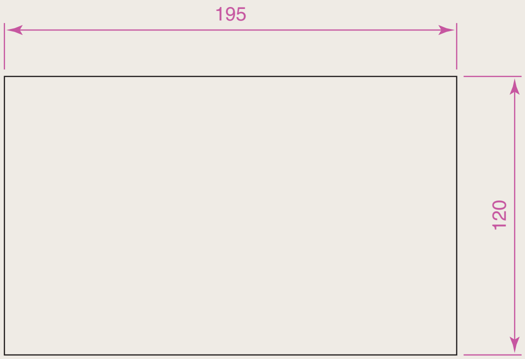

Fig. 2.29 Exercise 2

3. Using the **Line** tool, construct the outline Fig. 2.30.

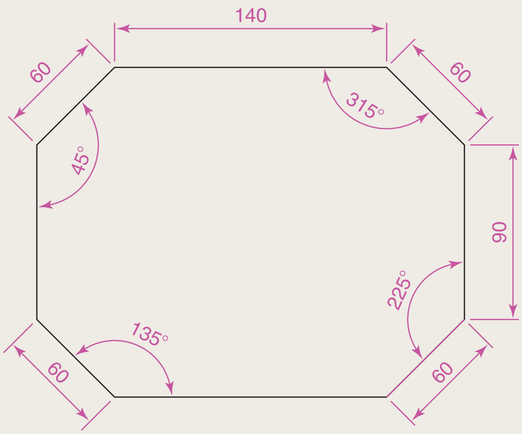

Fig. 2.30 Exercise 3

4. Using the **Circle** tool, construct the two circles of radius 50 and 30. Then using the **Ttr** prompt add the circle of radius 25 (Fig. 2 31).

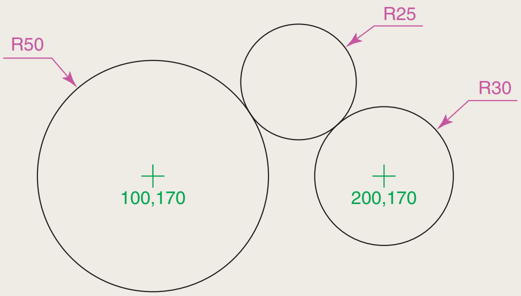

Fig. 2.31 Exercise 4

5. In an **acadiso.dwt** screen and using the **Circle** and **line** tools, construct the line and circle of radius **40** shown in Fig. 2 32. The, using the **Ttr** prompt, add the circle of radius **25**.

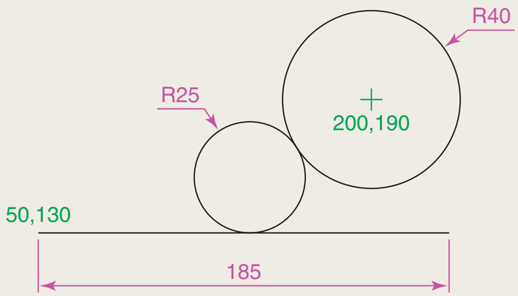

Fig. 2.32 Exercise 5

6. Using the **Line** tool construct the two lines at the length and angle as given in Fig. 2.33. Then with the **Ttr** prompt of the **Circle** tool, add the circle as shown.

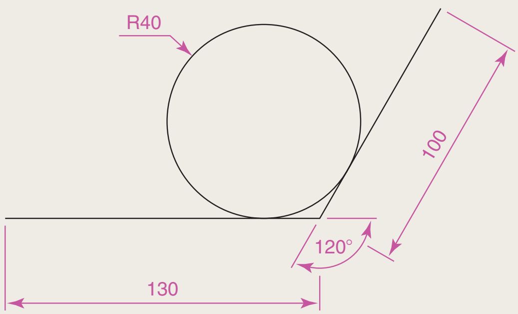

Fig. 2.33 Exercise 6

7. Using the **Polyline** tool, construct the outline given in Fig. 2.34.

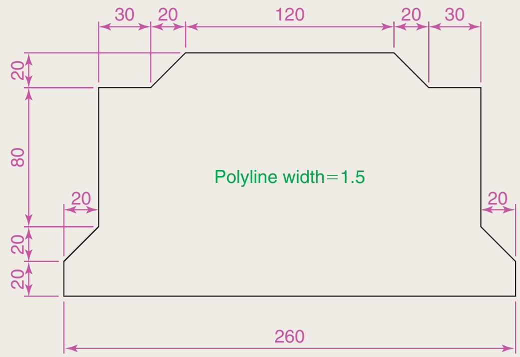

Fig. 2.34 Exercise 7

8. Construct the outline shown in Fig. 2.35.

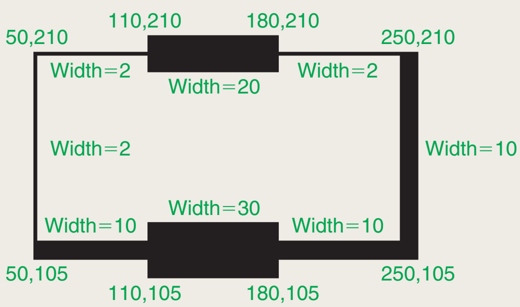

Fig. 2.35 Exercise 8

9. With the **Polyline** tool construct the arrows shown in Fig. 2.36.

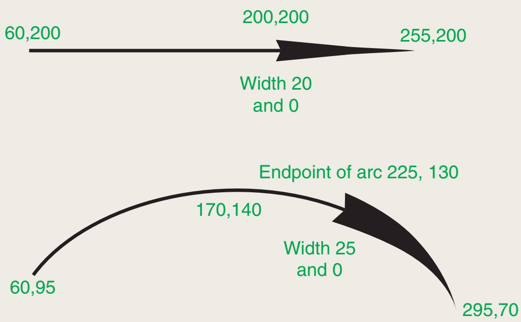

Fig. 2.36 Exercise 9

Chapter 3

Draw tools, Object Snap and Dynamic Input

AIMS OF THIS CHAPTER

The aims of this chapter are:

1. To give examples of the use of the **Arc**, **Ellipse**, **Polygon**, **Rectangle** tools from the **Home/Draw** panel.
2. To give examples of the uses of the **Polyline Edit** (pedit) tool.
3. To introduce the **Object Snaps** (osnap) and their uses.
4. To introduce the **Dynamic Input** (**DYN**) system and its uses.

Introduction

The majority of tools in AutoCAD 2010 can be called into use by any one of the following five methods:

1. By *clicking* on the tool's icon in the appropriate panel. Fig. 3.1 shows the **Polygon** tool called from the **Home/Draw** panel.

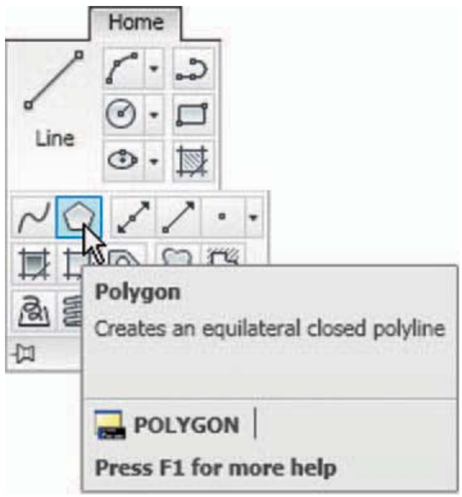

Fig. 3.1 The **Polygon** tool and its tooltip selected from the **Home/Draw** Panel

2. When working in the **Classic AutoCAD** screen, with a *click* on the tool's name in a toolbar. Fig. 3.2 shows the **Draw** toolbar. Placing the cursor on the **Polygon** tool icon in this toolbar shows the same tooltip as that shown in Fig. 3.2.

Fig. 3.2 The tool icons in the **Draw** toolbar

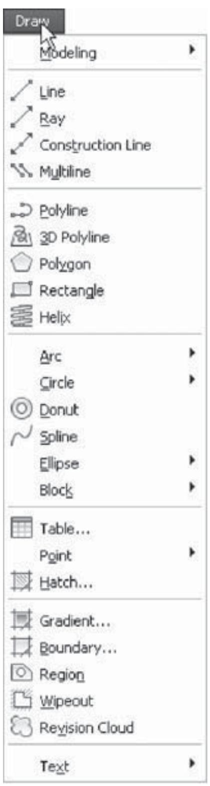

Fig. 3.3 The **Draw** drop-down menu

3. By *clicking* on the tool's name in an appropriate drop-down menu. Fig. 3.3 shows the tool names and icons displayed in the **Draw** drop-down menu. It is necessary to first bring the menu bar to screen with a *click* on **Show Menu Bar** in the *left-click* menu of the **Quick Access** toolbar (Fig. 3.4) if the menu bar is not already on screen.

4. By *entering* an abbreviation for the tool name at the command line in the command palette. For example the abbreviation for the **Line** tool is **l**, for the **Polyline** tool it is **pl** and for the **Circle** tool it is **c**.

5. By *entering* the full name of the tool at the command line.
6. By making use of the **Dynamic Input** method of constructing drawings (see page 60).

In practice operators constructing drawings in AutoCAD 2010 may well use a combination of these six methods.

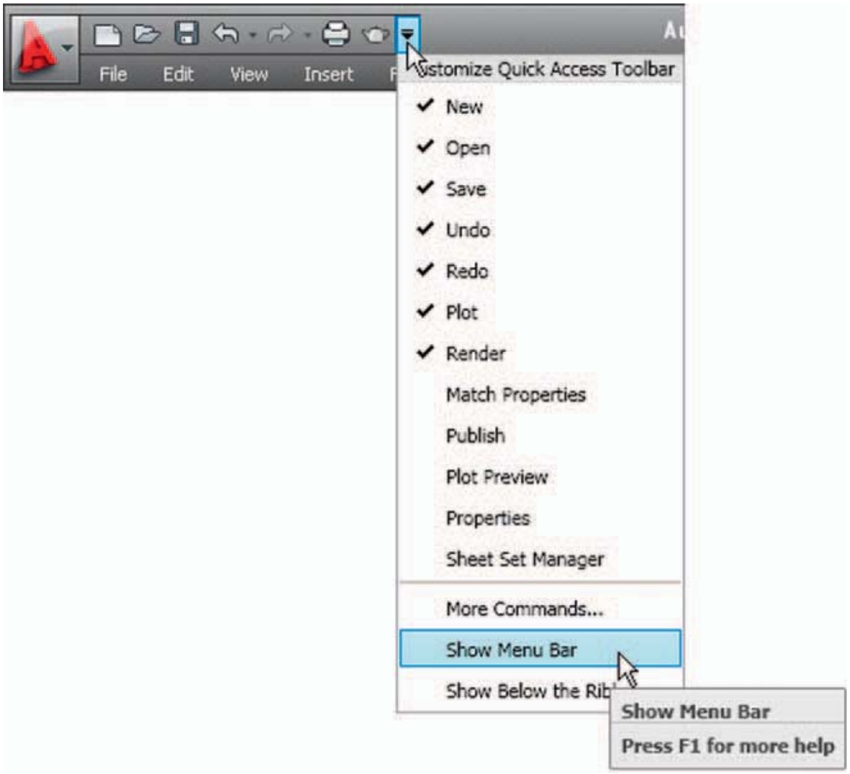

Fig. 3.4 Selecting **Show Menu Bar** from the *left-click* menu in the **Quick Access** Toolbar

The Arc tool

In AutoCAD 2010, arcs can be constructed using any three of the following characteristics of an arc: its **Start** point; a point on the arc (**Second** point); its **Center**; its **End**; its **Radius**; the **Length** of the arc; the **Direction** in which the arc is to be constructed; the **Angle** between lines of the arc.

These characteristics are shown in the menu appearing with a *click* on the **Arc** tool in the **Home/Draw** panel (Fig. 3.5).

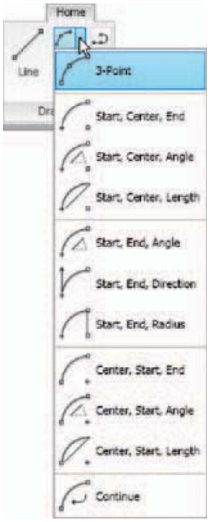

Fig. 3.5 The **Arc** tool flyout in the **Home/Draw** panel

To call the **Arc** tool *click* on the flyout of its tool icon in the **Home/Draw** panel, *click* on **Arc** in the **Draw** toolbar, *click* on **Arc** in the **Draw** drop-down menu, or *enter* **a** or **arc** at the command line. In the following examples initials of command prompts will be shown instead of selections from the menu shown in Fig. 3.6.

First example – Arc tool (Fig. 3.6)

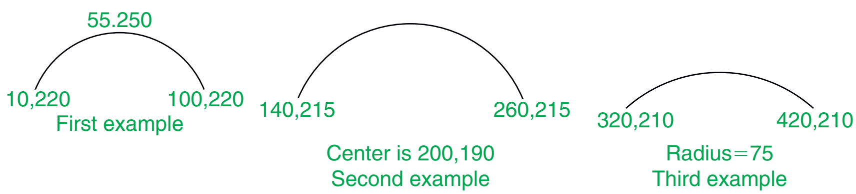

Fig. 3.6 Examples – **Arc** tool

```
Left-click the Arc tool icon. The command line
  shows:
Command:_arc Specify start point of arc or
  [Center]: 100,220
Specify second point of arc or [Center/End]: 55,250
Specify end point of arc: 10,220
Command:
```

Second example – Arc tool (Fig. 3.6)

```
Command:right-click brings back the Arc sequence
ARC Specify start point of arc or [Center]: c
  (Center)
Specify center point of arc: 200,190
Specify start point of arc: 260,215
Specify end point of arc or [Angle/chord Length]:
  140,215
Command:
```

Third example – Arc tool (Fig. 3.6)

```
Command:right-click brings back the Arc sequence
ARC Specify start point of arc or [Center]:
  420,210
```

```
Specify second point of arc or [Center/End]: e
  (End)
Specify end point of arc: 320,210
Specify center point of arc or
  [Angle/Direction/Radius]: r (Radius)
Specify radius of arc: 75
Command:
```


The Ellipse tool

Ellipses can be regarded as what is seen when a circle is viewed from directly in front of the circle and the circle is rotated through an angle about its horizontal diameter. Ellipses are measured in terms of two axes – a **major axis** and a **minor axis**, the major axis being the diameter of the circle, the minor axis being the height of the ellipse after the circle has been rotated through an angle (Fig. 3.7).

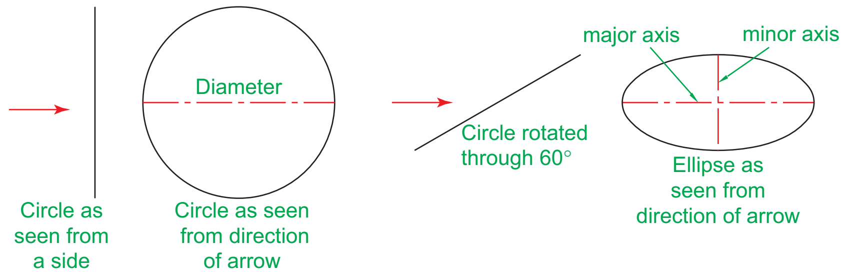

Fig. 3.7 An ellipse can be regarded as viewing a rotated circle

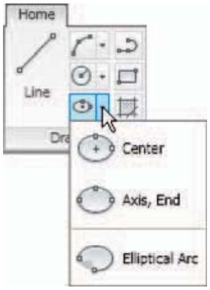

Fig. 3.8 The **Ellipse** tool icon flyout in the **Home/Draw** panel

To call the **Ellipse** tool, *click* on its tool icon in the **Home/Draw** panel (Fig. 3.8), *click* its name in the **Draw** drop-down menu, *click* on its tool icon in the **Draw** toolbar or *enter* **a** or **arc** at the command line.

First example – Ellipse (Fig. 3.9)

Left-click the **Ellipse** tool icon. The command line shows:

```
Command:_ellipse
```

```
Specify axis endpoint of elliptical arc or [Arc/
  Center]: 30,190
Specify other endpoint of axis: 150,190
Specify distance to other axis or [Rotation] 25
Command:
```

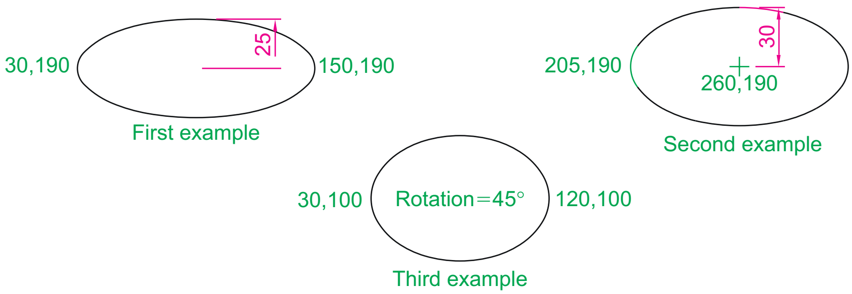

Fig. 3.9 Examples – **Ellipse**

Second example – Ellipse (Fig. 3.9)

In this second example, the coordinates of the centre of the ellipse (the point where the two axes intersect) are *entered*, followed by *entering* coordinates for the end of the major axis, followed by *entering* the units for the end of the minor axis.

```
Command: right-click
ELLIPSE
Specify axis endpoint of elliptical arc or [Arc/
  Center]: c
Specify center of ellipse: 260,190
Specify endpoint of axis: 205,190
Specify distance to other axis or [Rotation]: 30
Command:
```

Third example – Ellipse (Fig. 3.9)

In this third example, after setting the positions of the ends of the major axis, the angle of rotation of the circle from which an ellipse can be obtained is *entered*.

```
Command: right-click
ELLIPSE
Specify axis endpoint of elliptical arc or [Arc/
  Center]: 30,100
```

```
Specify other endpoint of axis: 120,100
Specify distance to other axis or [Rotation]: r
  (Rotation)
Specify rotation around major axis: 45
Command:
```

Saving drawings

Before going further it is as well to know how to save the drawings constructed when answering examples and exercises in this book. When a drawing has been constructed, *left-click* on **Save As** in the menu appearing with a *left-click* on the AutoCAD icon at the top right-hand corner of the menu (Fig. 3.10). The **Save Drawing As** dialog appears (Fig. 3.11).

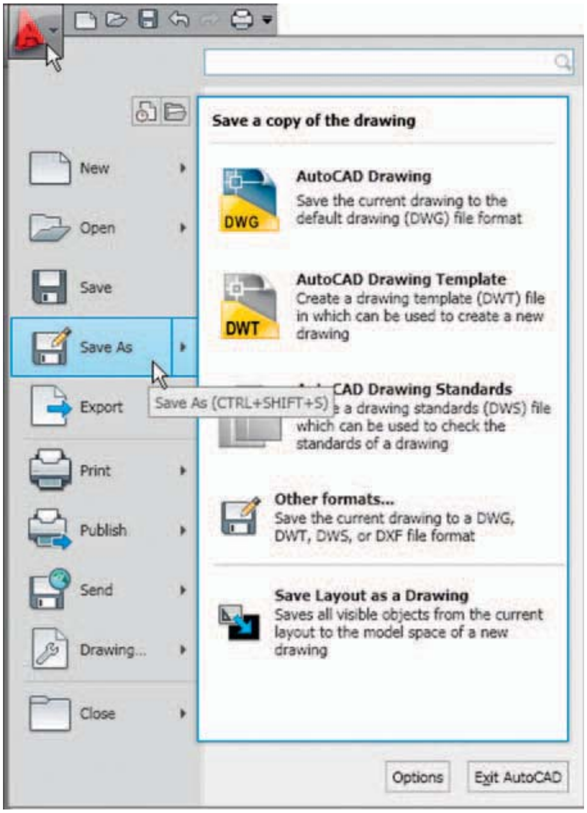

Fig. 3.10 Selecting **Save As** from the **Quick Access** menu

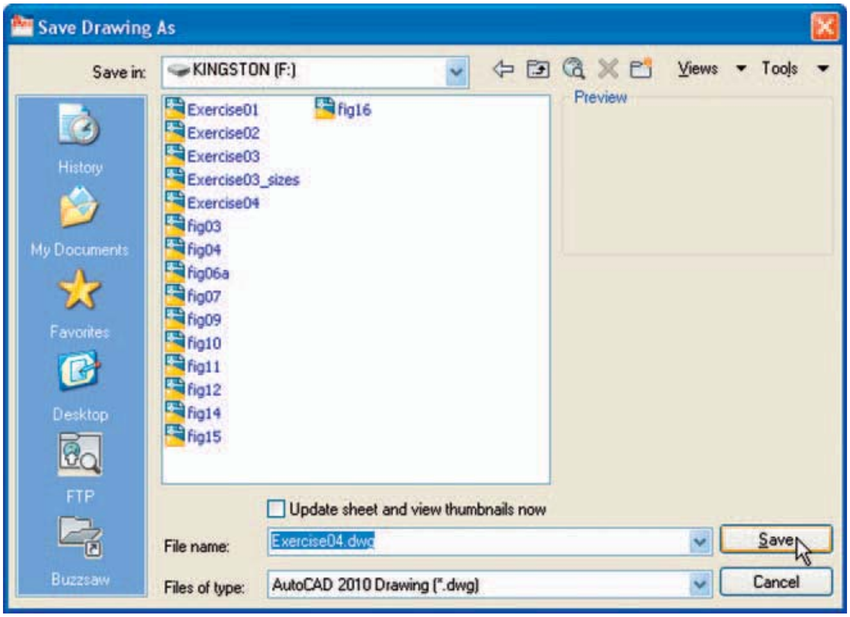

Fig. 3.11 The **Save Drawing As** dialog

Unless you are the only person to use the computer on which the drawing has been constructed, it is best to save work to a USB memory stick or other form of temporary saving device. To save a drawing to a USB memory stick:

1. Place a memory stick in a **USB** drive.
2. In the **Save in:** field of the dialog, *click* the arrow to the right of the field and from the popup list select **KINGSTON [F:]** (the name of my **USB** drive and stick).
3. In the **File name:** field of the dialog, type a name. The file name extension **.dwg** does not need to be typed – it will be added to the file name.
4. *Left-click* the **Save** button of the dialog. The drawing will be saved with the file name extension **.dwg** – the AutoCAD file name extension.

Snap

In previous chapters several methods of constructing accurate drawings have been described – using **Snap**; absolute coordinate entry; relative coordinate entry and tracking. Other methods of ensuring accuracy between parts of constructions are by making use of **Object Snaps** (**Osnaps**).

Snap Mode, **Grid Display** and **Object Snaps** can be toggled on/off from the buttons in the status bar or by pressing the keys **F9** (**Snap Mode**), **F7** (**Grid Display**) and **F3** (**Object Snap**).

Object Snaps (Osnaps)

Object Snaps allow objects to be added to a drawing at precise positions in relation to other objects already on screen. With Object Snaps, objects can be added to the end points, mid points, to intersections of objects, to centres and quadrants of circles and so on. Object Snaps also override snap points even when snap is set on.

To set **Object Snaps** – at the command line:

Command: *enter* os

And the **Drafting Settings** dialog appears (Fig. 3.12). *Click* the **Object Snap** tab in the upper part of the dialog and *click* the check boxes to the right of the Object Snap names to set them on (or off in on).

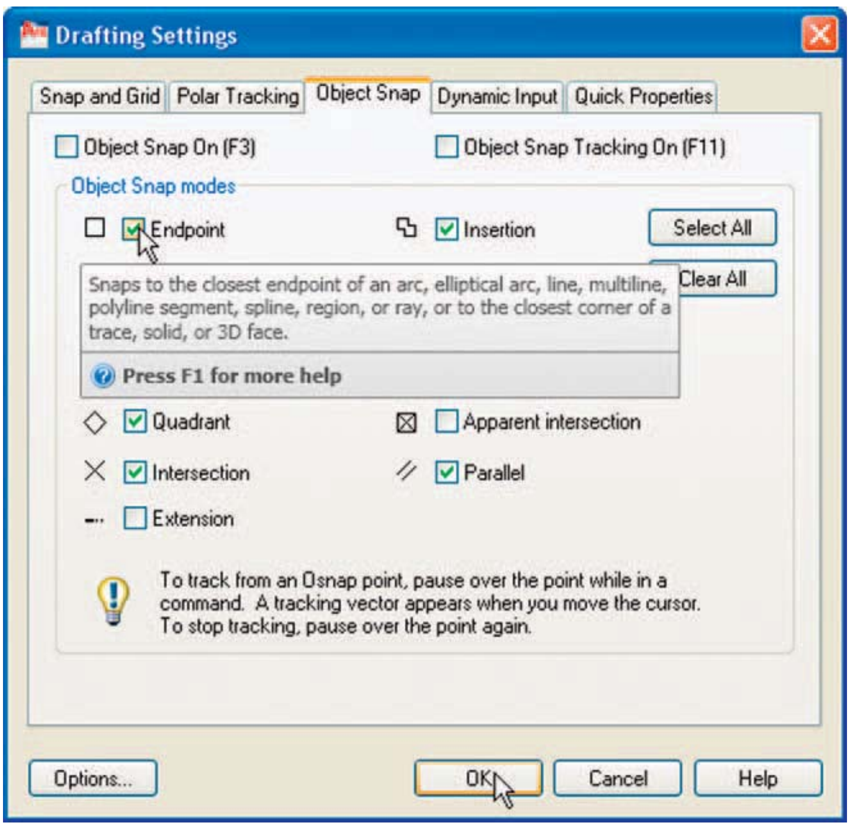

Fig. 3.12 The **Drafting Settings** dialog with some of the **Object Snaps** set on

When Object Snaps are set **ON**, as outlines are constructed using Object Snaps so Object Snap icons and their tooltips appear as indicated in Fig. 3.13.

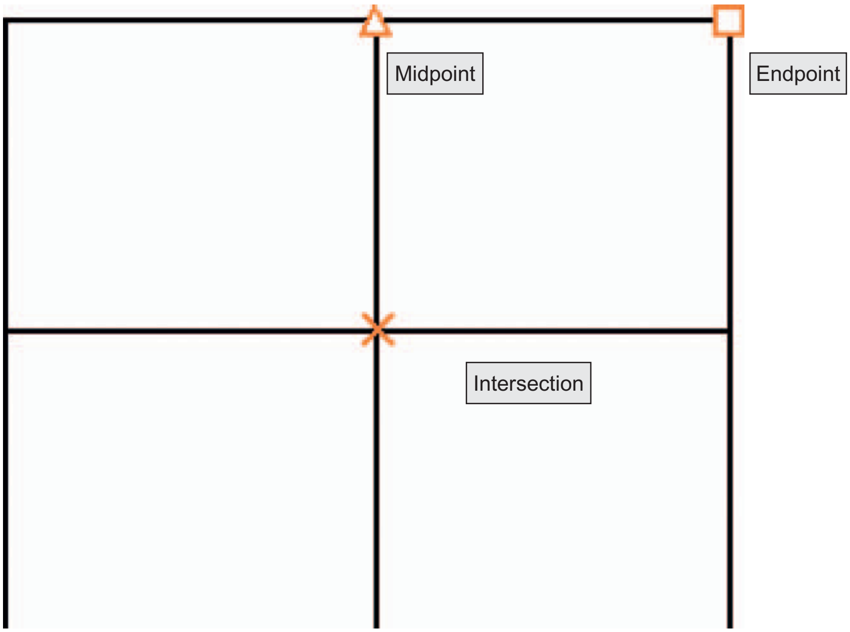

Fig. 3.13 Three **Object Snap** icons and their tooltips

First example – Object Snap (Fig. 3.14)

Call the **Polyline** tool:

```
Command:_pline
Specify start point: 50,230
[prompts]: w (Width)
Specify starting width: 1
Specify ending width <1> :right-click
Specify next point: 260,230
Specify next point:right-click
Command:right-click
PLINE
Specify start point: pick the right-hand end of
  the pline
Specify next point: 50,120
Specify next point:right-click
Command:right-click
PLINE
```

```
Specify start point: pick near the middle of first
  pline
Specify next point: 155,120
Specify next point:right-click
Command:right-click
PLINE
Specify start point: pick the plines at their
  intersection
Specify start point:right-click
Command:
```

The result is shown in Fig. 3.14. In this illustration the Object Snap tooltips are shown as they appear when each object is added to the outline.

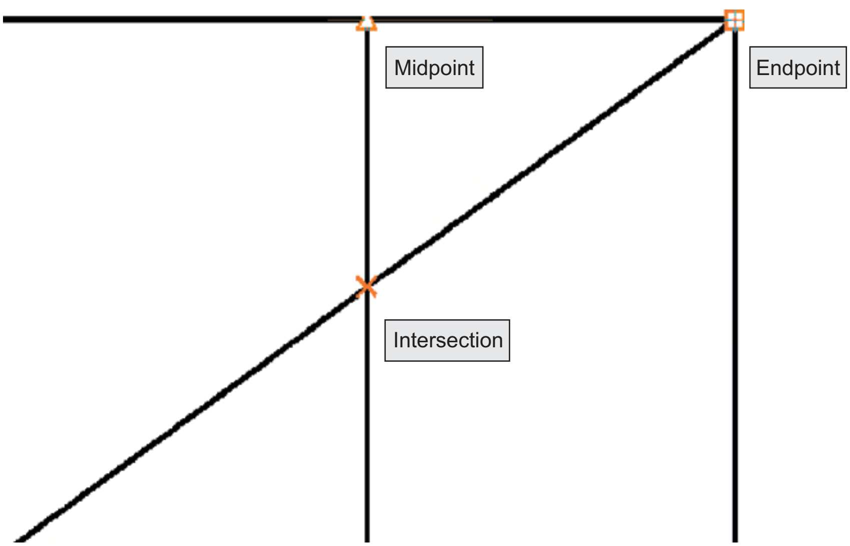

Fig. 3.14 First example – **Osnaps**

It is sometimes advisable not to have **Object Snaps** set on in the **Drafting Settings** dialog, but to set **Object Snap** off and use Object Snap abbreviations at the command line when using tools. The following example shows the use of some of these abbreviations.

Second example – Object Snap abbreviations (Fig. 3.15)

Call the **Circle** tool:

```
Command:_circle
Specify center point for circle: 180,170
```

```
Specify radius of circle: 60
Command: enter l (Line) right-click
Specify first point:enter qua right-click
of pick near the upper quadrant of the circle
Specify next point:enter cen right-click
of pick near the centre of the circle
Specify next point:enter qua right-click
of pick near right-hand side of circle
Specify next point:right-click
Command:
```

Note

With Object Snaps off, the following abbreviations can be used:

end – endpoint;
mid – midpoint;
int – intersection;
cen – centre;
qua – quadrant;
nea – nearest;
ext – extension.

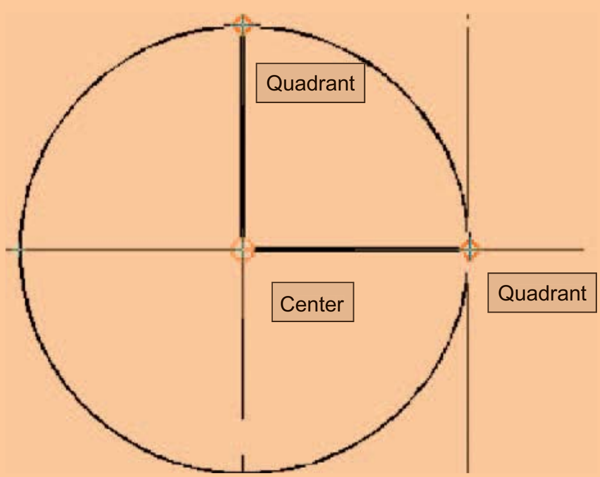

Fig. 3.15 Second example – **Osnaps**

Dynamic Input (DYN)

When **Dynamic Input** is set on by either pressing the **F12** key or with a *click* on the **Dynamic Input** button in the status bar, dimensions, coordinate positions and commands appear as tips when no tool is in action (Fig. 3.16).

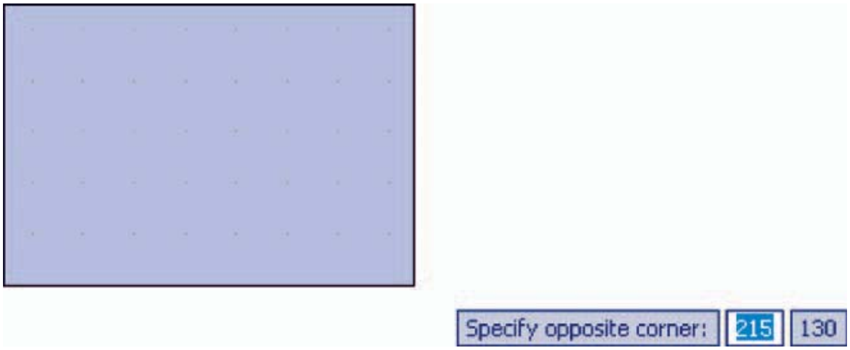

Fig. 3.16 The **DYN** tips appearing when no tool is in action and the cursor is moved

With a tool in action, as the cursor hairs are moved in response to movement of the mouse, **Dynamic Input** tips showing the coordinate figures for the point of the cursor hairs will show (Fig. 3.17), together with other details. To see the drop-down menu giving the prompts available with **Dynamic Input** press the **down** key of the keyboard and *click* the prompt to be used. Fig. 3.17 shows the **Arc** prompt as being the next to be used.

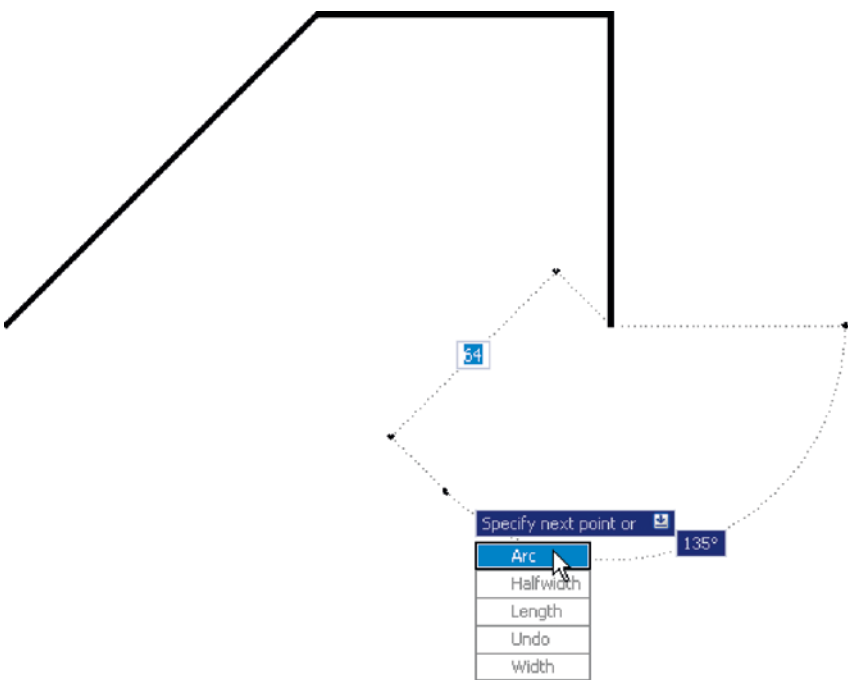

Fig. 3.17 Coordinate tips when **DYN** is in action

Notes on the use of dynamic input

Although **Dynamic Input** can be used in any of the AutoCAD 2010 workspaces, some operators may prefer a larger working area. To achieve this a *click* on the **Clean Screen** icon in the bottom right-hand corner of the AutoCAD 2010 window produces an uncluttered workspace area. The command palette can be cleared from screen by *entering* **commandlinehide** at the command line. To bring it back press the keys **Ctrl + 9**. These two operations produce a screen showing only title and status bars (Fig. 3.18). Some operators may well prefer working in such a larger-than-normal workspace.

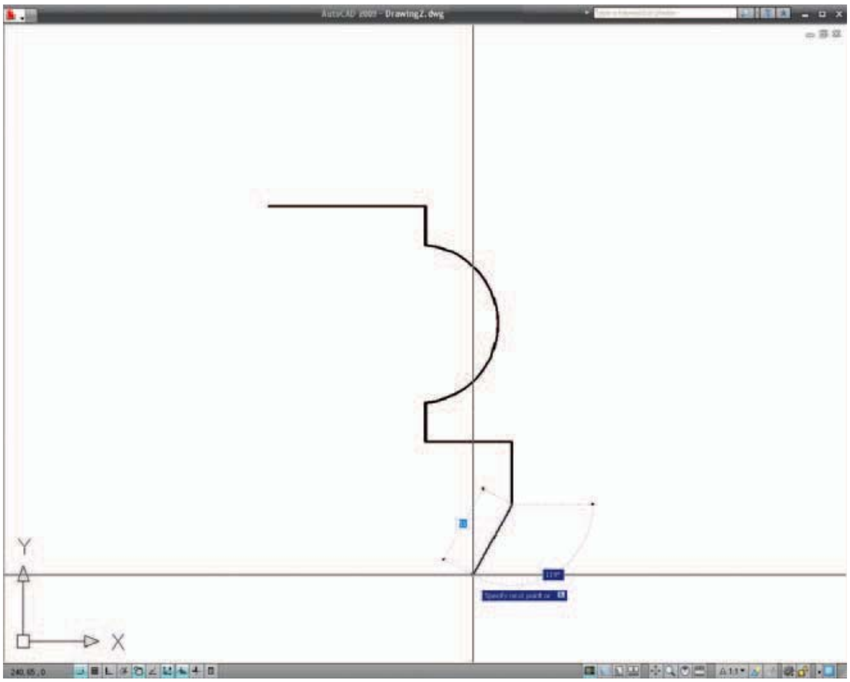

Fig. 3.18 Example of using **DYN** in a clear screen

Dynamic Input settings are made in the **Drafting Settings** dialog (Fig. 3.19), brought to screen by *entering* **ds** at the command line.

When **Dynamic Input** is in action, tools can be called by using any of the following methods:

1. By *entering* the name of the tool at the command line.
2. By *entering* the abbreviation for a tool name at the command line.
3. By selecting the tool's icon from a toolbar.

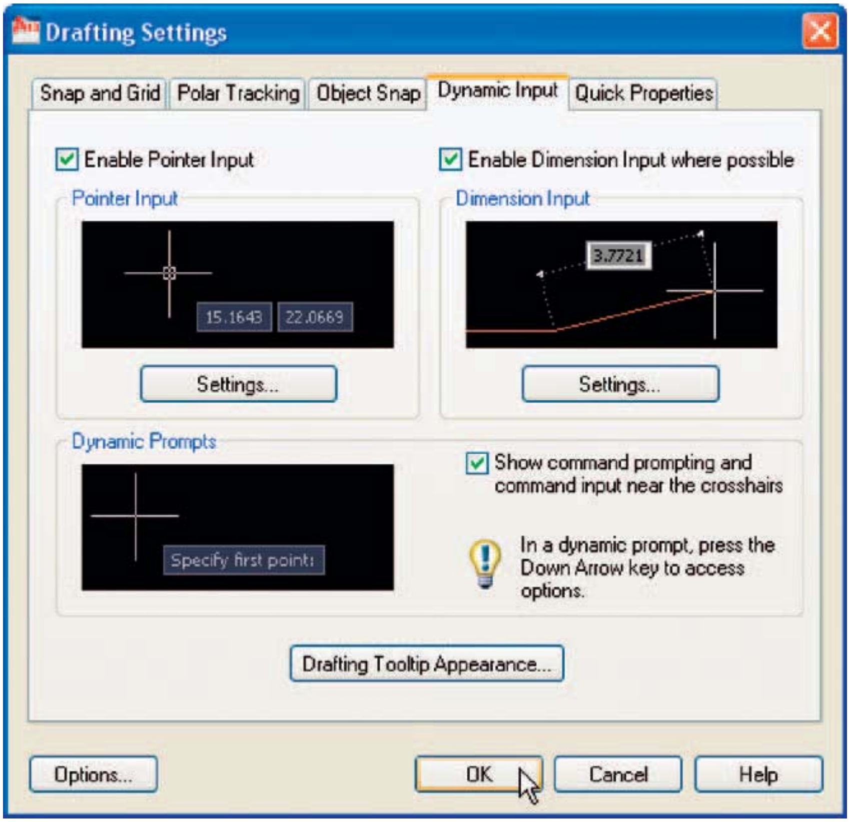

Fig. 3.19 Settings for **DYN** can be made in the **Drafting Settings** dialog

4. By selecting the tool's icon from a panel.
5. By selecting the tool's name from a drop-down menu.

When **Dynamic Input** is active and a tool is called, command prompts appear in a tooltip at the cursor position. Fig. 3.20 shows the tooltip appearing at the cursor position when the **Line** tool icon in the **Home/ Draw** panel is *clicked*.

Fig. 3.20 The prompt appearing on screen when the **Line** tool is selected

To commence drawing a line, either move the cursor under mouse control to the desired coordinate point and *left-click* as in Fig. 3.21, or *enter* the required *x,y* coordinates at the keyboard (Fig. 3.22) and *left-click*. To continue drawing with **Line** *drag* the cursor to a new position and either *left-click* at the position when the coordinates appear as required (Fig. 3.22), or *enter* a required length at the keyboard, which appears in the length box followed by a *left-click* (Fig. 3.23).

Fig. 3.21 *Drag* the cursor to the required point and *left-click*

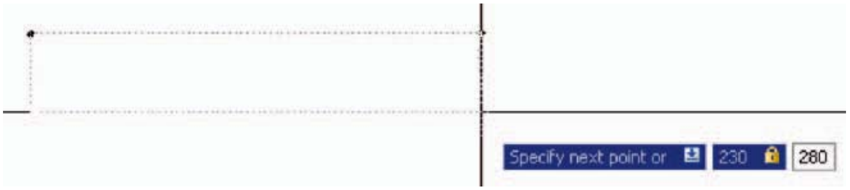

Fig. 3.22 *Enter* coordinates for the next point and *left-click*

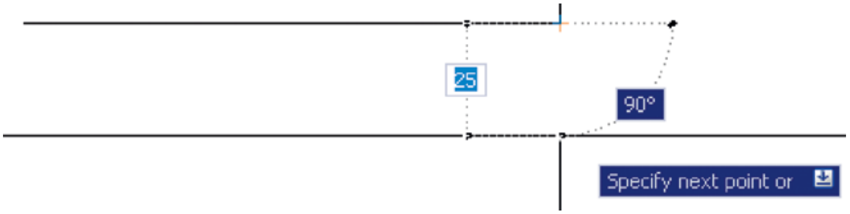

Fig. 3.23 *Enter* length at keyboard and *right-click*

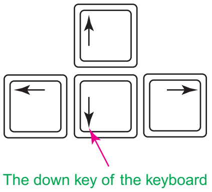

Fig. 3.24 The **down** key of the keyboard

Dynamic Input – first example – Polyline

When using **Dynamic Input** the selection of a prompt can be made by pressing the **down** key of the keyboard (Fig. 3.24) which causes a pop-up menu to appear. A *click* on the required prompt in such a pop-up menu will make that prompt active.

1. Select **Polyline** from the **Home/Draw** panel (Fig. 3.25).

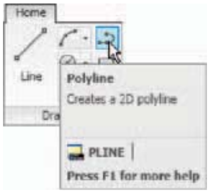

Fig. 3.25 Selecting **Polyline** from the **Home/Draw** panel

2. To start the construction *click* at any point on screen. The prompt for the polyline appears with the coordinates of the selected point showing. *Left-click* to start the drawing (Fig. 3.26).

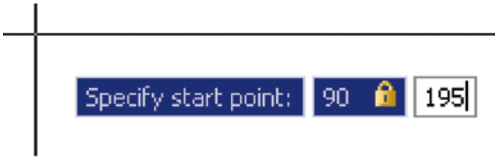

Fig. 3.26 **Dynamic Input –** first example – **Polyline –** the first prompt

3. Move the cursor and press the **down** key of the keyboard. A pop-up menu appears from which a prompt selection can be made. In the menu *click* **Width** (Fig. 3.27).

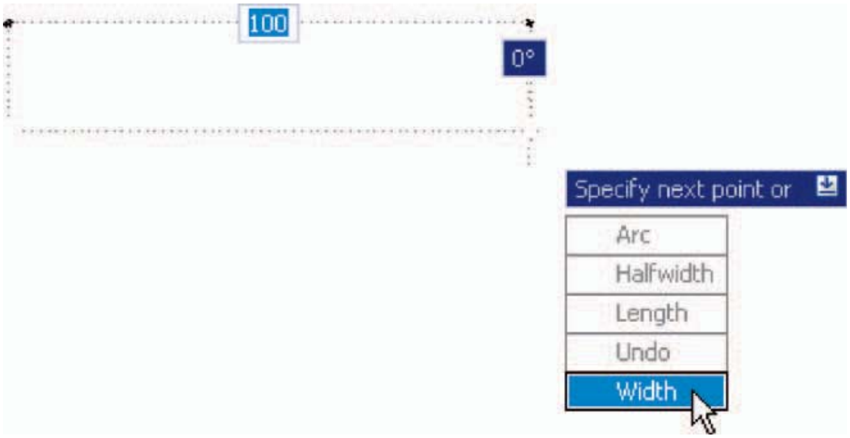

Fig. 3.27 **Dynamic Input –** first example – **Polyline –** *click* **Width** in the pop-up menu

4. Another prompt field appears. At the keyboard *enter* the required width and *right-click*. Then *left-click* and *enter* **ending width** or *right-click* if the **ending width** is the same as the **starting width** (Fig. 3.28).

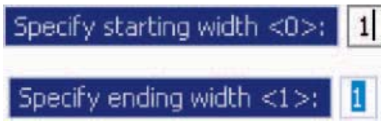

Fig. 3.28 **Dynamic Input –** first example – **Polyline –** *entering* widths

5. *Drag* the cursor to the right until the dimension shows the required horizontal length and *left-click* (Fig. 3.29).

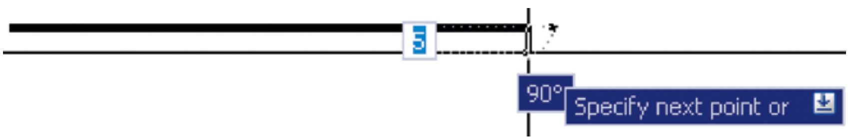

Fig. 3.29 **Dynamic Input –** first example – **Polyline –** the horizontal length

6. *Drag* the cursor down until the vertical distance shows and *left-click* (Fig. 3.30).

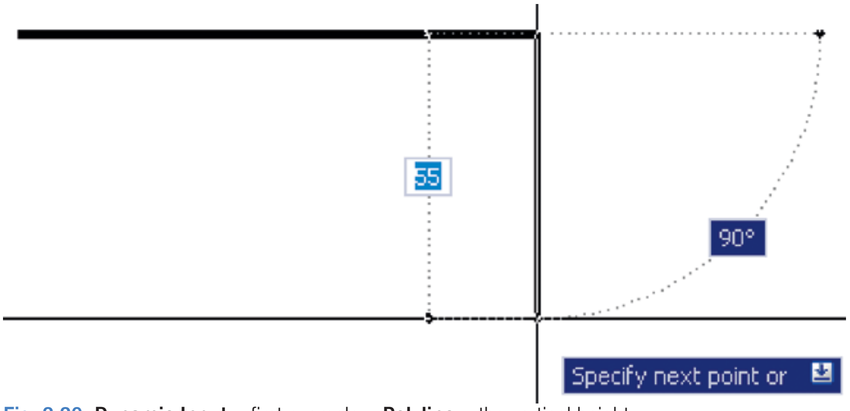

Fig. 3.30 **Dynamic Input –** first example – **Polyline –** the vertical height

7. *Drag* the cursor to the left until the required horizontal distance is showing and *right-click* (Fig. 3.31).

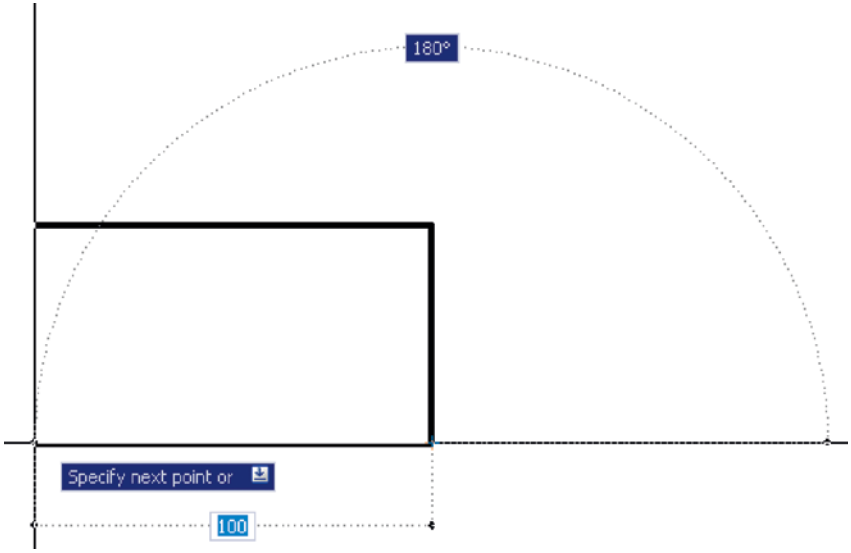

Fig. 3.31 **Dynamic Input –** first example – **Polyline –** the horizontal distance

8. Press the **down** key of the keyboard and *click* **Close** in the menu (Fig. 3.32). The rectangle completes.

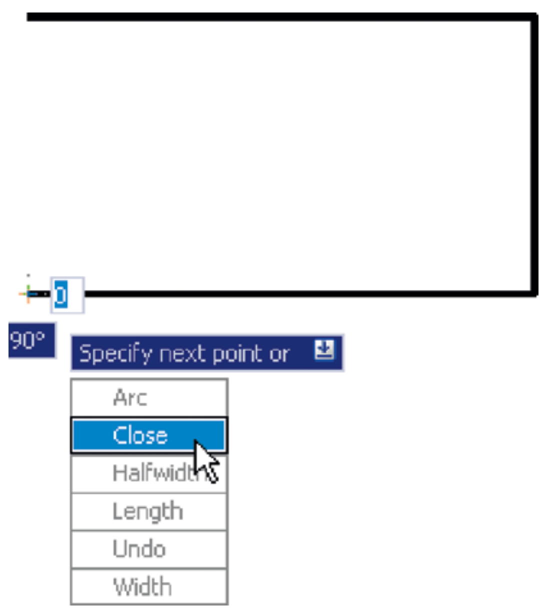

Fig. 3.32 **Dynamic Input –** first example – **Polyline –** selecting **Close** from the pop-up menu

Fig. 3.33 shows the completed drawing.

Fig. 3.33 **Dynamic Input** – first example – **Polyline**

Dynamic Input – second example – Zoom

1. *Click* the **Zoom** icon in the status bar. The first **Zoom** prompt appears (Fig. 3.34).

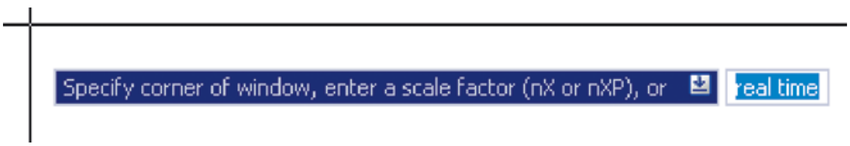

Fig. 3.34 **Dynamic Input –** second example – **Zoom –** *click* the **Zoom** icon.

The prompts then appear.

2. *Right-click* and press the **down** button of the keyboard. The pop-up list Fig. 3.35 appears from which a **Zoom** prompt can be selected.

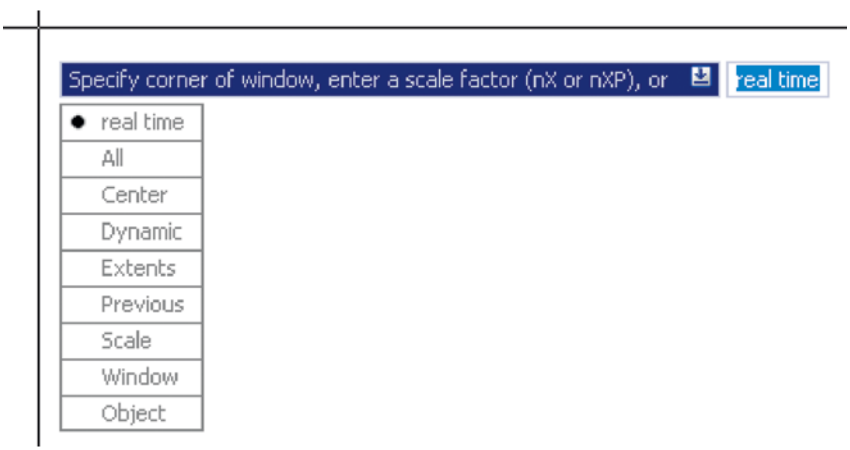

Fig. 3.35 **Dynamic Input** – second example – **Zoom** – the pop-up menu appearing with a *right-click* and pressing the **down** keyboard button

3. Carry on using the **Zoom** tool as described in Chapter 4.

Dynamic Input – third example – dimensioning

When using **DYN**, tools can equally well be selected from a toolbar. Fig. 3.36 shows the **Linear** tool from the **Home/Annotation** panel selected when dimensioning a drawing.

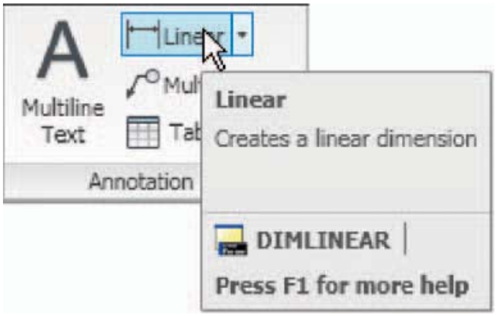

Fig. 3.36 Selecting **Linear** from the **Home/Annotation** panel

A prompt appears asking for the first point. Move the cursor to the second point, another prompt appears (Fig. 3.37). Press the **down** button of the keyboard and the pop-up list (Fig. 3.37) appears from which a selection can be made.

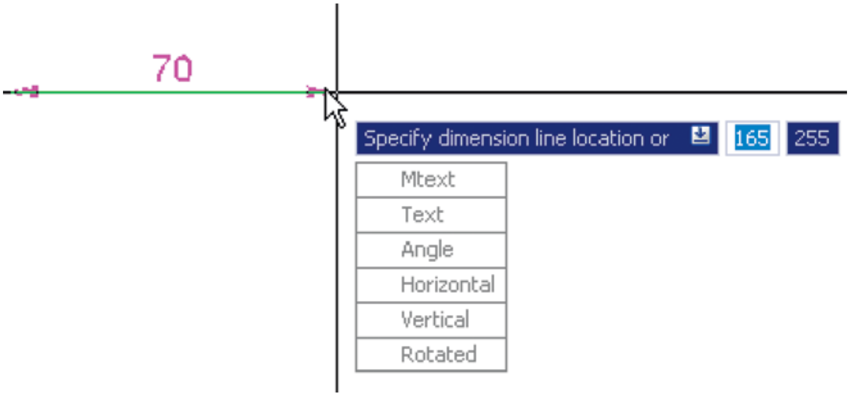

Fig. 3.37 **Dynamic Input** – third example – **dimensioning** – the pop-up menu associated with **Linear** dimensioning

Dynamic Input using 3D tools

The **Dynamic Input** method of constructing 2D drawings can equally well be used when constructing 3D solid model drawings (See Chapter 12 onwards).

Why use Dynamic Input?

Some operators may prefer constructing drawings without having to make entries at the command line in response to tool prompts. By using **DYN**, drawings, whether in 2D or in 3D format, can be constructed purely from operating and moving the mouse, *entering* coordinates at the command line and pressing the down key of the keyboard when necessary.

Examples of using other Draw tools

Polygon tool (Fig. 3.38)

1. Call the **Polygon** tool – either with a *click* on its tool icon in the **Home/Draw** panel (Fig. 3.1, page 50), from the **Draw** drop-down menu, from the **Draw** toolbar or by *entering* **pol** or **polygon** at the command line. No matter how the tool is called, the command line shows:

```
Command:_polygon Enter number of sides <4> : 6
Specify center of polygon or [Edge]: 60,210
Enter an option [Inscribed in circle/Circumscribed
  about circle] <I> :right-click(accept
  Inscribed)
Specify radius of circle: 60
Command:
```

2. In the same manner construct a **5**-sided polygon of centre **200,210** and of radius **60**.
3. Then, construct an **8**-sided polygon of centre **330,210** and radius **60**.
4. Repeat to construct a **9**-sided polygon circumscribed about a circle of radius **60** and centre **60,80**.
5. Construct yet another polygon with **10** sides of radius **60** and of centre **200,80**.
6. Finally another polygon circumscribing a circle of radius **60**, of centre **330,80** and sides **12**.

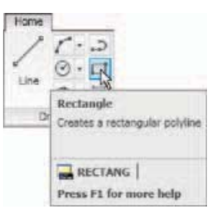

Fig. 3.39 The **Rectangle** tool from the **Home/Draw** panel

The result is shown in Fig. 3.38.

Rectangle tool – first example (Fig. 3.40)

Call the **Rectangle** tool – either with a *click* on its tool icon in the **Home/Draw** panel (Fig. 3.39) or by *entering* **rec** or **rectangle** at the command line. The tool can be also called from the **Draw** drop-down menu or **Draw** toolbar. The command line shows:

```
Command:_rectang
Specify first corner point or [Chamfer/Elevation/
  Fillet/Thickness/Width]: 25,240
Specify other corner point or [Area/Dimensions/
  Rotation]: 160,160
Command:
```

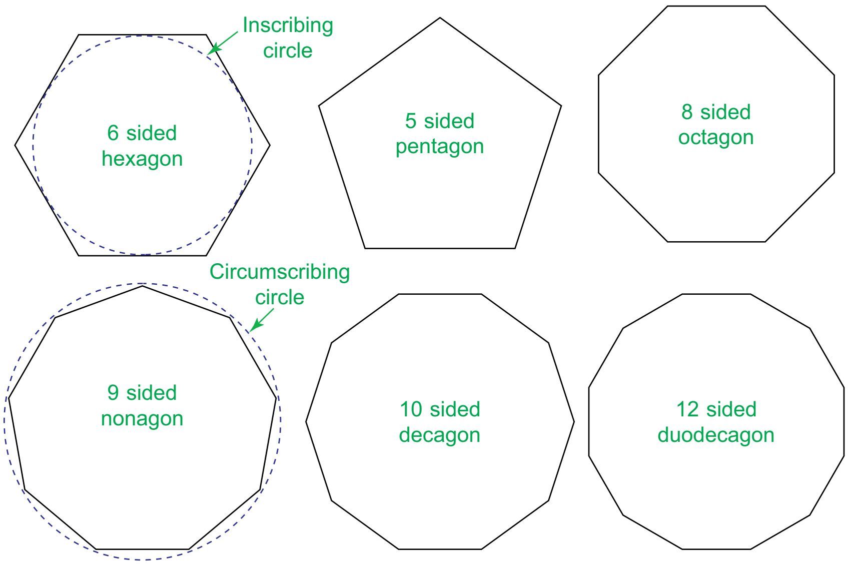

Fig. 3.38 First example – **Polygon** tool

Rectangle tool – second example (Fig. 3.40)

```
Command:_rectang
[prompts]: c (Chamfer)
Specify first chamfer distance for rectangles
  <0> : 15
Specify first chamfer distance for rectangles
  <15> :right-click
Specify first corner point: 200,240
Specify other corner point: 300,160
Command:
```

Rectangle tool – third example (Fig. 3.40)

```
Command: _rectang
Specify first corner point or [Chamfer/Elevation/
  Fillet/Thickness/Width]: f (Fillet)
Specify fillet radius for rectangles <0> : 15
```

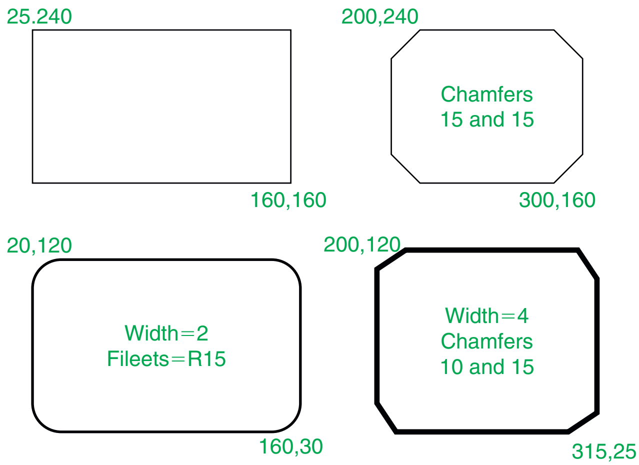

Fig. 3.40 Examples – **Rectangle** tool

```
Specify first corner point or [Chamfer/Elevation/
  Fillet/Thickness/Width]: w (Width)
Specify line width for rectangles <0> : 1
Specify first corner point or [Chamfer/Elevation/
  Fillet/Thickness/Width]: 20,120
Specify other corner point or [Area/Dimensions/
  Rotation]: 160,30
Command:
```

Rectangle – fourth example (Fig. 3.40)

```
Command:_rectang
Specify first corner point or [Chamfer/Elevation/
  Fillet/Thickness/Width]: w (Width)
Specify line width for rectangles <0> : 4
Specify first corner point or [Chamfer/Elevation/
  Fillet/Thickness/Width]: c (Chamfer)
Specify first chamfer distance for rectangles
  <0> : 15
Specify second chamfer distance for rectangles
  <15> :right-click
Specify first corner point: 200,120
Specify other corner point: 315,25
Command:
```

The Polyline Edit tool

The **Polyline Edit** tool is a valuable tool for the editing of polylines.

Examples – Polyline Edit (Fig 3.43)

1. With the **Polyline** tool construct the outlines **1** to **6** of Fig. 3.41.

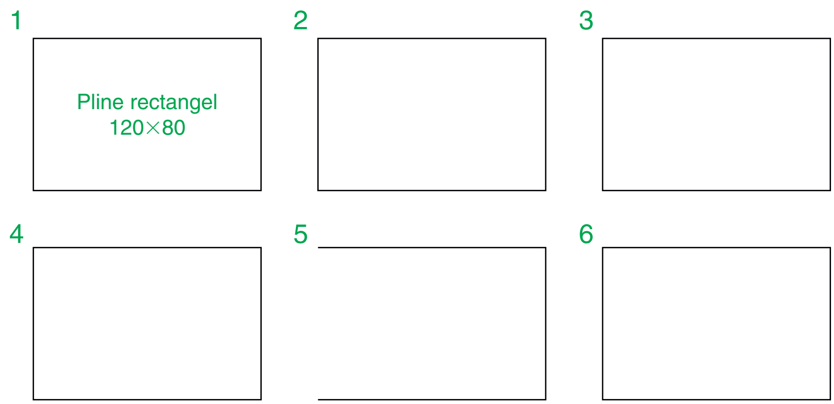

Fig. 3.41 Examples – **Edit Polyline –** the plines to be edited

2. Call the **Edit Polyline** tool either from the **Home/Modify** panel (Fig. 3.42) or from the **Modify** drop-down menu, or by *entering* **pe** or **pedit** at the command line, which then shows:

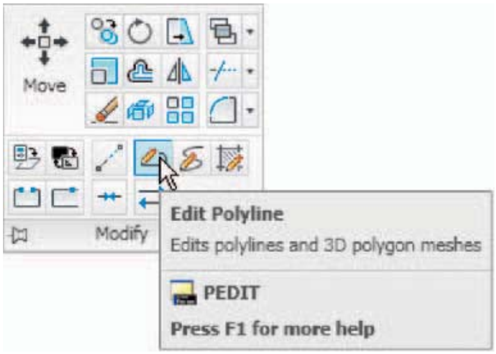

Fig. 3.42 Calling **Edit Polyline** from the **Home/Modify** panel

```
Command:enter pe
PEDIT Select polyline or [Multiple]: pick pline 2
Enter an option [Open/Join/Width/Edit vertex/
  Fit/Spline/Decurve/Ltype gen/Reverse/Undo]: w
  (Width)
Specify new width for all segments: 2
```

```
Enter an option [Open/Join/Width/
  Edit vertex/Fit/Spline/Decurve/Ltype
  gen/Reverse/Undo]:right-click
Command:
```

3. Repeat with pline **3** and pedit to Width = **10**.
4. Repeat with line **4** and *enter* **s** (Spline) in response to the prompt line:

```
Enter an option [Open/Join/Width/Edit vertex/Fit/
  Spline/Decurve/Ltype gen/Reverse/Undo]: enter s
```

5. Repeat with pline **5** and *enter* **j** in response to the prompt line:

```
Enter an option [Open/Join/Width/Edit vertex/Fit/
  Spline/Decurve/Ltype gen/Undo]: enter j
```

The result is shown in pline **6**.

The resulting examples are shown in Fig. 3.43.

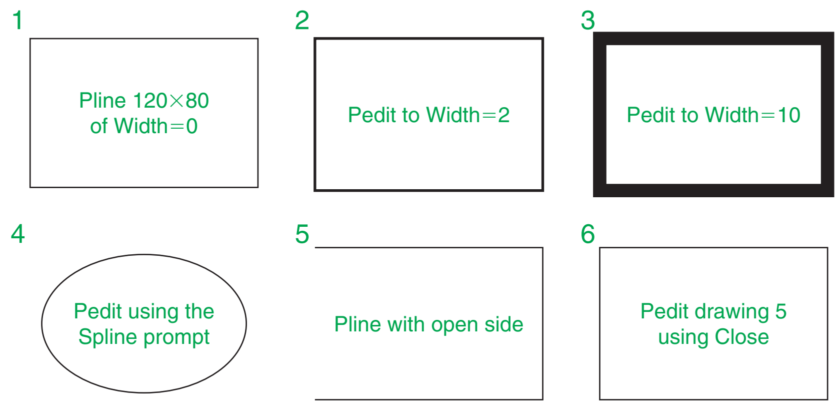

Fig. 3.43 Examples – **Polyline Edit**

Example – Multiple Polyline Edit (Fig. 3.44)

1. With the **Polyline** tool construct the left-hand outlines of Fig. 3.44.
2. Call the **Edit Polyline** tool. The command line shows:

```
Command:enter pe
PEDIT Select polyline or [Multiple]: m (Multiple)
Select objects:pick any one of the lines or arcs
  of the left-hand outlines of Fig. 6.16 1 found
Select objects:pick another line or arc 1 found 2
  total
```

Continue selecting lines and arcs as shown by the pick boxes of the left-hand drawing of Fig. 3.44 until the command line shows:

```
Select objects:pick another line or arc 1 found 24
  total
Select objects:right-click
[prompts]: w (Width)
Specify new width for all segments: 1.5
Convert Arcs, Lines and Splines to polylines [Yes/
  No]? <Y > :right-click
[prompts]:right-click
Command:
```

The result is shown in the right-hand drawing of Fig. 3.44.

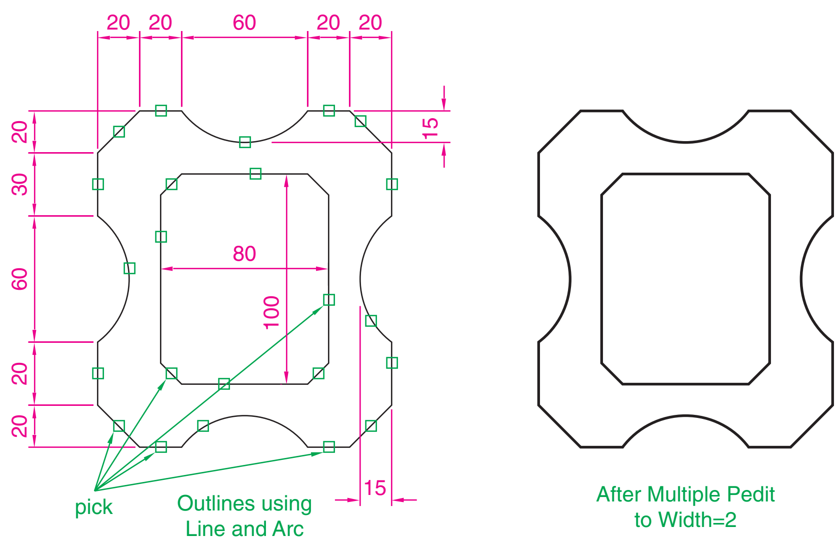

Fig. 3.44 Example – **Multiple Polyline Edit**

Transparent commands

When any tool is in operation it can be interrupted by prefixing the interrupting command with an apostrophe ('). This is particularly useful when wishing to zoom when constructing a drawing (see page 82). As an example when the **Line** tool is being used:

```
Command:_line
Specify first point: 100,120
Specify next point: 190,120
Specify next point:enter 'z (Zoom)
```

```
 > > Specify corner of window or [prompts]:pick
 > > > > Specify opposite corner:pick
Resuming line command.
Specify next point:
```

And so on. The transparent command method can be used with any tool.

The set variable PELLIPSE

Many of the operations performed in AutoCAD are carried out under settings of **set variables**. Some of the numerous set variables available in AutoCAD 2010 will be described in later pages. The variable **PELLIPSE** controls whether ellipses are drawn as splines or as polylines. It is set as follows:

```
Command:enter pellipse right-click
Enter new value for PELLIPSE <0 > :enter 1
  right-click
Command:
```

And now when ellipses are drawn they are plines. If the variable is set to **0**, the ellipses will be splines. The value of changing ellipses to plines is that they can then be edited using the **Polyline Edit** tool.

REVISION NOTES

The following terms have been used in this chapter:

Field – a part of a window or of a dialog in which numbers or letters are *entered* or which can be read.

Pop-up list – a list brought in-screen with a *click* on the arrow often found at the right-hand end of a field.

Object – a part of a drawing which can be treated as a single object. For example a line constructed with the **Line** tool is an object; a rectangle constructed with the **Polyline** tool is an object; an arc constructed with the **Arc** tool is an object. It will be seen in a later chapter (Chapter 9) that several objects can be formed into a single object.

Toolbar – a collection of tool icons all of which have similar functions. For example in the **Classic AutoCAD** workspace the **Draw** toolbar contains tool icons for those tools which are used for drawing and the **Modify** toolbar contains tool icons of those tools used for modifying parts of drawings.

Ribbon palettes – when working in either of the **2D Drafting and Annotation**, the **Classic AutoCAD** or the **3D Modeling** workspace, tool icons are held in panels in the **Ribbon**.

Command line – a line in the command palette which commences with the word **Command:**

REVISION NOTES (CONTINUED)

Snap Mode, **Grid Display** and **Object Snap** can be toggled with *clicks* on their respective buttons in the status bar. These functions can also be set with function keys – **Snap Mode – F9; Grid Display** – **F7**; **Object Snap** – **F3**.

Object Snaps ensure accurate positioning of objects in drawings.

Object Snap abbreviations can be used at the command line rather than setting **ON** in the **Drafting Settings** dialog.

Dynamic input allows constructions in any of the three AutoCAD 2010 workspaces or in a full-screen workspace, without having to use the command palette for *entering* the initials of command line prompts.

Notes on tools

There are two types of tooltip. When the cursor under mouse control is paced over a tool icon, the first (a smaller) tooltip is seen. If the cursor is held in position for a short time a second (larger tooltip) is seen.

Polygons constructed with the **Polygon** tool are regular polygons – the edges of the polygons are all the same length and the angles are of the same degrees.

Polygons constructed with the **Polygon** tool are plines, so can be changed by using the **Edit Polyline** tool.

The easiest method of calling the **Edit Polyline** tool is to *enter* **pe** at the command line.

The **Multiple** prompt of the **pedit** tool saves considerable time when editing a number of objects in a drawing.

Transparent commands can be used to interrupt tools in operation by preceding the interrupting tool name with an apostrophe (**'**).

Ellipses drawn when the variable **PELLIPSE** is set to **0** are splines, when **PELLIPSE** is set to **1**, ellipses are polylines. When ellipses are in polyline form they can be modified using the **pedit** tool.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/978-1-85617-868-6

1. Using the **Line and Arc** tools, construct the outline given in Fig. 3.45.

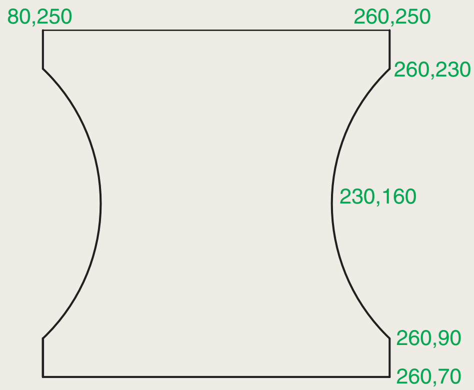

Fig. 3.45 Exercise 1

2. With the **Line** and **Arc** tools, construct the outline Fig. 3.46.

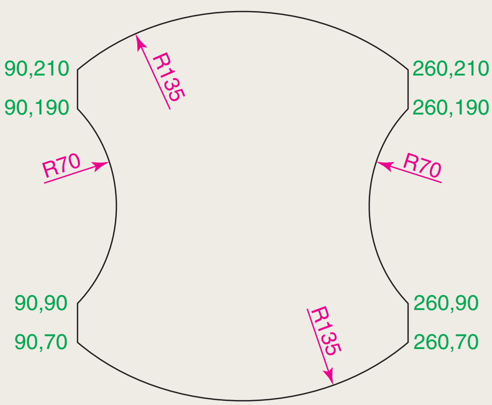

Fig. 3.46 Exercise 2

3. Using the **Ellipse** and **Arc** tools construct the drawing Fig. 3.47.

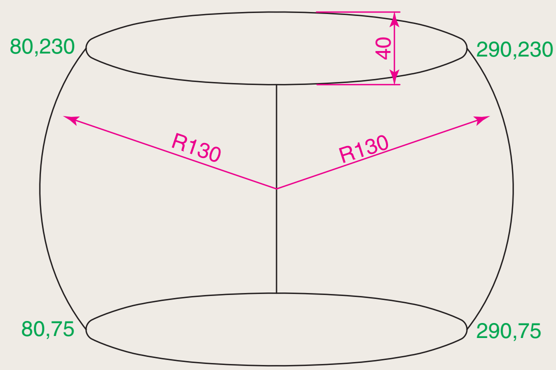

Fig. 3.47 Exercise 3

4. With the **Line**, **Circle** and **Ellipse** tools construct Fig. 3.48.

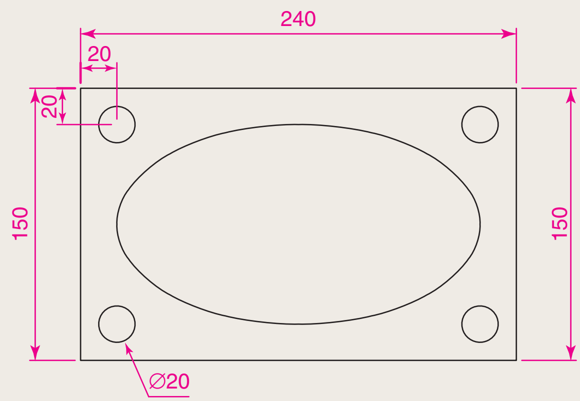

Fig. 3.48 Exercise 4

5. With the **Ellipse** tool, construct the drawing Fig. 3.49.

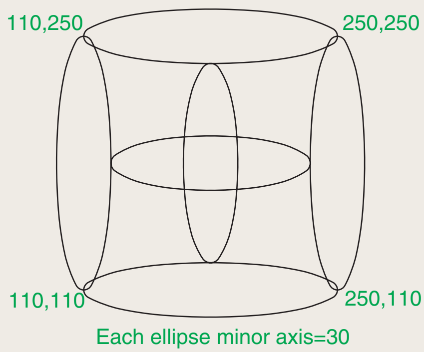

Fig. 3.49 Exercise 5

6. Fig. 3.50 shows a rectangle in the form of a square with hexagons along each edge. Using the **Dimensions** prompt of the **Rectangle** tool construct the square. Then, using the **Edge** prompt of the **Polygon** tool, add the four hexagons. Use the **Object Snap endpoint** to ensure the polygons are in their exact positions.

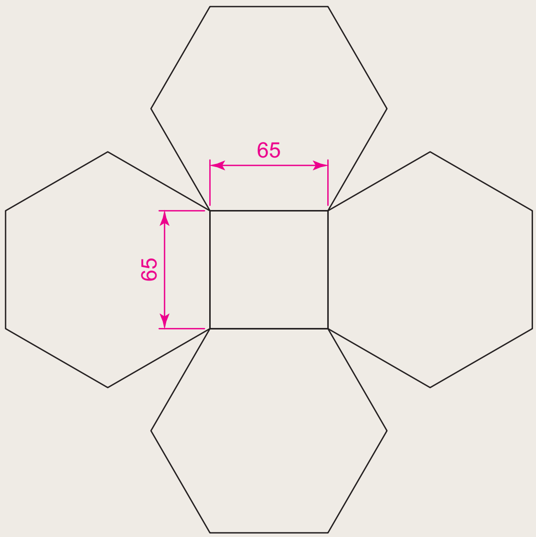

Fig. 3.50 Exercise 6

7. Fig. 3.51 shows seven hexagons with edges touching. Construct the inner hexagon using the **Polygon** tool, then with the aid of the **Edge** prompt of the tool, add the other six hexagons.

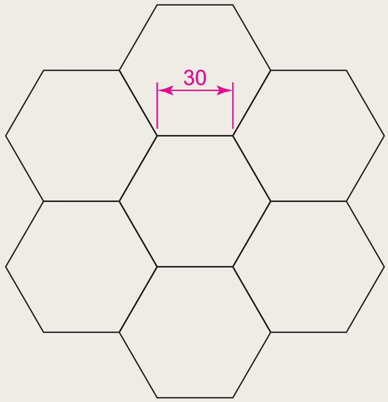

Fig. 3.51 Exercise 7

8. Fig. 3.52 was constructed using only the **Rectangle** tool. Make an exact copy of the drawing using only the **Rectangle** tool.

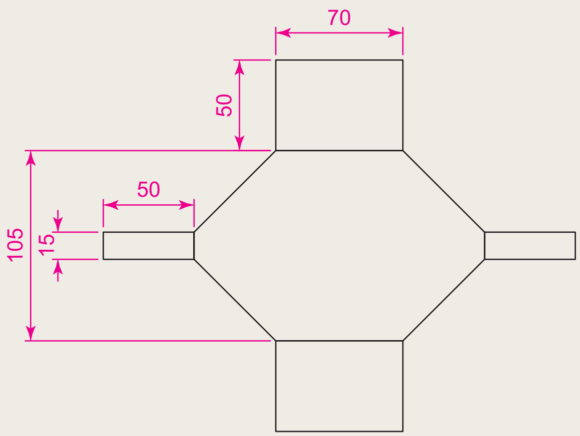

Fig. 3.52 Exercise 8

9. Construct the drawing Fig. 3.53 using the **Line** and **Arc** tools. Then, with the aid of the **Multiple** prompt of the **Edit Polyline** tool change the outlines into plines of **Width** = **1**.

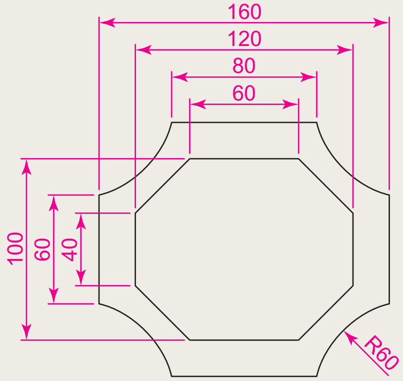

Fig. 3.53 Exercise 9

10. Construct Fig. 3.54 using the **Line** and **Arc** tools. Then change all widths of lines and arcs to a width of **2** with **Edit Polyline**.

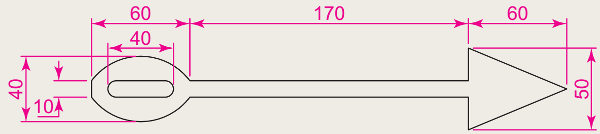

Fig. 3.54 Exercise 10

11. Construct Fig. 3.55 using the **Rectangle**, **Line** and **Edit Polyline** tools.

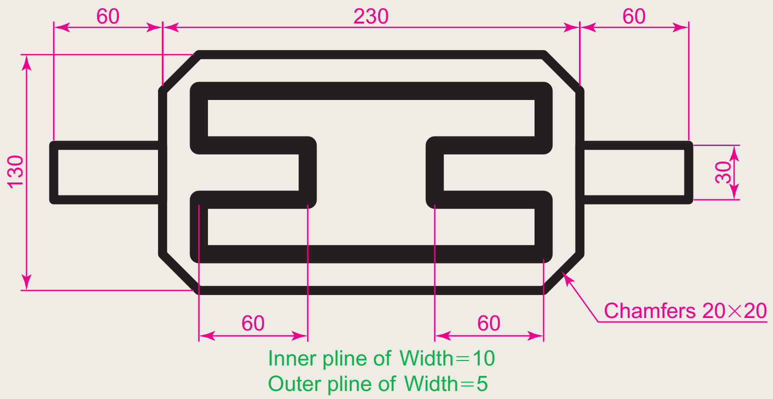

Fig. 3.55 Exercise 11

Chapter 4

Zoom, pan and templates

AIMS OF THIS CHAPTER

The aims of this chapter are:

1. To demonstrate the value of the **Zoom** tools.
2. To introduce the **Pan** tool.
3. To describe the value of using the **Aerial View** window in conjunction with the **Zoom** and **Pan** tools.
4. To update the **acadiso.dwt** template.
5. To describe the construction and saving of drawing templates.

Introduction

The use of the **Zoom** tools allows not only the close inspection of the most minute areas of a drawing in the AutoCAD 2010 drawing area, but allows the accurate construction of very small details in a drawing.

The **Zoom** tools can be called by *clicking* the **Zoom** button in the status bar (Fig. 4.1) or selecting from the **View/Zoom** drop down menu. However by far the easiest and quickest method of calling the Zoom is to *enter* **z** at the command line as follows:

```
Command: enter z right-click
ZOOM Specify corner of window, enter a scale factor
  (nX or nXP) or [All/Center/Dynamic/Extents/
  Previous/Scale/Window/Object] <real time >:
```

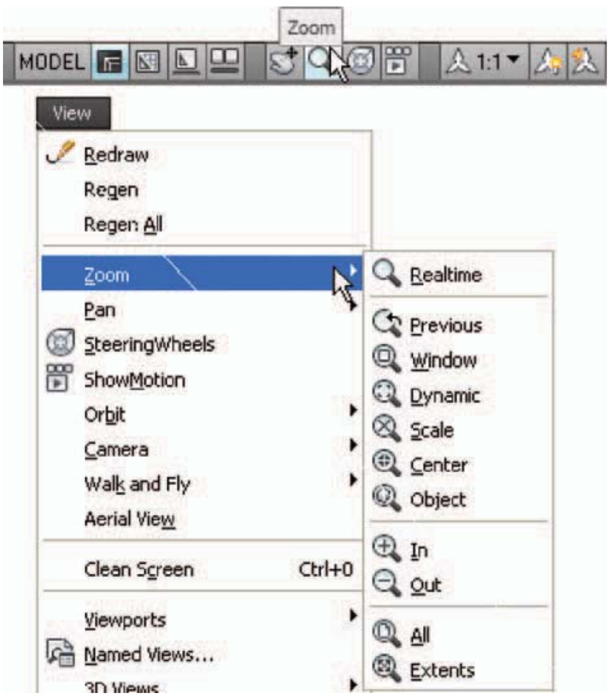

Fig. 4.1 Calling **Zoom –** by *clicking* the **Zoom** button in the status bar or from the **View** drop-down menu

This allows the different zooms:

Realtime – selects parts of a drawing within a window.
All – the screen reverts to the limits of the template.
Center – the drawing centres itself around a *picked* point.

Dynamic – a broken line surrounds the drawing which can be changed in size and repositioned to another part of the drawing.
Extents – the drawing fills the AutoCAD drawing area.
Previous – the screen reverts to its previous zoom.
Scale – entering a number or a decimal fraction scales the drawing.
Window – the parts of the drawing within a *picked* window appears on screen. The effect is the same as using **real time**.
Object – *pick* any object on screen and the object zooms.

The operator will probably be using **Realtime**, **Window** and **Previous** zooms most frequently.

Figures 4.2–4.4 show a drawing which has been constructed, a **Zoom Window** of part of the drawing allowing it to be checked for accuracy, and a **Zoom Extents** respectively.

It will be found that the **Zoom** tools are among those most frequently used when working in AutoCAD 2010.

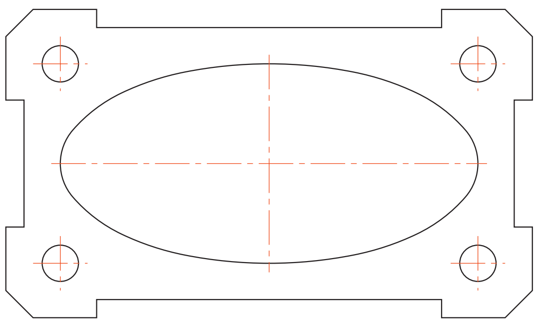

Fig. 4.2 Drawing to be acted upon by the **Zoom** tool

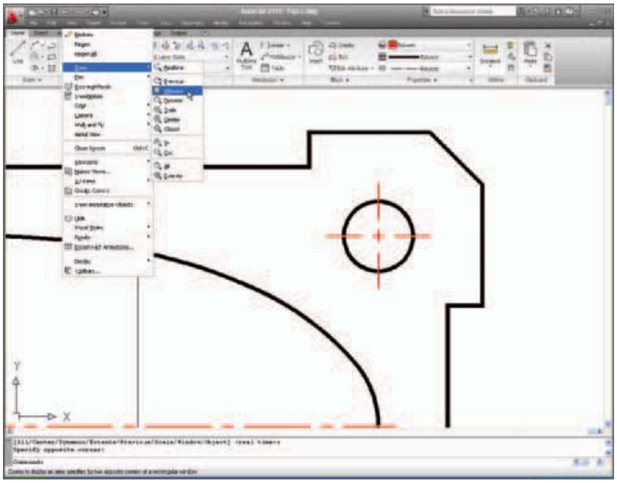

Fig. 4.3 A **Zoom Window** of part of the drawing Fig. 4.2

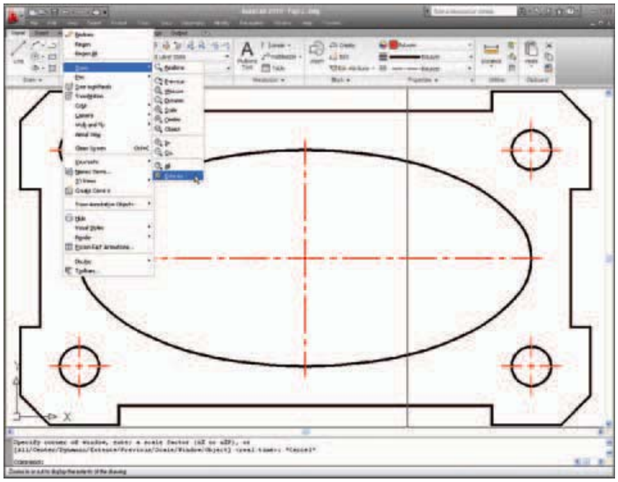

Fig. 4.4 A **Zoom Extents** of the drawing Fig. 4.2

The Aerial View window

Enter **dsviewer** at the command line and the **Aerial View** window appears – usually in the bottom right-hand corner of the AutoCAD 2010 window. The **Aerial View** window shows the whole of a drawing, even if larger than the limits. The **Aerial View** window is of value when dealing with large drawings – it allows that part of the window on screen to be shown in relation to the whole of the drawing. Fig. 4.5 is a three-view orthographic projection of a small bench vice.

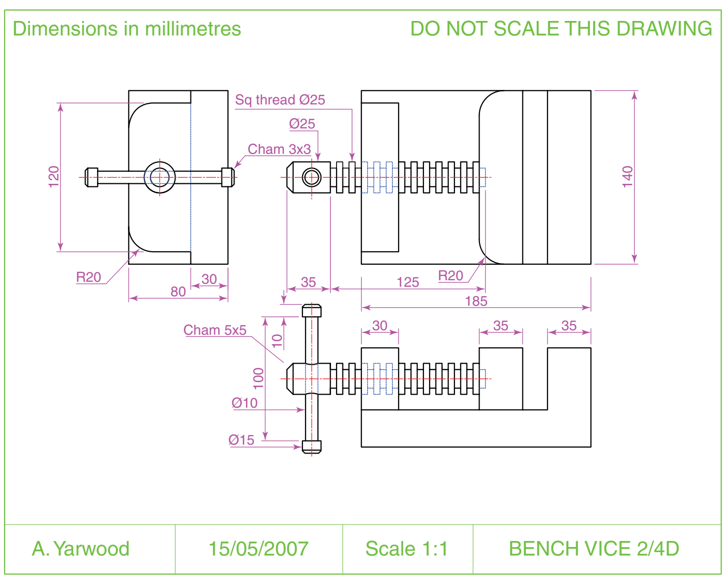

Fig. 4.5 The drawing used to illustrate Figures 4.6 and 4.7

Fig. 4.6 shows a **Zoom Window** of the drawing Fig. 4.5 including the **Aerial View Window**. The area of the drawing within the **Zoom Window** in the drawing area is bounded by a thick green line in the **Aerial View** window.

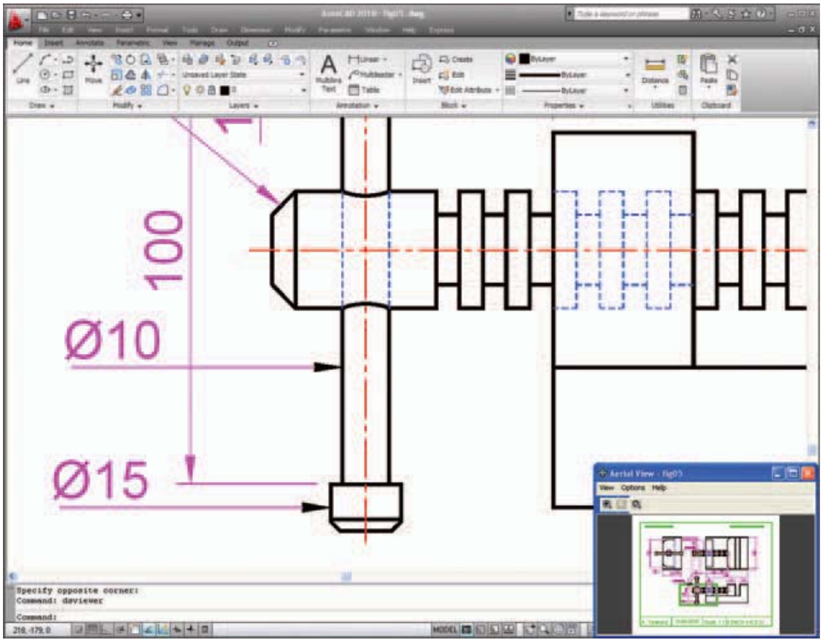

Fig. 4.6 A **Zoom Window** of the drawing Fig. 4.5 with its surrounding zoom rectangle showing in the **Aerial View** window

The Pan tool

The **Pan** tools can be called with a *click* on the **Pan** button in the status bar, from the **Pan** sub-menu of the **View** drop-down menu or by *entering* **p** at the command line. When the tool is called, the cursor on screen changes to an icon of a hand. *Dragging* the hand across screen under mouse movement allows various parts of the drawing not in the AutoCAD drawing area to be viewed. As the *dragging* takes place, the green rectangle in the **Aerial View** window moves in sympathy (see Fig. 4.7). The **Pan** tool allows any part of the drawing to be viewed and/or modified. When that part of the drawing which is required is on screen a *right-click* calls up the menu as shown in Fig. 4.7, from which either the tool can be exited, or other tools can be called.

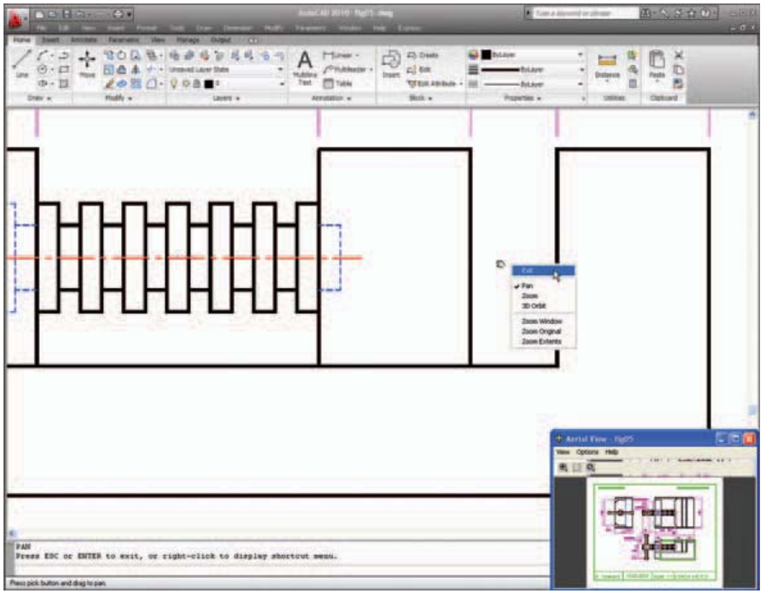

Fig. 4.7 The **Pan** tool in action showing a part of the drawing, while the whole drawing is shown in the **Aerial View** window

Notes

1. If using a mouse with a wheel both zooms and pans can be performed with the aid of the wheel. See page 8.
2. The **Zoom** tools are important in that they allow even the smallest parts of drawings to be examined and, if necessary, amended or modified.
3. The **Zoom** tools can be called with a *click* on the **Zoom** button in the status bar, from the **Zoom** toolbar, from the sub-menu of the **View** drop-down menu or by *entering* **zoom** or **z** at the command line. The easiest method is to enter **z** at the command line followed by a *right-click*.
4. Similarly the easiest method of calling the **Pan** tool is to *enter* **p** at the command line followed by a *right-click*.
5. When constructing large drawings, the **Pan** tool and the **Aerial View** window are of value for allowing work to be carried out in any part of a drawing, while showing the whole drawing in the **Aerial View** window.

Drawing templates

In Chapters 1 to 3, drawings were constructed in the template **acadiso.dwt** which loaded when AutoCAD 2010 was opened. The default **acadiso** template has been amended to **Limits** set to **420,297** (coordinates within which a drawing can be constructed), **Grid Display** set to **10**, **Snap Mode** set to **5**, and the drawing area **Zoomed** to **All**.

Throughout this book most drawings will be based on an **A3** sheet, which measures 420 units by 297 units (the same as **Limits**).

Note

As mentioned on page before, if others are using the computer on which drawings are being constructed, it is as well to save the template being used to another file name or, if thought necessary to a floppy disk or other temporary type of disk. A file name **My_template.dwt**, as suggested earlier, or a name such as **book_template** can be given.

Adding features to the template

Four other features will now be added to our template:

Text style – set in the **Text Style** dialog.
Dimension style – set in the **Dimension Style Manager** dialog.
Shortcutmenu variable – set to **0**.
Layers – set in the **Layer Properties Manager** dialog.

Setting text

1. At the command line:
   `Command:`*`enter`*` st (Style) `*`right-click`*
2. The **Text style** dialog appears (Fig. 4.8). In the dialog, *enter* **6** in the **Height** field. Then *left-click* on **Arial** in the **Font name** pop-up list. **Arial** font letters appear in the **Preview** area of the dialog.

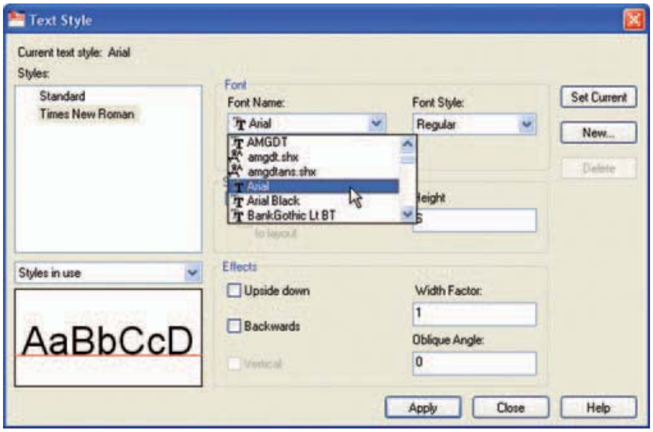

Fig. 4.8 The **Text Style** dialog

3. *Left-click* the **New** button and *enter* **Arial** in the **New** text style sub-dialog which appears (Fig. 4.9) and *click* the **OK** button.
4. *Left-click* the **Set Current** button of the **Text Style** dialog.
5. *Left-click* the **Close** button of the dialog.

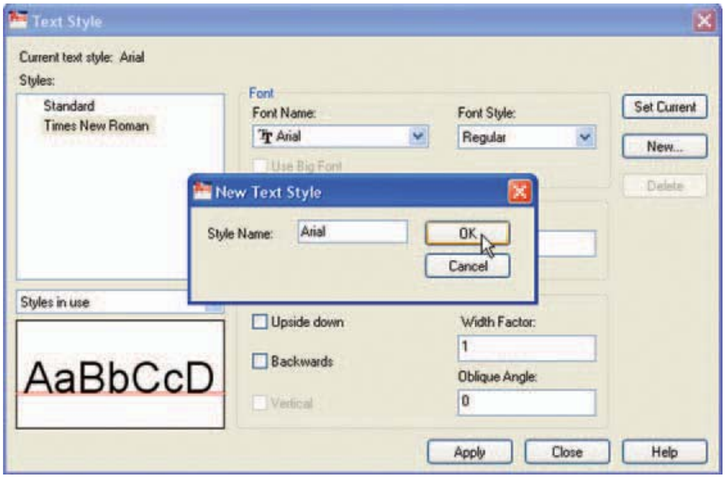

Fig. 4.9 The **New Text Style** sub-dialog

Setting dimension style

Settings for dimensions require making *entries* in a number of sub-dialogs in the **Dimension Style Manager**. To set the dimensions style:

1. At the command line:
   `Command:enter d` *`right-click`*
   And the **Dimension Style Manager** dialog appears (Fig. 4.10).

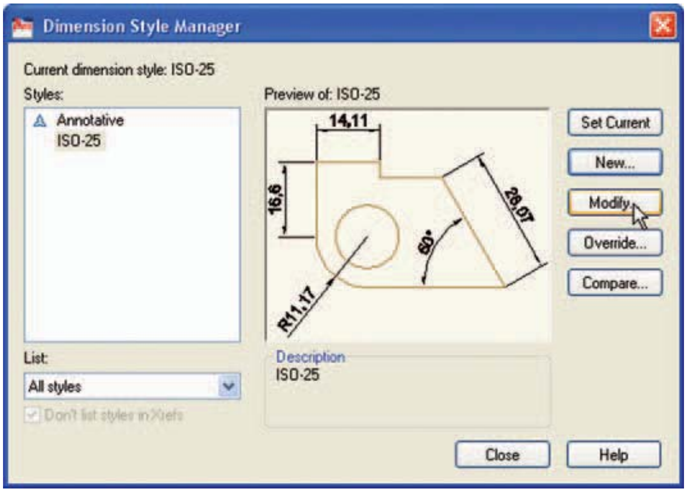

Fig. 4.10 The **Dimension Style Manager** dialog

2. In the dialog, *click* the **Modify…** button.
3. The **Modify Dimension Style** dialog appears (Fig. 4.11). A number of tabs show at the top of the dialog. *Click* the **Lines** tab and make settings as shown in Fig. 4.11. Then *click* the **OK** button of that dialog.

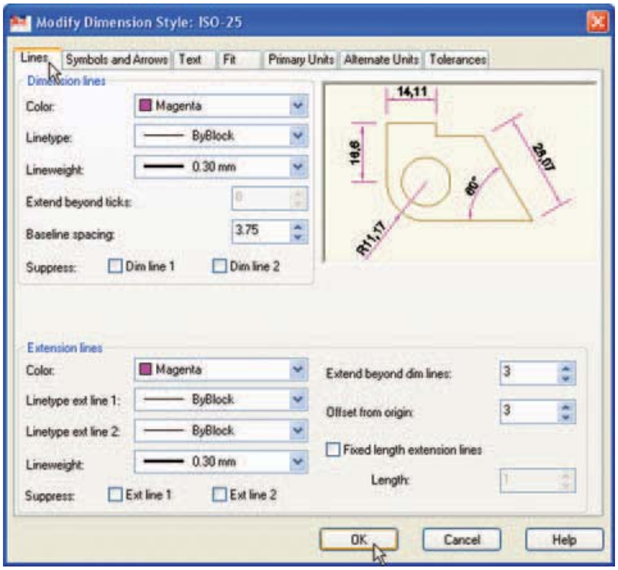

Fig. 4.11 The setting for **Lines** in the **Modify Dimension Style** dialog

4. The original **Dimension Style Manager** reappears. *Click* its **Modify** button again.
5. The **Modify Dimension Style** dialog reappears (Fig. 4.12). *Click* the **Symbols and Arrows** tab. Set **Arrow** size to **6**.
6. Then *click* the **Text** tab. Set **Text style** to **Arial**, set **Color** to **Magenta**, set **Text Height** to **6** and *click* the **ISO** check box in the bottom right-hand corner of the dialog.
7. Then *click* the **Primary Units** tab and set the units **Precision** to **0**, that is no units after decimal point and **Decimal separator** to **Period**. *Click* the sub-dialogs **OK** button (Fig. 4.12).
8. The **Dimension Styles Manager** dialog reappears showing dimensions, as they will appear in a drawing, in the **Preview of my-style** box. *Click* the **New…** button. The **Create New Dimension Style** dialog appears (Fig. 4.13).
9. *Enter a suitable name in the* **New style name** field – in this example this is **My-style**. *Click* the **Continue** button and the **Dimension Style Manager** appears (Fig. 4.14). This dialog now shows a preview of the **My-style** dimensions. *Click* the dialog's **Set Current** button, followed by another *click* on the **Close** button (Fig. 4.14).

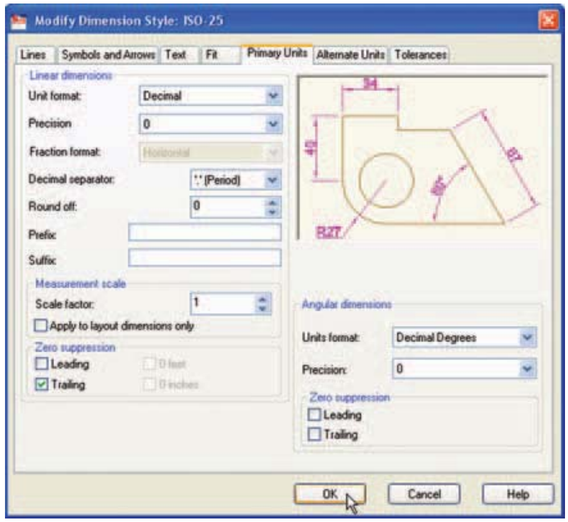

Fig. 4.12 Setting **Primary Units** in the **Dimension Style Manager**

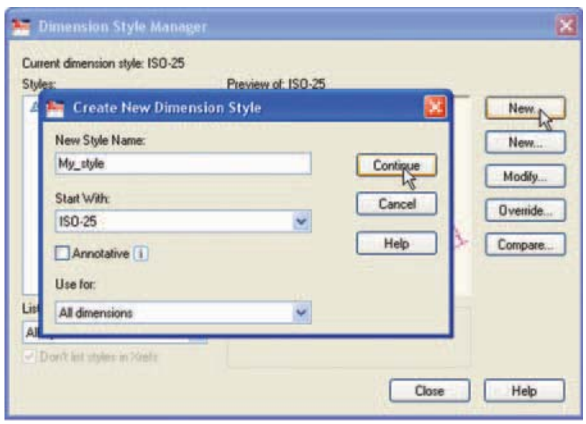

Fig. 4.13 The **Create New Dimension Style** dialog

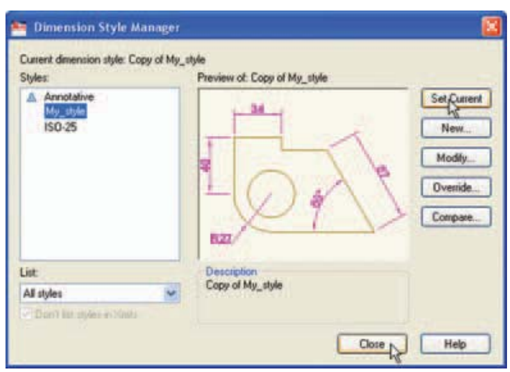

Fig. 4.14 The **Dimension Style Manager** reappears. *Click* the **Set Current** and **Close** buttons

Fig. 4.15 The right-click menu

Setting the shortcutmenu variable

Call the line tool, draw a few lines and then *right-click*. The *right-click* menu shown in Fig. 4.15 may well appear. The menu will also appear when any tool is called. Some operators prefer using this menu when constructing drawings. To stop this menu appearing:

```
Command:enter shortcutmenu right-click
Enter new value for SHORTCUTMENU <12>: 0
Command:
```

And the menu will no longer appear when a tool is in action.

Setting layers

1. At the command line *enter* **layer** followed by a *right-click*. The **Layer Properties Manager** palette appears (Fig. 4.16).
2. *Click* the **New Layer** icon. **Layer1** appears in the layer list. Overwrite the name **Layer1** *entering* **Centre**.

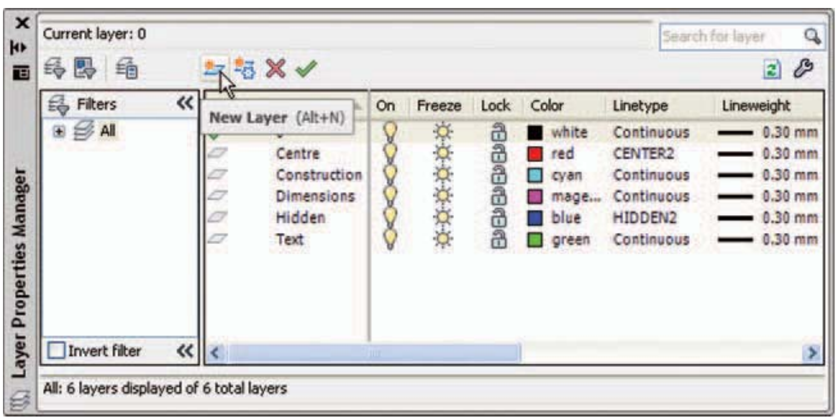

Fig. 4.16 The **Layer Properties Manager** palette

3. Repeat step **2** four times and make four more layers entitled **Construction**, **Dimensions**, **Hidden** and **Text**.
4. *Click* one of the squares under the **Color** column of the dialog. The **Select Color** dialog appears (Fig. 4.17). *Double-click* on one of the colours in the **Index Color** squares. The selected colour appears against the layer name in which the square was selected. Repeat until all 5 new layers have a colour.
5. *Click* on the linetype **Continuous** against the layer name **Centre**. The **Select Linetype** dialog appears (Fig. 4.18). *Click* its **Load …** button and from the **Load or Reload Linetypes** dialog *double-click* **CENTER2**. The dialog disappears and the name appears in the **Select Linetype** dialog. *Click* the **OK** button and the linetype **CENTER2** appears against the layer **Centre**.

Fig. 4.17 The **Select Color** dialog

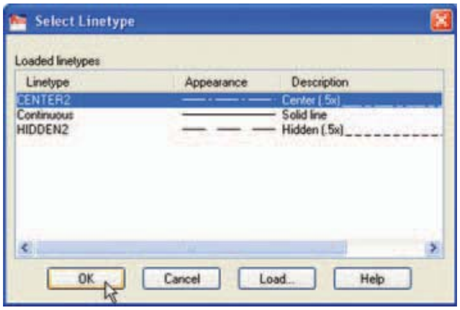

Fig. 4.18 The **Select Linetype** dialog

6. Repeat with layer **Hidden**, load the linetype **HIDDEN2** and make the linetype against this layer **HIDDEN2**.
7. *Click* on the any of the lineweights in the **Layer Properties Manager**. This brings up the **Lineweight** dialog (Fig. 4.19). Select the lineweight

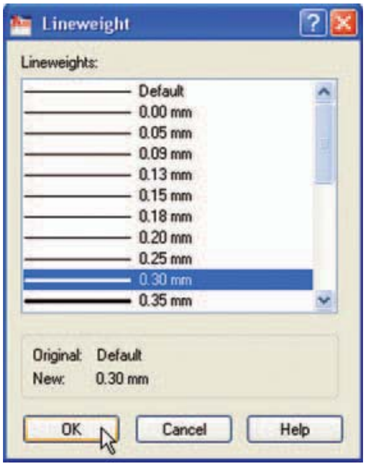

Fig. 4.19 The **Lineweight** dialog

0.3. Repeat the same for all the other layers. Then *click* the **Close** button of the **Layer Properties Manager**.

Saving the template file

1. *Left-click* on **Save As** in the menu appearing with a *left-click* on the AutoCAD icon at the top left-hand corner of the screen (Fig. 4.20).

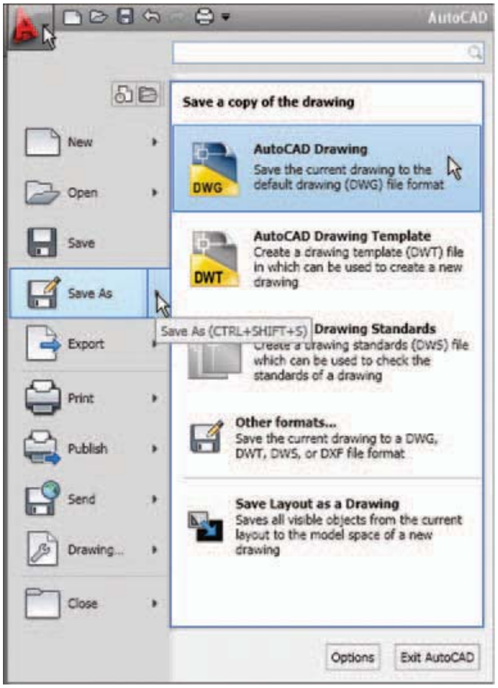

Fig. 4.20 Calling **Save As**

2. In the **Save Drawing As** dialog which comes on screen (Fig. 4.21), *click* the arrow to the right of the **Files of type** field and in the pop-up list associated with the field *click* on **AutoCAD Drawing Template (*.dwt)**. The list of template files in the **AutoCAD 2010/Template** directory appears in the file list.
3. *Click* on **acadiso** in the file list, followed by a *click* on the **Save** button.
4. The **Template Option** dialog appears. Make *entries* as suggested in Fig. 4.22, making sure that **Metric** is chosen from the pop-up list.

The template now saved can be opened for the construction of drawings as needed. Now when AutoCAD 2010 is opened again the template **acadiso.dwt** appears on screen.

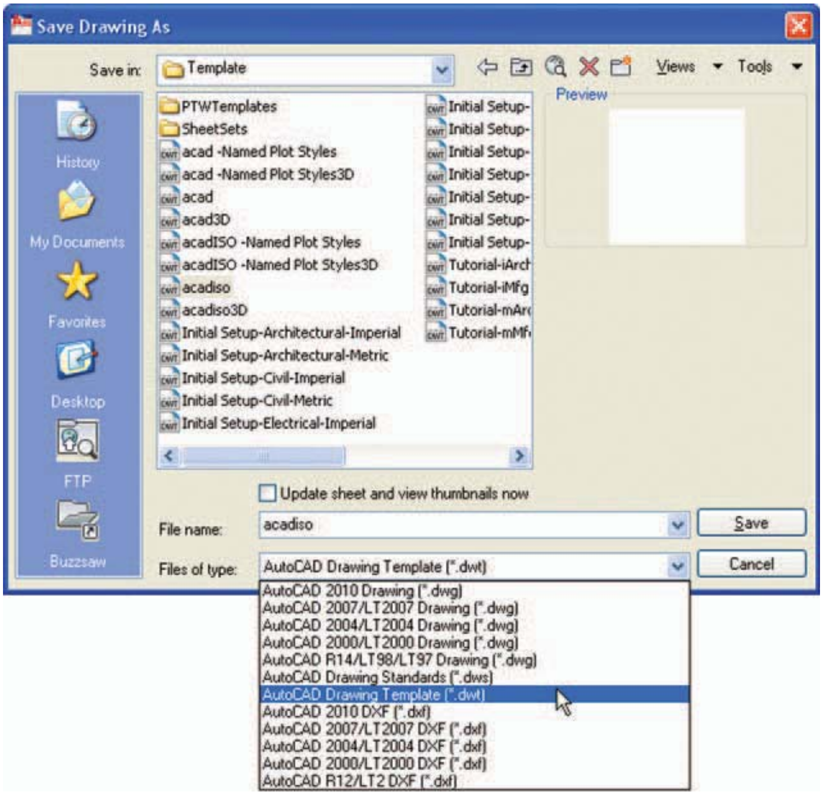

Fig. 4.21 Saving the template to the name **acadiso.dwt**

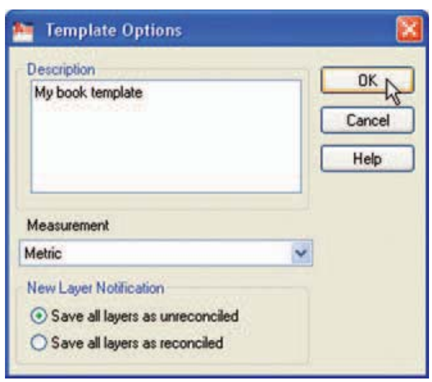

Fig 2.22 The **Template Description** dialog

Note

Please remember that if others are using the computer it is advisable to save the template to a name of your own choice.

Another template

A3_template – Fig. 4.25

In the **Select Template** dialog, a *click* on any of the file names, causes a preview of the template to appear in the **Preview** box of the dialog, unless the template is free of information – as is **acadiso.dwt**. To construct another template which includes a title block and other information based on the **acadiso.dwt** template:

1. In an **acadiso.dwt** template construct a border and title block.
2. *Click* the **Layout1** button (Fig. 4.23). The screen changes to a **Paper Space** setting.
3. **Zoom** to **Extents**.

Fig. 4.23 The **Layout1** button

4. It is suggested this template be saved as a **Paper Space** template with the name **A3_template.dwt** (Fig. 4.24).

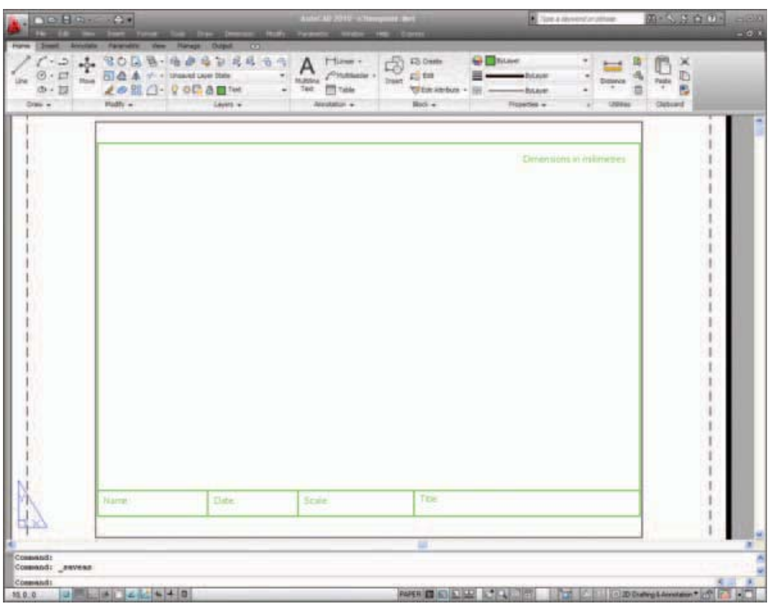

Fig. 4.24 The **A3_template.dwt**

Notes

1. The outline for this A3 template is a pline from **0,290** to **420,290** to **420,0** to **0,0** to **290,0** and of width **0.5**.
2. The upper line of the title block is a pline from **0,20** to **420,20**.
3. **Paper Space** is two-dimensional.
4. Further uses for **Layouts** and **Pspace** are given in Chapter 19.

The AutoCAD Classic workspace

It should be noted that any of the drawings described throughout **Part 1 – 2D Design** of this book could equally as well have been constructed in the **AutoCAD Classic** workspace as in the **2D Drafting & Annotation** workspace. Tools could as well be selected in the toolbars: **Draw –** *docked* left, **Modify –** *docked* right and **Standard –** *docked* top, as can be seen in Fig. 4.25.

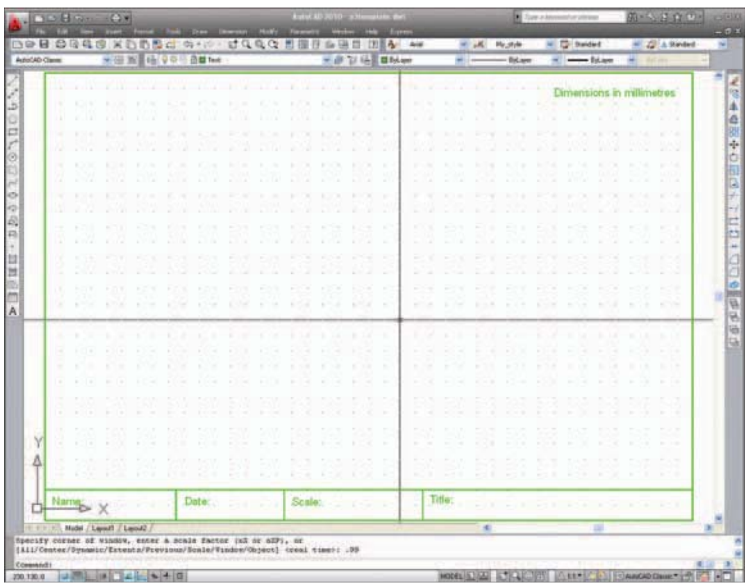

Fig. 4.25 The **AutoCAD Classic** workspace

REVISION NOTES

1. The **Zoom** tools are important in that they allow even the smallest parts of drawings to be examined and, if necessary, amended or modified.
2. The **Zoom** tools can be called with a *click* on the **Zoom** button in the status bar, from the **Zoom** toolbar, from the sub-menu of the **View** drop-down menu, or by *entering* **z**

or **zoom** at the command line. The easiest method is to *enter* **z** at the command line followed by a *right-click*.

3. There are five methods of calling tools for use – selecting a tool icon in a panel from a group of panels shown as **tabs** in the **Ribbon;** selecting a tool from a toolbar; *entering* the name of a tool in full at the command line; *entering* an abbreviation for a tool at the command line; selecting a tool from a drop-down menu.
4. When constructing large drawings, the **Pan** tool and the **Aerial View** window are of value for allowing work to be carried out in any part of a drawing, while showing the whole drawing in the **Aerial View** window.
5. An A3 sheet of paper is 420 mm by 297 mm. If a drawing constructed in the template **acadiso.dwt** described in this book is printed/plotted full size (scale 1:1), each unit in the drawing will be 1 mm in the print/plot.
6. When limits are set it is essential to call **Zoom** followed by **a** (All) to ensure that the limits of the drawing area are as set.
7. If the *right-click* menu appears when using tools, the menu can be aborted if required by setting the **SHORTCUTMENU** variable to **0**.

Exercises

If you have saved drawings constructed either by following the worked examples in this book or by answering exercises in Chapters 2 and 3, open some of them and practise zooms and pans.

Chapter 5

The Modify tools

AIM OF THIS CHAPTER

The aim of this chapter is to describe the uses of tools for modifying parts of drawings.

Introduction

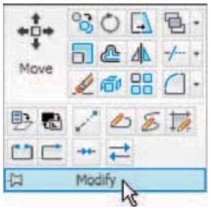

Fig. 5.1 The **Modify** tool icons in the **Home/ Modify** panel

The **Modify** tools are among those most frequently used. The tools are found in the **Home/Modify** panel. A *click* on the arrow in the **Home/ Modify** panel brings down a further set of tool icons (Fig. 5.1). They can also be selected from the Modify toolbar (Fig. 5.2) or from the **Modify** drop-down menu.

Using the **Erase** tool from **Home/Modify** was described in Chapter 2. Examples of tools other than the **Explode** follow. See also Chapter 9 for **Explode**.

Fig. 5.2 The **Modify** toolbar

The Copy tool

First example – Copy (Fig. 5.5)

1. Construct Fig. 5.3 using **Polyline**. Do not include the dimensions.
2. Call the **Copy** tool – either *left-click* on its tool icon in the **Home/ Modify** panel (Fig. 5.4), *pick* **Copy** from the **Modify** toolbar, or *enter* **cp** or **copy** at the command line.

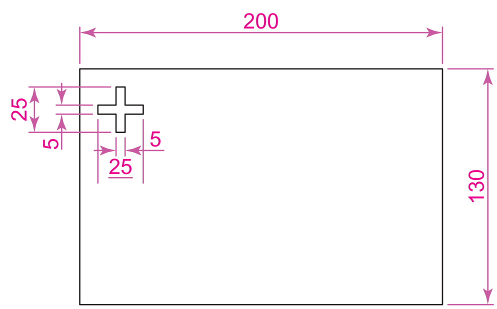

Fig. 5.3 First example – **Copy Object –** outlines

The command line shows:

```
Command: _copy
Select objects:pick the cross 1 found
Select objects:right-click
Current settings: Copy mode = Multiple
Specify base point or [Displacement/Mode]
  <Displacement> :pick
Specify second point or [Exit/Undo]:pick
```

Specify second point or
  [Exit/Undo] < Exit > :*right-click*

Command:

The result is given in Fig. 5.5.

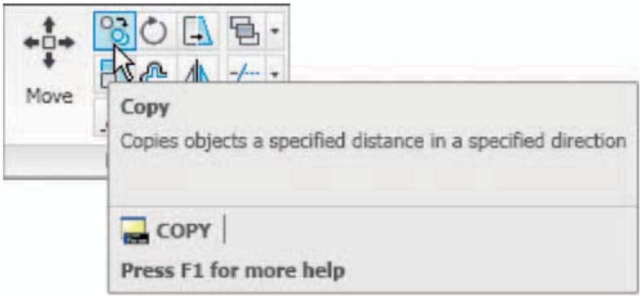

Fig. 5.4 The **Copy** tool from the **Home/Modify** panel

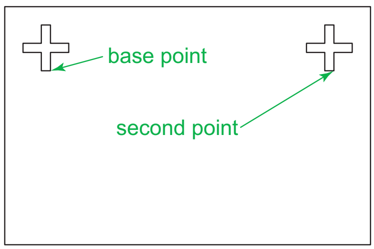

Fig. 5.5 First example – **Copy**

Second example – Multiple copy (Fig. 5.6)

1. Erase the copied object.
2. Call the **Copy** tool. The command line shows:

Command: _copy
Select objects:*pick* the cross 1 found
Select objects:*right-click*
Current settings: Copy mode = Multiple
Specify base point or [Displacement/Mode]
  <Displacement > :*pick*
Specify second point or <use first point as
  displacement > :*pick*
Specify second point or [Exit/Undo] <Exit > :*pick*
Specify second point or [Exit/Undo] <Exit > :*pick*
Specify second point or [Exit/Undo] <Exit > : e
  (Exit)
Command:

The result is shown in Fig. 5.6.

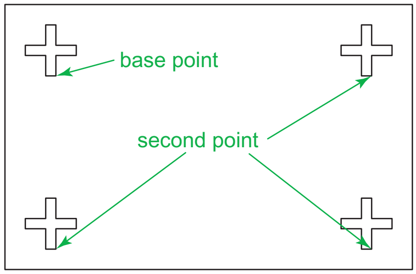

Fig. 5.6 Second example – **Copy – Multiple copy**

The Mirror tool

First example – Mirror (Fig. 5.9)

1. Construct the outline Fig. 5.7 using the **Line** and **Arc** tools.

2. Call the **Mirror** tool – *left-click* on its tool icon in the **Home/Modify** panel (Fig. 5.8), *pick* **Mirror** from the **Modify** toolbar or from the **Modify** drop-down menu, or *enter* **mi** or **mirror** at the command line. The command line shows:

```
Command:_mirror
Select objects:pick first cornerSpecify opposite
  corner:pick 7 found
Select objects:right-click
Specify first point of mirror line:pick
Specify second point of mirror line:pick
Erase source objects [Yes/No] <N > :right-click
Command:
```

The result is shown in Fig. 5.9.

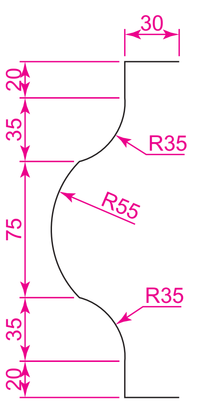

Fig. 5.7 First example – **Mirror** – outline

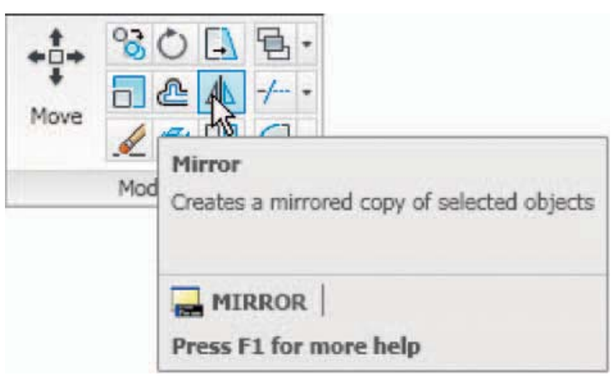

Fig. 5.8 The **Mirror** tool from the **Modify** toolbar

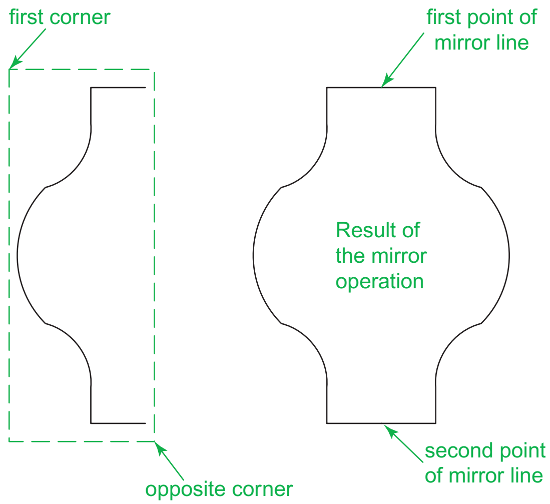

Fig. 5.9 First example – **Mirror**

Second example – Mirror (Fig. 5.10)

1. Construct the outline shown in the dimensioned polyline in the upper drawing of Fig. 5.10.
2. Call **Mirror** and using the tool three times complete the given outline. The two points shown in Fig. 5.10 are to mirror the right-hand side of the outline.

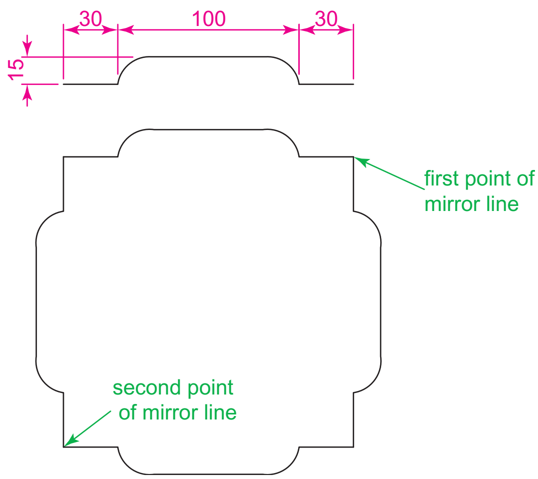

Fig. 5.10 Second example – **Mirror**

Third example – Mirror (Fig. 5.11)

Fig. 5.11 Third example – **Mirror**

If text is involved when using the **Mirror** tool, the set variable **MIRRTEXT** must be set correctly. To set the variable:

```
Command: mirrtext
Enter new value for MIRRTEXT <1> : 0
Command:
```

If set to **0** text will mirror without distortion. If set to **1** text will read backwards as indicated in Fig. 5.11.

The Offset tool

Examples – Offset (Fig. 5.14)

1. Construct the four outlines shown in Fig. 5.13.
2. Call the **Offset** tool – *left-click* on its tool icon in the **Home/Modify** panel (Fig. 5.12), *pick* the tool from the **Modify** toolbar, *pick* the tool name in the **Modify** drop-down menu, or *enter* **o** or **offset** at the command line. The command line shows:

```
Command:_offset
Current settings: Erase source = No
  Layer = Source OFFSETGAPTYPE = 0
Specify offset distance or [Through/Erase/Layer]
  <Through> : 10
Select object to offset or [Exit/Undo]
  <Exit> :pick drawing 1
Specify point on side to offset or [Exit/Multiple/
  Undo] <Exit> :pick inside the rectangle
Select object to offset or [Exit/Undo] <Exit> :
  e (Exit)
Command:
```

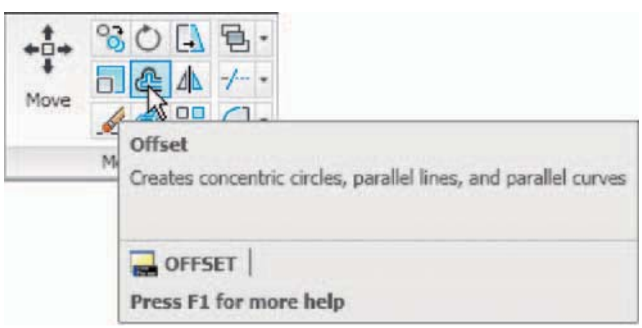

Fig. 5.12 The **Offset** tool from the **Home/Modify** panel

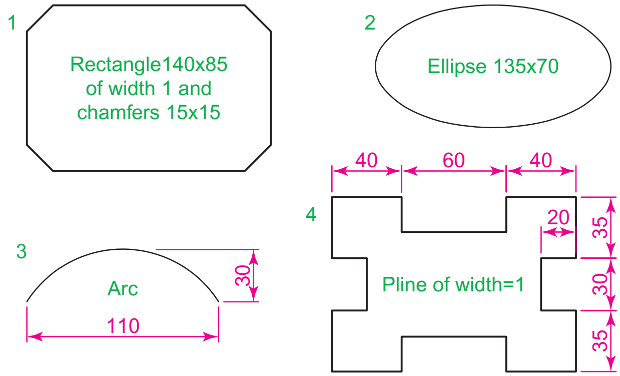

Fig. 5.13 Examples – **Offset** – outlines

3. Repeat for drawings **2**, **3** and **4** in Fig. 5.12 as shown in Fig. 5.14.

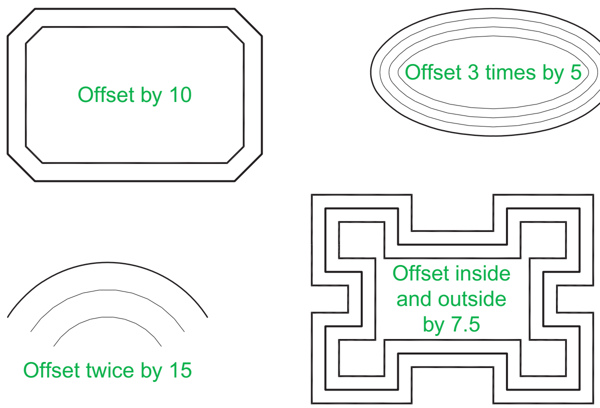

Fig. 5.14 Examples – **Offset**

The Array tool

Arrays can be in either a **Rectangular** form or in a **Polar** form as shown in the examples below.

First example – Rectangular Array (Fig. 5.17)

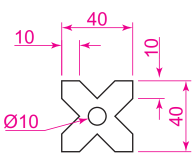

Fig. 5.15 First example – **Array** – drawing to be arrayed

1. Construct the drawing Fig. 5.15.
2. Call the **Array** tool – either *click* **Array** in the **Modify** drop-down menu (Fig. 5.16), from the **Home/Modify** panel, *pick* the **Array** tool icon from the **Modify** toolbar, or *enter* **ar** or **array** at the command line. The **Array** dialog appears (Fig. 5.17).
3. Make settings in the dialog:

Rectangular Array radio button set on (dot in button).
Row field – *enter* **5**

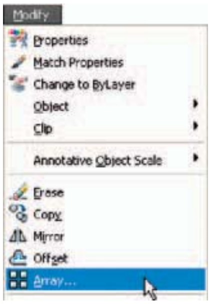

Fig. 5.16 Selecting **Array** from the **Modify** drop-down menu

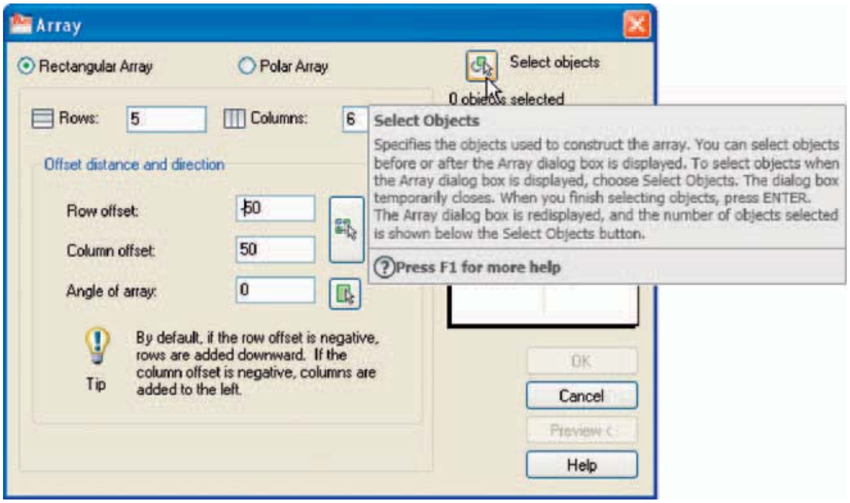

Fig. 5.17 First example – the **Array** dialog

Column field – *enter* **6**
Row offset field – *enter* **–50** (note the minus sign)
Column offset field – *enter* **50**

4. *Click* the **Select objects** button and the dialog disappears. Window the drawing. A second dialog appears which includes a **Preview**< button.
5. *Click* the **Preview**< button. The dialog disappears and the following prompt appears at the command line:

```
Pick or press Esc to return to drawing or <Right-
  click to accept drawing> :
```

6. If satisfied *right-click*. If not, press the **Esc** key and make revisions to the **Array** dialog fields as necessary.

The resulting array is shown in Fig. 5.18.

Second example – Polar Array (Fig. 5.22)

1. Construct the drawing Fig. 5.19.
2. Call **Array**. The **Array** dialog appears. Make settings as shown in Fig. 5.20.
3. *Click* the **Select objects** button of the dialog and window the drawing. The dialog returns to screen. *Click* the **Pick center point** button (Fig. 5.21) and when the dialog disappears, *pick* a centre point for the array.
4. The dialog reappears. *Click* its **Preview**< button. The array appears and the command line shows:

```
Pick or press Esc to return to drawing or <Right-
  click to accept drawing> :
```

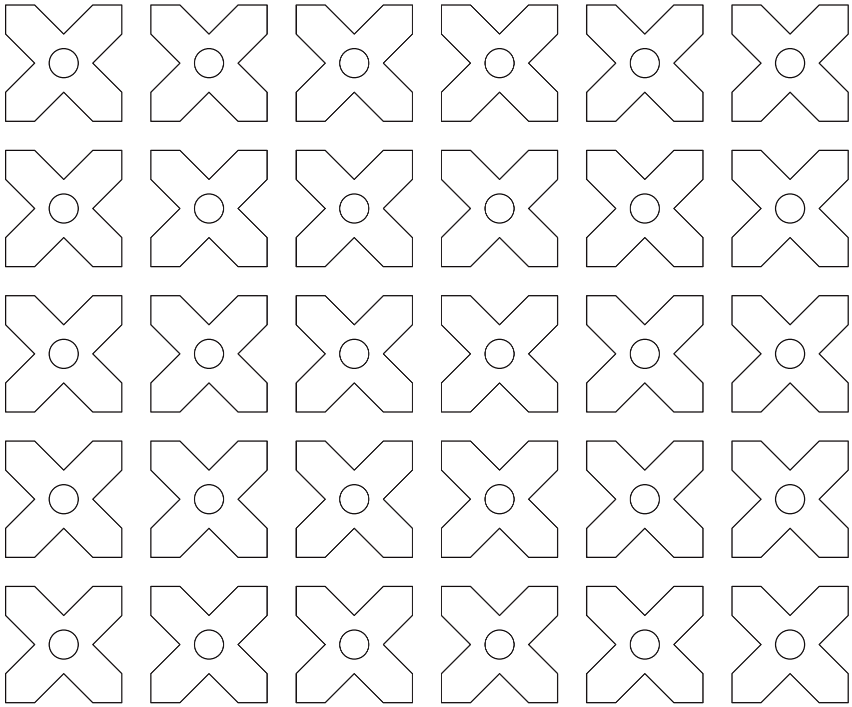

Fig. 5.18 First example – **Array**

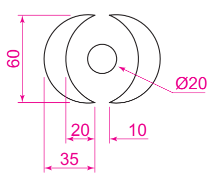

Fig. 5.19 Second example – the drawing to be arrayed

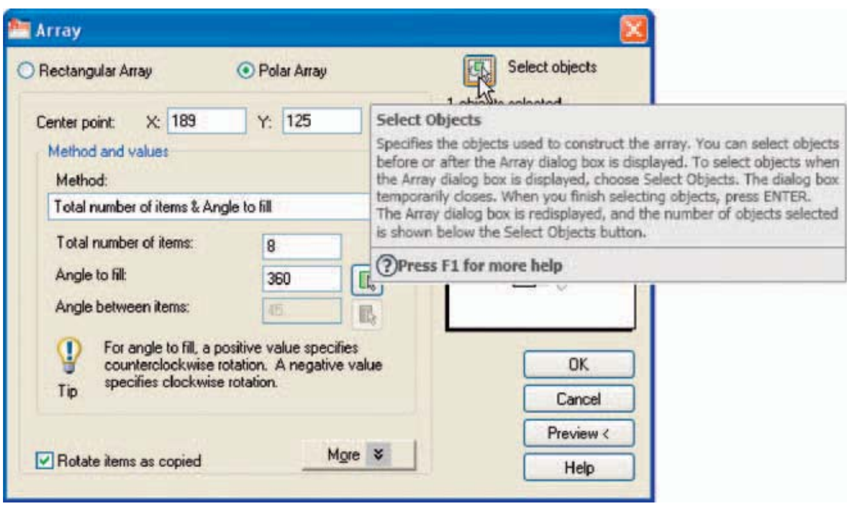

Fig. 5.20 Second example – **Array –** settings in the dialog

5. If satisfied *right-click*. If not, press the **Esc** key and make revisions to the **Array** dialog fields as necessary.

The resulting array is shown in Fig 5.22.

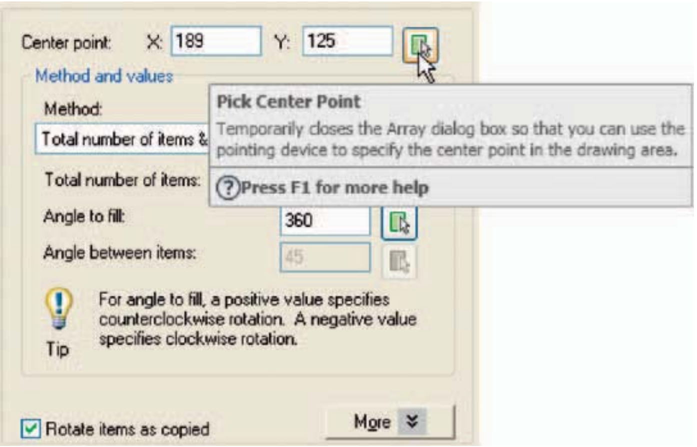

Fig. 5.21 Second example – **Array –** the **Pick Center point** button

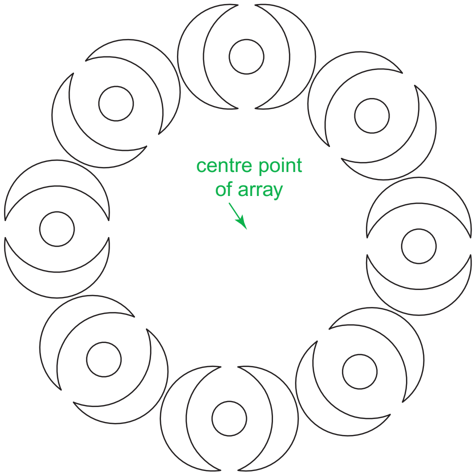

Fig. 5.22 Second example – **Array**

The Move tool

Example – Move (Fig. 5.25)

1. Construct the drawing Fig. 5.23.

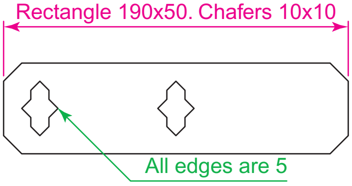

Fig. 5.23 Example – **Move** – drawing

2. Call **Move –** either *click* the **Move** tool icon in the **Home/Modify** panel (Fig. 5.24), *pick* **Move** from the **Modify** toolbar, *pick* **Move** from the **Modify** drop-down menu, or *enter* **m** or **move** at the command line, which shows:

Command:_move
Select objects:*pick* the middle shape in the drawing 1 found
Select objects:*right-click*
Specify base point or [Displacement] <Displacement> :*pick*
Specify second point or <use first point as displacement> :*pick*
Command:

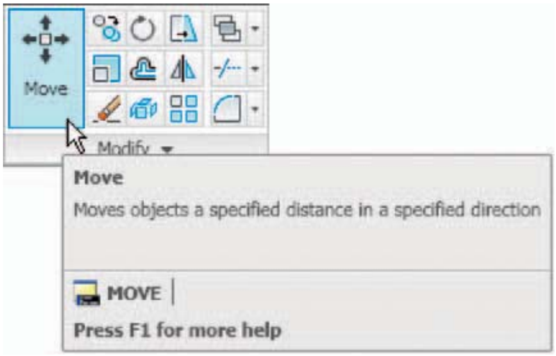

Fig. 5.24 The **Move** tool from the **Home/Modify** toolbar

The result is given in Fig. 5.25.

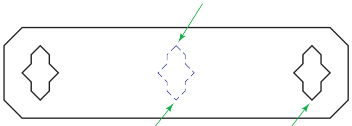

Fig. 5.25 Example – **Move**

The Rotate tool

When using the **Rotate** tool remember the default rotation of objects within AutoCAD 2010 is counterclockwise (anticlockwise).

Example – Rotate (Fig. 5.27)

1. Construct drawing **1** of Fig. 5.27 with **Polyline**. Copy the drawing **1** three times (Fig. 5.27).
2. Call **Rotate** – *left-click* on its tool icon in the **Home/Modify** panel (Fig. 5.26), *pick* its tool icon from the **Modify** toolbar, *pick* **Rotate** from the **Modify** drop-down menu, or *enter* **ro** or **rotate** at the command line. The command line shows:

```
Command:_rotate
Current positive angle in UCS: ANGDIR = countercl
  ockwise ANGBASE = 0
Select objects: window the drawing 3 found
Select objects:right-click
Specify base point:pick
Specify rotation angle or [Copy/Reference] <0> :
  45
Command:
```

and the first copy rotates through the specified angle.

3. Repeat for drawings **3** and **4** rotating as shown in Fig. 5.27.

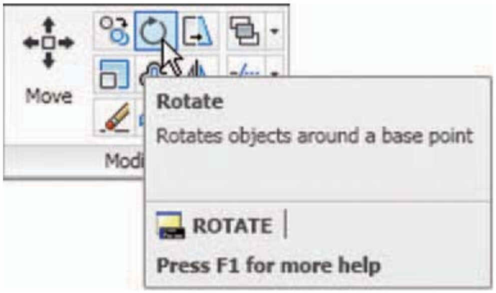

Fig. 5.26 The **Rotate** tool icon from the **Home/Modify** panel

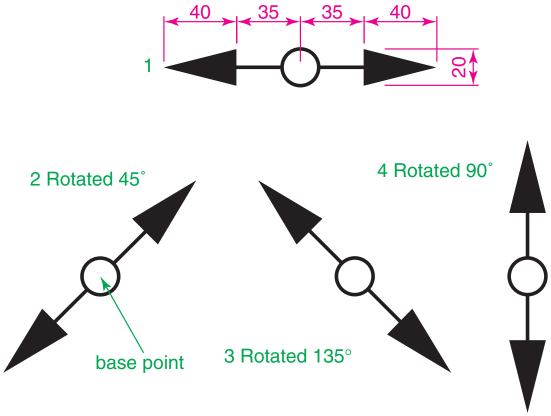

Fig. 5.27 Example – **Rotate**

The Scale tool

Examples – Scale (Fig. 5.29)

1. Using the **Rectangle** and **Polyline** tools, construct drawing **1** of Fig. 5.29. The **Rectangle** fillets are R10. The line width of all parts is **1**. Copy the drawing 3 times to give drawings **2**, **3** and **4**.
2. Call **Scale** – *left-click* on its tool icon in the **Home/Draw** panel (Fig. 5.28), *pick* its tool icon in the **Modify** toolbar, *pick* **Scale** from the **Modify** drop-down menu, or *click* its tool in the **Modify** toolbar, or *enter* **sc** or **scale** at the command line which then shows:

```
Command:_scale
Select objects: window drawing 2 5 found
Select objects:right-click
Specify base point:pick
Specify scale factor or [Copy/Reference] <1> : 0.75
Command:
```

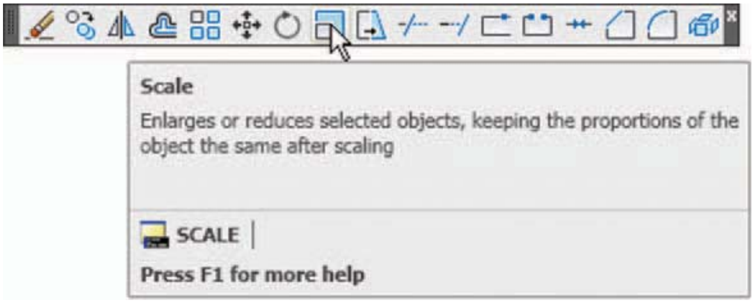

Fig. 5.28 The **Scale** tool icon from the **Modify** toolbar

3. Repeat for the other two drawings **3** and **4** scaling to the scales given with the drawings.

The results are shown in Fig. 5.29.

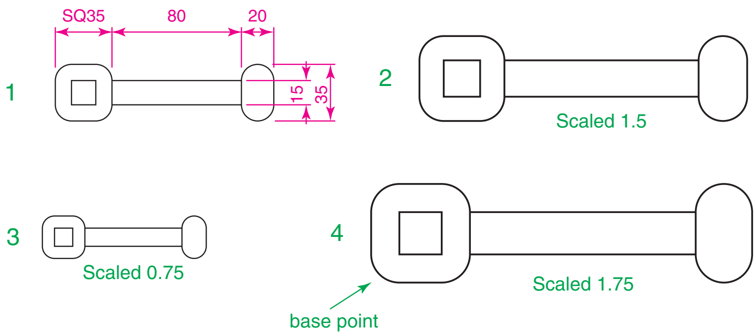

Fig. 5.29 Examples – **Scale**

The Trim tool

This tool is one which will be in frequent use when constructing drawings.

First example – Trim (Fig. 5.31)

1. Construct the drawing **Original drawing** in Fig. 5.31.
2. Call **Trim** – either *left-click* on its tool icon in the **Home/Modify** panel (Fig. 5.30), *pick* its tool icon in the **Modify** toolbar, *pick* **Trim** from the **Modify** drop-down menu, or *enter* **tr** or **trim** at the command line, which then shows:

```
Command:_trim
Current settings: Projection UCS. Edge = Extend
Select cutting edges....
Select objects or <select all> :pick the left-
  hand circle 1 found
Select objects to trim or shift-select to
  extend or [Fence/Project/Crossing/Edge/eRase//
  Undo]:pick one of the objects
Select objects to trim or shift-select to extend or
[Fence/Crossing/Project/Edge/eRase/Undo:pick the
  second of the objects
Select objects to trim or shift-select to extend
  or [Project/Edge/Undo]:right-click
Command:
```

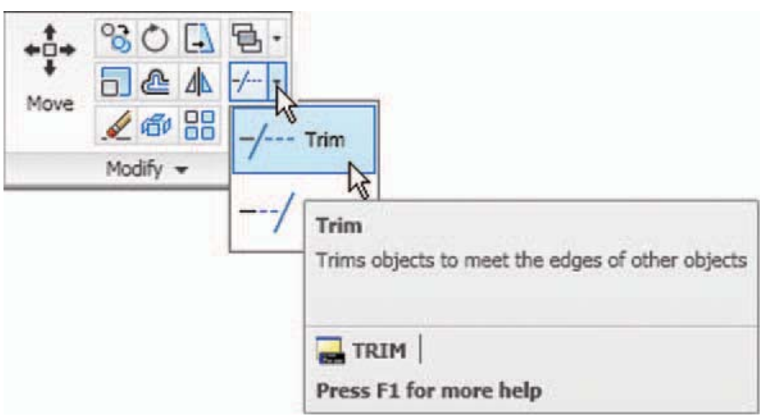

Fig. 5.30 The **Trim** tool icon from the **Modify** toolbar in the **Home/Modify** panel

3. This completes the **First stage** as shown in Fig. 5.31. Repeat the **Trim** sequence for the **Second stage**.
4. The **Third stage** drawing of Fig. 5.31 shows the result of the trims at the left-hand end of the drawing.

5. Repeat for the right-hand end. The final result is shown in the drawing labelled **Result** in Fig. 5.31.

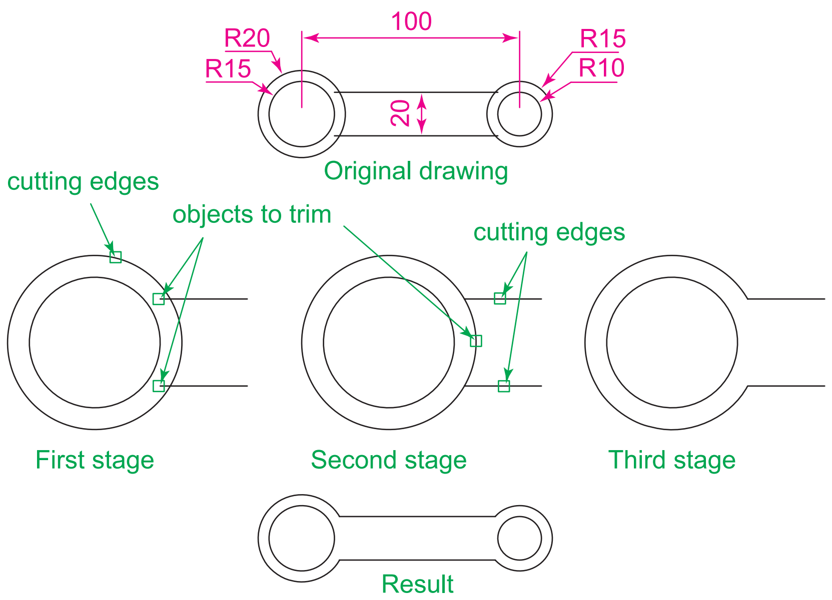

Fig. 5.31 First example – **Trim**

Second example – Trim (Fig. 5.32)

1. Construct the left-hand drawing of Fig. 5.32.
2. Call **Trim**. The command line shows:

```
Command:_trim
Current settings: Projection UCS. Edge = Extend
Select cutting edges ...
Select objects or <select all> :pick the left-
  hand arc 1 found
Select objects:right-click
Select objects to trim or shift-select to extend
  or [Fence/Crossing/Project/Edge/eRase/Undo]: e
  (Edge)
Enter an implied edge extension mode [Extend/No
  extend] <No extend> : e (Extend)
Select objects to trim:pick
Select objects to trim:pick
Select objects to trim:right-click
Command:
```

3. Repeat for the other required trims. The result is given in Fig. 5.32.

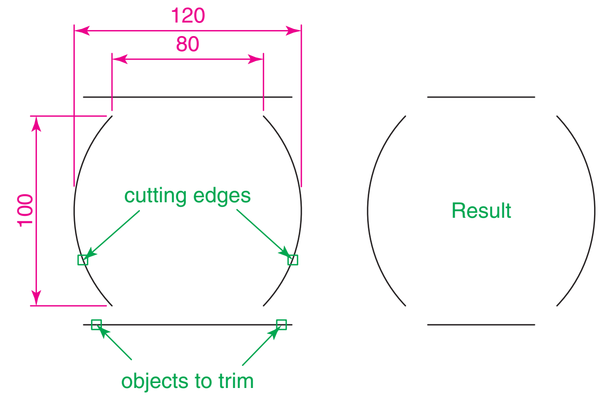

Fig. 5.32 Second example – **Trim**

The Stretch tool

Examples – Stretch (Fig. 5.34)

As its name implies the **Stretch** tool is for stretching drawings or parts of drawings. The action of the tool prevents it from altering the shape of circles in any way. Only **crossing** or **polygonal** windows can be used to determine the part of a drawing which is to be stretched.

1. Construct the drawing labelled **Original** in Fig. 5.34, but do not include the dimensions. Use the **Circle**, **Arc**, **Trim** and **Edit Polyline** tools. The resulting outlines are plines of width = 1. With the **Copy** tool make two copies of the drawing.

Note

In each of the three examples in Fig. 5.34, the broken lines represent the crossing windows required when **Stretch** is used.

2. Call the **Stretch** tool – either *click* on its tool icon in the **Home/Modify** panel (Fig. 5.33), *left-click* on its tool icon in the **Modify** toolbar, *pick* its name in the **Modify** drop-down menu, or *enter* **s** or **stretch** at the command line, which shows:

```
Command:_stretch
Select objects to stretch by crossing-window or
  crossing-polygon...
Select objects:enter c right-click
Specify first corner:pick Specify opposite
  corner:pick 1 found
Select objects:right-click
```

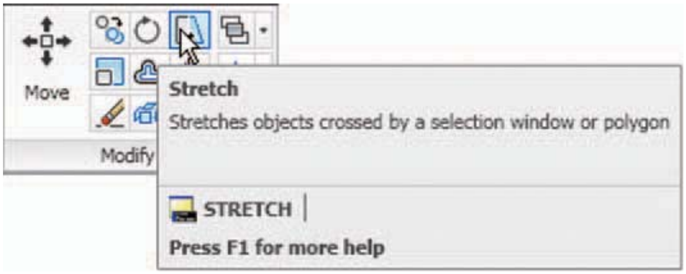

Fig. 5.33 The **Stretch** tool icon from the **Home/Modify** panel

```
Specify base point or [Displacement]
  <Displacement> :pick beginning of arrow
Specify second point of displacement or <use first
  point as displacement> :drag in the direction
  of the arrow to the required second point and
  right-click
Command:
```

Notes

1. When circles are windowed with the crossing window no stretching can take place. This is why, in the case of the first example in Fig. 5.33, when the **second point of displacement** was *picked*, there was no result – the outline did not stretch.
2. Care must be taken when using this tool as unwanted stretching can occur.

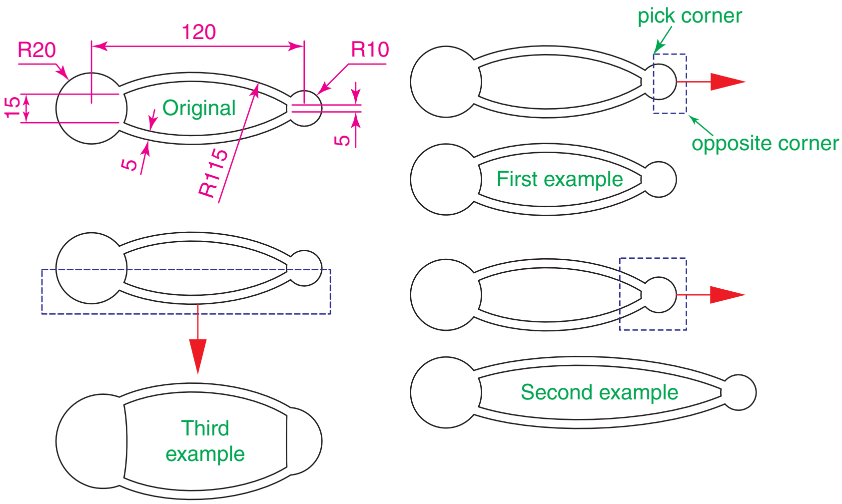

Fig. 5.34 Examples – **Stretch**

The Break tool

Examples – Break (Fig. 5.36)

1. Construct the rectangle, arc and circle (Fig. 5.36).
2. Call **Break** – either *click* on its tool icon in the **Home/Modify** panel (Fig. 5.35), *pick* its tool icon in the **Modify** toolbar, *click* **Break** in the **Modify** drop-down menu, or *enter* **br** or **break** at the command line, which shows:

For drawings 1 and 2

```
Command:_break Select object:pick at the point
Specify second break point or [First point]:pick
Command:
```

Fig. 5.35 The **Break** tool icon from the **Home/Modify** panel

For drawing 3

```
Command:_break Select object pick at the point
Specify second break point or [First point]:
  enter f right-click
Specify first break point:pick
Specify second break point:pick
Command:
```

The results are shown in Fig. 5.36.

Note

Remember the default rotation of AutoCAD 2010 is counterclockwise. This apples to the use of the **Break** tool.

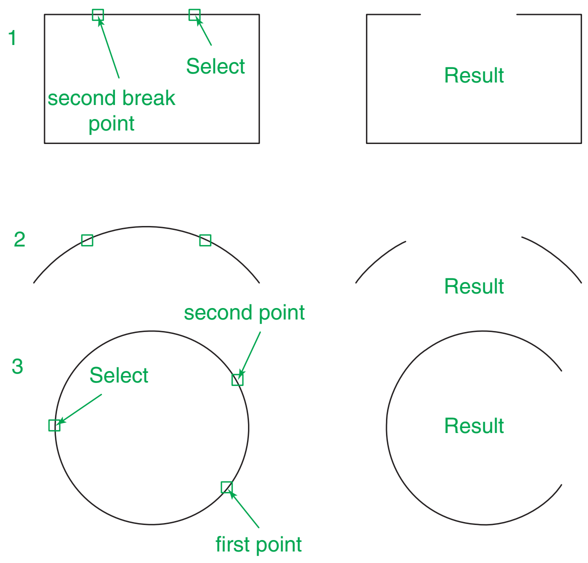

Fig. 5.36 Examples – **Break**

The Join tool

The **Join** tool can be used to join plines providing their ends are touching; to join lines which are in line with each other; to join arcs and convert arcs to circles.

Examples – Join (Fig. 5.38)

1. Construct a rectangle from four separate plines – drawing **1** of Fig. 5.38. Construct two lines – drawing **2** of Fig. 5.38 and an arc – drawing **3** of Fig. 5.38.
2. Call the **Join** tool – either *click* on the **Join** tool icon in the **Home/Modify** panel (Fig. 5.37), *left-click* its tool icon in the **Modify** toolbar, select **Join** from the **Modify** drop-down menu, or *enter* **join** or **j** at the command line. The command line shows:

```
Command: _join Select source object:
Select objects to join to source:pick a pline 1
  found
Select objects to join to source:pick another 1
  found, 2 total
Select objects to join to source:pick another 1
  found, 3 total
Select objects to join to source:right-click
3 segments added to polyline
```

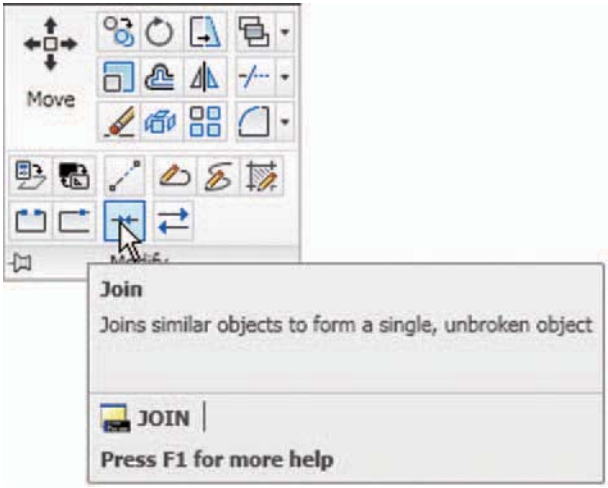

Fig. 5.37 The **Join** tool icon from the **Home/Modify** panel

```
Command:right-click
JOIN Select source object:pick one of the lines
Select lines to join to source:pick the other 1 found
Select lines to join to source:right-click
1 line joined to source
Command:right-click
JOIN Select source object:pick the arc
Select arcs to join to source or [cLose]:enter
  right-click
Arc converted to a circle.
Command:
```

The results are shown in Fig. 5.38

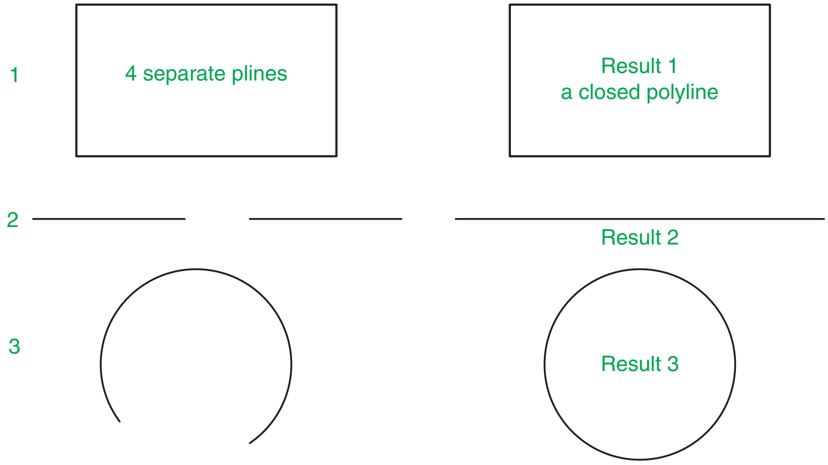

Fig. 5.38 Examples – **Join**

The Extend tool

Examples – Extend (Fig. 5.40)

1. Construct plines and a circle as shown in the left-hand drawings of Fig. 5.40.
2. Call **Extend** – either *click* on the **Extend** tool icon in the **Modify** toolbar (Fig. 5.39), *pick* **Extend** from the **Modify** drop-down menu, or *enter* **ex** or **extend** at the command line which then shows:

```
Command:_extend
Current settings: Projection = UCS Edge = Extend
Select boundary edges ...
Select objects or <select all> :pick 1 found
Select objects:right-click
Select object to extend or shift-select to trim
  or[Fence/Crossing/Project/Edge/Undo]:pick
Repeat for each object to be extended. Then:
Select object to extend or shift-select to trim or
  [Fence/Crossing/Project/Edge/Undo]:right-click
Command:
```

Fig. 5.39 The **Extend** tool icon in the **Modify** toolbar in the **AutoCAD Classic** workspace

The results are shown in Fig. 5.40.

Note

Observe the similarity of the **Extend** and **No extend** prompts with those of the **Trim** tool.

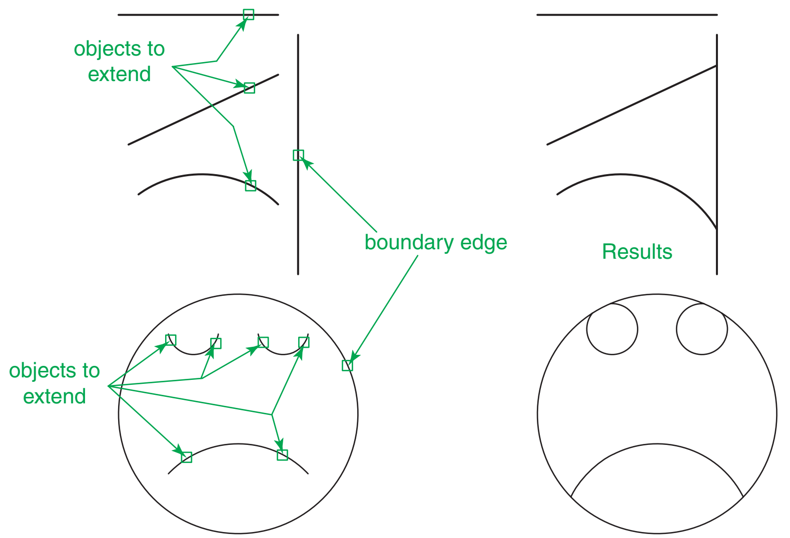

Fig. 5.40 Examples – **Extend**

The Fillet and Chamfer tools

These two tools can be called from the **Home/Modify** panel. There are similarities in the prompt sequences for these two tools. The major differences are that only one (**Radius**) setting is required for a fillet, but two (**Dist1** and **Dist2**) are required for a chamfer. The basic prompts for both are:

Fillet

```
Command:_fillet
Current settings: Mode = TRIM, Radius = 1
Select first object or [Polyline/Radius/Trim/
  Multiple]:enter r (Radius) right-click
Specify fillet radius <1> : 15
```

Chamfer

```
Command:_chamfer
(TRIM mode) Current chamfer Dist1 = 1, Dist2 = 1
Select first line or [Undo/Polyline/Distance/
  Angle/Trim/Method/Multiple]:enter d (Distance)
  right-click
Specify first chamfer distance <1> : 10
Specify second chamfer distance
  <10> :right-click
```

Examples – Fillet (Fig. 5.42)

1. Construct three rectangles 100 by 60 using either the **Line** or the **Polyline** tool (Fig. 5.42).
2. Call **Fillet** – *click* the arrow to the right of the tool icon in the **Home/Modify** panel and select **Fillet** from the menu which appears (Fig. 5.41), *pick* its tool icon in the **Modify** toolbar, *pick* **Fillet** from the **Modify** drop-down menu, or *enter* **f** or **fillet** at the command line which then shows:

```
Command:_fillet
Current settings: Mode = TRIM, Radius = 1
Select first object or [Polyline/Radius/Trim/
  Multiple]: r (Radius)
Specify fillet radius <0> : 15
Select first object or [Undo/Polyline/Radius/Trim/
  Multiple]:pick
Select second object or shift-select to apply
  corner:pick
Command:
```

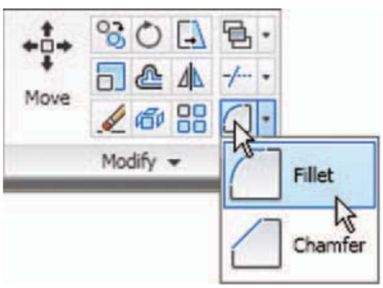

Fig. 5.41 Select **Fillet** from the menu in the **Home/Modify** panel

Three examples are given in Fig. 5.42.

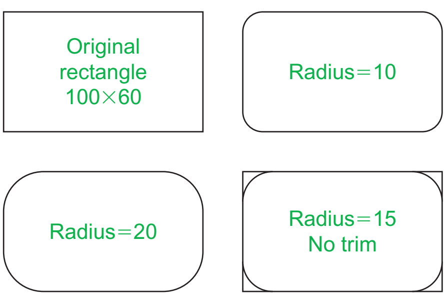

Fig. 5.42 Examples – **Fillet**

Examples – Chamfer (Fig. 5.44)

1. Construct three rectangles 100 by 60 using either the **Line** or the **Polyline** tool.
2. Call Chamfer – *click* the arrow to the right of the tool icon in the **Home/Modify** panel and select **Chamfer** from the menu which appears (Fig. 5.43), *click* on its tool icon in the **Modify** toolbar, *pick* **Chamfer** from the **Modify** drop-down menu, or *enter* **cha** or **chamfer** at the command line which then shows:

```
Command:_chamfer
(TRIM mode) Current chamfer Dist1 = 1, Dist2 = 1
Select first line or
  [Undo/Polyline/Distance/Angle/Trim/
Method/Multiple]: d
Specify first chamfer distance <1> : 10
Specify second chamfer distance
  <10> :right-click
Select first line or [Undo/Polyline/Distance/Angle/
  Trim/Method/Multiple]:pick the first line for the
  chamfer
Select second line or shift-select to apply
  corner:pick
Command:
```

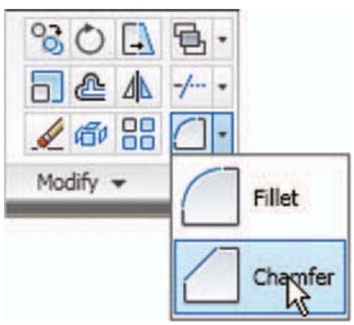

Fig. 5.43 Select **Chamfer** from the **Home/Modify** panel

The result is shown in Fig. 5.44. The other two rectangles are chamfered in a similar manner except that the **No trim** prompt is brought into operation with the bottom left-hand example.

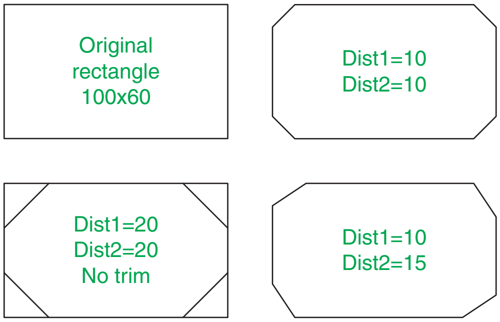

Fig. 5.44 Examples – **Chamfer**

REVISION NOTES

1. The **Modify** tools are among the most frequently used tools in AutoCAD 2010.
2. The abbreviations for the **Modify** tools are:

   Copy – cp or co

   Mirror – mi

   Offset – o

   Array – ar

   Move – m

   Rotate – ro

   Scale – sc

   Stretch – s

   Trim – tr

   Extend – ex

   Break – br

   Join – j

   Chamfer – cha

   Fillet – f
3. There are two other tools in the **Modify** toolbar or in the **2D Draw** control panel – **Erase** – some examples were given in Chapter 2 and **Explode** – further details of this tools will be given in Chapter 9

A note – selection windows and crossing windows

In the **Options** dialog settings can be made in the **Selection** sub-dialog for **Visual Effects**. A *click* on the **Visual Effects Settings…** button brings up another dialog. If the **Area Selection Effect** settings are set on a normal window from top left to bottom right, the window will colour in a chosen colour (default blue). A crossing window, bottom left to top right, will be coloured red (default colour). Note also that highlighting – **selection Preview Effect** – allows objects to highlight if this feature is on. These settings are shown in Fig. 5.45.

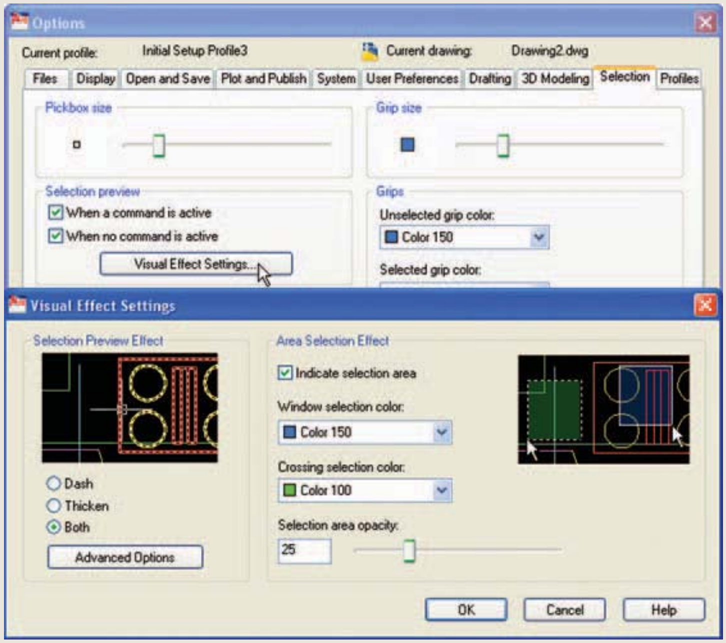

Fig. 5.45 **Visual Setting Effects Settings** sub-dialog of the **Options** dialog

4. When using **Mirror**, if text is part of the area to be mirrored, the set variable **Mirrtext** will require setting – to either **1** or **0**.
5. With **Offset** the **Through** prompt can be answered by *clicking* two points in the drawing area the distance of the desired offset distance.
6. **Polar Arrays** can be arrays around any angle set in the **Angle of array** field of the **Array** dialog.
7. When using **Scale**, it is advisable to practise the **Reference** prompt.
8. The **Trim** tool in either its **Trim** or its **No trim** modes is among the most useful tools in AutoCAD 2010.
9. When using **Stretch**, circles are unaffected by the stretching.
10. There are some other tools in the **Home/Modify** panel not described in this book. The reader is invited to experiment with these other tools. They are:
    Bring to Front, Send to Back, Bring above Objects, Send under Objects
    Set by Layer, Change Space, Lengthen, Edit Spline, Edit Hatch, Reverse.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/978-1-85617-868-6

1. Construct the drawing in Fig. 5.46. All parts are plines of width = 0.7 with corners filleted R10. The long strips have been constructed using **Circle**, **Polyline**, **Trim** and **Polyline Edit**. Construct one strip and then copy it using **Copy**.

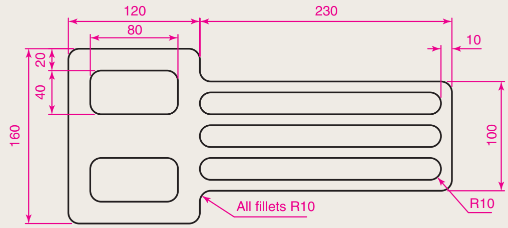

Fig. 5.46 Exercise 1

2. Construct the drawing Fig. 5.47. All parts of the drawing are plines of width = 0.7. The setting in the **Array** dialog is to be **180** in the **Angle of array** field.

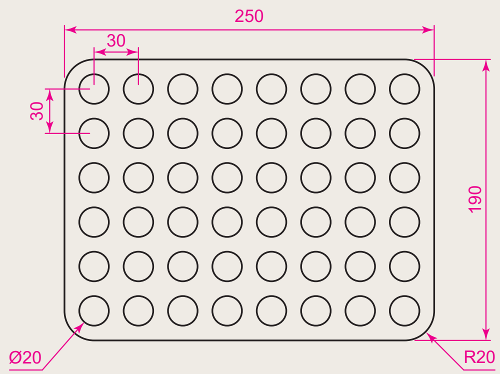

Fig. 5.47 Exercise 2

3. Using the tools **Polyline**, **Circle**, **Trim**, **Polyline Edit**, **Mirror** and **Fillet** construct the drawing in Fig. 5.48.

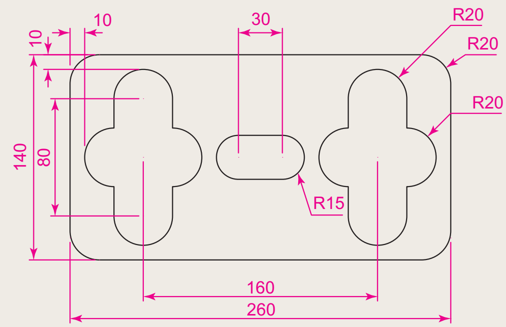

Fig. 5.48 Exercise 3

4. Construct the circles and lines in Fig. 5.49. Using **Offset** and the **Ttr** prompt of the **Circle** tool followed by **Trim**, construct one of the outlines arrayed within the outer circle. Then, with **Polyline Edit** change the lines and arcs into a pline of width = 0.3. Finally array the outline twelve times around the centre of the circles (Fig. 5.50).

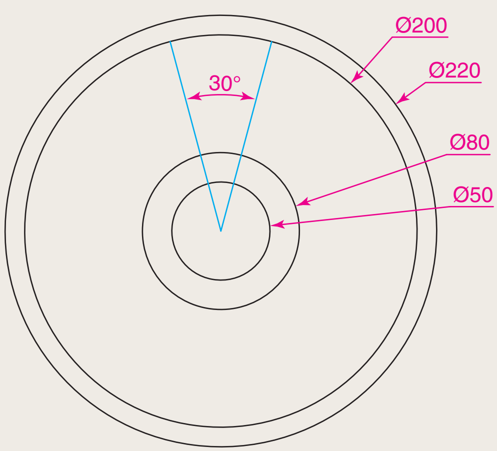

Fig. 5.49 Exercise 4 – circles and lines on which the exercise is based

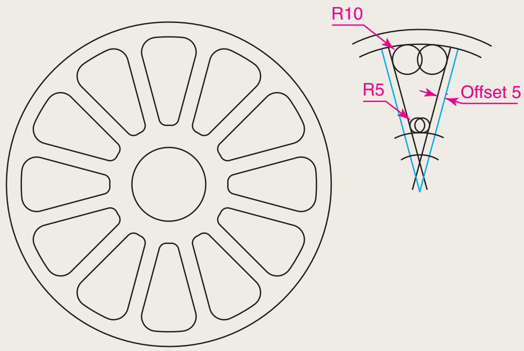

Fig. 5.50 Exercise 4

5. Construct the arrow in Fig. 5.51. Array the arrow around the centre of its circle 8 times to produce the right-hand drawing of Fig. 5 51.

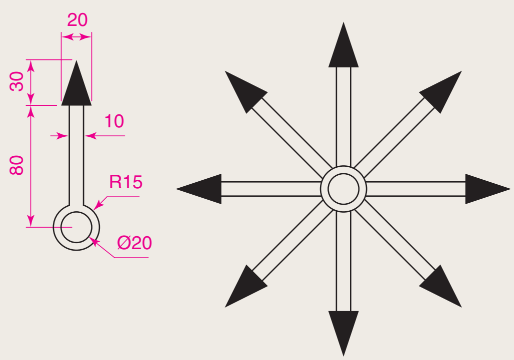

Fig. 5.51 Exercise 5

6. Construct the left-hand drawing of Fig. 5.52. Then with **Move**, move the central outline to the top left-hand corner of the outer outline. Then with **Copy** make copies to the other corners.

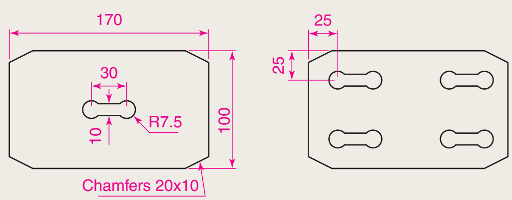

Fig. 5.52 Exercise 6

7. Construct the drawing Fig. 5.53 and make two copies using **Copy**. With **Rotate** rotate each of the copies to the angles as shown.

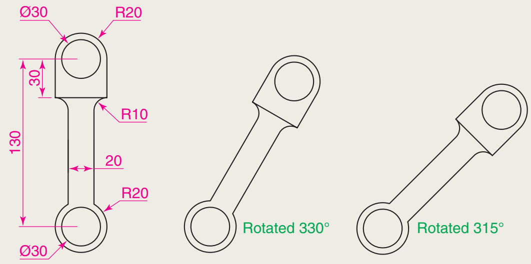

Fig. 5.53 Exercise 7

8. Construct the dimensioned drawing of Fig. 5.54. With **Copy**, copy the drawing. Then with **Scale,** scale the drawing to scale of **0.5**, followed by using **Rotate** to rotate the drawing through an angle of as shown. Finally scale the original drawing to a scale of **2:1**.

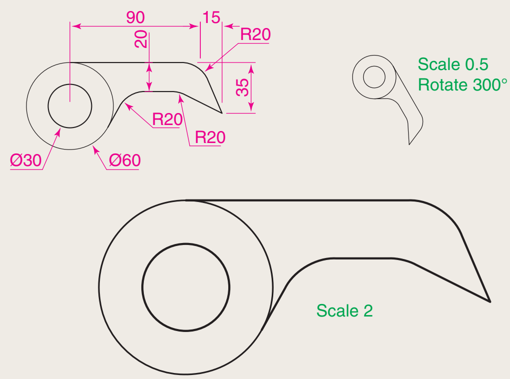

Fig. 5.54 Exercise 8

9. Construct the left-hand drawing of Fig. 5.55. Include the dimensions in your drawing. Then, using the **Stretch** tool, stretch the drawing, including its dimensions to the sizes as shown in the right-hand. The dimensions are said to be **associative**.

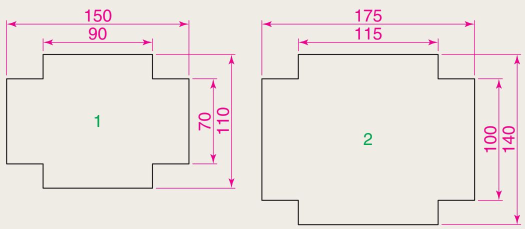

Fig. 5.55 Exercise 9

10. Construct the drawing Fig. 5.56. All parts of the drawing are plines of width = 0.7. The setting in the **Array** dialog is to be **180** in the **Angle of array** field.

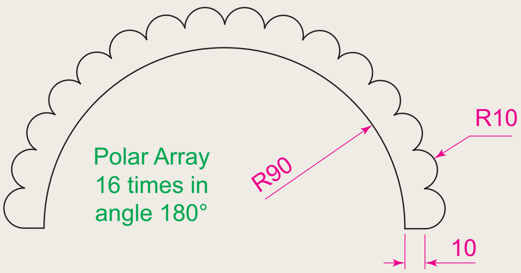

Fig. 5.56 Exercise 10

Chapter 6

Dimensions and Text

AIMS OF THIS CHAPTER

The aims of this chapter are:

1. To describe a variety of methods of dimensioning drawings.
2. To describe methods of adding text to drawings.

Introduction

The dimension style (**My_style**) has already been set in the **acadiso.dwt** template, which means that dimensions can be added to drawings using this dimension style.

The Dimension tools

There are several ways in which the dimension tools can be called.

1. From the **Annotate/Dimensions** panel (Fig. 6.1).

Fig. 6.1 Dimension tools in the **Annotate/Dimension** panel

2. From the **Dimension** toolbar (Fig. 6.2).

Fig. 6.2 The **Dimension** toolbar

3. *Click* **Dimension** in the menu bar. Dimension tools can be selected from the drop-down menu which appears.
4. By *entering* an abbreviation for a dimension tool at the command line.

Any one of these methods can be used when dimensioning a drawing, but some operators may well decide to use a combination of the four methods.

Adding dimensions using the tools

First example – Linear Dimension (Fig. 6.4)

1. Construct a rectangle 180 × 110 using the **Polyline** tool.
2. Make the **Dimensions** layer current (**Home/Layers** panel).

3. *Click* the **Linear** tool icon in the **Annotate/Dimension** panel (Fig. 6.3) or on **Linear** in the **Dimension** toolbar. The command line shows:

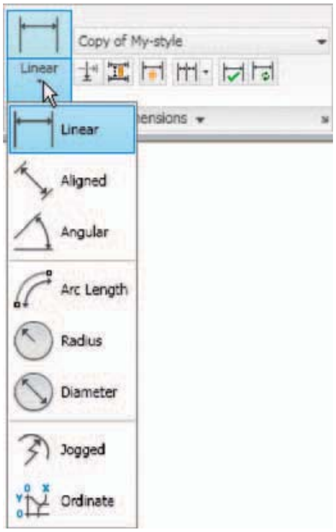

Fig. 6.3 The **Linear** tool icon in the **Annotate/Dimension** panel

```
Command: _dimlinear
Specify first extension line origin or <select
  object>:pick
Specify second extension line origin:pick
Non-associative dimension created.
Specify dimension line location or [Mtext/Text/
  Angle/Horizontal/Vertical/Rotated]:pick
Dimension text = 180
Command:
```

Fig. 6.4 shows the 180 dimension. Follow exactly the same procedure for the 110 dimension.

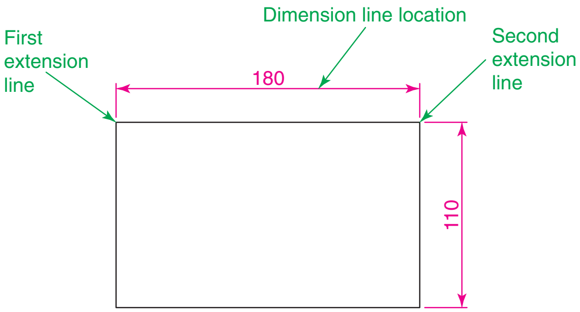

Fig. 6.4 First example – **Linear** dimension

Notes

1. If necessary use **Osnaps** to locate the extension line locations.
2. The prompt

```
Specify first extension line origin or [select
  object]:
```

also allows the line being dimensioned to be *picked*.

3. The drop-down menu from the **Line** tool icon contains the following tool icons – **Angular**, **Linear**, **Aligned**, **Arc Length**, **Radius**, **Diameter**, **Jog Line** and **Ordinate**. Please refer to Fig. 6.3 when working through the examples below. **Note** when a tool is chosen from this menu, the icon in the panel changes to the selected tool icon.

Second example – Aligned Dimension (Fig. 6.5)

1. Construct the outline Fig. 6.5 using the **Line** tool.

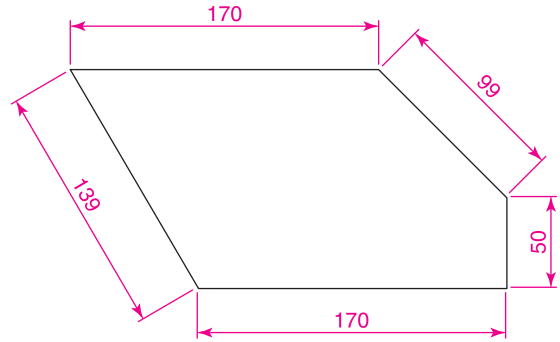

Fig. 6.5 Second example – **Aligned** dimension

2. Make the **Dimensions** layer current (**Home/Layers** panel).
3. *Left-click* the **Aligned** tool icon (see Fig. 6.3) and dimension the outline. The prompts and replies are similar to the first example.

Third example – Radius Dimension (Fig. 6.6)

1. Construct the outline Fig. 6.8 using the **Line** and **Fillet** tools.
2. Make the **Dimensions** layer current (**Home/Layers** panel).
3. *Left-click* the **Radius** tool icon (see Fig. 6.3). The command line shows:

```
Command:_dimradius
```

```
Select arc or circle:pick one of the arcs
Dimension text = 30
Specify dimension line location or [Mtext/Text/
  Angle]:pick
Command:
```

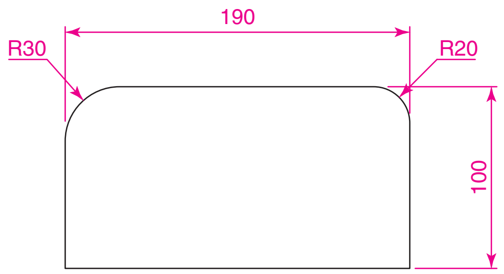

Fig. 6.6 Third example – **Radius** dimension

4. Continue dimensioning the outline as shown in Fig. 6.6.

Notes

1. At the prompt:
   `Mtext/Text/Angle]:`
   If a **t** (Text) is *entered*, another number can be *entered*, but remember if the dimension is a radius the letter **R** must be *entered* as a prefix to the new number.
2. If the response is **a** (Angle), and an angle number is *entered* the text for the dimension will appear at an angle. Fig. 6.7 shows a radius dimension *entered* as an angle of 45°.
3. If the response is **m** (Mtext) the **Text Formatting** dialog appears together with a box in which new text can be *entered*. See page 143
4. Dimensions added to a drawing using other tools from the **Dimensions** control panel or from the **Dimension** toolbar should be practised.

Adding dimensions from the command line

From Figs. 6.1 and 6.2 it will be seen that there are some dimension tools which have not been described in examples. Some operators may prefer *entering* dimensions from the command line. This involves abbreviations for the required dimension such as:

For **Linear Dimension** – **hor** (horizontal) or **ve** (vertical);
For **Aligned Dimension** – **al**;

For **Radius Dimension** – **ra**;
For **Diameter Dimension** – **d**;
For **Angular Dimension** – **an**;
For **Dimension Text Edit** – **te**;
For **Quick Leader** – **l.**

And to exit from the dimension commands – **e** (Exit).

First example – hor and ve (horizontal and vertical) – Fig. 6.8

1. Construct the outline Fig. 6.7 using the **Line** tool. Its dimensions are shown in Fig. 6.8.

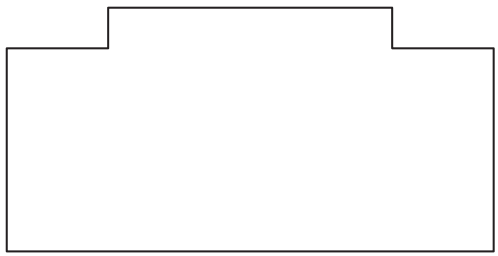

Fig. 6.7 First example – outline to dimension

2. Make the **Dimensions** layer current (**Home/Layers** panel).
3. At the command line *enter* **dim**. The command line will show:

```
Command:enter dim right-click
Dim:enter hor (horizontal) right-click
Specify first extension line origin or <select
  object>:pick
Specify second extension line origin:pick
Non-associative dimension created.
Specify dimension line location or [Mtext/Text/
  Angle]:pick
Enter dimension text <50>:right-click
Dim:right-click
HORIZONTAL
Specify first extension line origin or <select
  object>:pick
Specify second extension line origin:pick
Non-associative dimension created.
Specify dimension line location or [Mtext/Text/
  Angle/Horizontal/Vertical/Rotated]:pick
Enter dimension text <140>:right-click
Dim:right-click
```

And the 50 and 140 horizontal dimensions are added to the outline.

4. Continue to add the right-hand 50 dimension. Then when the command line shows:

```
Dim:enter ve (vertical)right-click
Specify first extension line origin or <select
  object>:pick
Specify second extension line origin:pick
Specify dimension line location or [Mtext/Text/
  Angle/Horizontal/Vertical/Rotated]:pick
Dimension text <20>:right-click
Dim:right-click
VERTICAL
Specify first extension line origin or <select
  object>:pick
Specify second extension line origin:pick
Specify dimension line location or [Mtext/Text/
  Angle/Horizontal/Vertical/Rotated]:pick
Dimension text <100>:right-click
Dim: enter e (Exit)right-click
Command:
```

The result is shown in Fig. 6.8.

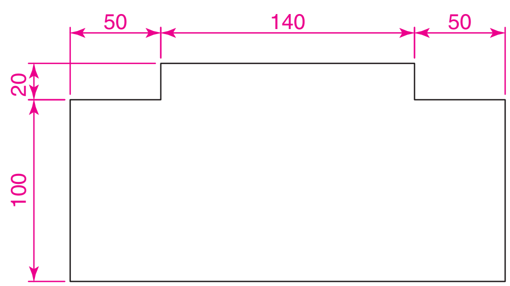

Fig. 6.8 First example – horizontal and vertical dimensions

Second example – an (Angular) – Fig. 6.10

1. Construct the outline Fig. 6.9 – a pline of width = 1.
2. Make the **Dimensions** layer current (**Home/Layers** panel).
3. At the command line:

```
Command:enter dim right-click
Dim:enter an right-click
Select arc, circle, line or <specify vertex>:
  pick
Select second line:pick
```

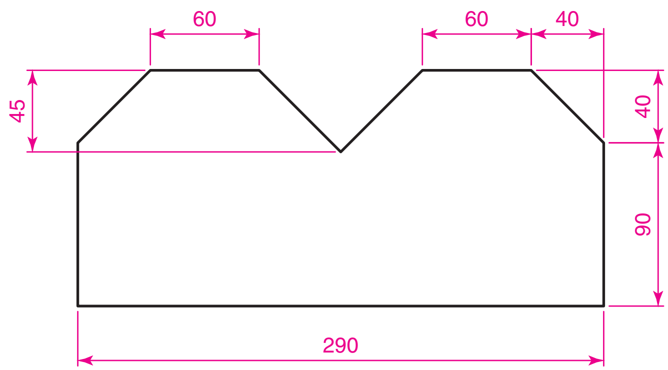

Fig. 6.9 Second example – outline for dimensions

```
Specify dimension arc line location or
  [Mtext/Text/Angle/Quadrant]:pick
Enter dimension <90>:right-click
Enter text location (or press ENTER):pick
Dim:
```

And so on to add the other angular dimensions.

The result is given in Fig. 6.10.

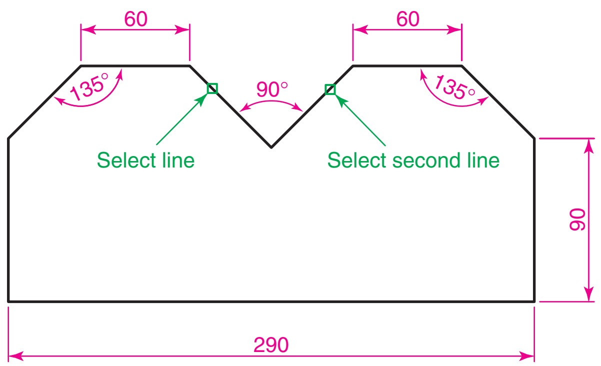

Fig. 6.10 Second example – **an** (Angular) dimension

Third example – l (Leader) – (Fig. 6.12)

1. Construct Fig. 6.11.
2. Make the **Dimensions** layer current (**Home/Layers** panel).
3. At the command line:

```
Command:enter dim right-click
Dim:enter l (Leader) right-click
```

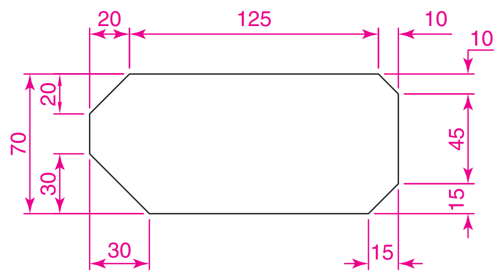

Fig. 6.11 Third example – outline for dimensioning

```
Leader start:enter nea (osnap nearest) right-click
  to pick one of the chamfer lines
To point:pick
To point:pick
To point:right-click
Dimension text <0>:enter CHA 10 × 10 right-click
Dim:right-click
```

Continue to add the other leader dimensions – Fig. 6.12.

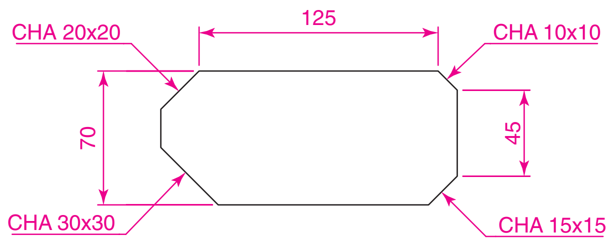

Fig. 6.12 Third example – l (Leader) dimensions

Fourth example – te (Dimension Text Edit) – (Fig. 6.14)

1. Construct Fig. 6.13.

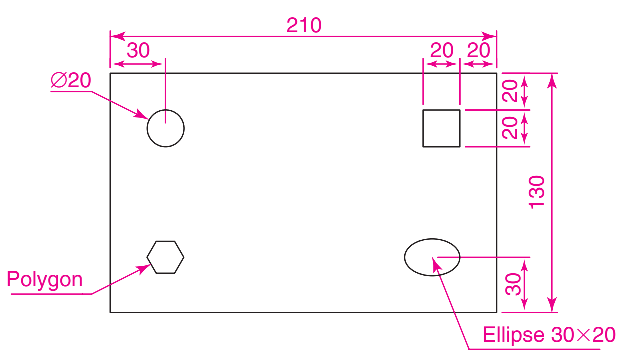

Fig. 6.13 Fourth example – dimensioned drawing

2. Make the **Dimensions** layer current (**Home/Layers** panel).
3. At the command line:

```
Command:enter dim right-click
Dim:enter te (tedit) right-click
Select dimension:pick the dimension to be changed
Specify new location for text or [Left/Right/
  Center/Home/Angle]: either pick or enter a
  prompt capital letter
Dim:
```

The results as given in Fig. 6.14 show dimensions which have been moved. The **210** dimension changed to the left-hand end of the dimension line, the **130** dimension changed to the left-hand end of the dimension line and the **30** dimension position changed.

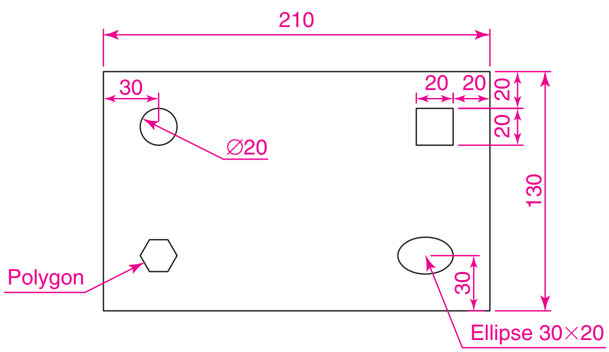

Fig. 6.14 Fourth example – dimensions amended with **te** (Dimension Text Edit)

The Arc Length tool (Fig. 6.15)

1. Construct two arcs of different sizes as in Fig. 6.15.

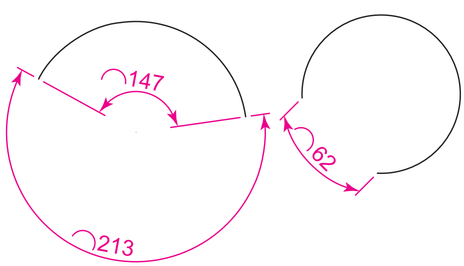

Fig. 6.15 Examples – **Arc Length** tool

2. Make the **Dimensions** layer current (**Home/Layers** panel).
3. Call the **Arc Length** tool from the **Annotate/Dimensions** panel (see Fig. 6.3), or *click* on **Arc Length** in the **Dimension** toolbar, or *enter* **dimarc** at the command line. The command line shows:

```
Command: _dimarc
Select arc or polyline arc segment:pick an arc
Specify arc length dimension location, or [Mtext/
  Text/Angle/Partial/Leader]:pick a suitable
  position
Dimension text = 147
Command:
```

Examples on two arcs are shown in Fig. 6.15.

The Jogged tool (Fig. 6.16)

1. Draw a circle and an arc as indicated in Fig. 6.16.

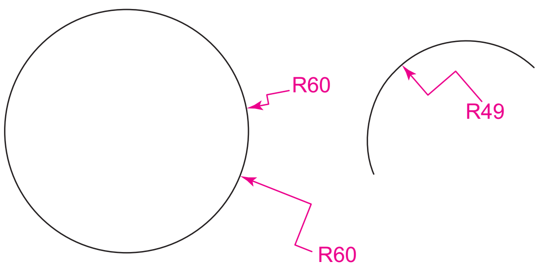

Fig. 6.16 Examples – the **Jogged** tool

2. Make the **Dimensions** layer current (**Home/Layers** panel).
3. Call the **Jogged** tool, either with a *left-click* on its tool icon in the **Annotation/Dimension** panel (see Fig. 6.3), or with a *click* on **Jogged** in the **Dimension** toolbar, or by *entering* **jog** at the command line. The command line shows:

```
Command: _dimjogged
Select arc or circle:pick the circle or the arc
Specify center location override:pick
Dimension text = 60
Specify dimension line location or [Mtext/Text/
  Angle]:pick
```

```
Specify jog location:pick
Command:
```

The results of placing a jogged dimension on a circle and an arc are shown in Fig. 6.16.

Dimension tolerances

Before simple tolerances can be included with dimensions, new settings will need to be made in the **Dimension Style Manager** dialog as follows:

1. Open the dialog. The quickest way of doing this is to *enter* **d** at the command line followed by a *right-click*. This opens up the dialog.
2. *Click* the **Modify…** button of the dialog, followed by a *left-click* on the **Primary Units** tab and in the resulting sub-dialog make settings as shown in Fig. 6.17. Note the changes in the preview box of the dialog.

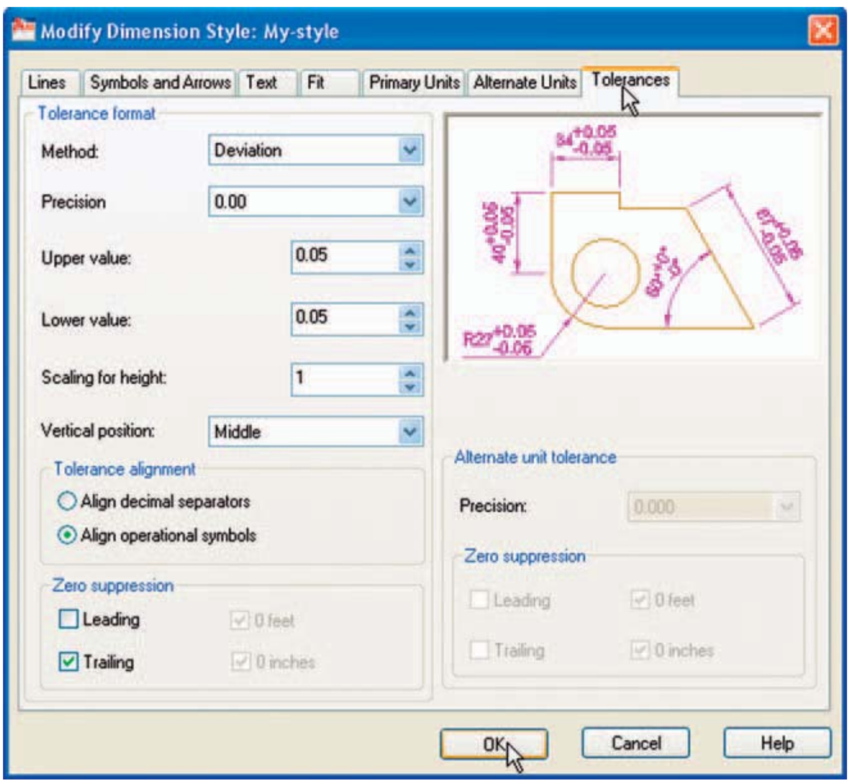

Fig. 6.17 The **Tolerances** sub-dialog of the **Modify Dimension Style** dialog

Example – tolerances (Fig. 6.19)

1. Construct the outline Fig. 6.18.

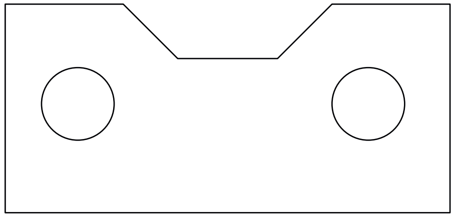

Fig. 6.18 First example – simple tolerances – outline

2. Make the **Dimensions** layer current (**Home/Layers** panel).
3. Dimension the drawing using either tools from the **Dimension** toolbar or by *entering* abbreviations at the command line. Because tolerances have been set in the **Dimension Style Manager** dialog (Fig. 6.17), the toleranced dimensions will automatically be added to the drawing (Fig. 6.19).

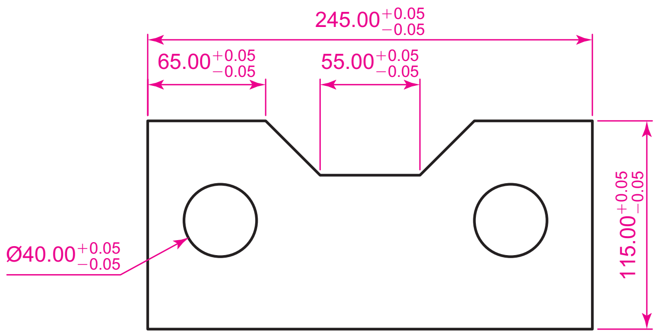

Fig. 6.19 Example – tolerances

Text

There are two main methods of adding text to drawings – **Multiline Text** and **Single Line Text**.

Example – Single Line Text (Fig. 6.23)

1. Open the drawing from the example on tolerances – Fig. 6.19.
2. Make the **Text** layer current (**Home/Layers** panel).
3. At the command line *enter* **dt** (for Single Line Text) followed by a *right-click*:

```
Command: enter dt right-click
```

CHAPTER 6

```
TEXT
Current text style "ARIAL" Text height: 8
  Annotative No:
Specify start point of text or
  [Justify/Style]:pick
Specify rotation angle of text <0>:right-click
Enter text:enter The dimensions in this drawing
  show tolerances press the Return key twice
Command:
```

The result is given in Fig. 6.20.

Notes

1. When using **Dynamic Text** the **Return** key of the keyboard is pressed when the text has been *entered*. A *right-click* does not work.

2. At the prompt:

```
Specify start point of text or [Justify/
  Style]:enter s (Style)right-click
Enter style name or [?] <ARIAL>:enter ?
  right-click
Enter text style(s) to list <*>:right-click
```

And an **AutoCAD Text Window** (Fig. 6.20) appears listing all the styles which have been selected in the **Text Style** dialog.

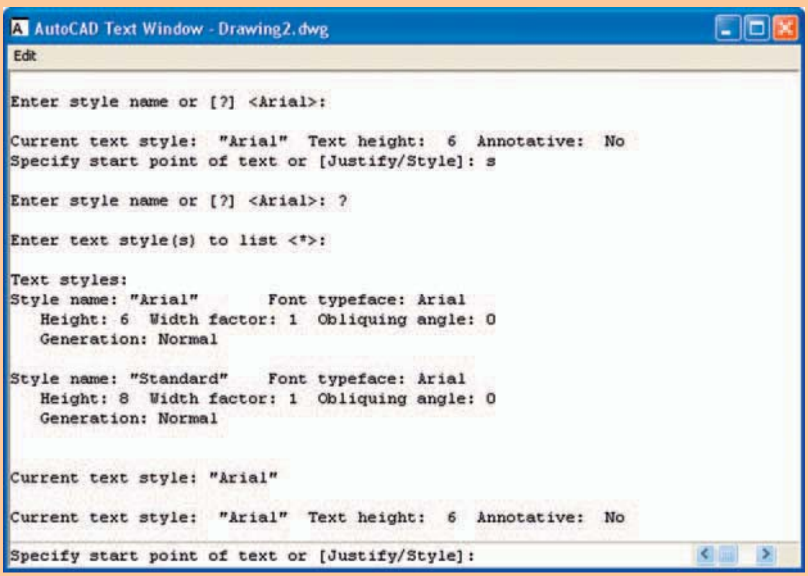

Fig. 6.20 The **AutoCAD Text Window**

3. In order to select the required text style its name must be *entered* at the prompt:

```
Enter style name or [?]
  <ARIAL>:enter Romand right-click
```

And the text *entered* will be in the **Romand** style of height **9**. But only if that style was previously selected in the **Text Style** dialog.

4. Fig. 6.21 shows some text styles from the **AutoCAD Text Window**.

This is the TIMES text

This is ROMANC text

This is ROMAND text

This is STANDARD text

This is ITALIC text

This is ARIAL text

Fig. 6.21 Some text styles

5. There are two types of text fonts available in AutoCAD 2010 – the **AutoCAD SHX** fonts and the **Windows True Type** fonts. The **ITALIC**, **ROMAND**, **ROMANS** and **STANDARD** styles shown in Fig. 6.21 are **AutoCAD** text fonts. The **TIMES** and **ARIAL** styles are **Windows True Type** styles. Most of the **True Type** fonts can be *entered* in **Bold**, **Bold Italic**, **Italic** or **Regular** styles, but these variations are not possible with the AutoCAD fonts.

6. In the **Font name** pop-up list of the **Text Style** dialog, it can be seen that a large number of text styles are available to the AutoCAD 2010 operator. It is advisable to practise using a variety of these fonts to familiarise oneself with the text opportunities available with AutoCAD 2010.

Example – Multiline Text (Fig. 6.23)

1. Make the **Text** layer current (**Home/Layers** panel).
2. Either *left-click* on the **Multiline Text** tool icon in the **Home/Annotation** panel (Fig. 6.22), or *click* on **Multiline Text…** in the **Draw** toolbar, or *enter* **t** at the command line:

```
Command:_mtext
```

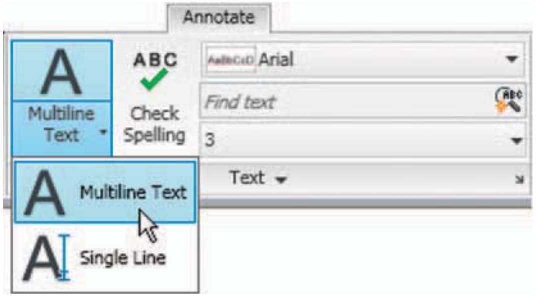

Fig. 6.22 Selecting **Multiline Text…** from the **Home/Annotation** panel

```
Current text style: "Arial" Text height: 6
  Annotative No
Specify first corner:pick
Specify opposite corner or [Height/Justify/Line
  spacing/Rotation/Style/Width/Columns]:pick
```

As soon as the **opposite corner** is *picked*, the **Text Formatting** box appears (Fig. 6.23). Text can now be *entered* as required within the box as indicated in this illustration.

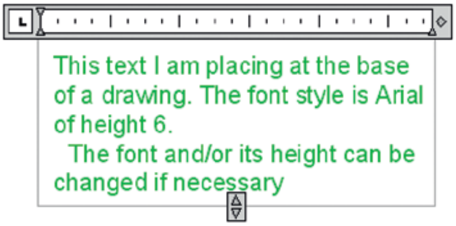

Fig. 6.23 Example – **Multiline Text** entered in the text box

When all the required text has been entered *left-click* and the text box disappears leaving the text on screen.

Symbols used in text

When text has to be added by *entering* letters and figures as part of a dimension, the following symbols must be used:

To obtain **Ø75** *enter* **%%c75**;
To obtain **55%** *enter* **55%%%**;
To obtain **±0.05** *enter* **%%p0.05**;
To obtain **90°** *enter* **90%%d**.

Checking spelling

Note

When a misspelt word or a word not in the AutoCAD spelling dictionary is *entered* in the **Multiline Text** box, red dots appear under the word, allowing immediate correction.

There are two methods for the checking of spelling in AutoCAD 2010.

First example – spell checking – ddedit (Fig. 6.24)

1. *Enter* some badly spelt text as indicated in Fig. 6.24.

Fig. 6.24 First example – **spell checking – ddedit**

2. *Enter* **ddedit** at the command line.
3. *Left-click* on the text. The text is highlighted. Edit the text as if working in a word-processing application and when satisfied *left-click* followed by a *right-click*.

Second example – the Spelling tool (Fig. 6.24)

1. *Enter* some badly spelt text as indicated in Fig. 6.24.
2. Either *click* the **Spell Check…** icon in the **Annotate/Text** panel (Fig. 6.25) or *enter* **spell** or **sp** at the command line.
3. The **Check Spelling** dialog appears (Fig. 6.26). In the **Where to look** field select **Entire drawing** from the field's pop-up list. The first badly spelt word is highlighted with words to replace them listed in the **Suggestions** field. Select the appropriate correct spelling as

Fig. 6.25 The **Spell Check…** icon in the **Annotate/Text** panel

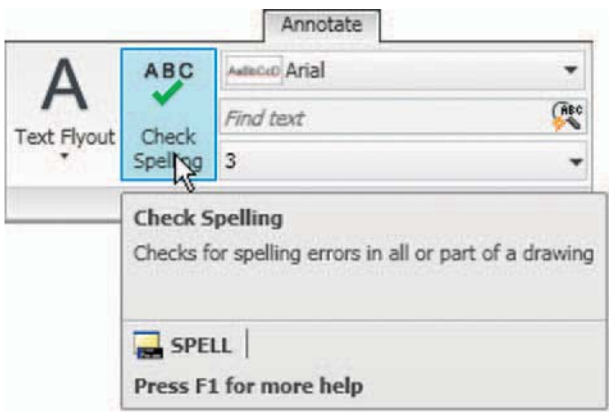

Fig. 6.26 Second example – the **Check Spelling** dialog

Fig. 6.27 The **AutoCAD Message** window showing that spelling check is complete

shown. Continue until all text is checked. When completely checked an **AutoCAD Message** appears (Fig. 6.27). If satisfied *click* its **OK** button.

REVISION NOTES

1. In the **Line and Arrows** sub-dialog of the **Dimension Style Manager** dialog **Lineweights** were set to **0.3**. If these lineweights are to show in the drawing area of AutoCAD 2010, the **Show/Hide Lineweight** button in the status bar must be set **ON**.
2. Dimensions can be added to drawings using the tools from the **Annotate/Dimensions** panel, from the **Dimension** toolbar, or by *entering* **dim**, followed by abbreviations for the tools at the command line.
3. It is usually advisable to use **Osnaps** when locating points on a drawing for dimensioning.
4. The **Style** and **Angle** of the text associated with dimensions can be changed during the dimensioning process.
5. When wishing to add tolerances to dimensions it will probably be necessary to make new settings in the **Dimension Style Manager** dialog.
6. There are two methods for adding text to a drawing – **Single Line Text** and **Multiline Text**.
7. When adding **Single Line Text** to a drawing, the **Return** key must be used and not the right-hand mouse button.
8. Text styles can be changed during the process of adding text to drawings.
9. AutoCAD 2010 uses two types of text style – **AutoCAD SHX** fonts and **Windows True Type** fonts.
10. Most **True Type** fonts can be in **bold**, ***bold italic***, *italic* or regular format. **AutoCAD** fonts can only be added in the single format.
11. To obtain the symbols Ø; ±; °; % use **%%c**; **%%p**; **%%d**; **%%%** before the figures of the dimension.
12. Text spelling can be checked by selecting **Text/Edit…** from the **Modify** drop-down menu, by selecting **Spell Check…** from the **Text** control panel, or by *entering* **spell** or **sp** at the command line.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/978-1-85617-868-6

1. Open any of the drawings previously saved from working through examples or as answers to exercises and add appropriate dimensions.

2. Construct the drawing Fig. 6.28 but in place of the given dimensions add dimensions showing tolerances of 0.25 above and below.

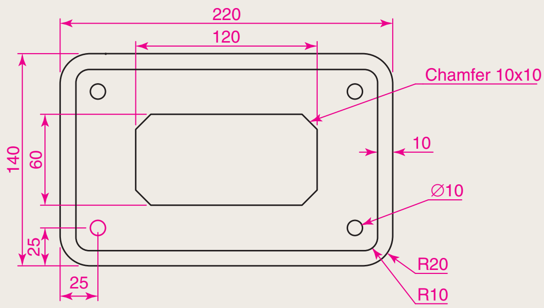

Fig. 6.28 Exercise 2

3. Construct and dimension the drawing Fig. 6.29.

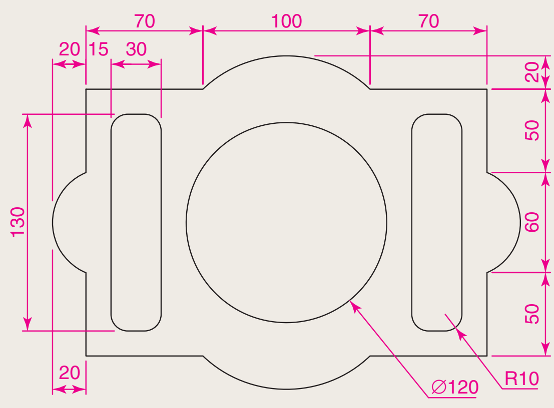

Fig. 6.29 Exercise 3

4. Construct two polygons as in Fig. 6.30 and add all diagonals. Set osnaps **endpoint** and **intersection** and using the lines as in Fig. 6.30 construct the stars as shown using a polyline of width = 3. Next erase all unwanted lines. Dimension the angles labelled **A**, **B**, **C** and **D**.

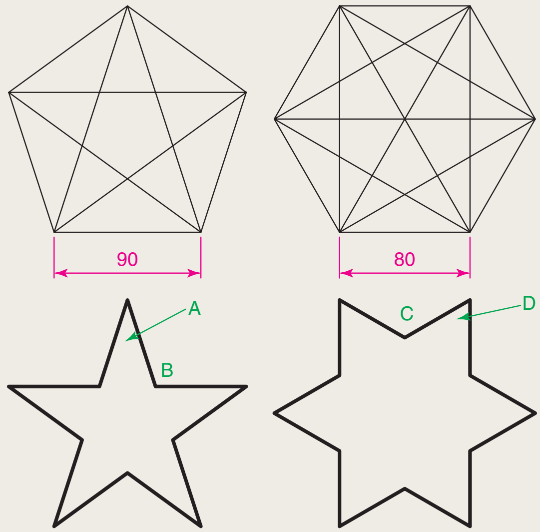

Fig. 6.30 Exercise 4

5. Using the text style **Arial** of height **20** and enclosing the wording within a pline rectangle of Width = 5 and Fillet = 10, construct Fig. 6.31.

Fig. 6.31 Exercise 5

Chapter 7

Orthographic and Isometric

AIM OF THIS CHAPTER

To introduce methods of constructing views in orthographic projection and the construction of isometric drawings.

Orthographic projection

Orthographic projection involves viewing an article being described in a technical drawing from different directions – from the front, from a side, from above, from below or from any other viewing position. Orthographic projection often involves:

The drawing of details which are hidden, using hidden detail lines.
Sectional views in which the article being drawn is imagined as being cut through and the cut surface drawn.
Centre lines through arcs, circles, spheres and cylindrical shapes.

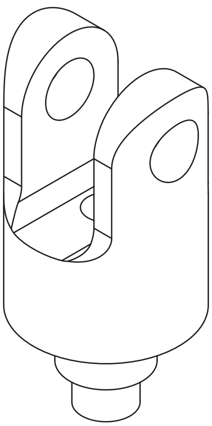

Fig. 7.1 Example – orthographic

An example of an orthographic projection

Taking the solid shown in Fig. 7.1, construct a three-view orthographic projection of the solid:

1. Draw what is seen when the solid is viewed from its left-hand side and regard this as the **front** of the solid. What is drawn will be a **front view** (Fig. 7.2).

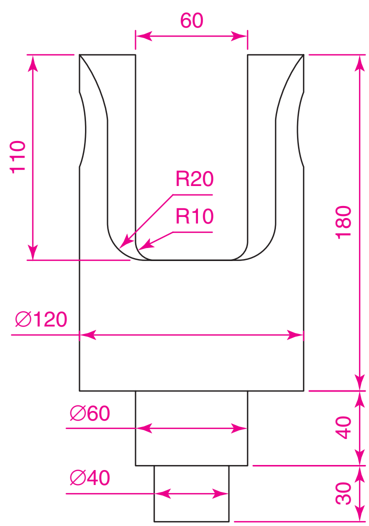

Fig. 7.2 The **front view** of the solid

2. Draw what is seen when the solid is viewed from the left-hand end of the front view. This produces an **end view**. Fig. 7.3 shows the end view alongside the front view.
3. Draw what is seen when the solid is viewed from above the front view. This produces a **plan**. Fig. 7.4 shows the plan below the front view.
4. In the **Home/Layers** panel, in the **Layer list** *click* on **Centre** to make it the current layer (Fig. 7.5). All lines will now be drawn as centre lines.

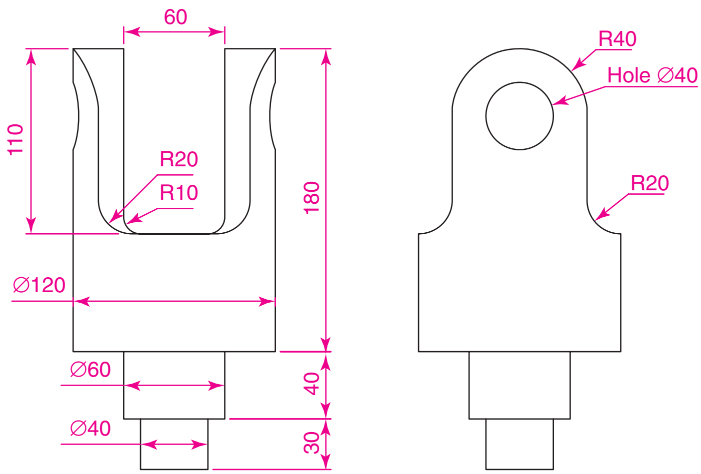

Fig. 7.3 **Front** and **end** views of the solid

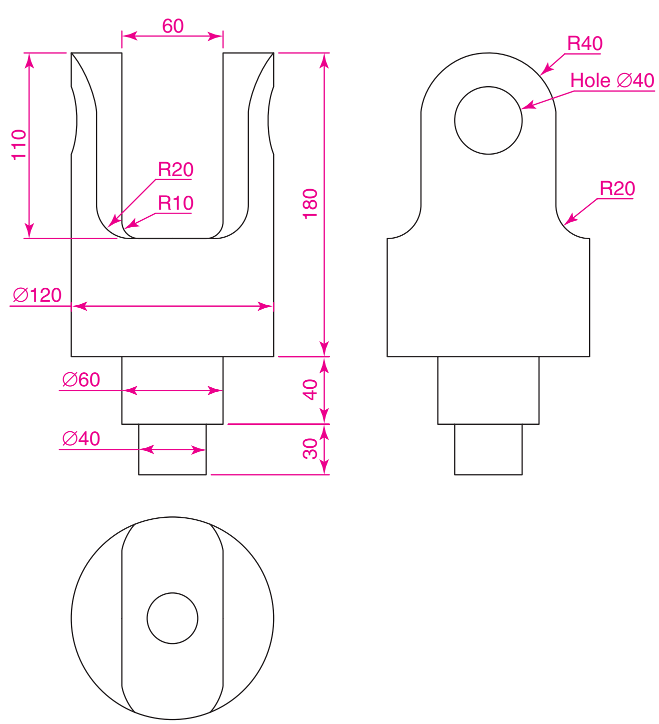

Fig. 7.4 **Front** and **end** views and **plan** of the solid

5. In the three-view drawing add centre lines.
6. Make the **Hidden** layer the current layer and add hidden detail lines.
7. Make the **Text** layer current and add border lines and a title block.
8. Make the **Dimensions** layer current and add all dimensions.

The completed drawing is shown in Fig. 7.6.

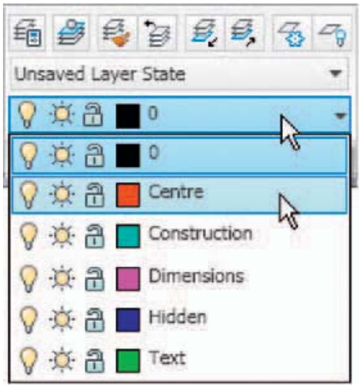

Fig. 7.5 Making the **Centre** layer current from the **Home/Layers** panel

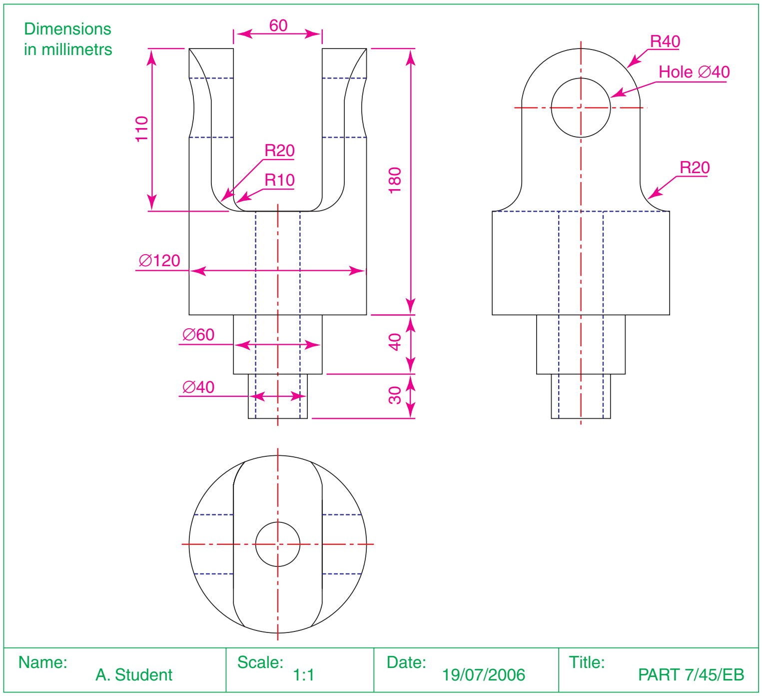

Fig. 7.6 The completed working drawing of the solid

First angle and third angle

There are two types of orthographic projection – **first angle** and **third angle**. Fig. 7.7 is a pictorial drawing of the solid used to demonstrate the two angles. Fig. 7.8 shows a three-view **first angle projection** and Fig. 7.9 the same views in **third angle**.

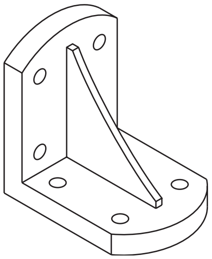

Fig. 7.7 The solid used to demonstrate first and third angles of projection

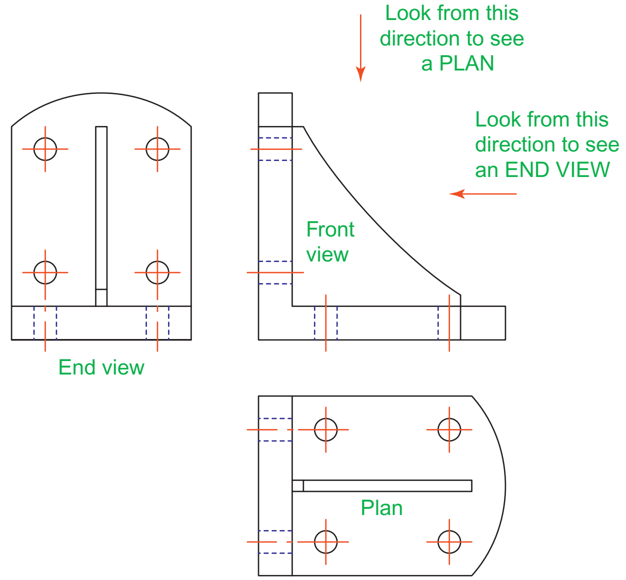

Fig. 7.8 A **first angle** projection

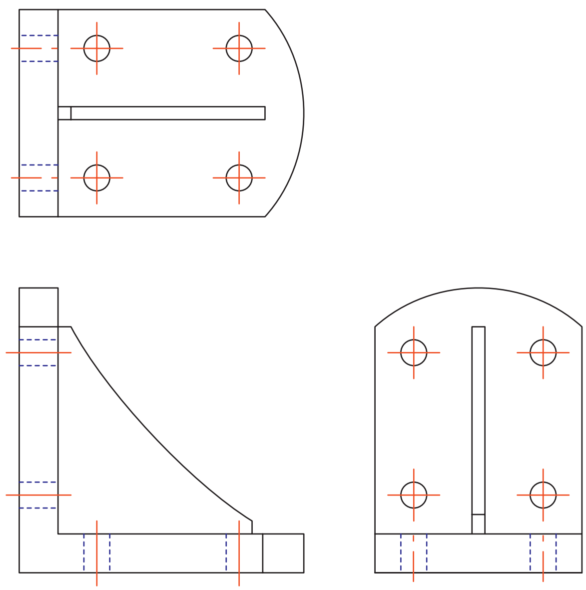

Fig. 7.9 A **third angle** projection

In both angles the viewing is from the same directions. The difference is that the view as seen is placed on the viewing side of the front view in **third angle** and on the opposite side to the viewing in **first angle**.

Sectional views

In order to show internal shapes of a solid being drawn in orthographic projection the solid is imagined as being cut along a plane and the cut surface then drawn as seen. Common practice is to **hatch** the areas which then show in the cut surface. Note the section plane line, the section label and the hatching in the sectional view Fig. 7.10.

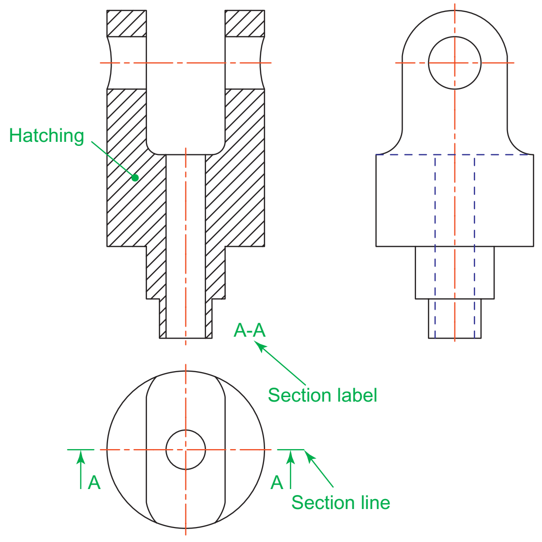

Fig. 7.10 A sectional view

Adding hatching

To add the hatching as shown in Fig. 7.10:

1. Call the **Hatch** tool – either *left-click* on its tool icon in the **Home/Draw** panel (Fig. 7.11), *click* the tool in the **Draw** toolbar, or *enter* **h** at the command line. (***Note*** – do not *enter* **hatch** as this gives a different result). The **Hatch and Gradient** dialog (Fig. 7.12) appears.

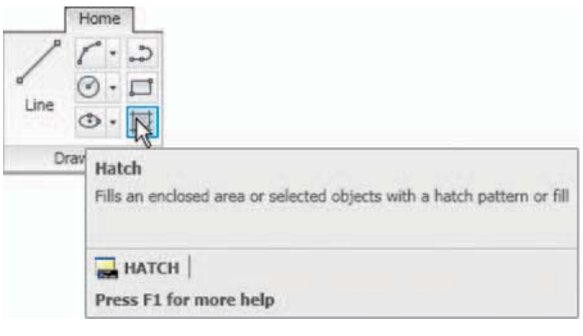

Fig. 7.11 The **Hatch** tool icon and tooltip from the **Home/Draw** panel

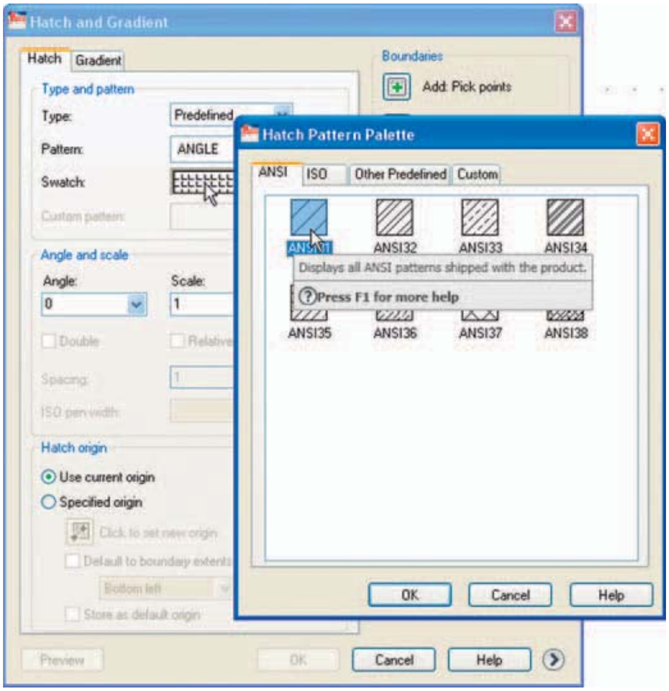

Fig. 7.12 The **Hatch and Gradient** dialog and the **ANSI Hatch Pattern** palette

2. *Click* in the **Swatch** field. The **Hatch Pattern Palette** appears. *Left-click* the **ANSI** tab and from the resulting pattern icons *double-click* the **ANSI31** icon. The palette disappears and the **ANSI31** pattern appears in the **Swatch** field.
3. In the dialog *left-click* the **Pick an internal point** button (Fig. 7.13). The dialog disappears.

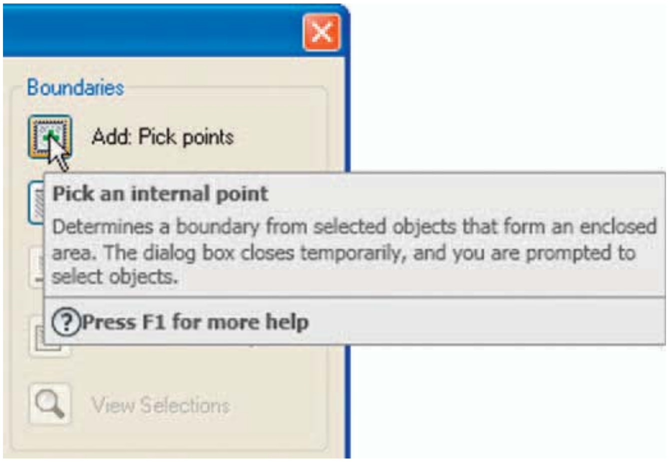

Fig. 7.13 The **Pick an internal point** button of the **Boundary Hatch and Fill** dialog

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4. In the front view *pick* points as shown in the left-hand drawing of Fig. 7.14. The dialog reappears. *Click* the **Preview** button of the dialog and, in the sectional view which reappears, check whether the hatching is satisfactory. In this example it may well be that the **Scale** figure in the dialog needs to be *entered* as **2** in place of the default **1**. Press the **Esc** key of the keyboard and the dialog returns. Change the figure and **Preview** again. If satisfied *right-click*.

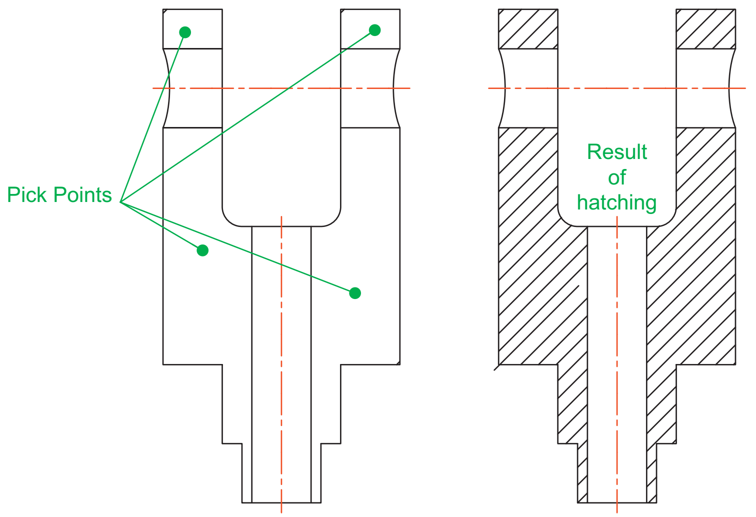

Fig. 7.14 The result of hatching

Isometric drawing

Isometric drawing must not be confused with solid model drawing, examples of which are given in Chapters 12 to 19. Isometric drawing is a 2D method of describing objects in a pictorial form.

Setting the AutoCAD window for isometric drawing

To set the AutoCAD 2010 window for the construction of isometric drawings:

1. At the command line:

```
Command:enter snap
Specify snap spacing or [On/Off/Aspect/Rotate/
  Style/Type] <5>: s (Style)
Enter snap grid style [Standard/Isometric] <S>:
  i (Isometric)
Specify vertical spacing <5>:right-click
Command:
```

And the grid dots in the window assume an isometric pattern as shown in Fig. 7.15. Note also the cursor hair lines which are at set in an **Isometric Left** angle.

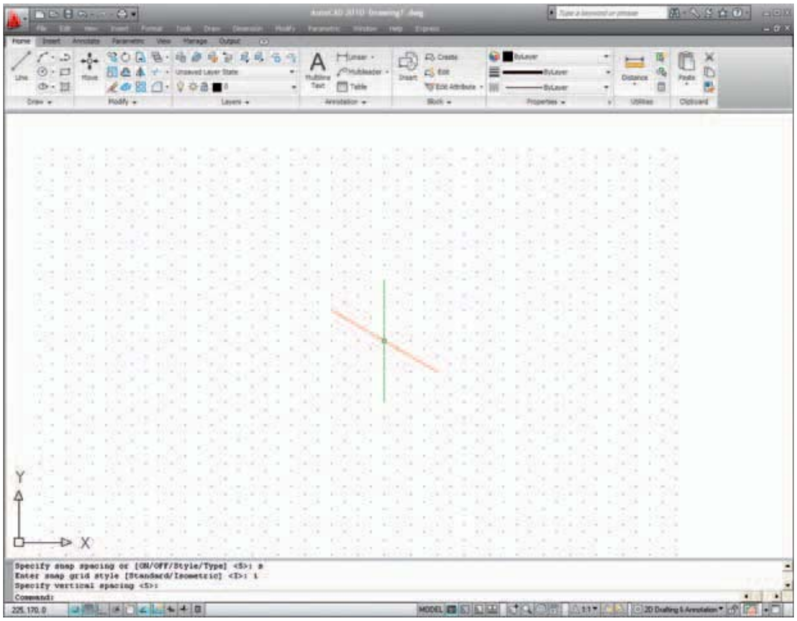

Fig. 7.15 The AutoCAD grid points set for isometric drawing

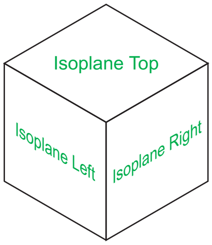

Fig. 7.16 The three isoplanes

2. There are three isometric angles – **Isoplane Top**, **Isoplane Left** and **Isoplane Right**. These can be set either by pressing the **F5** function key or by pressing the **Ctrl** and **E** keys. Repeated pressing of either of these "toggles" between the three settings. Fig. 7.16 is an isometric view showing the three isometric planes.

The Isometric circle

Circles in an isometric drawing show as ellipses. To add an isometric circle to an isometric drawing, call the **Ellipse** tool. The command line shows:

```
Command: _ellipse
Specify axis endpoint of ellipse or [Arc/Center/
  Isocircle]:enter i (Isocircle) right-click
Specify center of isocircle:pick or enter
  coordinates
Specify radius of isocircle or [Diameter]:enter a
  number
Command:
```

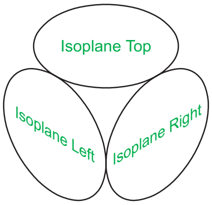

Fig. 7.17 The three isocircles

And the isocircle appears. Its isoplane position is determined by which of the isoplanes is in operation at the time the isocircle was formed. Fig 7.17 shows these three isoplanes containing isocircles.

Examples of isometric drawings

First example – isometric drawing (Fig. 7.20)

1. Working to the shapes and sizes given in the orthographic projection Fig. 7.18. Set **Snap** on (press the **F9** function key) and **Grid** on (**F7**).
2. Set **Snap** to **Isometric** and set the isoplane to **Isoplane Top** using **F5**.
3. With **Line**, construct the outline of the top of the model (Fig. 7.19) working to the dimensions given in Fig. 7.18.

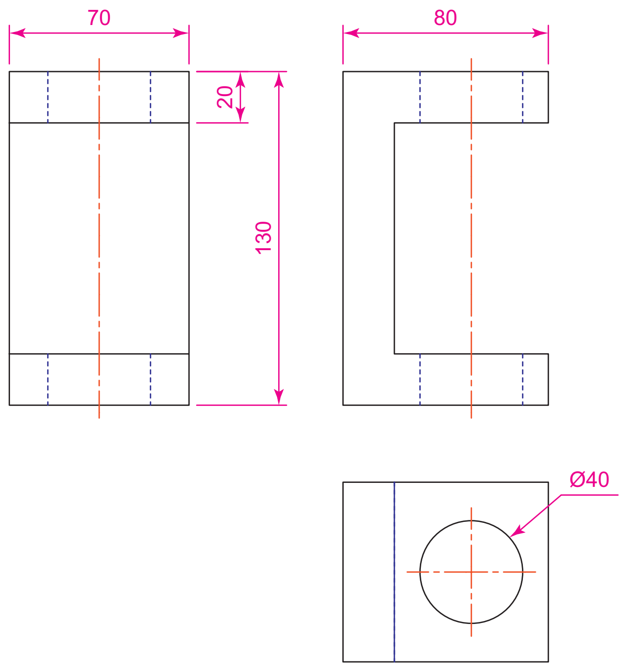

Fig. 7.18 First example – isometric drawing – the model

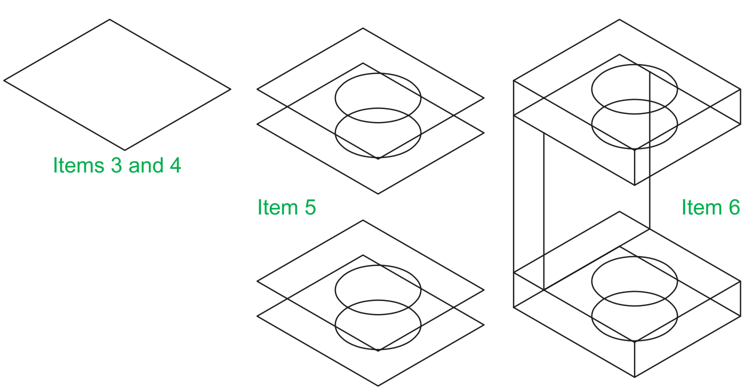

Fig. 7.19 First example – isometric drawing – items **3**, **4**, **5** and **6**

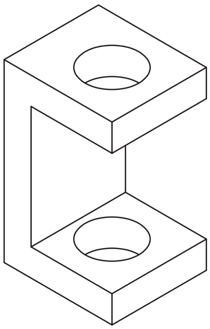

Fig. 7.20 First example – isometric drawing

4. Call **Ellipse** tool and set to isocircle and add the isocircle of radius 20 centred in its correct position in the outline of the top (Fig. 7.19).
5. Set the isoplane to **Isoplane Right** and with the **Copy** tool, copy the top with its ellipse vertically downwards three times as shown in Fig. 7.20.
6. Add lines as shown in Fig. 7.19.
7. Finally using **Trim** remove unwanted parts of lines and ellipses to produce Fig. 7.20.

Second example – isometric drawing (Fig. 7.22)

Fig. 7.21 is an orthographic projection of the model of which the isometric drawing is to be constructed. Fig. 7.22 shows the stages in its construction. The numbers refer to the items in the list below.

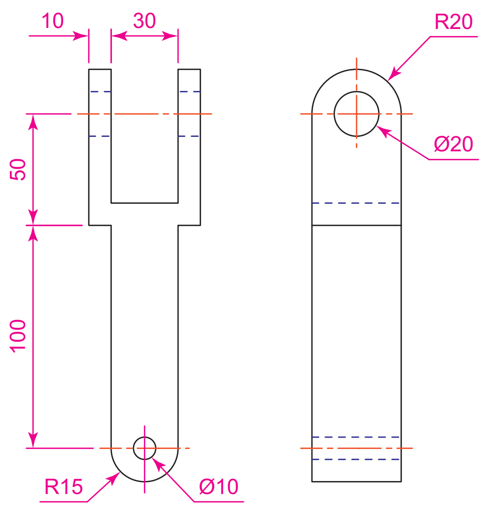

Fig. 7.21 Second example – isometric drawing – orthographic projection of model

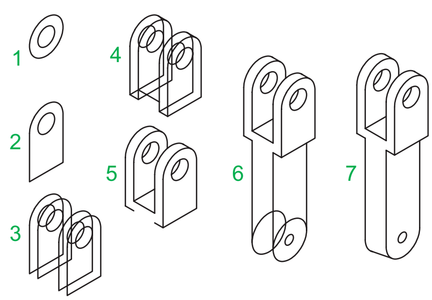

Fig. 7.22 Second example – isometric drawing – stages in the construction

1. In **Isoplane Right** construct two isocircles of radii 10 and 20.
2. Add lines as in drawing **2** and trim unwanted parts of isocircle.
3. With **Copy**, copy three times as in drawing **3**.

4. With **Trim**, trim unwanted lines and parts of isocircle as in drawing **4**.
5. In **Isoplane Left** add lines as in drawing **5**.
6. In **Isoplane Right** add lines and isocircles as in drawing **6**.
7. With **Trim**, trim unwanted lines and parts of isocircles to complete the isometric drawing – drawing **7**.

REVISION NOTES

1. There are, in the main, two types of orthographic projection – first angle and third angle.
2. The number of views included in an orthographic projection depends upon the complexity of the component being drawn – a good rule to follow is to attempt fully describing the object in as few views as possible.
3. Sectional views allow parts of an object which are normally hidden from view to be more fully described in a projection.
4. When a layer is turned **OFF**, all constructions on that layer disappear from the screen.
5. If a layer is locked, objects can be added to the layer but no further additions or modifications can be added to the layer. If an attempt is made to modify an object on a locked layer, a small lock icon appears near the object and the command line shows:

```
Command: _erase
Select objects:pick 1 found
1 was on a locked layer
```

   and the object will not be modified.

6. Frozen layers cannot be selected, but note that layer **0** cannot be frozen.
7. Isometric drawing is a 2D pictorial method of producing illustrations showing objects. It is not a 3D method of showing a pictorial view.
8. When drawing ellipses in an isometric drawing the **Isocircle** prompt of the **Ellipse** tool command line sequence must be used.
9. When constructing an isometric drawing **Snap** must be set to **Isometric** mode before construction can commence.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/ 978-1-85617-868-6

Fig. 7.23 is an isometric drawing of a slider fitment on which the three exercises **1**, **2** and **3** are based.

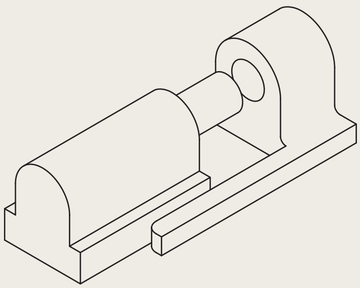

Fig. 7.23 Exercises 1, 2 and 3 – an isometric drawing of the three parts of the slider on which these exercises are based

1. Fig. 7.24 is a first angle orthographic projection of part of the fitment shown in the isometric drawing Fig. 7.23. Construct a three-view third angle orthographic projection of the part.

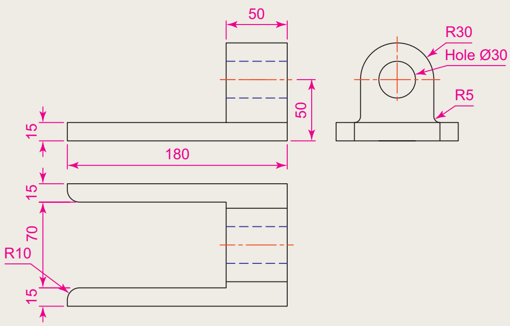

Fig. 7.24 Exercise 1

2. Fig. 7.25 is a first angle orthographic projection of the other part of the fitment. Construct a three-view third angle orthographic projection of the part.

3. Construct an isometric drawing of the part shown in Fig. 7.25.

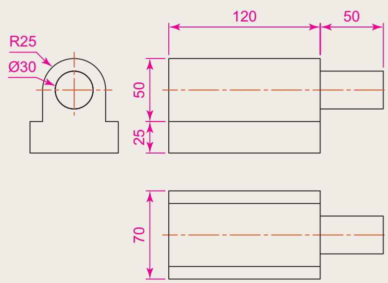

Fig. 7.25 Exercises 2 and 3

4. Construct a three-view orthographic projection in an angle of your own choice of the tool holder assembled as shown in the isometric drawing Fig. 7.26. Details are given in Fig. 7 27.

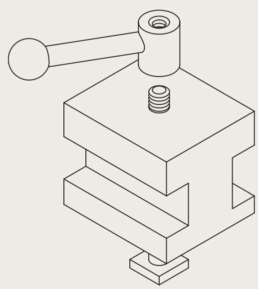

Fig. 7.26 Exercises 4 and 5 – orthographic projections of the three parts of the tool holder

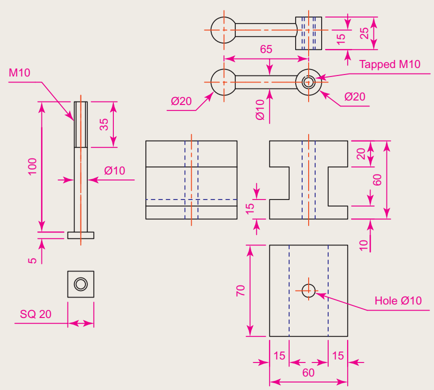

Fig. 7.27 Exercises 4 and 5 – orthographic drawing of the tool holder on which the two exercises are based

5. Construct an isometric drawing of the body of the tool holder shown in Figures 7.26 and 7.27.

6. Construct the orthographic projection given in Fig. 7.29.

7. Construct an isometric drawing of the angle plate shown in Figures 7.28 and 7.29.

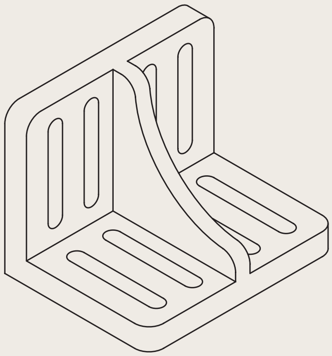

Fig. 7.28 An isometric drawing of the angle plate on which exercises 6 and 7 are based

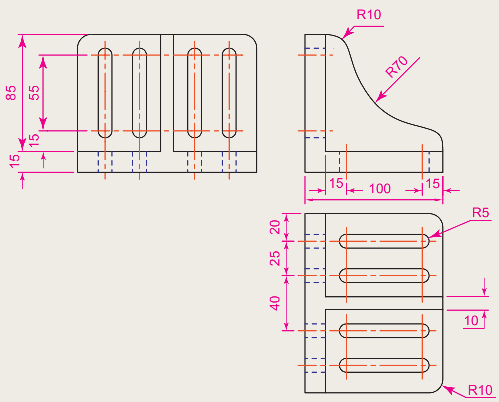

Fig. 7.29 Exercises 6 and 7 – an orthographic projection of the angle plate

8. Construct a third angle projection of the component shown in the isometric drawing Fig. 7.30 and the three-view first angle projection Fig. 7.31.

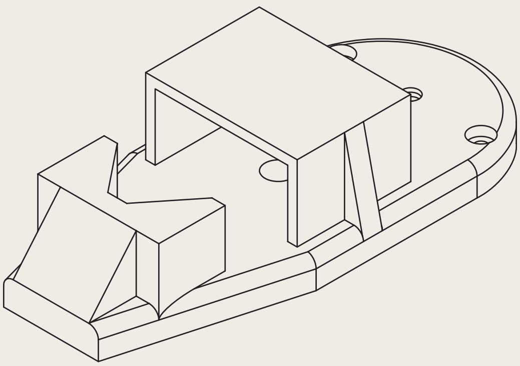

Fig. 7.30 Exercises 8 and 9 – an isometric drawing of the component for the two exercises

9. Construct the isometric drawing shown in Fig. 7.30 working to the dimensions given in Fig. 7.31.

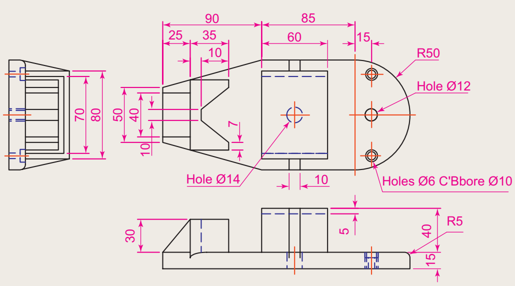

Fig. 7.31 Exercises 8 and 9

Chapter 8

Hatching

AIM OF THIS CHAPTER

To give further examples of the use of hatching in its various forms.

Introduction

In Chapter 7 an example of the hatching of a sectional view in an orthographic projection was given. Further examples of the use of hatching will be described in this chapter.

There are a large number of hatch patterns available when hatching drawings in AutoCAD 2010. Some examples from the **Other Predefined** set of hatch patterns (Fig. 8.2) in the **Hatch Pattern Palette** sub-dialog are shown in Fig. 8.1.

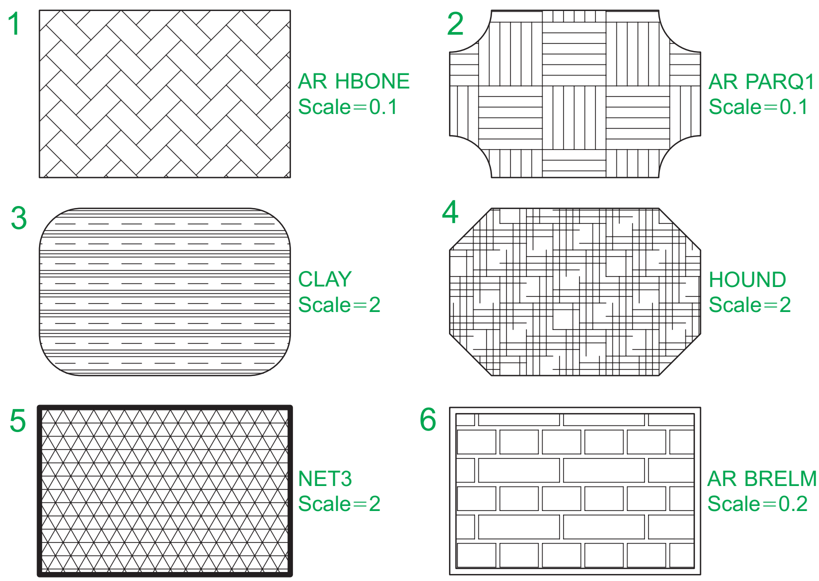

Fig. 8.1 Some hatch patterns from **Predefined** hatch patterns

Other hatch patterns can be selected form the **ISO** or **ANSI** hatch pattern palettes, or the operator can design his/her own hatch patterns and save them to the **Custom** hatch palette.

First Example – hatching a sectional view (Fig. 8.3)

Figure. 8.3 shows a two-view orthographic projection which includes a sectional end view. Note the following in the drawing:

1. The section plane line, consisting of a centre line with its ends marked **A** and arrows showing the direction of viewing to obtain the sectional view.
2. The sectional view labelled with the letters of the section plane line.
3. The cut surfaces of the sectional view hatched with the **ANSI31** hatch pattern, which is in general use for the hatching of engineering drawing sections.

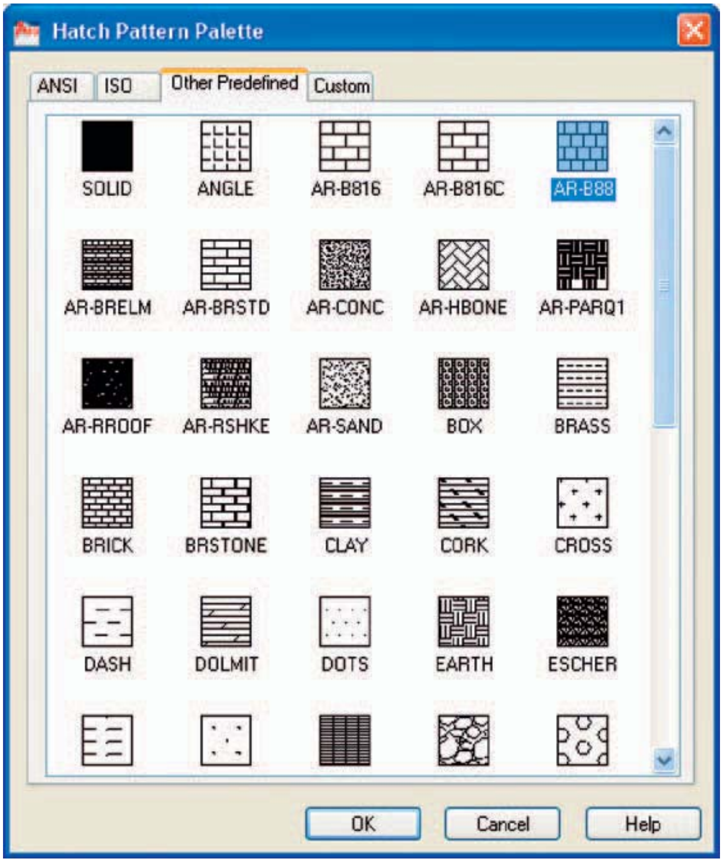

Fig. 8.2 The **Other Predefined** Hatch Pattern Palette

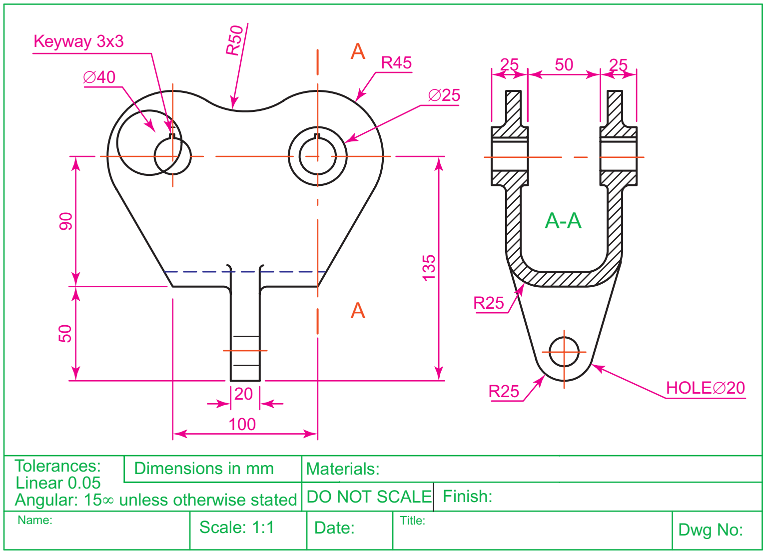

Fig. 8.3 First example – **Hatching**

Second example – hatching rules (Fig. 8.4)

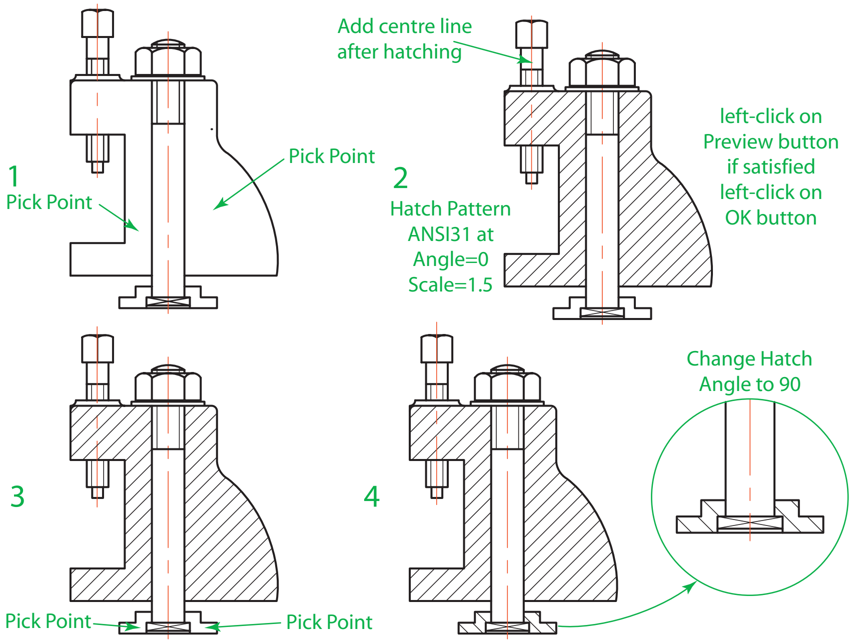

Fig. 8.4 Second example – hatching rules for sections

Figure 8.4 describes the stages in hatching a sectional end view of a lathe tool holder. Note the following in the section:

1. There are two angles of hatching to differentiate separate parts of the section.
2. The section follows the general rule that parts such as screws, bolts, nuts, rivets, other cylindrical objects, webs and ribs and other such features are shown as outside views within sections.

Third example – Associative hatching (Fig. 8.5)

Figure 8.5 shows two end views of a house. After constructing the left-hand view, it was found that the upper window had been placed in the wrong position. Using the **Move** tool, the window was moved to a new position. The brick hatching automatically adjusted to the new position. Such associative hatching is only possible if check box is **ON –** a tick in the check box in the **Options** area of the dialog (Fig. 8.6).

Fourth example – Colour Gradient hatching (Fig. 8.9)

Figure 8.8 shows two examples of hatching from the **Gradient** sub-dialog of the **Hatch and Gradient** dialog.

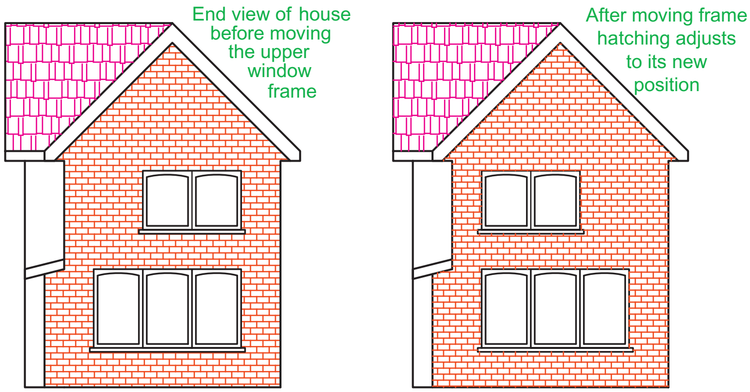

Fig. 8.5 Third example – **Associative** hatching

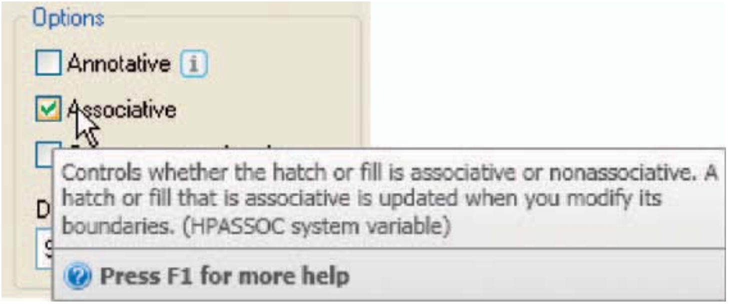

Fig. 8.6 **Associative** hatching set ON in the **Hatch and Gradient** dialog

1. Construct two outlines each consisting of six rectangles (Fig. 8.9).
2. *Click* the **Gradient** icon in the **Home/Draw** panel (Fig. 8.7) or in the **Draw** toolbar. In the **Hatch and Gradient** dialog which appears

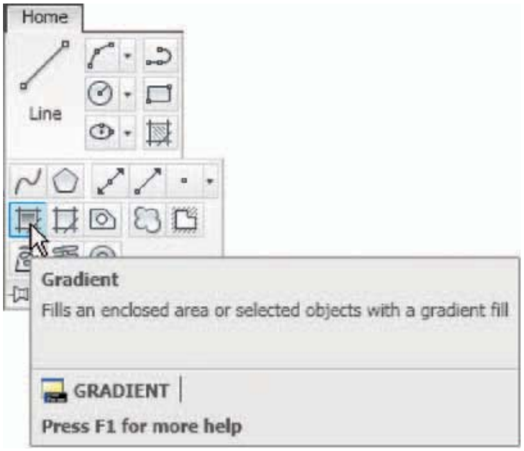

Fig. 8.7 The **Gradient…** tool icon from the **Home/Draw** panel

(Fig. 8.8) *pick* one of the gradient choices, followed with a *click* on the **Pick an internal point** button. *Click* one of the colour panels in the dialog and when then the dialog disappears, *pick* a single area of one of the rectangles in the left-hand drawings, followed by a *click* on the dialog's **OK** button when the dialog reappears.

3. Repeat in each of the other rectangles of the left-hand drawing, changing the pattern in each of the rectangles.
4. *Click* the button (…) to the right of the **Color** field, select a new colour from the **Select Color** dialog which appears and repeat items **3** and **4** in six rectangles.

The result is shown in Fig. 8.9.

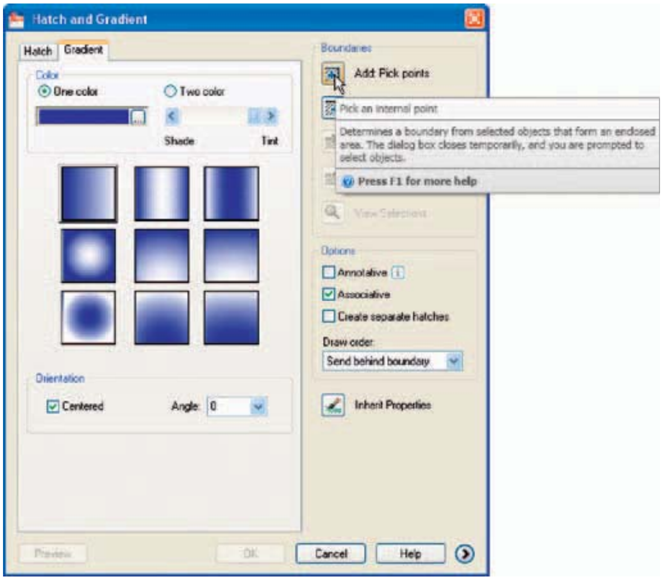

Fig. 8.8 The **Hatch and Gradient** dialog

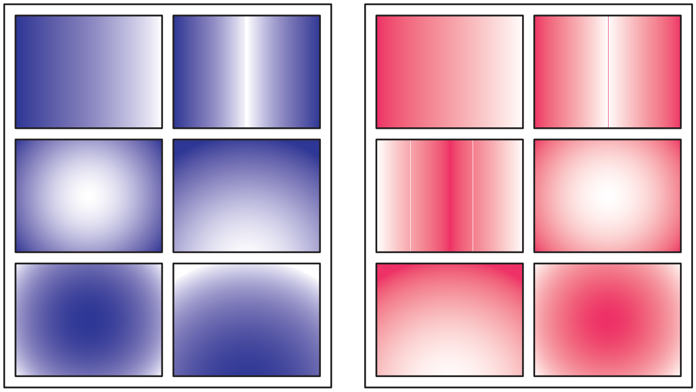

Fig. 8.9 Fourth example – **Gradient** hatching

> **Note**
>
> If the **Two color** radio button is set on (dot in circle) the colours involved in the gradient hatch can be changed by *clicking* the button marked with three full stops (…) on the right of the colour field. This brings a **Select Color** dialog on screen, which offers three choices of sub-dialogs from which to select colours.

Fifth example – advanced hatching (Fig. 8.12)

Fig. 8.11 The **Island display style** selections in the expanded **Hatch and Gradient** dialog

If the arrow at the bottom right-hand corner of the **Hatch and Gradient** dialog is *clicked* (Fig. 8.10) the dialog expands to show the **Island display style** selections (Fig. 8.11).

Fig. 8.10 The **More Options** arrow of the **Hatch and Gradient** dialog

1. Construct a drawing which includes three outlines as shown in the left-hand drawing of Fig. 8.12 and copy it twice to produce three identical drawings.
2. Select the hatch patterns **STARS** at an angle of **0** and scale **1**.
3. *Click* in the **Normal** radio button of the **Island display style** area.
4. *Pick* a point in the left-hand drawing. The drawing hatches as shown.
5. Repeat in the centre drawing with the radio button of the **Outer** style set on (dot in button).
6. Repeat in the right-hand drawing with **Ignore** set on.

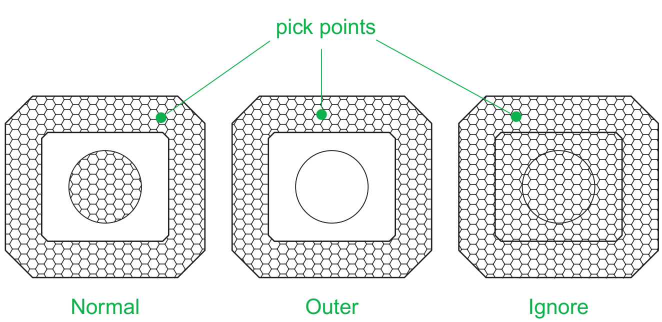

Fig. 8.12 Fifth example – advanced hatching

Sixth example – text in hatching (Fig. 8.13)

1. Construct a pline rectangle using the sizes given in Fig. 8.13.
2. In the **Text Style Manager** dialog, set the text font to **Arial** and its **Height = 25**.
3. Using the **Dtext** tool *enter* the text as shown central to the rectangle.
4. Hatch the area using the **HONEY** hatch pattern set to an angle of **0** and scale of **1**.

The result is shown in Fig. 8.13.

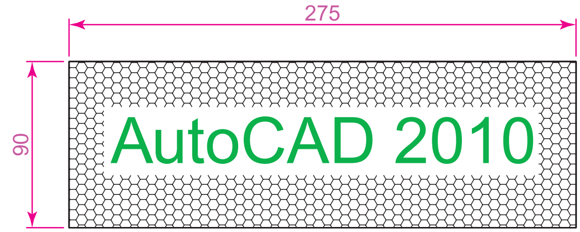

Fig. 8.13 Sixth example – text in hatching

Note

Text will be entered with a surrounding boundary area free from hatching providing the **Normal** radio button of the **Island display style** selection is on.

Seventh example – advanced hatching (Fig. 8.14)

1. From the **Home/Layers** panel open the **Layer** list with a *click* on the arrow to the right of the **Layer Control** field (Fig. 8.14).

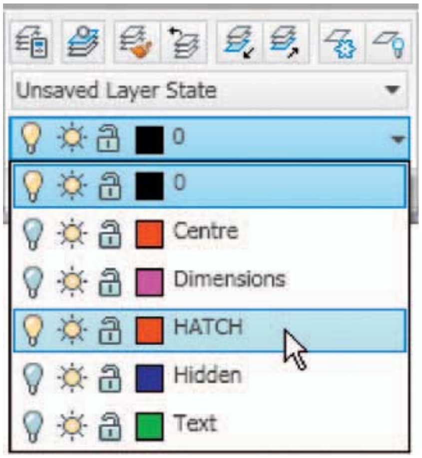

Fig. 8.14 Seventh example – the layers setup for the advanced hatch example

2. Note the extra added layer **HATCH** colour red (Fig. 8.14).
3. With the layer **0** current construct the outline as given in Fig. 8.15.

Fig. 8.15 Seventh example – construction on layer **0**

4. Make layer **Text** current and construct the lines as shown in Fig. 8.16.

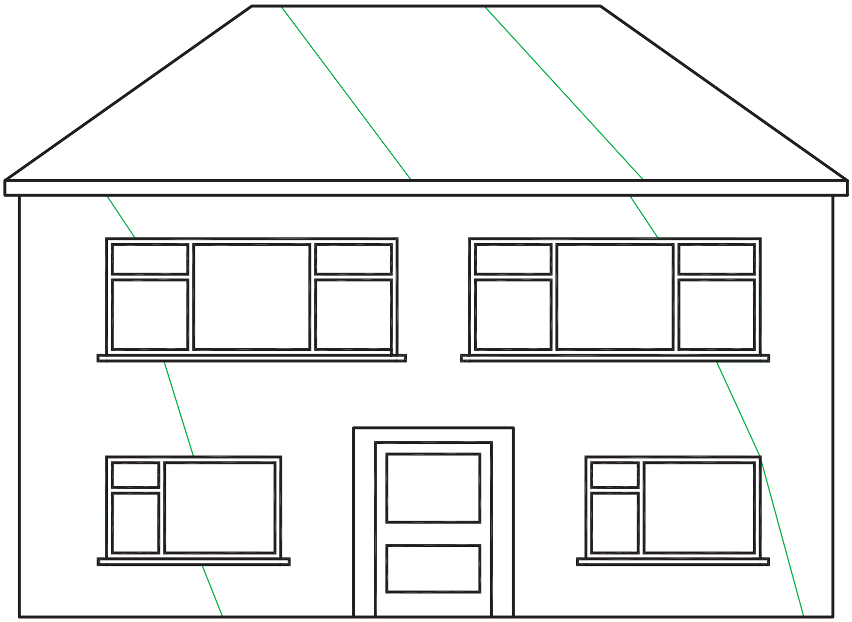

Fig. 8.16 Seventh example – construction on layer **Text**

5. Make the layer **HATCH** current and add hatching to the areas shown in Fig. 8.17 using the hatch patterns **ANGLE** at scale **2** for the roof and **BRICK** at a scale of **0.75** for the wall.

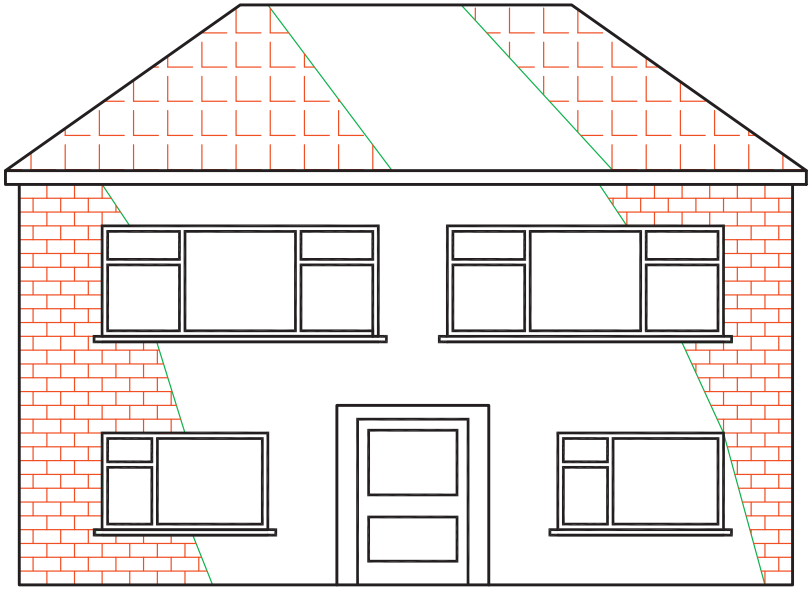

Fig. 8.17 Seventh example – construction on layer **HATCH**

6. Finally turn the layer **Text** off. The result is given in Fig. 8.18.

Fig. 8.18 Seventh example – the finished drawing

REVISION NOTES

1. A large variety of hatch patterns are available when working with AutoCAD 2010.
2. In sectional views in engineering drawings it is usual to show items such as bolts, screws, other cylindrical objects, webs and ribs as outside views.
3. When **Associative** hatching is set on, if an object is moved within a hatched area, the hatching accommodates to fit around the moved object.
4. Colour gradient hatching is available in AutoCAD 2010.
5. When hatching takes place around text, a space around the text will be free from hatching.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/ 978-1-85617-868-6

1. Figure 8.19 is a pictorial drawing of the component shown in the three-view orthographic projection Fig. 8 20. Construct the three views but with the front view as a sectional view based on the section plane **A–A**.

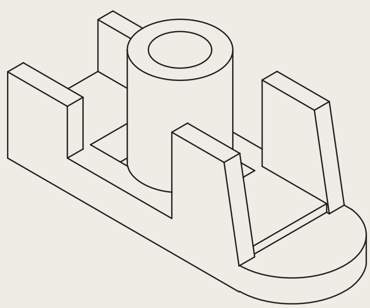

Fig. 8.19 Exercise 1 – a pictorial view

2. Construct the three-view orthographic projection Fig. 8.21 to the given dimensions with the front view as the sectional view **A-A**.

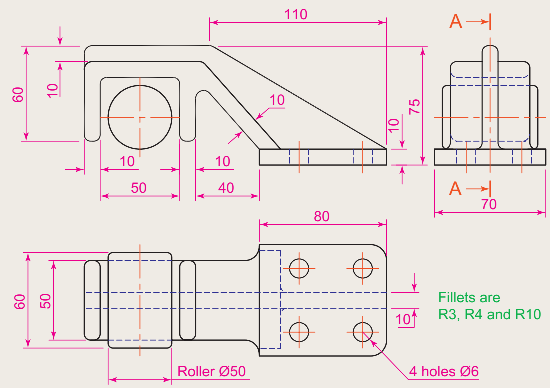

Fig. 8.21 Exercise 2

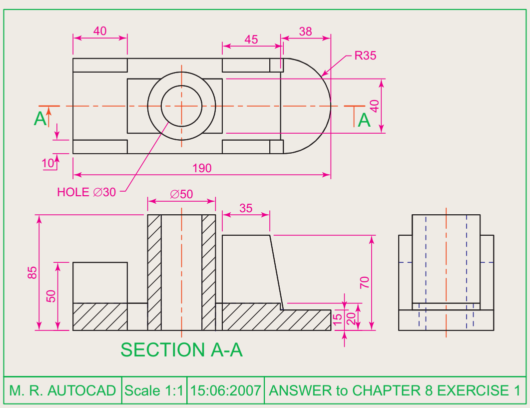

Fig. 8.20 Exercise 1

3. Construct the drawing **Stage 5** following the descriptions of stages given in Fig. 8.22.

Fig. 8.22 Exercise 3

CHAPTER 8

4. Fig. 8.23 is a front view of a car with parts hatched. Construct a similar drawing of any make of car, using hatching to emphasise the shape.

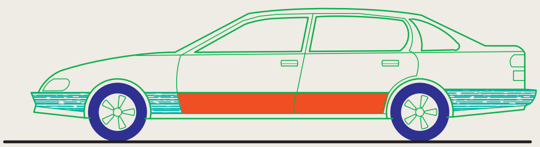

Fig. 8.23 Exercise 4

5. Working to the notes given with the drawing Fig. 8.24, construct the end view of a house as shown. Use your own discretion about sizes for the parts of the drawing.

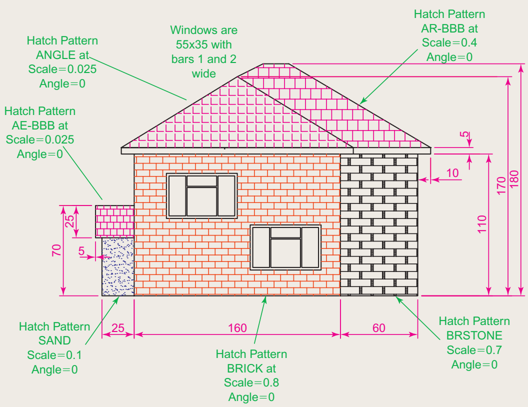

Fig. 8.24 Exercise 5

6. Working to dimensions of your own choice, construct the three-view projection of a two-storey house as shown in Fig. 8.25.

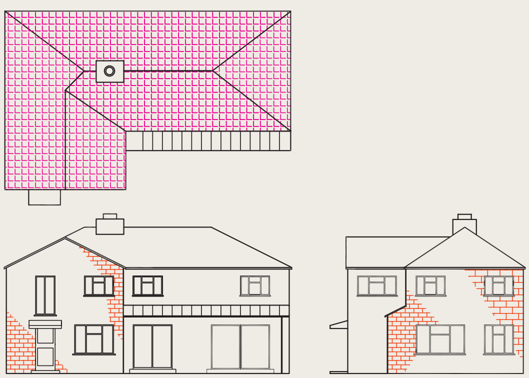

Fig. 8.25 Exercise 6

7. Construct Fig. 8.26 as follows:

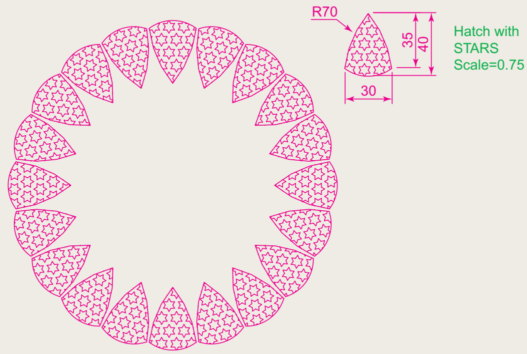

Fig. 8.26 Exercise 7

(a) On layer **Text**, construct a circle of radius **90**.
(b) Make layer **0** current.
(c) Construct the small drawing to the details as shown and save as a block with a block name **shape** (see Chapter 9).
(d) Call the **Divide** tool by *entering* **div** at the command line:

```
Command:enter div right-click
Select object to divide:pick
  the circle
Enter number of segments or
  [Block]:enter b right-click
Enter name of block to insert:
  enter shape right-click
Align block with object? [Yes/
  No] <Y > :right-click
Enter the number of segments:
  enter 20 right-click
Command:
```

(e) Turn the layer **Text** off.

Chapter 9

Blocks and Inserts

AIMS OF THIS CHAPTER

The aims of this chapter are:

1. To describe the construction of **blocks** and **wblocks** (written blocks).
2. To introduce the insertion of **blocks** and **wblocks** into drawings.
3. To introduce uses of the **DesignCenter** palette.
4. To explain the use of the **Explode** and **Purge** tools.

Introduction

Blocks are drawings which can be inserted into other drawings. Blocks are contained in the data of the drawing in which they have been constructed. Wblocks (written blocks) are saved as drawings in their own right, but can be inserted into other drawings if required.

Blocks

First example – Blocks (Fig. 9.3)

1. Construct the building symbols as shown in Fig. 9.1 to a scale of 1:50.

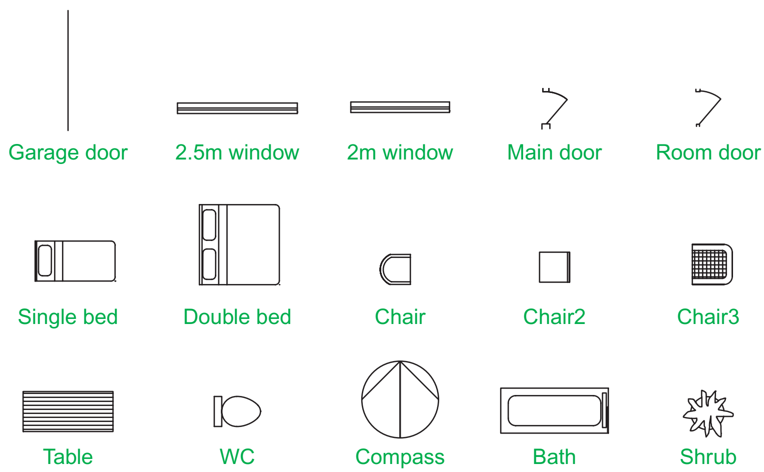

Fig. 9.1 First example – **Blocks –** symbols to be saved as blocks

2. *Left-click* the **Create** tool icon in the **Home/Block** panel (Fig. 9.2). The **Block Definition** dialog (Fig. 9.3) appears. To make a block from the **Compass** symbol drawing:
   (a) *Enter* **compass** in the **Name** field.
   (b) *Click* the **Select Objects** button. The dialog disappears. Window the drawing of the compass. The dialog reappears. Note the icon of the compass at the top-centre of the dialog.
   (c) *Click* the **Pick Point** button. The dialog disappears. *Click* a point on the compass drawing to determine its **insertion point**. The dialog reappears.

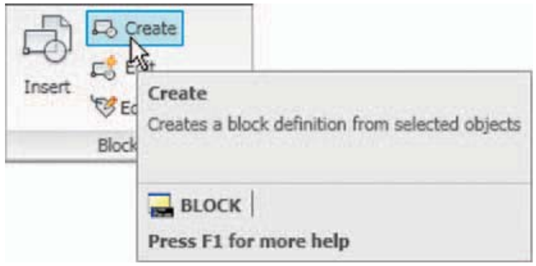

Fig. 9.2 *Click* **Create** tool icon in the **Home/Block** panel

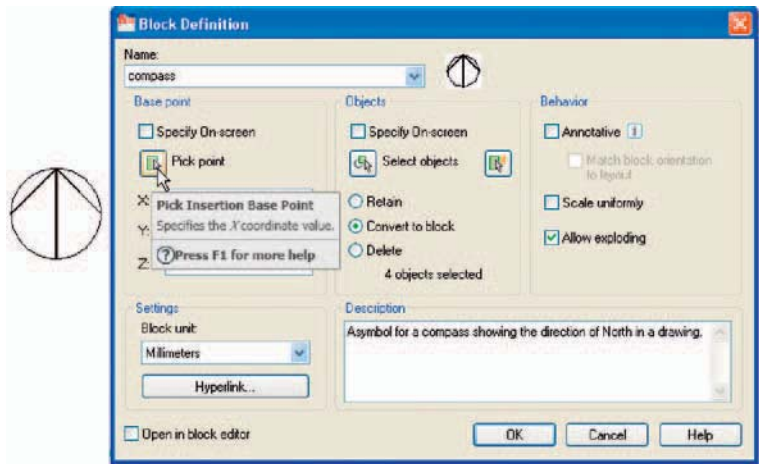

Fig. 9.3 The **Block Definition** dialog with entries for the **compass block**

(d) If thought necessary *enter* a description in the **Description** field of the dialog.

(e) *Click* the **OK** button. The drawing is now saved as a **block** in the drawing.

3. Repeat items **1** and **2** to make blocks of all the other symbols in the drawing.
4. Open the **Block Definition** dialog again and *click* the arrow on the right of the **Name** field. Blocks saved in the drawing are listed (Fig. 9.4).

Inserting blocks into a drawing

There are two methods by which symbols saved as blocks can be inserted into another drawing.

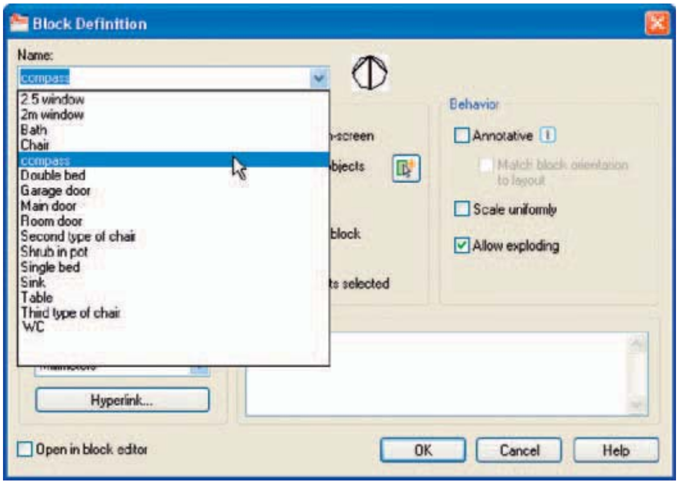

Fig. 9.4 The pop-up list in the **Name** field of the **Block Definition** dialog showing all blocks saved in the drawing

Example – first method of inserting blocks

Ensure that all the symbols saved as blocks using the **Create** tool are saved in the data of the drawing in which the symbols were constructed, erase the drawings of the symbols and in their place construct the outline of the plan of a bungalow to a scale of 1:50 (Fig. 9.5). Then:

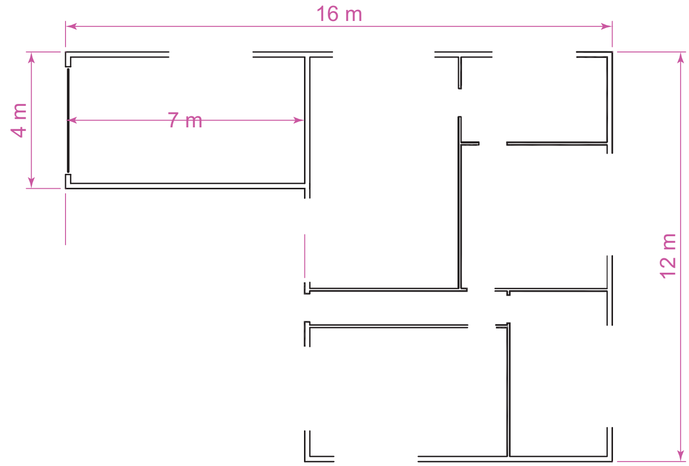

Fig. 9.5 First example – inserting blocks. Outline plan

1. *Left-click* the **Insert** tool icon in the **Home/Block** panel (Fig. 9.6) or the **Insert Block** tool in the **Draw** toolbar. The **Insert** dialog appears on screen (Fig. 9.7). From the **Name** pop-up list select the name of the block which is to be inserted, in this example the **2.5 window**.

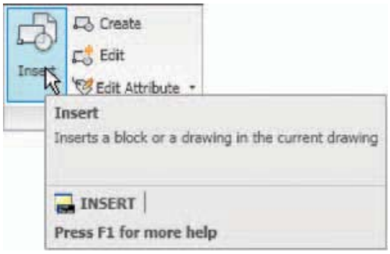

Fig. 9.6 The **Insert** tool icon in the **Home/Block** panel

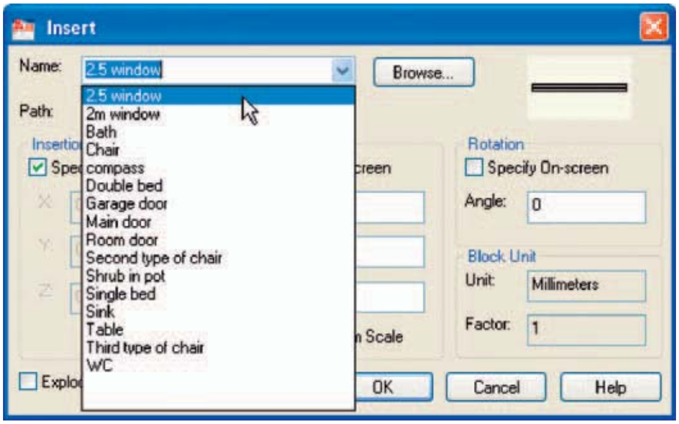

Fig. 9.7 The **Insert** dialog with its **Name** pop-up list displaying the names of all blocks in the drawing

2. *Click* the dialog's **OK** button; the dialog disappears. The symbol drawing appears on screen with its insertion point at the intersection of the cursor hairs ready to be *dragged* into its position in the plan drawing.
3. Once all the block drawings are placed, their positions can be adjusted. Blocks are single objects and can thus be dragged into new positions as required under mouse control. Their angle of position can be amended at the command line, which shows:

```
Command:
INSERT
Specify insertion point or [Basepoint/Scale/X/
  Y/Z/Rotate/PScale/PX/PY/PZ/PRotate]:enter r
  (Rotate) right-click
Specify insertion angle:enter 180 right-click
Specify insertion point:pick
Command:
```

Selection from these prompts allows scaling, stretching along any axis, previewing etc. as the block is inserted.

4. Insert all necessary blocks and add other detail as required to the plan outline drawing. The result is given in Fig. 9.8.

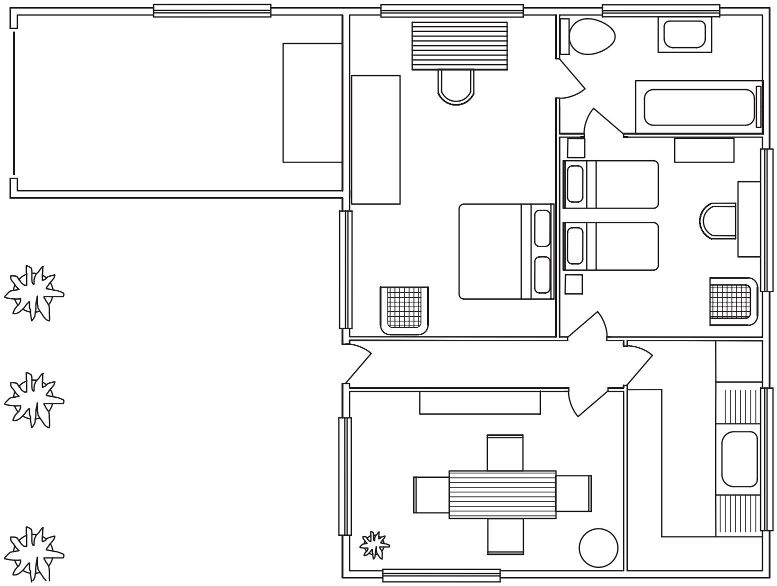

Fig. 9.8 Example – first method of inserting blocks

Example – second method of inserting blocks

1. Save the drawing which includes all the blocks to a suitable file name (e.g. **building_symbols.dwg**). Remember this drawing includes data of the blocks in its file.
2. *Left-click* **Design Center** in the **View/Palettes** panel (Fig. 9.9) or press the **Ctrl + 2** keys. The **DesignCenter** palette appears on screen (Fig. 9.10).

Fig. 9.9 Selecting **Design Center** from the **View/Palettes** panel

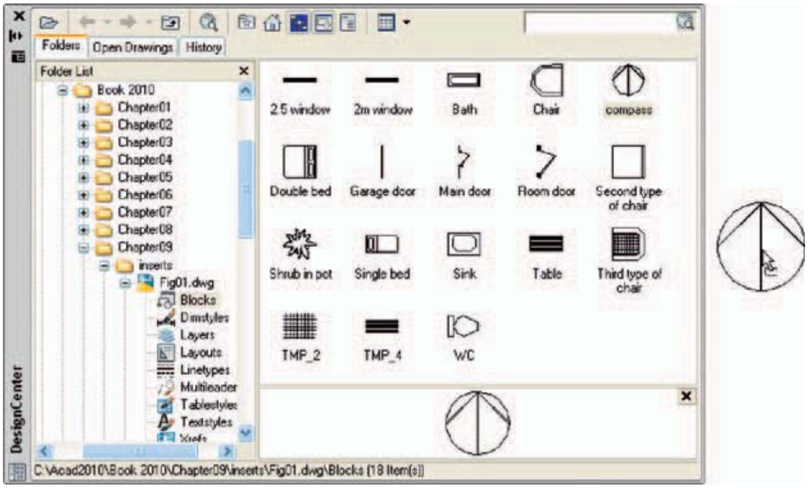

Fig. 9.10 The **DesignCenter** with the compass block *dragged* on screen

3. With the outline plan (Fig. 9.5) on screen the symbols can all be *dragged* into position from the **DesignCenter**.

Notes about DesignCenter palette

1. As with other palettes, the **DesignCenter** palette can be re-sized by *dragging* the palette to a new size from its edges or corners.

2. *Clicks* on one of the three icons at the top-right corner of the palette (Fig. 9.11) have the following results:

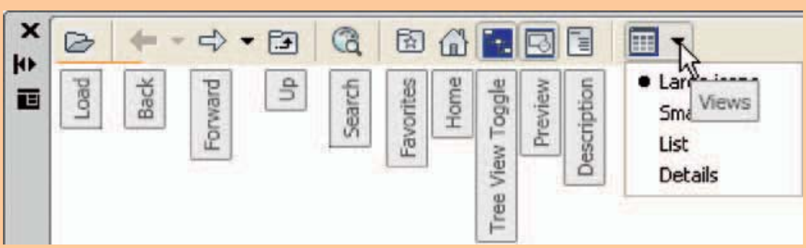

Fig. 9.11 The icons at the top of the **DesignCenter** palette

Tree View Toggle – changes from showing two areas – a **Folder List** and icons of the blocks within a file and icons of the blocks within a file – to a single area showing the block icons (Fig. 9.12).

Preview – a *click* on the icon opens a small area at the base of the palette showing an enlarged view of the selected block icon.

CHAPTER 9

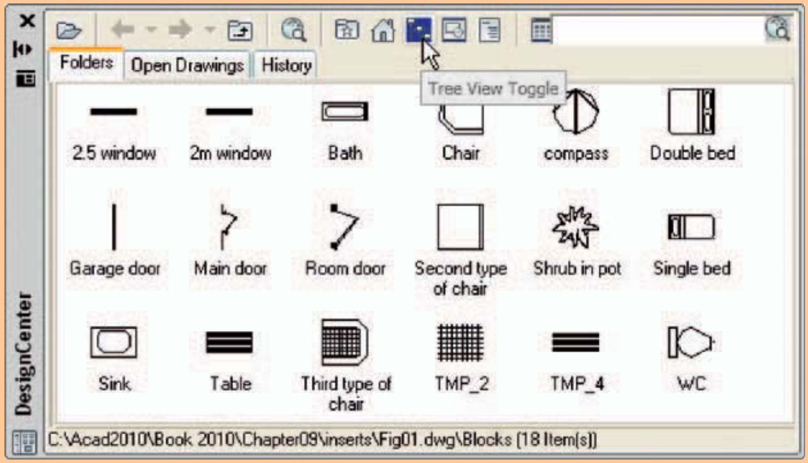

Fig. 9.12 The results of a *click* on **Tree View Toggle**

Description – a *click* on the icon opens another small area with a description of the block.

A block is a single object no matter how many objects it was originally constructed from. This enables a block to be *dragged* about the drawing area as a single object.

The Explode tool

Fig. 9.13 The **Explode** check box in the **Insert** dialog

A check box in the bottom left-hand corner of the **Insert** dialog is labelled **Explode**. If a tick is in the check box, **Explode** will be set on and when a block is inserted it will be exploded into the objects from which it was constructed (Fig. 9.13).

Another way of exploding a block would be to use the **Explode** tool from the **Home/Modify** panel (Fig. 9.14). A *click* on the icon or *entering* **ex** at the command line brings prompts into the command line:

```
Command:_explode
Select objects:pick a block on screen 1 found.
Select objects:right-click
Command:
```

And the *picked* object is exploded into its original objects.

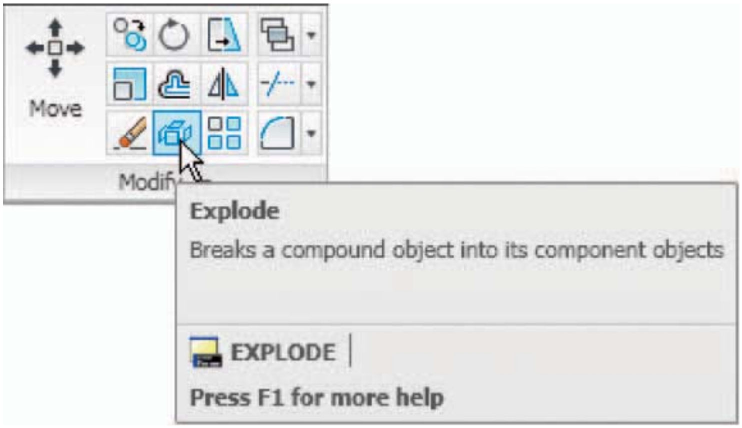

Fig. 9.14 The **Explode** tool icon in the **Home/Modify** panel

Purge

The **Purge** dialog (Fig. 9.15) is called to screen by *entering* **pu** or **purge** at the command line.

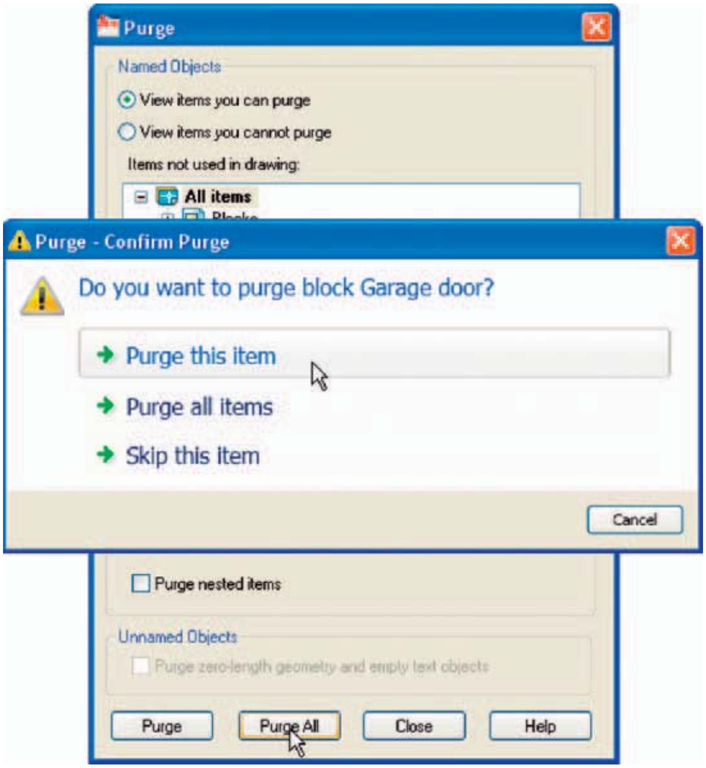

Fig. 9.15 The **Purge** dialog

Purge can be used to remove data (if any is to be purged) from within a drawing, thus saving file space when a drawing is saved to disk.

To purge a drawing of unwanted data (if any), in the dialog *click* the **Purge All** button and a sub-dialog appears with three suggestions – purging of a named item, purging of all the items or skip purging a named item.

Taking the drawing Fig. 9.8 (page 182) as an example. If all the unnecessary data is purged from the drawing, the file will be reduced from 145 Kbytes to 67 Kbytes when the drawing is saved to disk.

Using the DesignCenter (Fig. 9.18)

1. Construct the set of electric/electronic circuit symbols shown in Fig. 9.16 and make a series of blocks from each of the symbols.

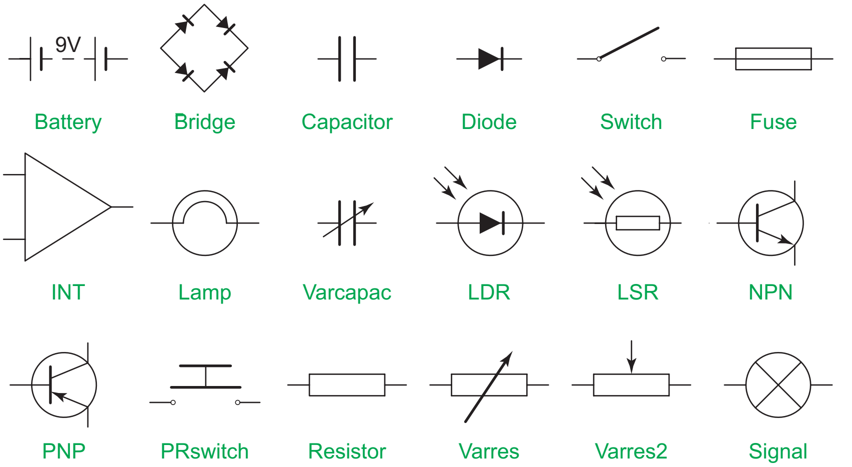

Fig. 9.16 Example using the **DesignCenter** – a set of electric/electronic symbols

2. Save the drawing to a file **Fig16.dwg**.
3. Open the **acadiso.dwt** template. Open the **DesignCenter** with a *click* on its icon in the **View/Palettes** panel.
4. From the **Folder list** select the file **Fig16.dwg** and *click* on **Blocks** under its file name. Then *drag* symbol icons from the **DesignCenter** into the drawing area as shown in Fig. 9.17. Ensure they are placed in appropriate positions in relation to each other to form a circuit. If necessary either **Move** and/or **Rotate** the symbols into correct positions.

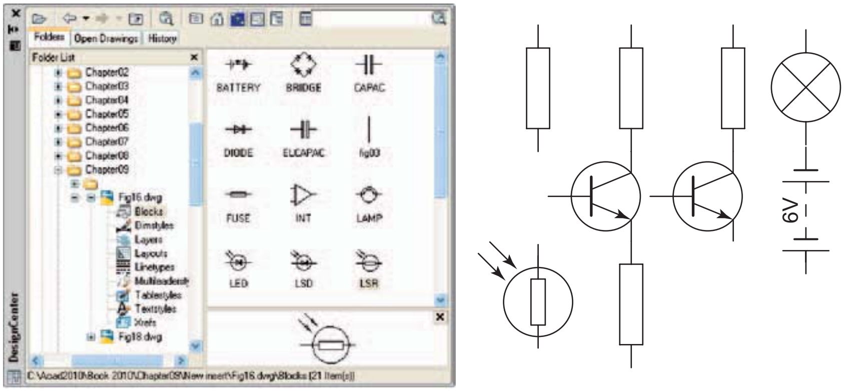

Fig. 9.17 Example using the DesignCenter

5. Close the **DesignCenter** palette with a *click* on the **x** in the top left-hand corner.
6. Complete the circuit drawing as shown in Fig. 9.18.

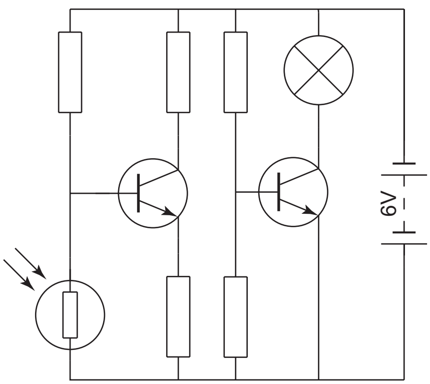

Fig. 9.18 Example using the **DesignCenter** – the completed circuit

> **Note**
>
> Figure 9.18 does not represent an authentic electronics circuit.

Wblocks

Wblocks or written blocks are saved as drawing files in their own right and are not part of the drawing in which they have been saved.

Example – wblock (Fig. 9.19)

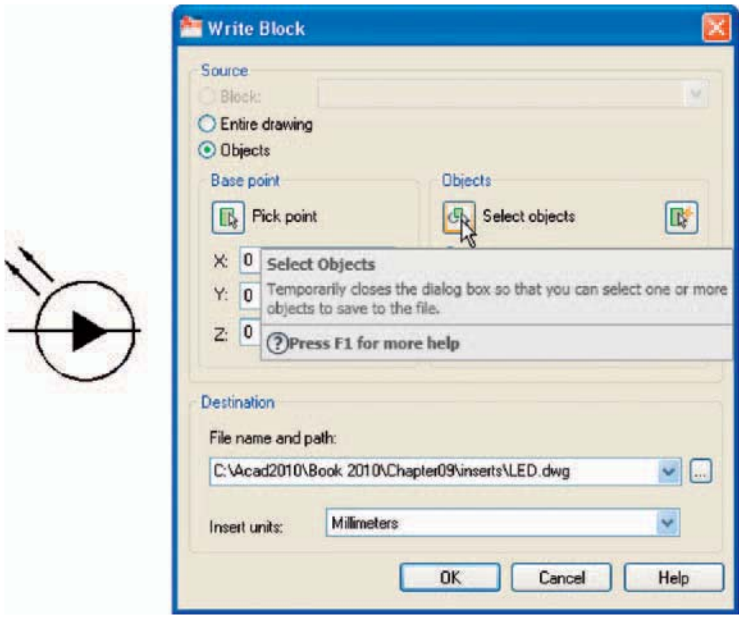

Fig. 9.19 Example – **Wblock**

1. Construct a light-emitting diode (**LED**) symbol and *enter* **w** at the command line. The **Write Block** dialog appears (Fig. 9.19).

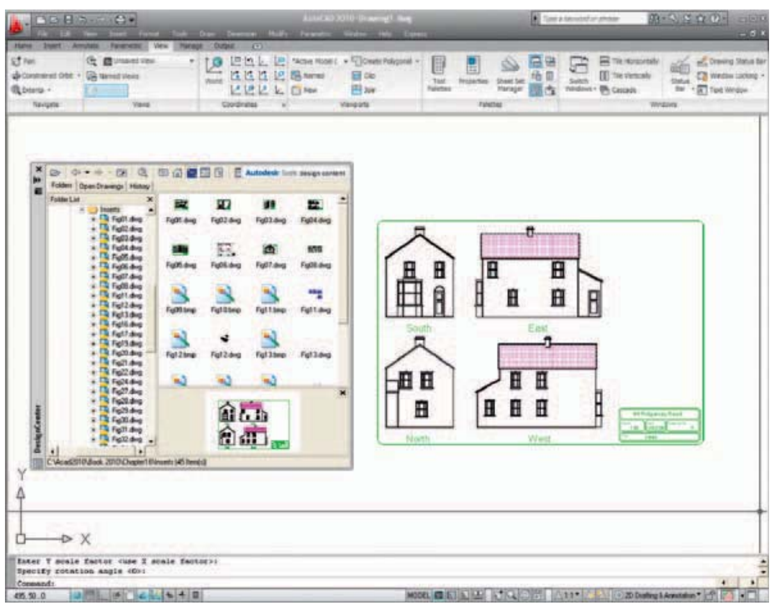

Fig. 9.20 An example of a drawing *dragged* from the **DesignCenter**

2. *Click* the button marked with three full stops (…) to the right of the **File name and path** field and from the **Browse for Drawing File** dialog which comes to screen select an appropriate directory. The directory name appears in the **File name and path** field. Add **LED.dwg** at the end of the name.
3. Make sure the **Insert units** is set to **Millimeters** in its pop-up list.
4. *Click* the **Select objects** button, Window the symbol drawing and when the dialog reappears, *click* the **Pick point** button, followed by selecting the left-hand end of the symbol.
5. Finally *click* the **OK** button of the dialog and the symbol is saved in its selected directory as a drawing file **LED.dwg** in its own right.

Note on the DesignCenter

Drawings can be inserted into the AutoCAD window from the **DesignCenter** by dragging the icon representing the drawing into the window (Fig. 9.20).

When such a drawing is *dragged* into the AutoCAD window, the command line shows a sequence such as:

```
Command: _-INSERT Enter block name or [?]:
"C:\Acad2010\Chapter16\Inserts\Fig06.dwg"
Units: Millimetres Conversion: 1.0000
Specify insertion point or [Basepoint/Scale/X/Y/
  Z/Rotate]:enter s right-click
Specify scale factor for XYZ axes
  <1> :enter 4 right-click
Specify insertion point or
  [Basepoint/Scale/X/Y/Z/Rotate]:pick
Specify rotation angle <0>:
Command:
```

REVISION NOTES

1. Blocks become part of the drawing file in which they were constructed.
2. Wblocks become drawing files in their own right.
3. Drawings or parts of drawings can be inserted in other drawings with the **Insert** tool.
4. Inserted blocks or drawings are single objects unless either the **Explode** check box of the **Insert** dialog is checked or the block or drawing is exploded with the **Explode** tool.
5. Drawings can be inserted into the AutoCAD drawing area using the **DesignCenter**.
6. Blocks within drawings can be inserted into drawings from the **DesignCenter**.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/ 978-1-85617-868-6

1. Construct the building symbols Fig. 9 21 in a drawing saved as **symbols.dwg**. Then using the **DesignCenter** construct a building drawing of the first floor of the house you are living in making use of the symbols. Do not bother too much about dimensions because this exercise is designed to practise using the idea of making blocks and using the **DesignCenter**.

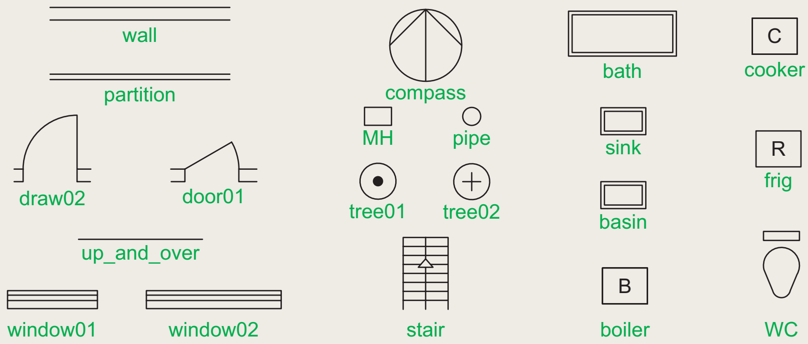

Fig. 9.21 Exercise 1

2. Construct drawings of the electric/electronics symbols in Fig. 9.17 (page 187) and save them as blocks in a drawing file **electronics.dwg**.

3. Construct the electronics circuit given in Fig. 9.22 from the file **electronics.dwg** using the **DesignCenter**.

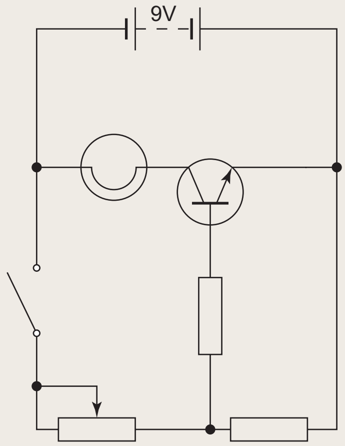

Fig. 9.22 Exercise 3

4. Construct the electronics circuit given in Fig. 9.23 from the file **electronics.dwg** using the **DesignCenter**.

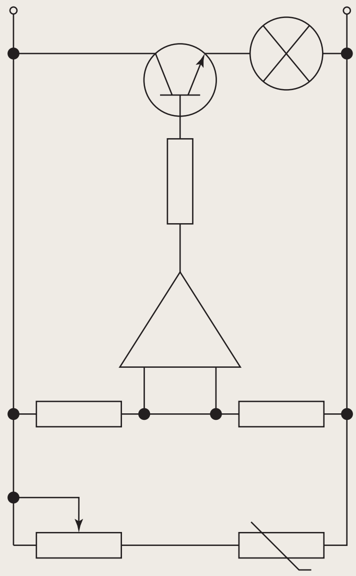

Fig. 9.23 Exercise 4

Chapter 10

Other types of file format

AIMS OF THIS CHAPTER

The aims of this chapter are:

1. To introduce **Object Linking and Embedding** (**OLE**) and its uses.
2. To introduce the use of **Encapsulated Postscript (EPS**) files.
3. To introduce the use of **Data Exchange Format** (**DXF**) files.
4. To introduce raster files.
5. To introduce **Xrefs**.

Object linking and embedding

First example – Copying and Pasting (Fig. 10.2)

1. Open any drawing in the AutoCAD 2010 window (Fig. 10.1).

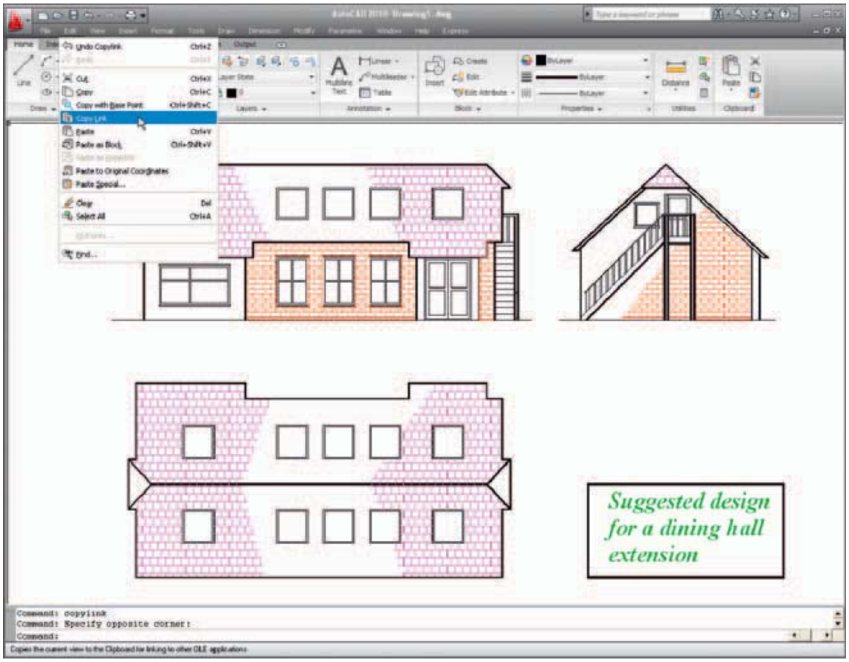

Fig. 10.1 A drawing in the AutoCAD 2009 window showing **Copy Link** selected from the **Edit** drop-down menu

2. *Click* **Copy Link** in the **Edit** drop-down menu, or *enter* **copylink** at the command line.

3. Open **Microsoft Word** and *click* on **Paste** in the **Edit** drop-down menu (Fig. 10.2). The drawing from the **Clipboard** appears in the **Microsoft Word** document (Fig. 10.2). Add text as required.

Note

Similar results can be obtained using the **Copy Clip** and **Copy with Base Point** tools from the **Edit** drop-down menu.

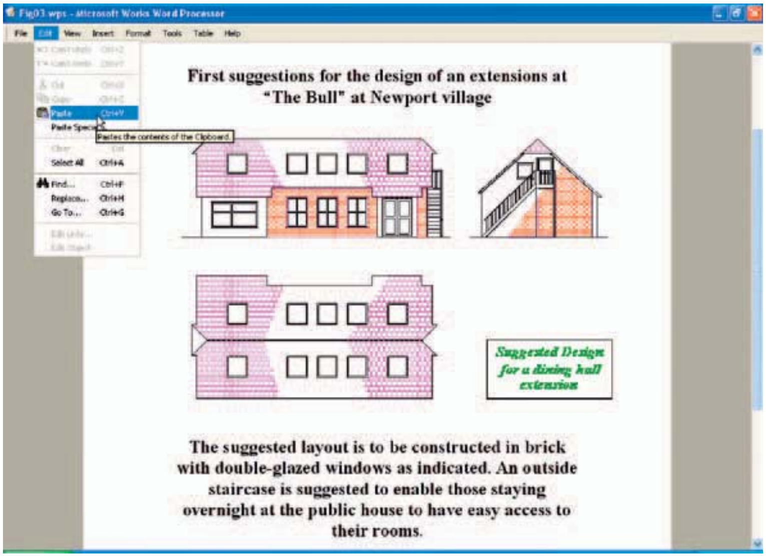

Fig. 10.2 Example – **Copying** and **Pasting**

Second example – EPS file (Fig. 10.5)

1. With the same drawing on screen *click* on **Export…** in the **File** drop-down menu (Fig. 10.3). The **Export Data** dialog appears (Fig. 10.3). *Pick* **Encapsulated PS (*.eps)** from the **Files of type** pop-up list then *enter* a suitable file name (e.g. **building.eps**) in the **File name field** and *click* the **Save** button.

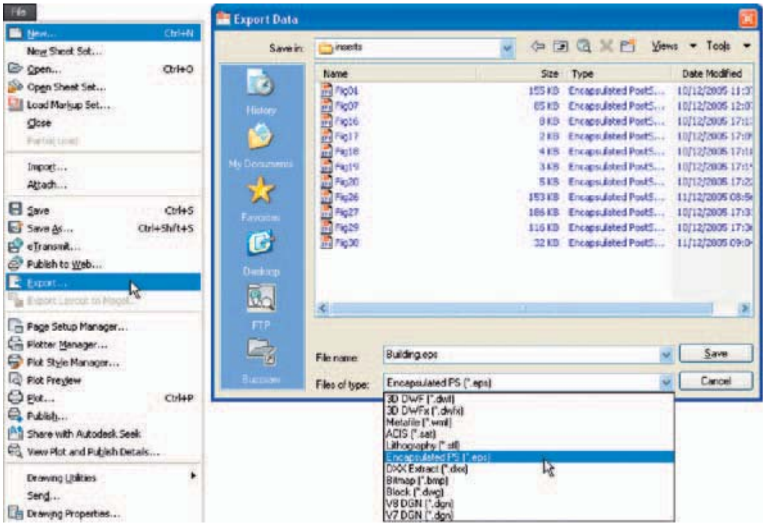

Fig. 10.3 Selecting the **Export** tool icon from the **File** drop-down menu and the **Export Data** dialog

2. Open a desktop publishing application. That shown in Fig. 10.4 is **PageMaker**.

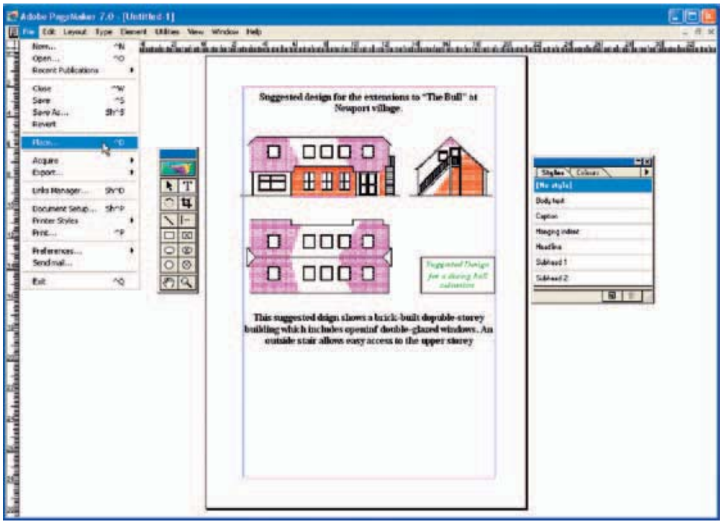

Fig. 10.4 An ***.eps** file placed in position in a PageMaker document

3. From the **File** drop-down menu of **PageMaker** *click* **Place…** A dialog appears listing files which can be placed in a PageMaker document. Among the files named will be **building.eps**. *Double-click* that file name and an icon appears, the placing of which determines the position of the ***.eps** file drawing in the PageMaker document (Fig. 10.4).
4. Add text as required.
5. Save the PageMaker document to a suitable file name.
6. Go back to the AutoCAD drawing and delete the title.
7. Make a new ***.eps** file with the same file name (**building.eps**).
8. Go back into **PageMaker** and *click* **Links Manager…** in the **File** drop-down menu. The **Links Manager** dialog appears (Fig. 10.5).

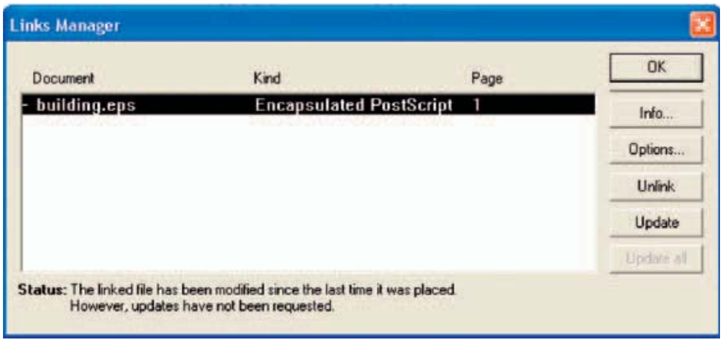

Fig. 10.5 The **Links Manager** dialog of PageMaker

Against the name of the **building.eps** file name is a dash and a note at the bottom of the dialog explaining that changes have taken place in the drawing from which the ***.eps** had been derived. *Click* the **Update** button and when the document reappears the drawing in PageMaker no longer includes the erased title.

Notes

1. This is **Object Linking and Embedding** (**OLE**). Changes in the AutoCAD drawing saved as an ***.eps** file are linked to the drawing embedded in another application document, so changes made in the AutoCAD drawing are reflected in the PageMaker document.
2. There is actually no need to use the **Links Manager** because if the file from PageMaker is saved with the old *.**eps** file in place, when it is reopened the file will have changed to the redrawn AutoCAD drawing, without the erased title.

DXF (data exchange format) files

The **DXF** format was originated by Autodesk (publishers of AutoCAD), but is now in general use in most **CAD** (computer-aided design) software. A drawing saved to a *.**dxf** format file can be opened in most other CAD software applications. This file format is of great value when drawings are being exchanged between operators using different CAD applications.

Example – DXF file (Fig. 10.7)

1. Open a drawing in AutoCAD. This example is shown in Fig. 10.6.
2. *Click* on **Save As…** in the **Menu Browser** dialog and in the **Save Drawing As** dialog which appears *click* **AutoCAD 2007 DXF [*.dxf]** in the **Files of type** field pop-up list.
3. *Enter* a suitable file name. In this example this is **Fig06.dxf**. The extension **.dxf** is automatically included when the **Save** button of the dialog is *clicked* (Fig. 10.7).
4. The **DXF** file can now be opened in the majority of CAD applications and then saved to the drawing file format of the CAD in use.

Note

To open a **DXF** file in AutoCAD 2010, select **Open…** from the **Menu Browser** dialog and in the **Select File** dialog select **AutoCAD 2007 DXF [*.dxf]** from the pop-up list from the **Files of type** field.

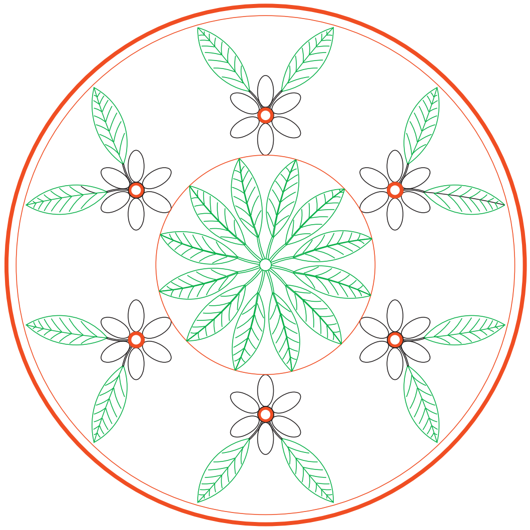

Fig. 10.6 Example – **DXF file**. Drawing to be saved as a *.**dxf** file

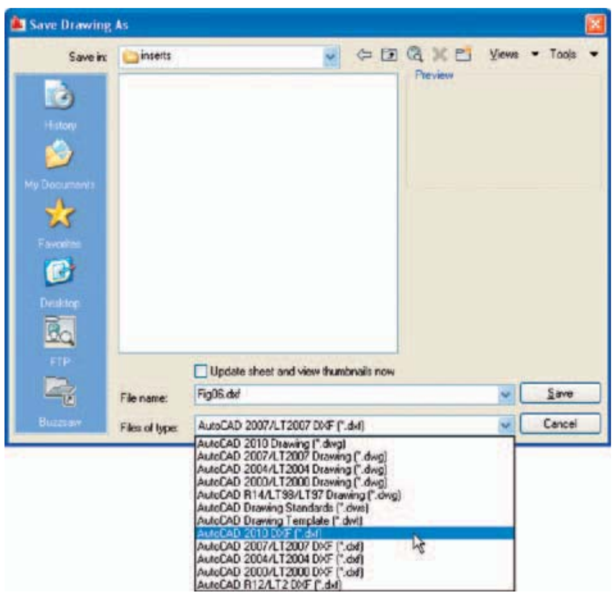

Fig. 10.7 The **Save Drawing As** dialog set to save drawings in **DXF** format

Raster images

A variety of raster files can be placed into AutoCAD 2010 drawings from the **Select Image File** dialog brought to screen with a *click* on **Raster Image Reference…** from the **Insert** drop-down menu. In this example the selected raster file is a bitmap (extension ***.bmp**) of a rendered 3D model drawing constructed to the views in an assembly drawing of a lathe tool post (see Chapter 15 about the rendering of 3D models).

Example – placing a raster file in a drawing (Fig. 10.11)

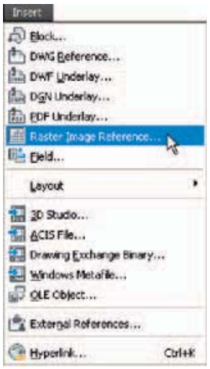

Fig. 10.8 Selecting **Raster Image Reference...** from the **Insert** drop-down menu

1. *Click* **Raster Image Reference…** from the **Insert** drop-down menu (Fig. 10.8). The **Select Reference File** dialog appears (Fig. 10.9). *Click* the file name of the image to be inserted, in this example **Fig05** (a bitmap *.bmp). A preview of the bitmap appears in the **Preview** area of the dialog.

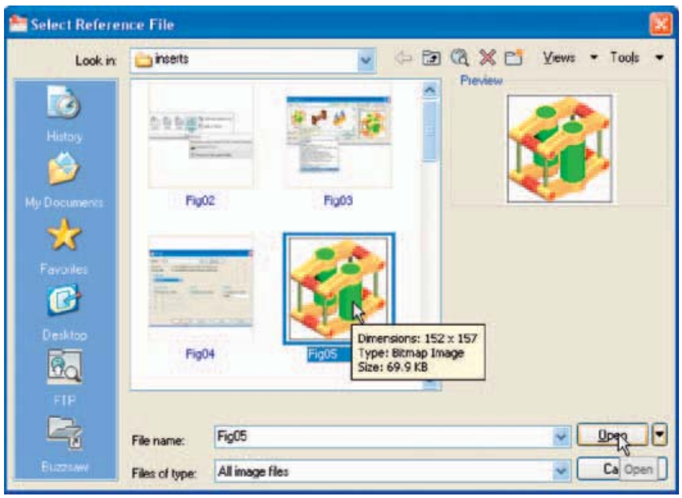

Fig. 10.9 The **Select Reference File** dialog

2. *Click* the **Open** button of the dialog. The **Attach Image** dialog appears (Fig. 10.10) showing a preview of the bitmap image.

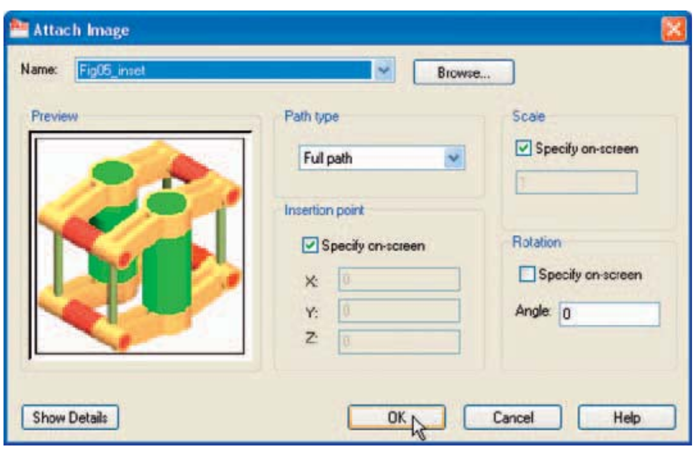

Fig. 10.10 The **Attach Image** dialog

3. *Click* the **OK** button, the command line shows:

```
Command: _imageattach
Specify insertion point <0,0>:click at a point on
  screen
Base image size: Width: 1.000000, Height:
  1.032895, Millimeters
Specify scale factor <1>:drag a corner of the
  image to obtain its required size
Command:
```

And the raster image appears at the *picked* point (Fig. 10.11).

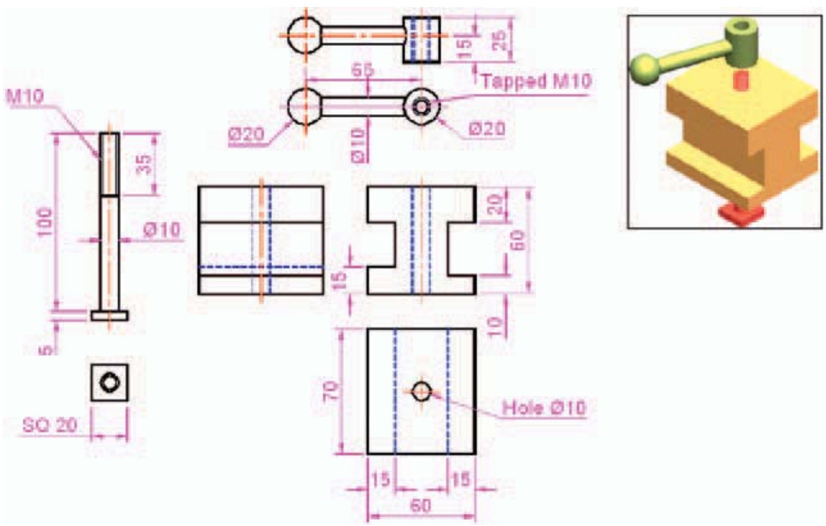

Fig. 10.11 Example – placing a raster file in a drawing

Notes

As will be seen from the **Insert** drop-down menu and the dialogs which can be opened from the menu, a variety of different types of images can be inserted into an AutoCAD drawing. Some examples are:

External References (Xrefs) – If a drawing is inserted into another drawing as an external reference, any changes made in the original Xref drawing are automatically reflected in the drawing into which the Xref has been inserted. See later in this chapter.

Field – A *click* on the name brings up the **Field** dialog. Practise inserting various categories of field names from the dialog.

Layout – A wizard appears allowing new layouts to be created and saved for new templates if required.

3D Studio – allows the insertion of images constructed in the Autodesk software **3D Studio** from files with the format ***.3ds**.

External References (Xrefs)

If a drawing is inserted into another drawing as an external reference, any changes made in the original Xref drawing subsequent to its being inserted are automatically reflected in the drawing into which the Xref has been inserted.

Example – External References (Fig. 10.19)

1. Construct the three-view orthographic drawing Fig. 10.12. Dimensions for this drawing will be found in Fig. 15.52. Save the drawing to a suitable file name.

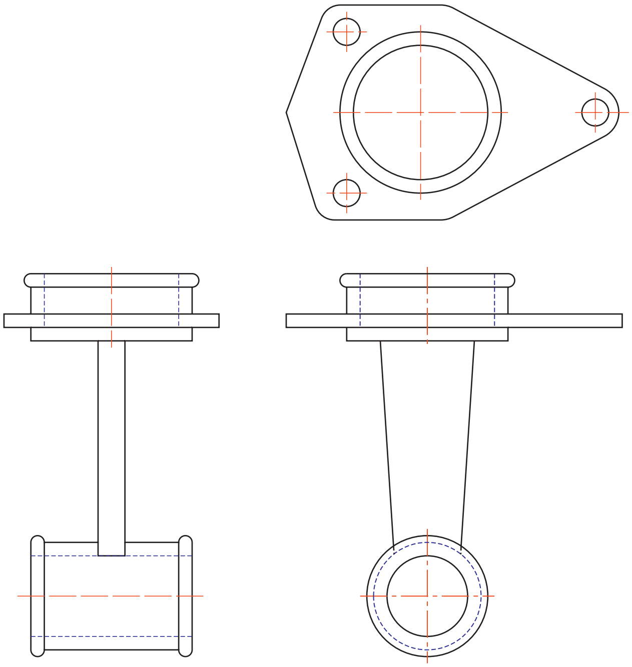

Fig. 10.12 Example – **External References –** original drawing

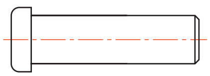

Fig. 10.13 The spindle drawing saved as **Fig13.dwg**

2. As a separate drawing construct Fig. 10.13. Save it as a wblock with the name of **Fig13.dwg** and with a base insertion point at the crossing of its centre line with the left-hand end of its spindle.

3. *Click* **External References** in the **View/Palettes** panel (Fig. 10.14). The **External References** palette appears (Fig. 10.15).

Fig. 10.15 The **External References** palette

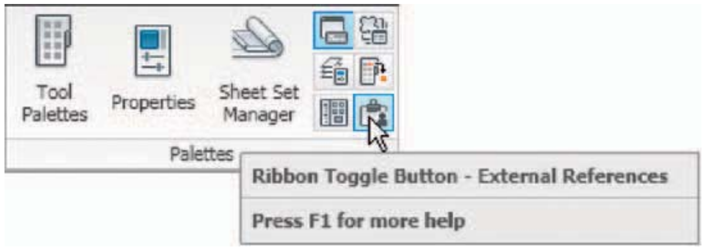

Fig. 10.14 The **External References** tool in the **View/Palettes** panel

4. *Click* its **Attach** button and select **Attach DWG…** from the pop-up list which appears when a *left-click* is held on the button. Select the drawing of a spindle (**Fig13.dwg**) from the **Select Reference file** dialog which appears followed by a *click* on the dialog's **Open** button. This brings up the **Attach External Reference** dialog (Fig. 10.16) showing **Fig13** in its **Name** field. *Click* the dialog's **OK** button.

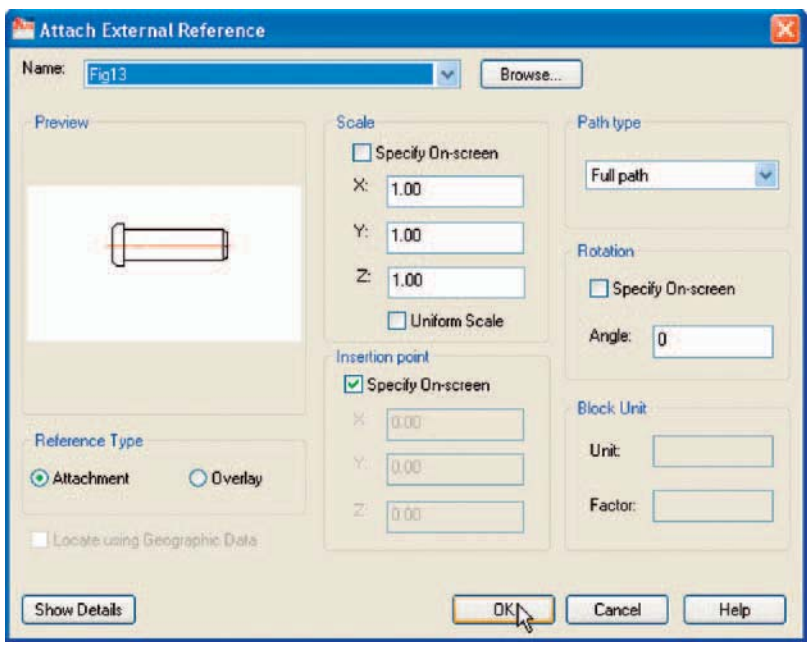

Fig. 10.16 The **Attach External Reference** dialog

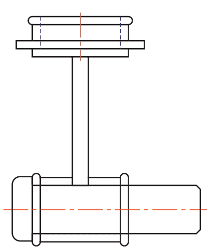

Fig. 10.17 The spindle in place in the original drawing

5. The spindle drawing appears on screen ready to be *dragged* into position. Place it in position as indicated in Fig. 10.17.

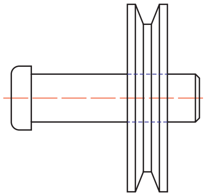

Fig. 10.18 The revised **spindle.dwg** drawing

6. Save the drawing with its xref to its original file name.
7. Open the drawing **Fig15.dwg** and make changes as shown in Fig. 10.18.
8. Now reopen the original drawing. The **external reference** within the drawing has changed in accordance with the alterations to the spindle drawing. Fig. 10.19 shows the changes in the front view of the original drawing.

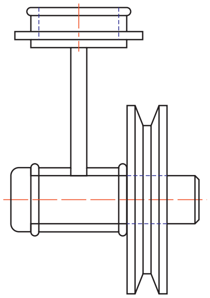

Fig. 10.19 Example – **Xrefs**

Note

In this example, to ensure accuracy of drawing the **external reference** will need to be exploded and parts of the spindle changed to hidden detail lines.

Dgnimport and dgnexport

Drawings constructed in MicroStation V8 format (***.dgn**) can be imported into AutoCAD 2010 format using the command **dgnimport** at the command line. AutoCAD drawings in AutoCAD 2004 format can be exported into MicroStation ***.dgn** format using the command **dgnexport**.

Example of importing a *.dgn drawing into AutoCAD

1. Fig 10.20 is an example of an orthographic drawing constructed in MicroStation V8.
2. In AutoCAD 2010 at the command line *enter* **dgnimport**. The dialog Fig. 10.21 appears on screen from which the required drawing file name can be selected. When the **Open** button of the dialog is *clicked* a warning window appears informing the operator of steps to take in order to load the drawing. When completed the drawing loads (Fig. 10.22).

In a similar manner AutoCAD drawing files can be exported to MicroStation using the command **dgnexport** *entered* at the command line.

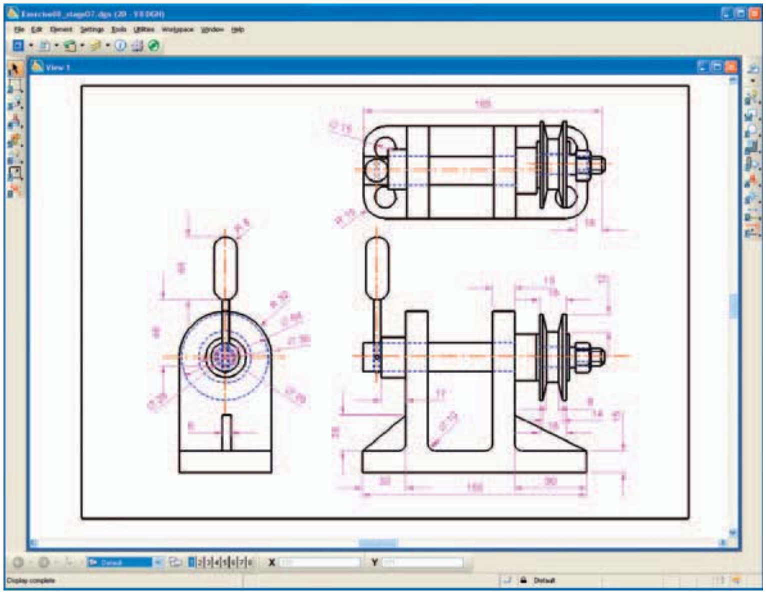

Fig. 10.20 Example – a drawing in MicroStation V8

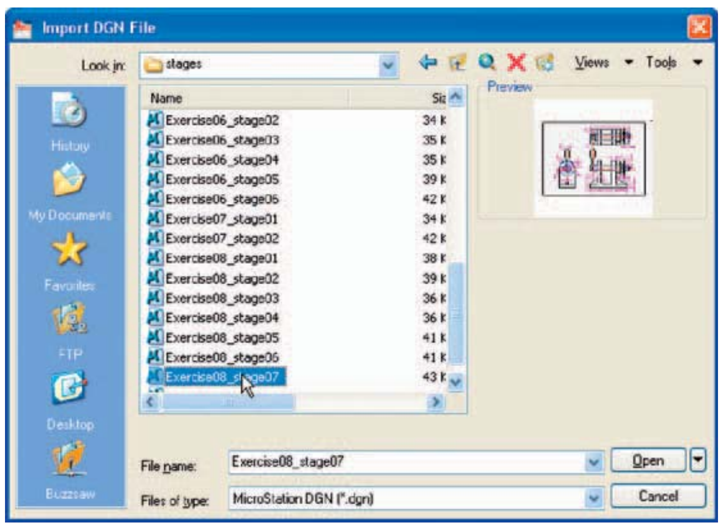

Fig. 10.21 The **Import DGN File** dialog

Multiple Document Environment (MDE)

1. Open several drawings in AutoCAD; in this example four separate drawings have been opened.
2. In the **View/Window** panel, *click* **Tile Horizontally** (Fig. 10.23). The four drawings rearrange as shown in Fig. 10.24.

Fig. 10.23 Selecting **Tile Horizontally** from the **View/Windows** panel

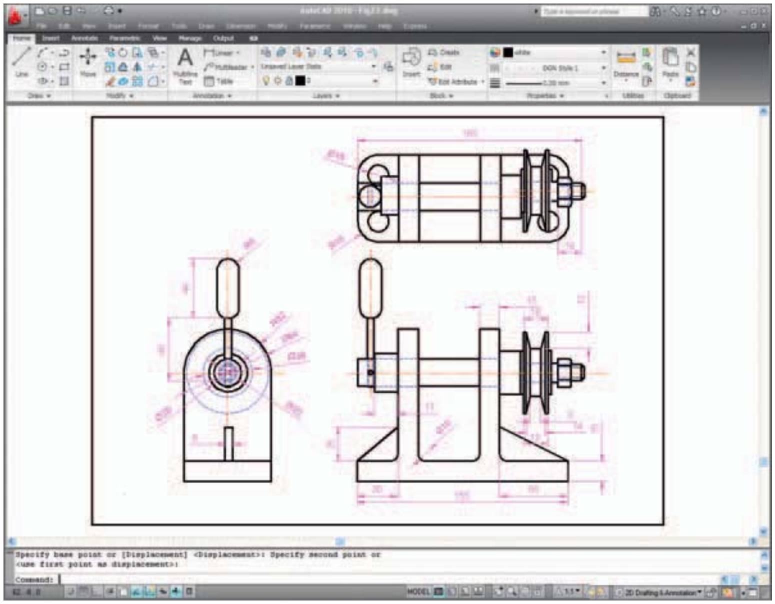

Fig. 10.22 The ***.dgn** file imported into AutoCAD 2010

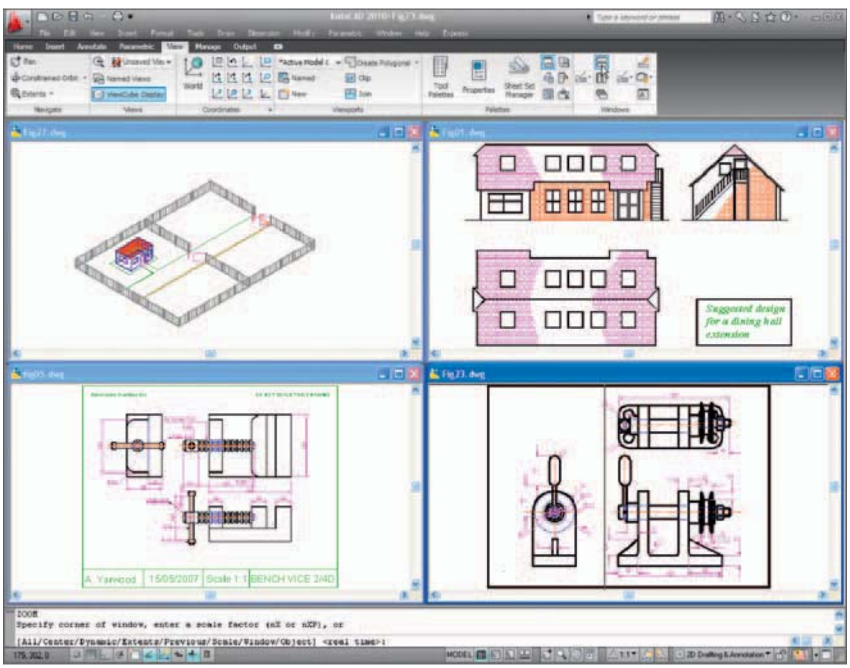

Fig. 10.24 Four drawings in the **Multiple Document Environment**

Note

The names of the drawings appear in the **Window** drop-down menu, showing their directories, file names and file name extensions.

REVISION NOTES

1. The **Edit** tools **Copy Clip**, **Copy with Base Point** and **Copy Link** enable objects from AutoCAD 2010 to be copied for **Pasting** onto other applications.
2. Objects can be copied from other applications to be pasted into the AutoCAD 2010 window.
3. Drawings saved in AutoCAD as **DXF** (***.dxf**) files can be opened in other computer-aided design (CAD) applications.
4. Similarly drawings saved in other CAD applications as ***.dxf** files can be opened in AutoCAD 2010.
5. **Raster** files of the format types ***.bmp**, ***.jpg**, ***pcx**, ***.tga**, ***.tif** among other raster type file objects can be inserted into AutoCAD 2010 drawings.
6. Drawings saved to the **Encapsulated Postscript** (***.eps**) file format can be inserted into documents of other applications.
7. Changes made in a drawing saved as an ***.eps** file will be reflected in the drawing inserted as an ***.eps** file in another application.
8. When a drawing is inserted into another drawing as an **external reference** changes made to the inserted drawing will be updated in the drawing into which it has been inserted.
9. A number of drawings can be opened in the AutoCAD 2010 window.
10. Drawings constructed in MicroStation V8 can be imported into AutoCAD 2010 using the command **dgnimport.**
11. Drawings constructed in AutoCAD 2010 can be saved as MicroStation ***.dgn** drawings to be opened in MicroStation V8.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/ 978-1-85617-868-6

1. Fig. 10.25 shows a pattern formed by inserting an **external reference** and then copying or arraying the **external reference**.

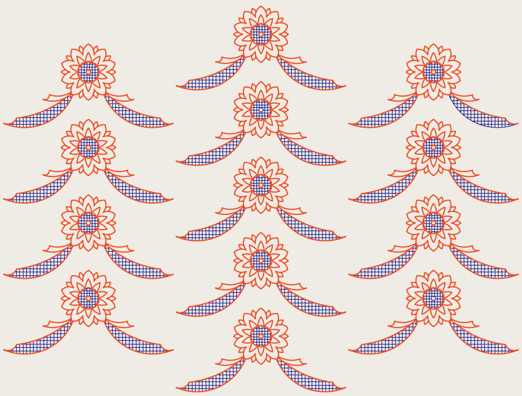

Fig. 10.25 Exercise 1 – original pattern

The hatched parts of the **external reference** drawing were then changed using a different hatch pattern. The result of the change is shown in Fig. 10.26.

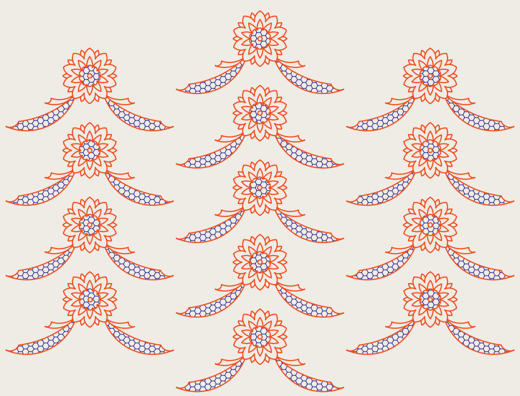

Fig. 10.26 Exercise 1

Construct a similar **xref** drawing, insert as an **xref**, array or copy to form the pattern, then change the hatching, save the **xref** drawing and note the results.

2. Fig 10.27 is a rendering of a roller between two end holders. Fig. 10.28 gives details the end holders and the roller in orthographic projections.

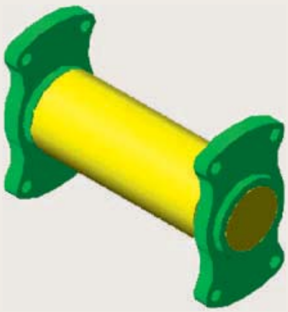

Fig. 10.27 Exercise 2 – a rendering of the holders and roller

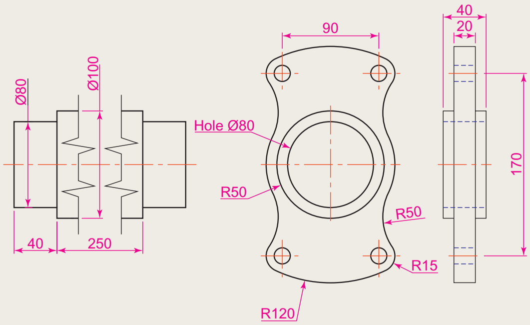

Fig. 10.28 Exercise 2 – details of the parts of the holders and roller

Construct a full size front view of the roller and save to a file named **roller.dwg**. Then as a separate drawing construct a front view of the two end holders in their correct positions to receive the roller and save to a file named **assembly.dwg**.

Insert the roller drawing into the assembly drawing as an **xref**.

Open the **roller.dwg** and change its outline as shown in Fig. 10.29. Save the drawing. Open **assembly.dwg** and note the change in the inserted **xref**.

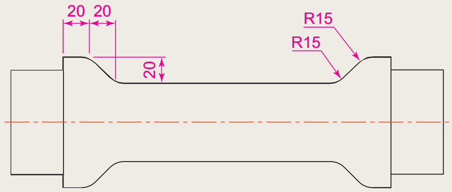

Fig. 10.29 The amended **xref** drawing

3. *Click* **Image…** in the **Reference** panel and insert a **JPEG** image (***.jpg** file) of a photograph into the AutoCAD 2010 window. An example is given in Fig. 10.30.

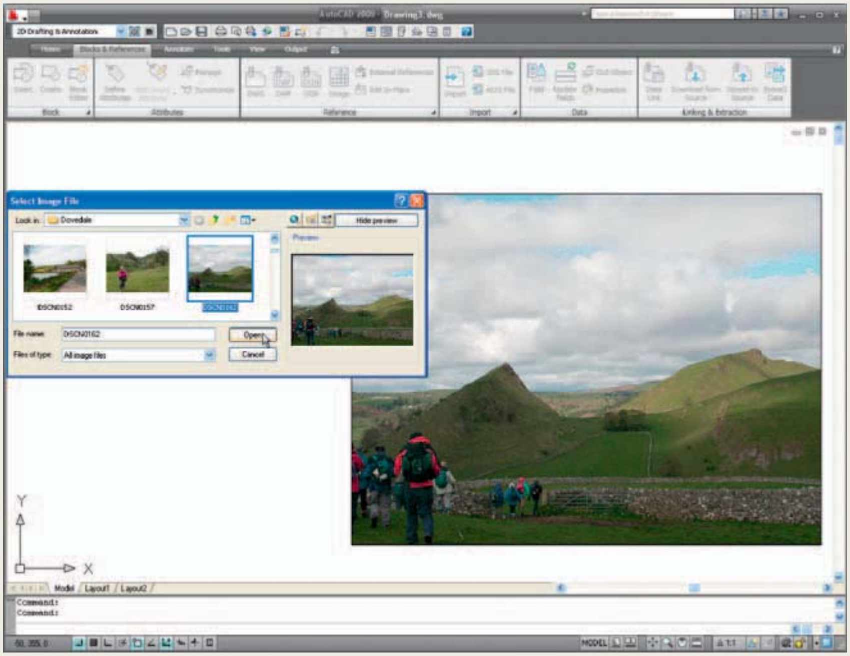

Fig. 10.30 Exercise 3 – an example

4. Using **Copy** from the **Insert** drop-down menu, copy a drawing from AutoCAD 2010 into a Microsoft Word document. An example is given in Fig. 10.31. Add some appropriate text.

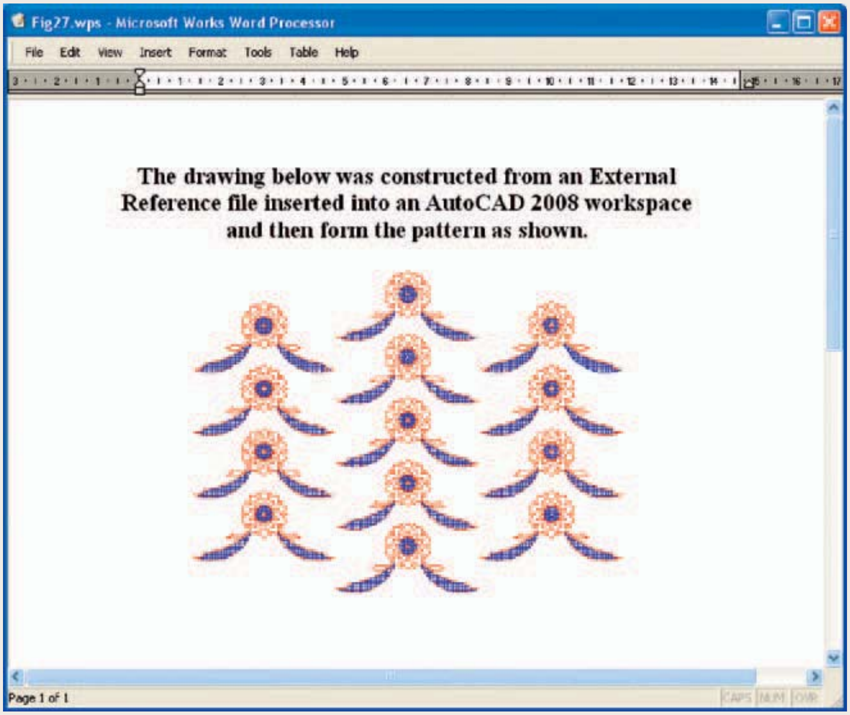

Fig. 10.31 Exercise 4 – an example

5. The plan in Figures 10.1, 10.2 and 10.3 is incorrect in that some details have been missed from the drawing. Can you identify the error?

Chapter 11

Sheet sets

AIMS OF THIS CHAPTER

The aims of this chapter are:

1. To introduce sheet sets.
2. To describe the use of the **Sheet Set Manager**.
3. To give an example of a sheet set based on a design of a two-storey house.

Sheet sets

When anything is to be manufactured or constructed, whether it be a building, an engineering design, an electronics device or any other form of manufactured artefact, a variety of documents, many in the form of technical drawings, will be needed to convey to those responsible for constructing the design all the information necessary to be able to proceed according to the wishes of the designer. Such sets of drawings may be passed between the people or companies responsible for the construction, enabling all those involved to make adjustments or suggest changes to the design. In some cases there may well be a considerable number of drawings required in such sets of drawings. In AutoCAD 2010 all the drawings from which a design is to be manufactured can be gathered together in a **sheet set**. This chapter shows how a much reduced sheet set of drawings for the construction of a house at 62 Pheasant Drive can be produced. Some other drawings, particularly detail drawings, would be required in this example, but to save page space the sheet set described here consists of only four drawings with a subset of another four drawings.

A sheet set for 62 Pheasant Drive

1. Construct a template **62 Pheasant Drive.dwt** based upon the **acadiso.dwt** template, but including a border and a title block. Save the template in a **Layout1** format. An example of the title block from one of the drawings constructed in this template is shown in Fig. 11.1.

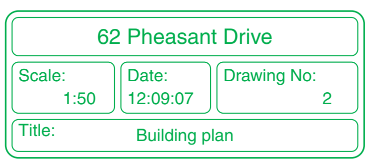

Fig. 11.1 The title block from drawing number **2** of the sheet set drawings

2. Construct each of the drawings which will form the sheet set in this drawing template. The whole set of drawings is shown in Fig. 11.2. Save the drawings in a directory – in this example this has been given the name **62 Pheasant Drive**.
3. *Click* **Sheet Set Manager** in the **View/Palettes** panel (Fig. 11.3). The **Sheet Set Manager** palette appears (Fig. 11.4). *Click* **New Sheet Set…** in the pop-up menu at the top of the palettes. The first of a series of **Create Sheet Set** dialogs appears – the **Create Sheet Set – Begin** dialog (Fig. 11.5). *Click* the radio button next to **Existing drawings**, followed by a *click* on the **Next** button and the next dialog **Sheet Set Details** appears (Fig. 11.6).

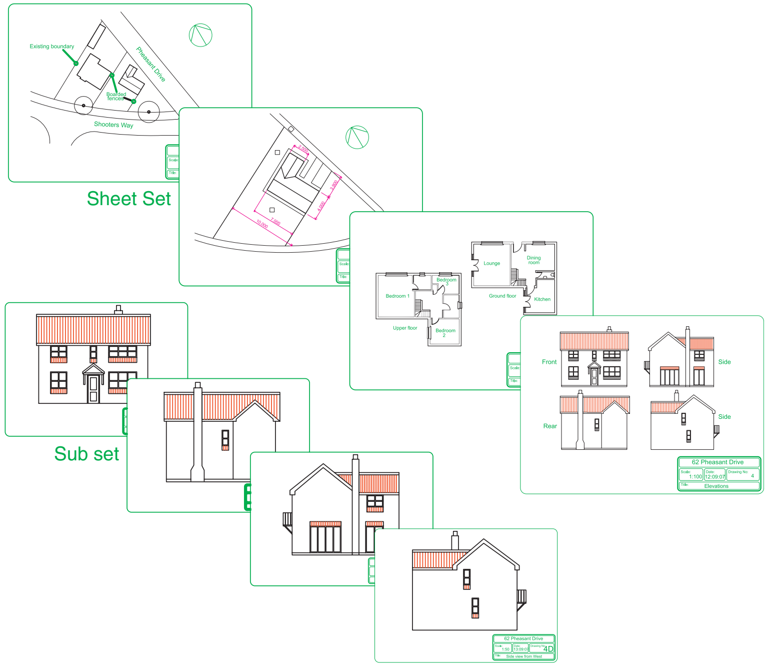

Fig. 11.2 The eight drawings in the **62 Pheasant Drive** sheet set

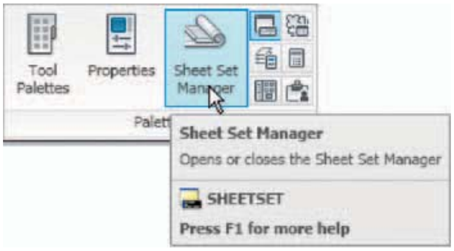

Fig. 11.3 Selecting **Sheet Set Manager** from the **View/Palettes** panel

Fig. 11.4 The **Sheet Set Manager** palette

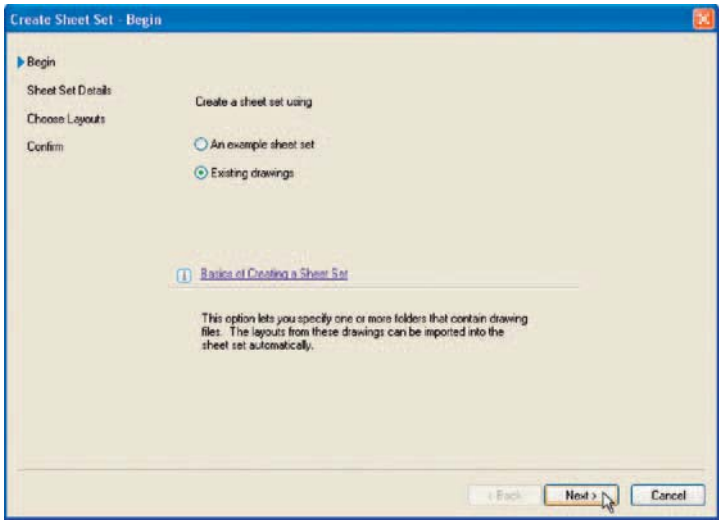

Fig. 11.5 The first of the **Create Sheet Set** dialogs – **Begin**

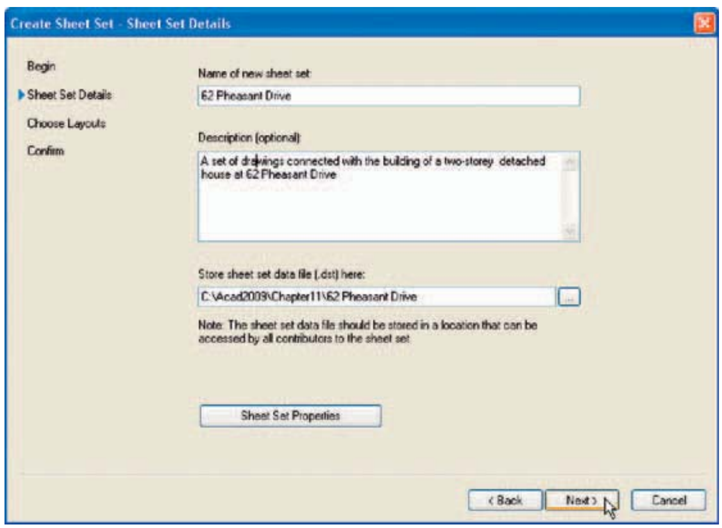

Fig. 11.6 The **Sheet Set Details** dialog

4. *Enter* details in the dialog as shown in Fig. 11.6. Then *click* the **Next** button to bring the **Choose Layouts** dialog to screen (Fig. 11.7).
5. *Click* its **Browse** button and from the **Browse for Folder** list which comes to screen, *pick* the directory **62 Pheasant Drive**. *Click* the **OK** button and the drawings held in the directory appear in the **Choose Layouts** dialog (Fig. 11.7). If satisfied the list is correct, *click* the **Next** button. A **Confirm** dialog appears (Fig. 11.8). If satisfied *click* the **Finish** button and the **Sheet Set Manager** palette appears showing the drawings which will be in the **62 Pheasant Drive** sheet set (Fig. 11.9).

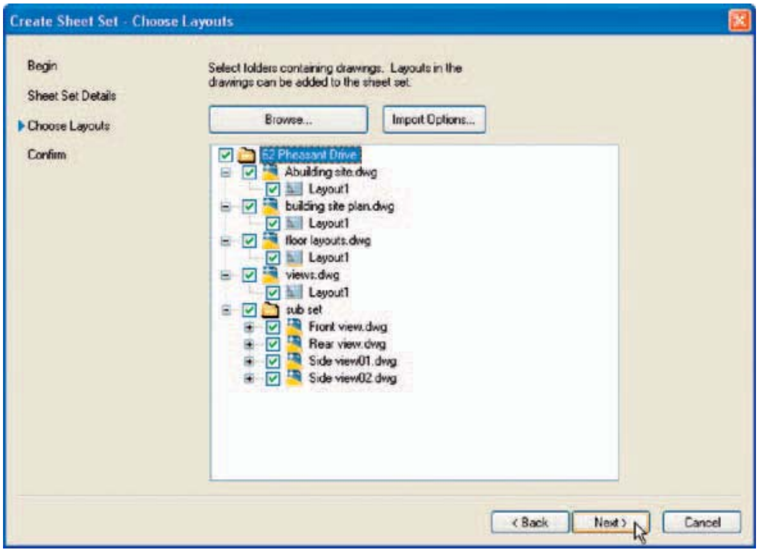

Fig. 11.7 The **Choose Layouts** dialog

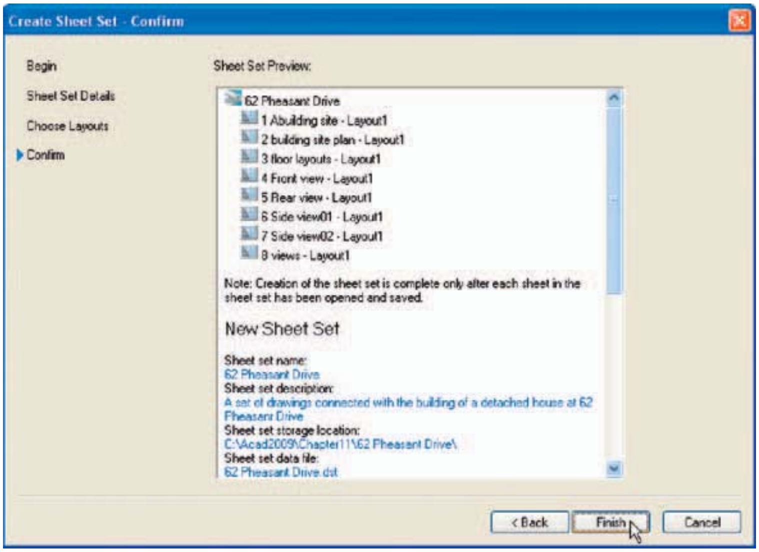

Fig. 11.8 The **Confirm** dialog

Notes

1. The eight drawings in the sheet set are shown in Fig. 11.9. If any of the drawings in the sheet set are subsequently amended or changed, when the drawing is opened again from the **62 Pheasant Drive Sheet Manager** palette, the drawing will include any changes or amendments.

CHAPTER 11

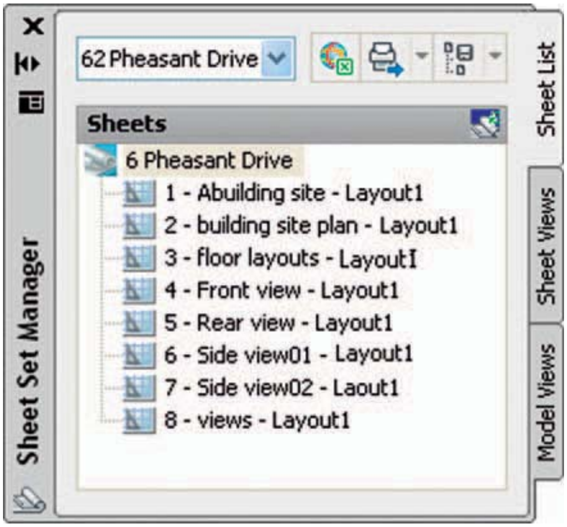

Fig. 11.9 The **Sheet** Manager palette for **62 Pheasant Drive**

2. Drawings can only be placed into sheet sets if they have been saved in a **Layout** screen. Note that all the drawings shown in the **62 Pheasant Drive** Sheet Set Manager have **Layout1** after the drawing names because each has been saved after being constructed in a **Layout1** template.

3. Sheet sets in the form of **DWF** (Design Web Format) files can be sent via email to others who are using the drawings or placed on an intranet. The method of producing a **DWF** for the **62 Pheasant Drive** Sheet Set follows.

62 Pheasant Drive DWF

1. In the **62 Pheasant Drive Sheet Set Manager** *click* the **Publish** icon, followed by a *click* on **Publish to DWF** in the menu which appears (Fig. 11.10). The **Specify DWF File** dialog appears (Fig. 11.11). *Enter* **62 Pheasant Drive** in the **File name** field followed by a *click* on the **Select** button. A warning window (Fig. 11.12) appears. *Click* its **Close** button. The **Publish Job in Progress** icon in the bottom right-hand corner of the AutoCAD 2010 window starts fluctuating in shape, showing that the DWF file is being processed (Fig. 11.12). When the icon becomes stationary *right-click* the icon and *click* **View Plotted file** in the right-click menu which appears (Fig. 11.13).

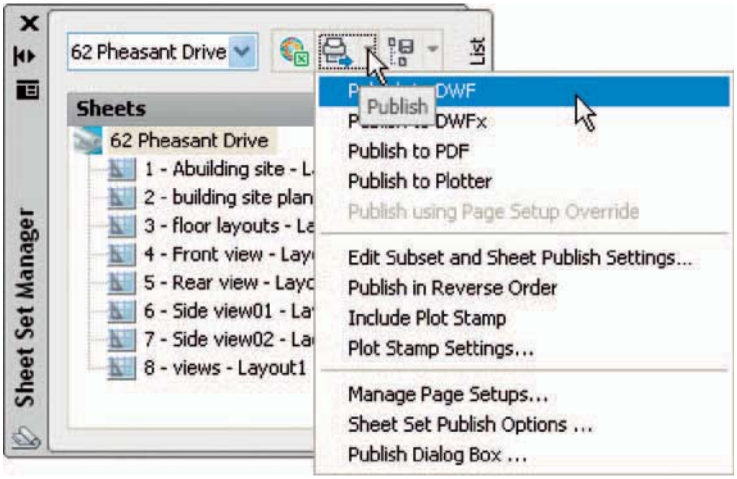

Fig. 11.10 The **Publish** icon in the **Sheet Set Manager**

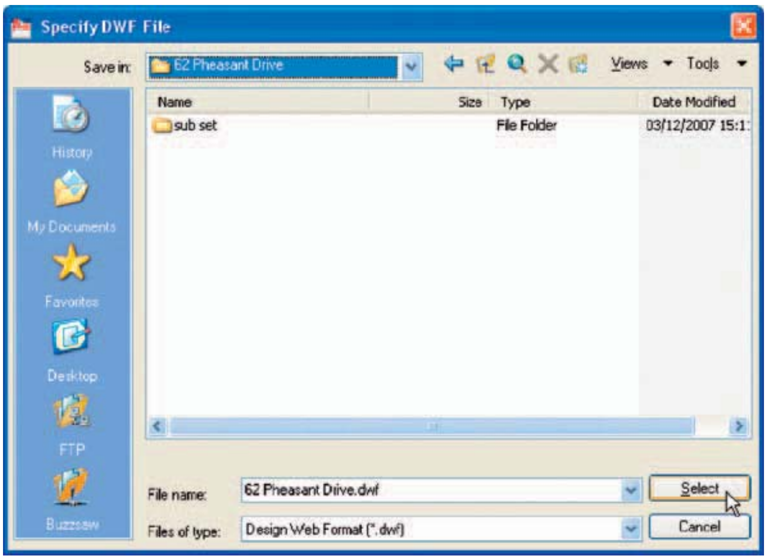

Fig. 11.11 The **Select DWF File** dialog

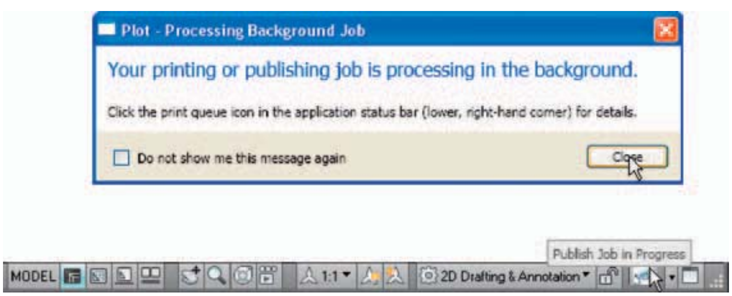

Fig. 11.12 The Publish Job in Progress icon

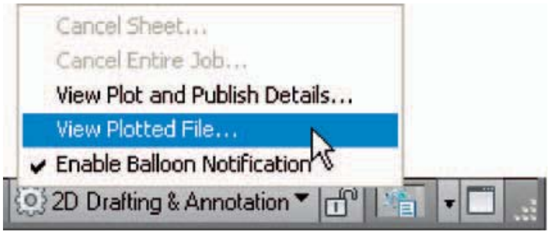

Fig. 11.13 *The right-click* menu of the icon

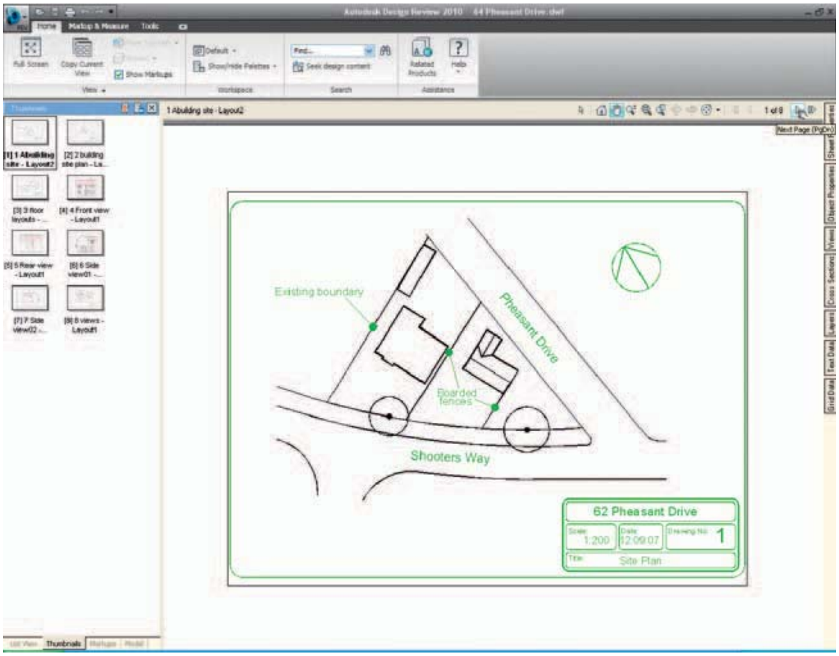

Fig. 11.14 The **Autodesk Design Review** showing details of the **62 Pheasant Drive.dwf** file

2. The **Autodesk Design Review** window appears showing the **62 Pheasant Drive.dwf** (Fig. 11.14). *Click* on the arrow **Next Page (Page On)** to see other drawings in the DWF file.
3. If required the Design Review file can be sent between people by email as an attachment, opened in a company's intranet or, indeed, included within an internet web page.

REVISION NOTES

1. To start off a new sheet set, select the **Sheet Set Manager** icon in the **Tools/Palettes** panel.
2. Sheet sets can only contain drawings saved in **Layout** format.
3. Sheet sets can be published as **Design Review Format** (*.**dwf**) files which can be sent between offices by email, published on an intranet or published on a web page.
4. Sub-sets can be included in sheet sets.
5. Changes or amendments made to any drawings in a sheet set are reflected in the sheet set drawings when the sheet set is opened.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/ 978-1-85617-868-6

1. Fig. 11.15 is an exploded orthographic projection of the parts of a piston and its connecting rod. There are four parts in the assembly. Small drawings of the required sheet set are shown in Fig. 11.17. Construct the drawing in Fig. 11.15 and also the four drawings of its parts. Save each of the drawings in a **Layout1** format and construct the sheet set which contains the five drawings.

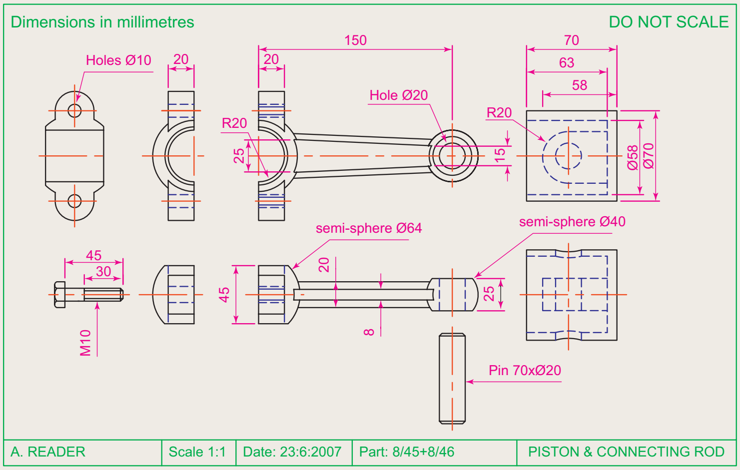

Fig. 11.15 Exercise 1 – exploded orthographic projection

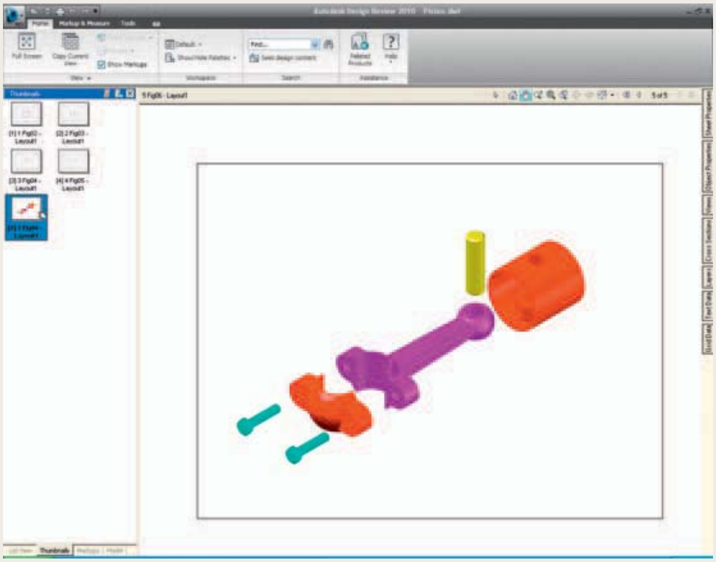

Fig. 11.16 The **DWF** for exercise 1

Construct the **DWF** file of the sheet set (Fig. 11.16). Experiment sending it to a friend via email as an attachment to a document, asking him/her to return the whole email to you without changes. When the email is returned, open its DWF file and *click* each drawing icon in turn to check the contents of the drawings.

2. Construct a sheet set similar to that in the answer to Exercise 1 from the exploded orthographic drawing of a **Machine adjusting spindle** given in Fig. 11.18.

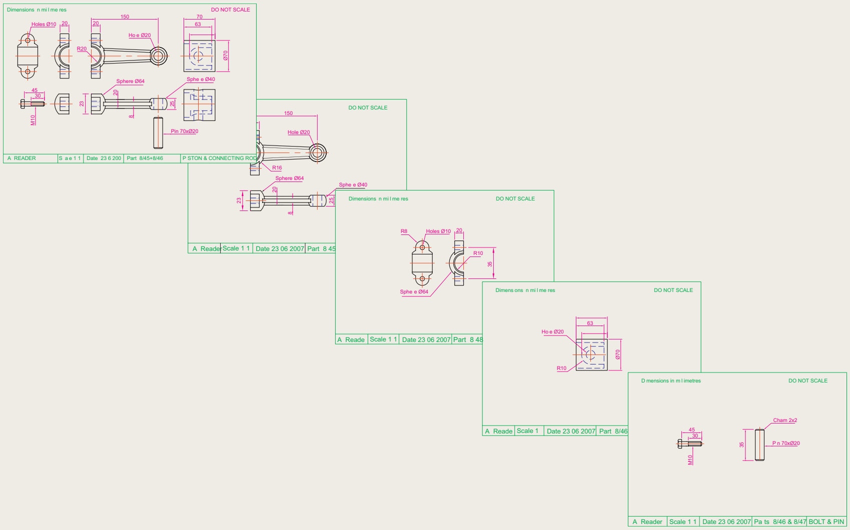

Fig. 11.17 Exercise 1 – the five drawings in the sheet set

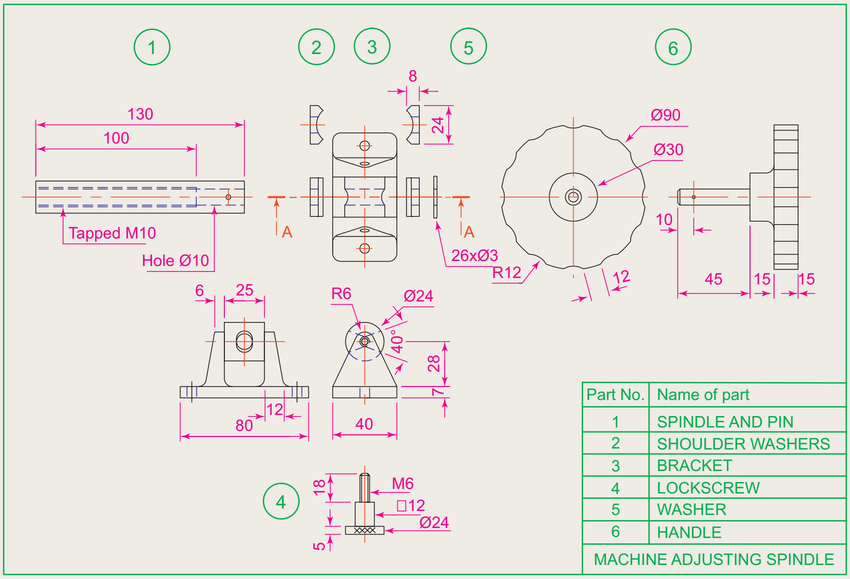

Fig. 11.18 Exercise 2

Part 2

3D Design

Chapter 12

Introducing 3D modelling

AIMS OF THIS CHAPTER

The aims of this chapter are:

1. To introduce the tools used for the construction of 3D solid models.
2. To give examples of the construction of 3D solid models using tools from the **Home/Modeling** panel.
3. To give examples of 2D outlines suitable as a basis for the construction of 3D solid models.
4. To give examples of constructions involving the Boolean operators **Union**, **Subtract** and **Intersect**.

Introduction

As shown in Chapter 1 the AutoCAD coordinate system includes a third coordinate direction **Z**, which, when dealing with 2D drawing in previous chapters, has not been used. 3D model drawings make use of this third **Z** coordinate.

The 3D Modeling workspace

It is possible to construct 3D model drawings in the **AutoCAD Classic** or **2D Drafting & Annotation** workspaces, but in **Part 2** of this book we will be working in the **3D Modeling** workspace. To set this workspace *click* the **Workspace Settings** icon in the status bar and select **3D Modeling** from the menu which appears (Fig. 12.1). The **3D Modeling** workspace appears (Fig. 12.2).

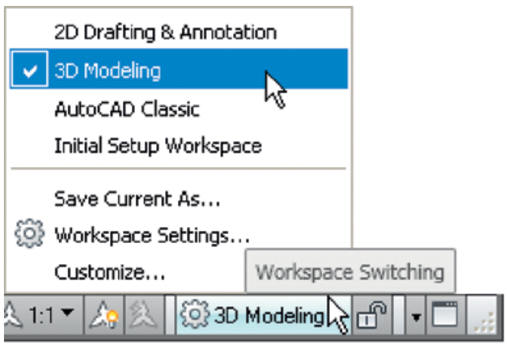

Fig. 12.1 Selecting **3D Modeling** from the **Workspace Switching** menu

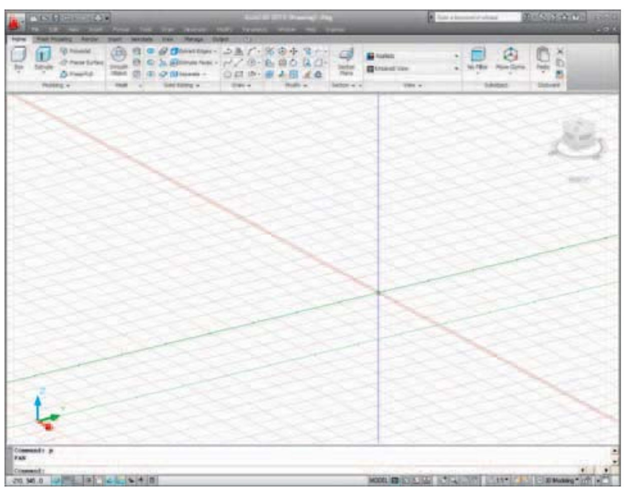

Fig. 12.2 The **3D Modeling** workspace in **Parallel projection**

The workspace in Fig. 12.2 shows grid lines in **Parallel projection** mode, brought about by *entering* **perspective** at the command line, followed by *entering* **0** in response to the prompt which appears. This is the window in which the examples in this chapter will be constructed. Note the **ViewCube** at the top right-hand corner of the drawing area. In Fig. 12.2 this has been highlighted by moving the cursor onto the cube. Changes can be made to the appearance and uses of the cube in the **ViewCube Settings** dialog brought to screen from the *right-click* menu of the **ViewCube** (Fig. 12.3).

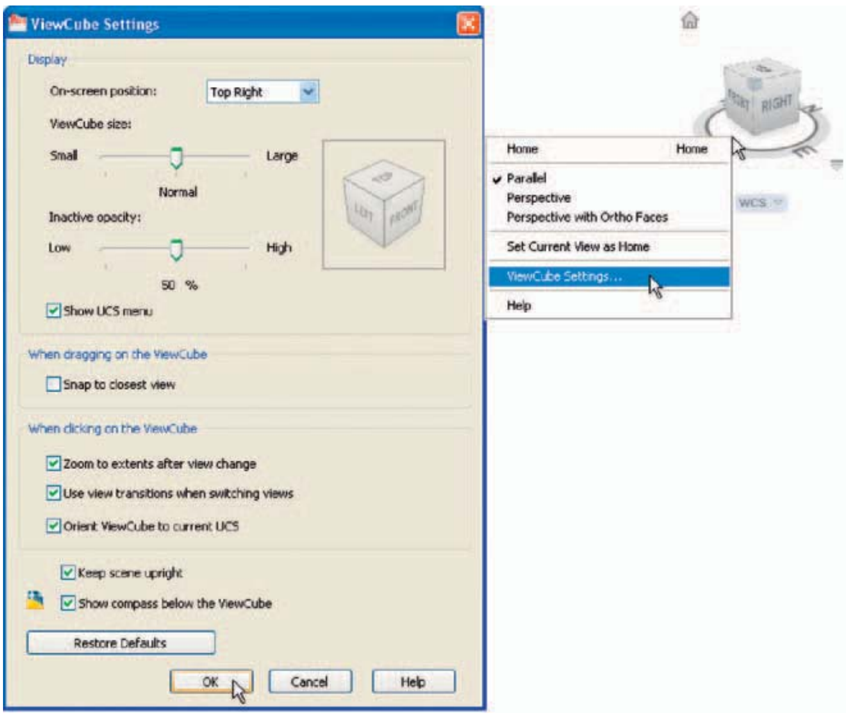

Fig. 12.3 The **ViewCube Settings** dialog

Methods of calling tools for 3D modelling

The default **3D Modeling** ribbon is shown in Fig. 12.4.

Fig. 12.4 The **3D Modeling** panels

When calling the tools for the construction of 3D model drawings, similar methods can be used as when constructing 2D drawings. 3D tools can be called by:

1. A *click* on a tool icon in a **3D Modeling** panel.
2. A *click* on a tool icon in the **Modeling** toolbar.
3. A *click* on the name of a tool from the **Draw/Modeling** drop-down menu.
4. *Entering* the tool name at the command line followed by pressing the *Return* button of the mouse or the **Return** key of the keyboard.
5. Some of the 3D tools have an abbreviation which can be *entered* at the command line instead of its full name.
6. Using the **Dynamic Input** method.

Notes

1. As when constructing 2D drawings, no matter which method is used, and most operators will use a variety of these six methods, calling a tool results in prompt sequences appearing at the command prompt (or if using **Dynamic Input** on screen) as in the following example:

```
Command:enter box right-click
Specify first corner or [Center]:enter 90,120
  right-click
Specify other corner or [Cube/Length]:enter
  150,200
Specify height or [2Point]:enter 50
Or, if the tool is called from its tool icon, or
  from a drop-down menu:
Command:_box
Specify first corner or [Center]:enter 90,120
  right-click
Specify other corner or [Cube/Length]:enter
  150,200
Specify height or [2Point]:enter 50
```

2. In the following pages, if the tool's sequences are to be repeated, they may be replaced by an abbreviated form such as:

```
Command: box
[prompts]: 90,120
[prompts]: 150,200
```

The Polysolid tool (Fig. 12.8)

Fig. 12.5 *Click* **Top** in the **ViewCube**

1. Make sure layer **0** is current.
2. *Click* **Top** in the **ViewCube** (Fig. 12.5). The screen switches to a **Top** view.
3. Construct an octagon of edge length **60** using the **Polygon** tool.
4. With *click* the house icon in the **ViewCube** (Fig. 12.6). The screen switches to an **Isometric** view.
5. Call the **Polysolid** tool with a *click* on its tool icon in the **Home/Modeling** panel (Fig. 12.7). The command line shows:

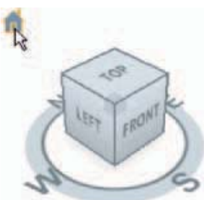

Fig. 12.6 Selecting **Isometric** from the **ViewCube**

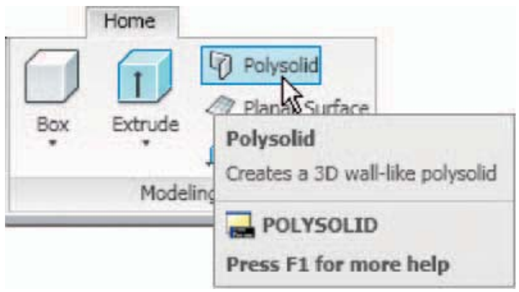

Fig. 12.7 The **Polysolid** tool icon from the **Draw/Modeling** drop-down menu

```
Command: _Polysolid Height = 0, Width = 0,
  Justification = Center
Specify start point or [Object/Height/Width/
  Justify] <Object>:enter h (Height)
Specify height <4>: 60
Height = 60, Width = 0, Justification = Center
Specify start point or [Object/Height/Width/
  Justify] <Object>:enter w (Width)
Specify width <0>: 5
Height = 60, Width = 5, Justification = Center
Specify start point or [Object/Height/Width/
  Justify] <Object>:right-click
Select object:pick the octagon
Command:
```

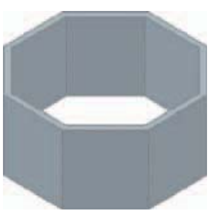

Fig. 12.8 Example polysolid

And the **Polysolid** forms (Fig. 12.8).

2D outlines suitable for 3D models

When constructing 2D outlines suitable as a basis for constructing some forms of 3D model, select a tool from the **Home/Draw** panel, or *enter* tool names or abbreviations for the tools at the command line. If constructed using tools such as **Line**, **Circle** and **Ellipse**, before being of any use for 3D modelling, outlines must be changed into regions with the **Region** tool . Closed polylines can be used without the need to use the **Region** tool.

First example – Line outline & Region (Fig. 12.9)

1. *Click* **Top** in the **ViewCube** to switch the screen to **Top** view and **Zoom** to **1**.
2. Construct the left-hand drawing of Fig. 12.9 using the **Line** tool.
3. *Click* the **Region** tool from the **Home/Draw** panel (Fig. 12.10), or select **Region** from the **Draw** drop-down menu, or from the **Draw** toolbar, or *enter* **reg** at the command line. The command line shows:

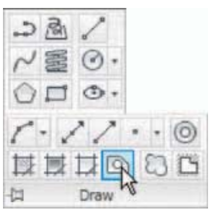

Fig. 12.10 Selecting the **Region** tool from the **Home/Draw** panel

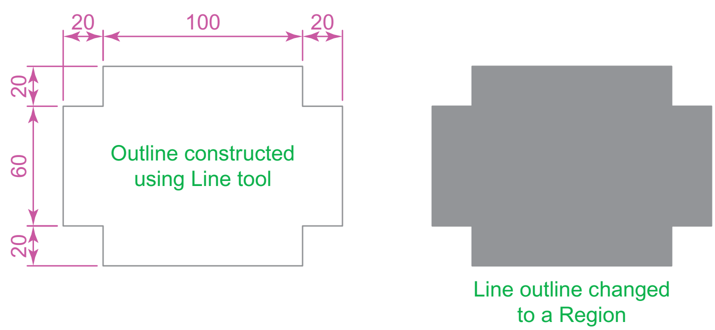

Fig. 12.9 First example – **Line** outline and **Region**

```
Command:_region
Select objects:window the drawing 12 found
Select objects:right-click
1 loop extracted.
1 Region created.
Command:
```

And the **Line** outline is changed to a **Region** – right-hand drawing in Fig. 12.9.

Second example – Union & Subtract regions (Fig. 12.11)

1. In the **ViewCube/Top** view, construct drawing **1** of Fig. 12.11 and with the **Copy** tool (**Home/Modify** panel), copy the drawing three times to produce drawings **2**, **3** and **4**.

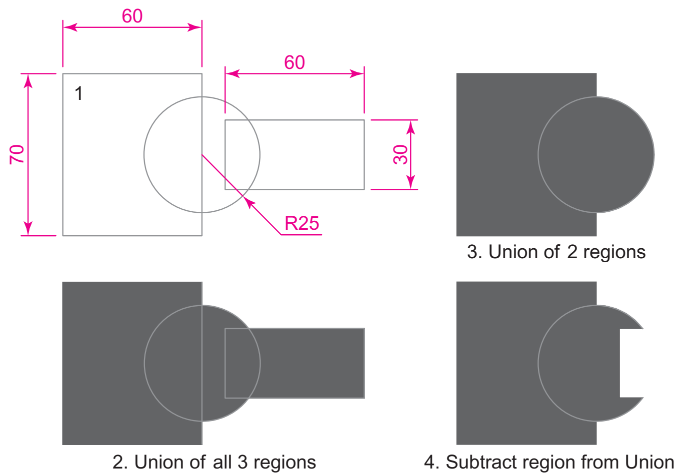

Fig. 12.11 Second example – **Union** and **Subtract** of regions

2. With the **Region** tool change all the outlines into regions.
3. Drawing **2 –** call the **Union** tool from the **Home/Solid Editing** panel (Fig. 12.12). The command line shows:

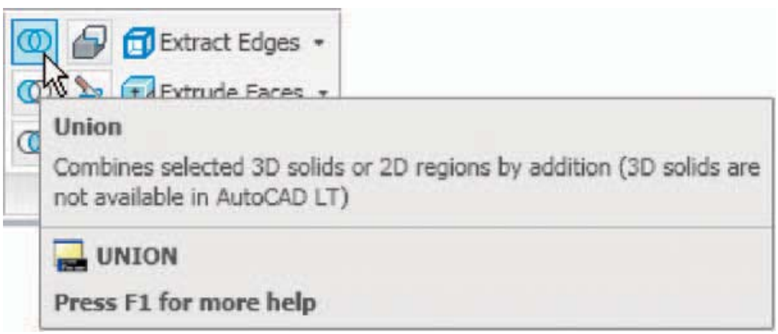

Fig. 12.12 The **Union** tool icon in the **Home/Solid Editing** panel

```
Command:_union
Select objects:pick the left-hand region 1 found
Select objects:pick the circular region 1 found, 2
  total
Select objects:pick the right-hand region 1 found,
  3 total
Command:
```

4. Drawing **3 –** with the **Union** tool form a union of the left-hand region and the circular region.

5. Drawing **4 –** call the **Subtract** tool, also from the **Home/Solid Editing** panel. The command line shows:

```
Command:_subtract Select solids and regions to
  subtract from ...
Select objects:pick the region just formed 1 found
Select objects:right-click
Select solids and regions to subtract:pick the
  right-hand region 1 found
Select objects:right-click
Command:
```

The Extrude tool

The **Extrude** tool can be called with a *click* in the **Modeling** toolbar, with a *click* on its name in the **Draw/Modeling** panel (Fig. 12.13), or by *entering* **extrude** or its abbreviation **ext** at the command line.

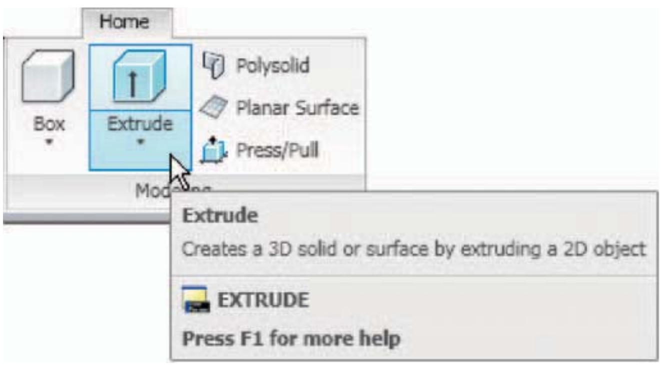

Fig. 12.13 The **Extrude** tool from the **Draw/Modeling** drop-down menu

Note

In this chapter 3D models are shown in illustrations as they appear in the **acadiso3D.dwt** template screen. In later chapters, 3D models are sometimes shown in outline only. This is to allow the reader to see the parts of 3D models in future chapters more clearly in the illustrations.

Examples of the use of the Extrude tool

The first two examples of forming regions given in Figures 12.10 and 12.11 are used to show the results of using the **Extrude** tool.

First example – Extrude (Fig. 12.14)

From the first example of forming a region:

1. Call **Extrude** (Fig. 12.13). The command line shows:

```
Command:_extrude
Current wire frame density: ISOLINES=4
Select objects to extrude:pick region 1 found
Select objects to extrude:right click
Specify height of extrusion or [Direction/Path/
  Taper angle] <45>:enter 50 right-click
Command:
```

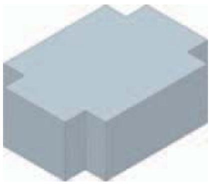

Fig. 12.14 First example – **Extrude**

2. Select **ViewCube/Isometric**. The extrusion appears in an isometric view.
3. Call **Zoom** and zoom to **1**.

The result is shown in Fig. 12.14.

Notes

1. In the above example we made use of an isometric view possible from the **ViewCube** (Fig. 12.5). The **ViewCube** can be manipulated to show a variety of views by *dragging* to its required positions under mouse control.

2. Note the **Current wire frame density: ISOLINES = 4** in the prompts sequence when **Extrude** is called. The setting of **4** is suitable when extruding plines or regions consisting of straight lines, but when arcs are being extruded it may be better to set **ISOLINES** to a higher figure as follows:

```
Command:enter isolines right-click
Enter new value for ISOLINES <4>:enter 16
  right-click
Command:
```

Second example – Extrude (Fig. 12.16)

From the second example of forming a region:

1. Set **ISOLINES** to **16**.
2. Call the **Extrude** tool. The command line shows:

```
Command:_extrude
Current wire frame density: ISOLINES=16
```

```
Select objects to extrude:pick the region 1 found
Select objects to extrude:right-click
Specify height of extrusion or [Direction/Path/
  Taper angle]:enter t right-click
Specify angle of taper for extrusion:enter 5
  right-click
Specify height of extrusion or [Direction/Path/
  Taper angle]:enter 100 right-click
Command:
```

Fig. 12.15 Second example – new position of the **ViewCube**

3. *Drag* the **ViewCube** to a new view as shown in Fig. 12.15.
4. **Zoom** to **1**.

The result is shown in Fig. 12.16.

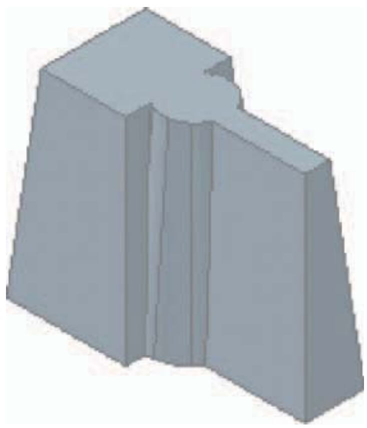

Fig. 12.16 Second example – **Extrude**

Third example – Extrude (Fig. 12.18)

From the third example of forming a region:

1. Place the screen in the **ViewCube/Top** view and construct a rectangle of size **80** × **50**, filleted to a radius of **15**. Place the drawing in the **View Cube/Front** view and using the **3D Polyline** tool from the **Home/Draw** panel (Fig. 12.17) construct a 3D polyline of three plines each of length **45** and at **45**° to each other at the centre of the outline as shown in Fig. 12.18.
2. Place the screen in the **ViewCube/Isometric** view.
3. Set **ISOLINES** to **24**.
4. Call the **Extrude** tool. The command line shows:

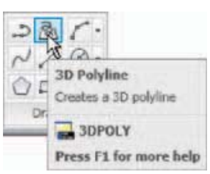

Fig. 12.17 The **3D Polyline** tool from the **Home/Draw** panel

```
Command:enter ext right-click
Current wire frame density: ISOLINES=24
```

```
Select objects to extrude:pick the rectangle 1
  found
Select objects to extrude:right-click
Specify height of extrusion or [Direction/Path/
  Taper angle] <100 > :enter p right-click
Select extrusion path or [Taper angle]:pick the
  path
Command:
```

The result is shown in Fig. 12.18.

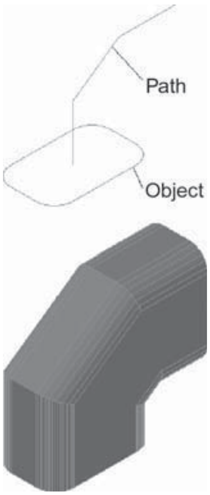

Fig. 12.18 Third example – **Extrude**

The Revolve tool

The **Revolve** tool can be called with a *click* on its tool icon in the **Modeling** toolbar, by a *click* on its tool icon in the **Home/Modeling** panel, by a *click* on its name in the **Modeling** sub-menu of the **Draw** drop-down menu, or by *entering* **revolve** or its abbreviation **rev** at the command line.

Examples of the use of the Revolve tool

Solids of revolution can be constructed from closed plines or from regions.

First example – Revolve (12.21)

1. Construct the closed polyline Fig. 12.19.

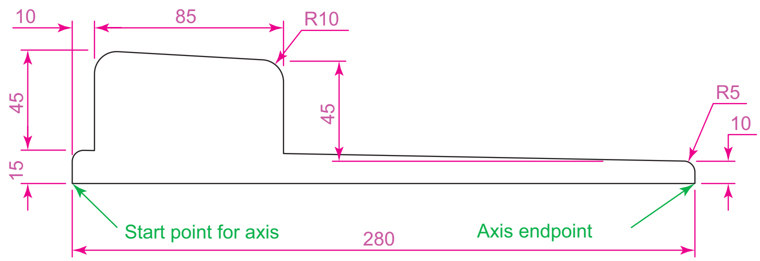

Fig. 12.19 First example – **Revolve**. The closed pline

2. Set **ISOLINES** to **24**.
3. Call the **Revolve** tool from the **Home/Modeling** control panel (Fig. 12.20). The command line shows:

```
Command:
Command:_revolve
Current wire frame density: ISOLINES=24
Select objects to revolve:pick the polyline 1 found
Select objects to revolve:right-click
Specify axis start point or define axis by [Object/
  X/Y/Z] <Object>:pick
Specify axis endpoint:pick
Specify angle of revolution or [Start angle]
  <360>:right-click
Command:
```

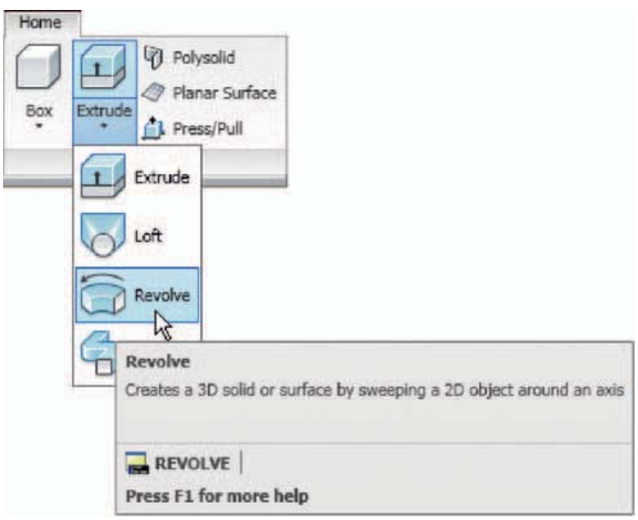

Fig. 12.20 The **Revolve** tool from the **Home/3D Modeling** panel

Fig. 12.21 First example – **Revolve**

4. Place in the **ViewCube/Isometric** view. Zoom to **1**.

The result is shown in Fig. 12.21.

Second example – Revolve (Fig. 12.23)

1. Place the screen in the **ViewCube/Front** view. **Zoom** to **1**.
2. Construct the pline outline (Fig. 12.22).

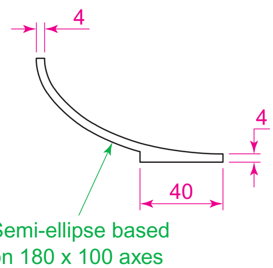

Fig. 12.22 Second example – **Revolve**. The pline outline

3. Set **ISOLINES** to **24**.
4. Call the Revolve tool and construct a solid of revolution.
5. Place the screen in the **ViewCube/Isometric** view. Zoom to **1**.

Fig. 12.23 Second example – **Revolve**

Third example – Revolve (Fig. 12.24)

1. Construct the pline (left-hand drawing of Fig. 12.24). The drawing must be either a closed pline or a region.
2. Call **Revolve** and form a solid of revolution through 180°.
3. Place the model in the **ViewCube/Isometric** view. **Zoom** to **1**.

The result is shown in Fig. 12.24 (right-hand drawing).

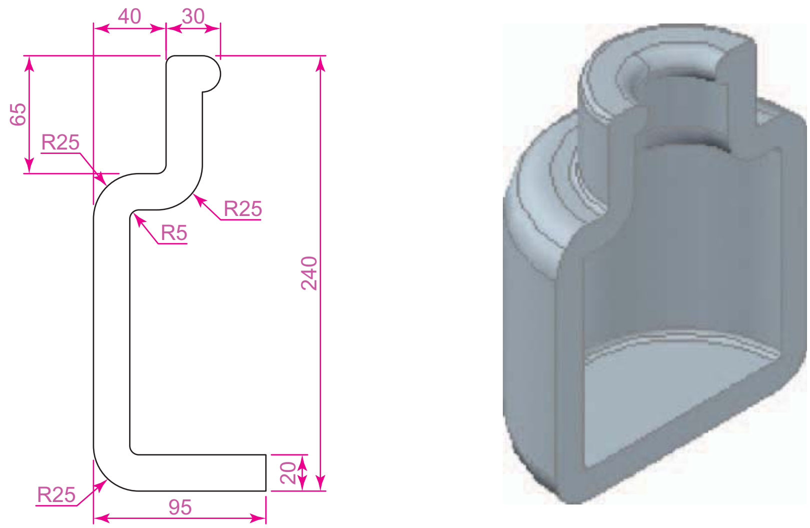

Fig. 12.24 Third example – **Revolve**. The outline to be revolved and the solid of revolution

Other tools from the Home/Modeling panel

First example – Box (Fig. 12.26)

1. Place the window in the **ViewCube/Front** view.
2. *Click* the **Box** tool icon in the **Home/Modeling** panel (Fig. 12.25). The command line shows:

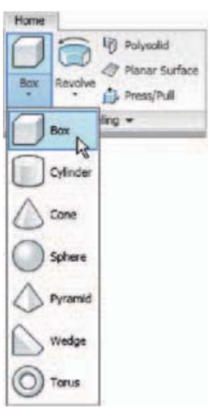

Fig. 12.25 Selecting the **Box** tool from the pop-up in the **Home/Modeling** panel

```
Command:_box
Specify first corner or [Center]:enter 90,90
  right-click
Specify other corner or [Cube/Length]:enter 110,-30
  right-click
Specify height or [2Point]:enter 75 right-click
Command:right-click
BOX Specify first corner or [Center]: 110,90
Specify other corner or [Cube/Length]: 170,70
Specify height or [2Point]: 75
Command:
BOX Specify first corner or [Center]: 110,-10
Specify other corner or [Cube/Length]: 200,-30
Specify height or [2Point]: 75
Command:
```

3. Place in the **ViewCube/Isometric** view. **Zoom** to **1**.
4. Call the **Union** tool from the **Home/Solid Editing** panel. The command line shows:

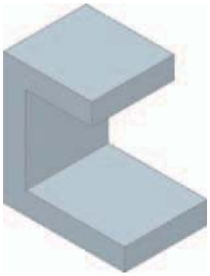

Fig. 12.26 First example – **Box**

```
Command:_union
Select objects:pick one of the boxes 1 found
Select objects:pick the second of box 1 found, 2
  total
Select objects:pick the third box 1 found, 3 total
Select objects:right-click
Command:
```

And the three boxes are joined in a single union. See Fig. 12.26.

Second example – Sphere and Cylinder (Fig. 12.27)

1. Set **ISOLINES** to **16**.
2. *Click* the **Sphere** tool icon from the **Home/Modeling** panel. The command line shows:

```
Command:_sphere
Specify center point or [3P/2P/Ttr]: 180,170
Specify radius or [Diameter]: 50
Command:
```

3. *Click* the **Cylinder** tool icon in the **Home/Modeling** panel. The command line shows:

```
Command: _cylinder
Specify center point of base or [3P/2P/Ttr/
  Elliptical]: 180,170
Specify base radius or [Diameter]: 25
Specify height or [2Point/Axis endpoint]: 110
Command:
```

4. Place the screen in the **ViewCube/Front** view. **Zoom** to **1**.
5. With the **Move** tool (from the **Home/Modify** panel), move the cylinder vertically down so that the bottom of the cylinder is at the bottom of the sphere.
6. *Click* the **Subtract** tool icon in the **Home/Solid Editing** panel. The command line shows:

```
Command:_subtract Select solids and regions to
  subtract from ..
Select objects:pick the sphere 1 found
```

```
Select objects:right-click
Select solids and regions to subtract
Select objects:pick the cylinder 1 found
Select objects:right-click
Command:
```

7. Place the screen in the **ViewCube/Isometric** view. **Zoom** to **1**.

The result is shown in Fig. 12.27.

Fig. 12.27 Second example – **Sphere** and **Cylinder**

Third Example – Cylinder, Cone and Sphere (Fig. 12.28)

1. Call the **Cylinder** tool and with a centre **170,150** construct a cylinder of radius **60** and height **15**.
2. *Click* the **Cone** tool in the **Home/Modeling** panel. The command line shows:

```
Command:_cone
Specify center point of base or [3P/2P/Ttr/
  Elliptical]: 170,150
Specify base radius or [Diameter]: 40
Specify height or [2Point/Axis endpoint/Top
  radius]: 150
Command:
```

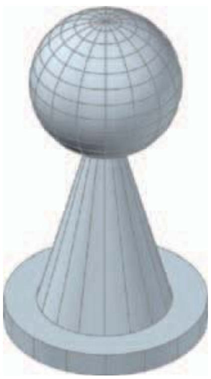

Fig. 12.28 Third example – **Cylinder, Cone** and **Sphere**

3. Call the **Sphere** tool and construct a sphere of centre **170,150** and radius **45**.
4. Place the screen in the **Front** view and with the **Move** tool, move the cone and sphere so that the cone is resting on the cylinder and the centre of the sphere is at the apex of the cone.
5. Place in the **ViewCube/Isometric** view, **Zoom** to **1** and with the **Union** tool form a single 3D model from the three objects.

The result is shown in Fig. 12.28.

Fourth Example – Box and Wedge (Fig. 12.29)

1. *Click* the **Box** tool icon in the **Home/Modeling** panel and construct two boxes, the first of corners **70,210** and **290,120** of height **10**, the second of corners **120,200,10** and **240,120,10** and of height **80**.
2. Place the screen in the **ViewCube/Front** view and **Zoom** to **1**.
3. *Click* the **Wedge** tool icon in the **Home/Modeling** panel. The command line shows:

```
Command:_wedge
Specify first corner or [Center]: 120,170,10
```

```
Specify other corner or [Cube/Length]: 80,160,10
Specify height or [2Point]: 70
Command:right-click
WEDGE
Specify first corner of wedge or [Center]:
  240,170,10
Specify corner or [Cube/Length]: 280,160,10
Specify height or [2Point]: 70
Command:
```

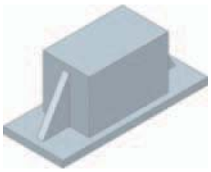

Fig. 12.29 Fourth example – **Box** and **Wedge**

4. Place the screen in the **ViewCube/Isometric** view and **Zoom** to **1**.
5. Call the **Union** tool from the **Home/Solid Editing** panel and in response to the prompts in the tool's sequences *pick* each of the 4 objects in turn to form a union of the 4 objects.

The result is shown in Fig. 12.29.

Fifth Example – Cylinder and Torus (Fig. 12.30)

1. Using the **Cylinder** tool from the **Home/Modeling** panel, construct a cylinder of centre **180,160**, of radius **40** and height **120**.
2. *Click* the **Torus** tool icon in the **Home/Modeling** panel. The command line shows:

```
Command:_torus
Specify center point or [3P/2P/Ttr]: 180,160,10
Specify radius or [Diameter]: 40
Specify tube radius or [2Point/Diameter]: 10
Command:right-click
TORUS
Specify center point or [3P/2P/Ttr]: 180,160,110
Specify radius or [Diameter] <40>:right-click
Specify tube radius or [2Point/Diameter] <10>:
  right-click
Command:
```

Fig. 12.30 Fifth example – **Cylinder** and **Torus**

3. Call the **Cylinder** tool and construct another cylinder of centre **180,160**, of radius **35** and height **120**.
4. Place in the **ViewCube/Isometric** view and **Zoom** to **1**.
5. *Click* the **Union** tool icon in the **Home/Solid Editing** panel and form a union of the larger cylinder and the two torii.
6. *Click* the **Subtract** tool icon in the **Home/Solid Editing** panel and subtract the smaller cylinder from the union.

The result is shown in Fig. 12.30.

The Chamfer and Fillet tools

The **Chamfer** and **Fillet** tools from the **Home/Modify** panel (Fig. 12.31) used to create chamfers and fillets in 2D drawings in AutoCAD 2010 can just as well be used when constructing 3D models.

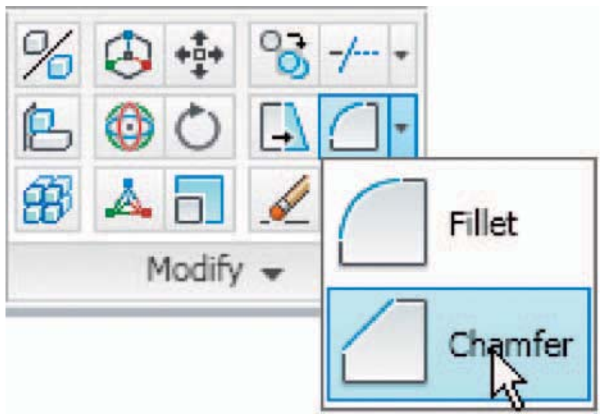

Fig. 12.31 The **Chamfer** and **Fillet** tools in the **Home/Modify** panel

Example – Chamfer and Fillet (Fig. 12.34)

1. Working to the sizes given in Fig. 12.32 and using the **Box** and **Cylinder** tools, construct the 3D model in Fig. 12.33.
2. Place in the **ViewCube/Isometric** view. **Union** the two boxes and with the **Subtract** tool, subtract the cylinders from the union.

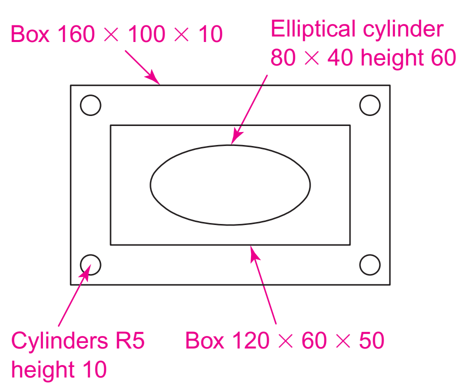

Fig. 12.32 Example – **Chamfer and Fillet –** sizes for the model

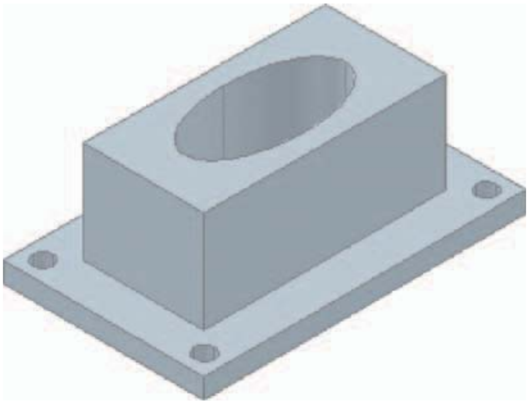

Fig. 12.33 Example – isometric view – **Chamfer and Fillet –** the model before using the tools

Note

To construct the elliptical cylinder, call the **Cylinder** tool from the **Home/Modeling** panel. The command line shows:

```
Command:_cylinder
Specify center point of base or [3P/2P/Ttr/
  Elliptical]:enter e right-click
Specify endpoint of first axis or [Center]:
  130,160
Specify other endpoint of first axis: 210,160
Specify endpoint of second axis: 170,180
Specify height or [2Point/Axis endpoint]: 50
Command:
```

3. *Click* the **Fillet** tool icon in the **Home/Modify** panel (Fig. 12.31). The command line shows:

```
Command:_fillet
Current settings: Mode=TRIM. Radius=1
Specify first object or [Undo/Polyline/Radius/Trim/
  Multiple]:enter r (Radius) right-click
Specify fillet radius <1>: 10
Select first object:pick one corner
Select an edge or [Chain/Radius]:pick a second
  corner
Select an edge or [Chain/Radius]:pick a third
  corner
Select an edge or [Chain/Radius]:pick the fourth
  corner
```

```
Select an edge or [Chain/Radius]:right-click
4 edge(s) selected for fillet.
Command:
```

4. *Click* the **Chamfer** tool in the **Home/Modify** panel (Fig. 12.31). The command line shows:

```
Command:_chamfer
(TRIM mode) Current chamfer Dist1=1, Dist2=1
Select first line or [Undo/Polyline/Distance/
  Angle/Trim/mEthod/Multiple]:enter d
  (Distance)right-click
Specify first chamfer distance <1>: 10
Specify second chamfer distance <10>: 10
Select first line:pick one corner One side of the
  box highlights
Base surface selection ... Enter surface selection
  [Next/OK (current)] <OK>:right click
Specify base surface chamfer distance <10>:
  right-click
Specify other surface chamfer distance <10>:
  right-click
Select an edge or [Loop]:pick the edge again
  Select an edge:pick the second edge
Select an edge [or Loop]:right-click
Command:
```

And two edges are chamfered. Repeat to chamfer the other two edges.

Figure 12.34 shows the completed 3D model.

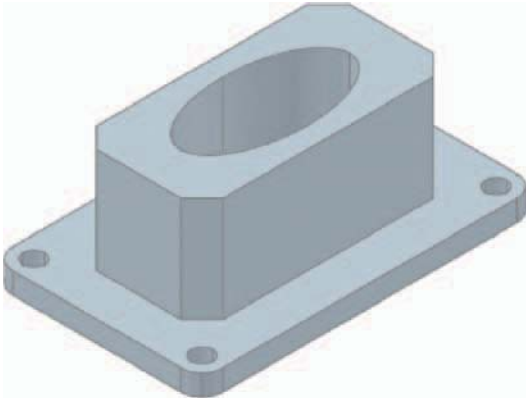

Fig. 12.34 Example – **Chamfer and Fillet**

Note on the tools Union, Subtract and Intersect

The tools **Union**, **Subtract** and **Intersect** found in the **Home/Solids Editing** panel are known as the **Boolean** operators after the mathematician Boole. They can be used to form unions, subtractions or intersections between extrusions, solids of revolution, or any of the 3D Objects.

Note on using 2D Draw tools on 3D models

As was seen when using the **Move** from the **Home/Draw** panel when working in the **2D Drafting & Annotation** workspace and the **Chamfer** and **Fillet** tools from the **Home/Modify** panel, so can other tools – **Move, Copy**, **Mirror**, **Rotate** and **Scale** from the **Home/Modify** panel in the **3D Modeling** workspace – be used in connection with the construction of 3D models.

Constructing 3D surfaces using the Extrude tool

In this example of the construction of a 3D surface model the use of the **Dynamic Input** (DYN) method of construction will be shown.

1. Place the AutoCAD drawing area in the **ViewCube/Isometric** view.
2. *Click* the **Dynamic Input** button in the status bar to make dynamic input active.

Example – Dynamic Input (Fig. 12.36)

1. Using the **Line** tool from the **Home/Draw** panel construct the outline (Fig. 12.35).

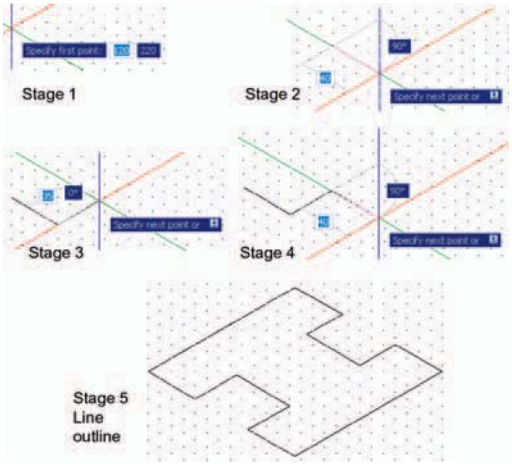

Fig. 12.35 Example – constructing the **Line** outline

2. Call the **Extrude** tool and window the line outline.
3. Extrude to a height of **100**.

The stages of producing the extrusion are shown in Fig. 12.35 and Fig. 12.36. The resulting 3D model is a surface model.

Note

The resulting 3D model shown in Fig. 12.36 is a surface model because the extrusion was constructed from an outline consisting of lines, which are individual objects in their own right. If the outline had been a polyline, the resulting 3D model would have been a solid model.

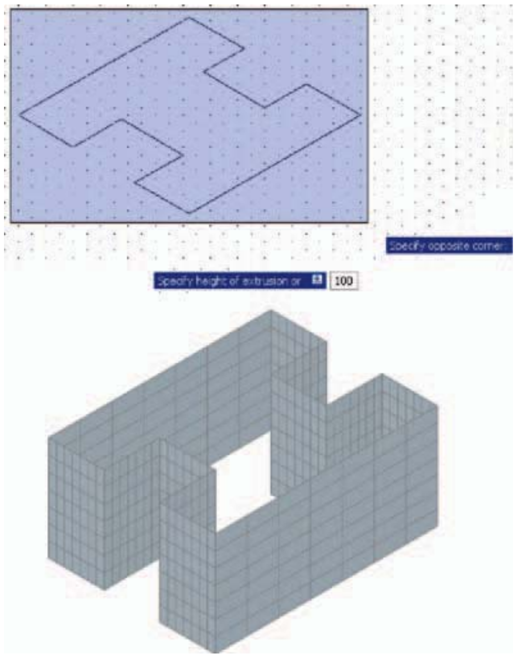

Fig. 12.36 Example – **Dynamic Input**

The Sweep tool

To call the **Sweep** tool, *click* on its tool icon in the **Home/Modeling** panel (Fig. 12.37).

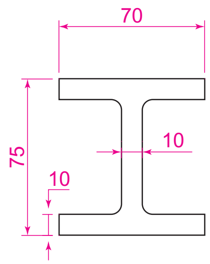

Fig. 12.38 Example **Sweep –** the outline to be swept

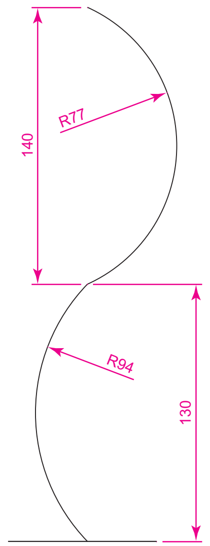

Fig. 12.39 Example **Sweep –** the pline path

Fig. 12.40 Example – **Sweep**

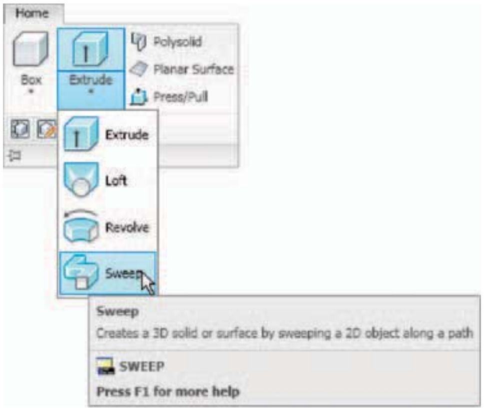

Fig. 12.37 Selecting the **Sweep** tool from the **Home/Modeling** panel

Example – Sweep (Fig. 12.40)

1. Construct the pline outline Fig. 12.38 in the **ViewCube/Top** view.
2. Change to the **ViewCube/Front** view, **Zoom** to **1** and construct a pline as shown in Fig. 12.39 as a path central to the ellipse.
3. Place the window in a **ViewCube/Isometric** view and *click* the **Sweep** tool icon (Fig. 12.37). The command line shows:

```
Command:_sweep
Current wire frame density: ISOLINES=4
Select objects to sweep:pick the ellipse 1 found
Select objects to sweep:right-click
Select sweep path or [Alignment/Base point/Scale/
  Twist]:pick the pline
Command:
```

The result is shown in Fig. 12.40.

The Loft Tool

To call the **Left** tool, *click* on its icon in the **Home/Modeling** panel.

Example – Loft (Fig. 12.43)

1. Construct the seven circles shown in Fig. 12.41 at vertical distances of **30** units apart.
2. Place the drawing area in the **ViewCube/Isometric** view.
3. Call the **Loft** tool with a *click* on its tool icon in the **Home/Modeling** panel (Fig. 12.42).

4. The command line shows:

```
Command:_loft
Select cross-sections in lofting order:<Snap
  off>pick the bottom circle 1 found
Select cross-sections in lofting order:pick the
  next circle 1 found, 2 total
Select cross-sections in lofting order:pick the
  next circle 1 found, 3 total
Select cross-sections in lofting order:pick the
  next circle 1 found, 4 total
```

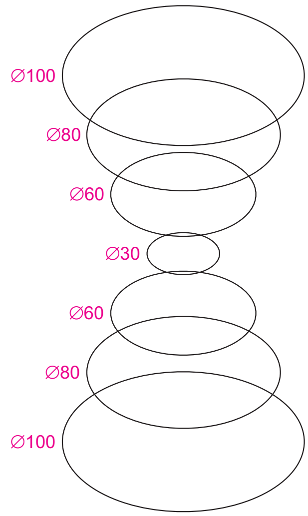

Fig. 12.41 Example **Loft** – the cross sections

```
Select cross-sections in lofting order:pick the
  next circle 1 found, 5 total
Select cross-sections in lofting order:pick the
  next circle 1 found, 6 total
Select cross-sections in lofting order:pick the
  next circle 1 found, 7 total
Select cross-sections in lofting order:
  right-click
```

And the **Loft Settings** dialog appears (Fig. 12.43).

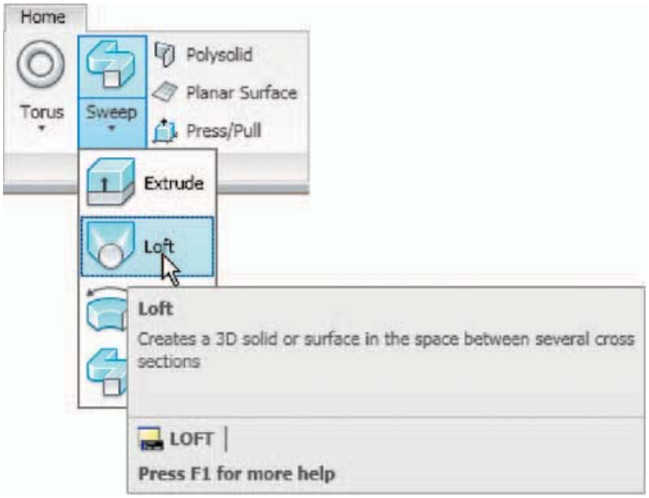

Fig. 12.42 Selecting the **Loft** tool from the **Home/Modeling** panel

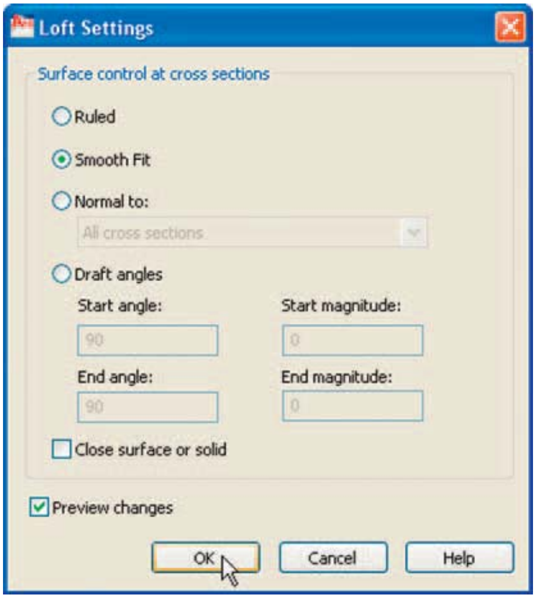

Fig. 12.43 The **Loft Settings** dialog

Fig. 12.44 Example **Loft**

5. *Click* the **Smooth Fit** radio button to make it active, followed by a *click* on the **OK** button. The loft appears.

The result is shown in Fig. 12.44.

REVISION NOTES

1. In the AutoCAD 3D coordinate system, positive Z is towards the operator away from the monitor screen.
2. A 3D face is a mesh behind which other details can be hidden.
3. The **Extrude** tool can be used for extruding closed plines or regions to stated heights, to stated slopes or along paths.
4. The **Revolve** tool can be used for constructing solids of revolution through any angle up to 360°.
5. 3D models can be constructed from the 3D objects **Box**, **Sphere**, **Cylinder**, **Cone**, **Torus** and **Wedge**. Extrusions and/or solids of revolutions may form part of models constructed using the 3D objects.
6. Tools such as **Chamfer** and **Fillet** from the **Home/Modify** panel can be used when constructing 3D models.
7. The tools **Union**, **Subtract** and **Intersect** are known as the **Boolean** operators.
8. When polylines forming an outline which is not closed are acted upon by the **Extrude** tool the resulting models will be 3D Surface models.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/ 978-1-85617-868-6

The exercises that follow require the use of tools from the **Home/Modeling** panel in association with tools from other panels.

1. Figure 12.45 shows the pline outline from which the polysolid outline Fig. 12.46 has been constructed to a height of **100** and **Width** of **3**. When the polysolid has been constructed, construct extrusions which can then be subtracted from the polysolid. Sizes of the extrusions are left to your judgement.

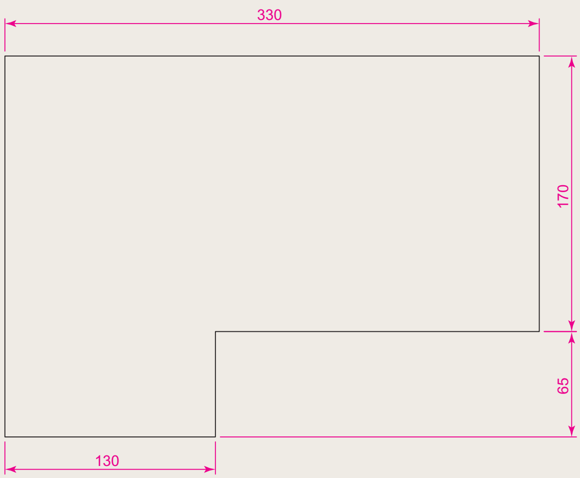

Fig. 12.45 Exercise 1 – outline for polyline

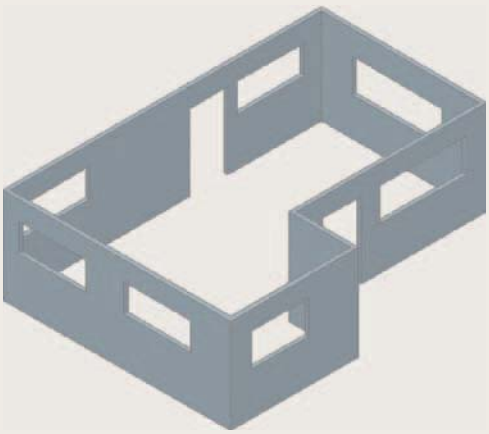

Fig. 12.46 Exercise 1 – polysolid outline

2. Figure 12.47 shows a 3D model constructed from four polysolids which have been formed into a union using the **Union** tool from the **Home/Modify** panel. The original polysolid was formed from a hexagon of edge length **30**. The original polysolid was of height **40** and **Width 5**. Construct the union.

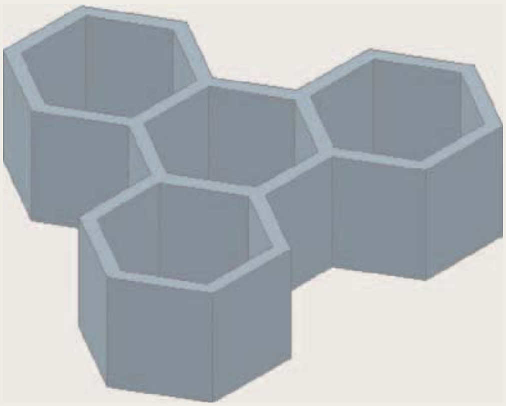

Fig. 12.47 Exercise 2

3. Figure 12.48 shows the 3D model from Exercise 2 acted upon by the **Presspull** tool which can be called by *entering* **presspull** at the command line. With the 3D model from Exercise 2 on screen and using the **Presspull** tool, construct the 3D model shown in Fig. 12.48. The distance of the pull can be estimated.

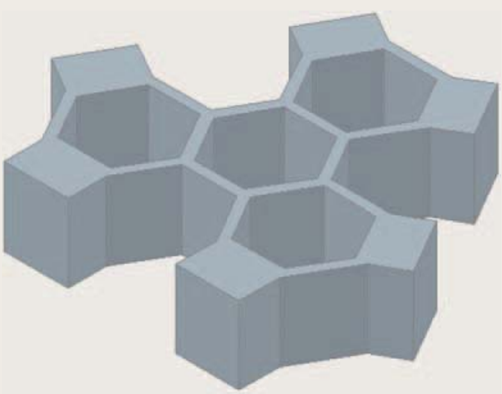

Fig. 12.48 Exercise 3

4. Construct the 3D model of a wine glass as shown in Fig. 12.50, working to the dimensions given in the outline drawing Fig. 12.49.

You will need to construct the outline and change it into a region before being able to change the outline into a solid of revolution using the **Revolve** tool from the **Home/Modeling** panel. This is because the semi-elliptical part of the outline has been constructed using the **Ellipse** tool, resulting in part of the outline being a spline, which cannot be acted upon by **Polyline Edit** to form a closed pline.

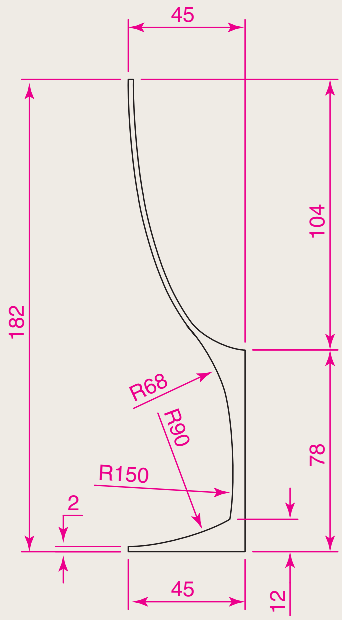

Fig. 12.49 Exercise 4 – outline drawing

Fig. 12.50 Exercise 4

5. Figure 12.51 shows the outline from which a solid of revolution can be constructed. Use the **Revolve** tool from the **Home/Modeling** panel to construct the solid of revolution.

6. Construct a 3D solid model of a bracket working to the information given in Fig. 12.52.

7. Working to the dimensions given in Fig. 12.53 construct an extrusion of the plate to a height of **5** units.

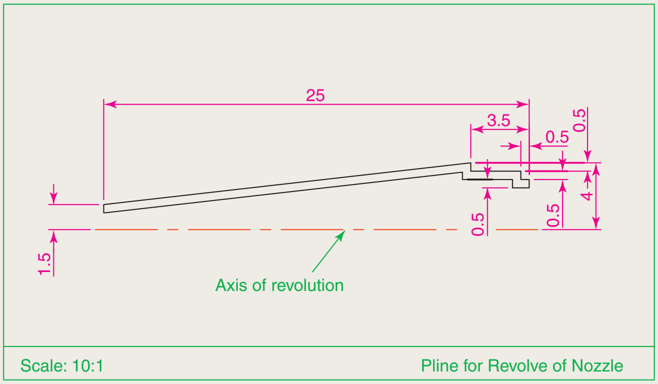

Fig. 12.51 Exercise 5

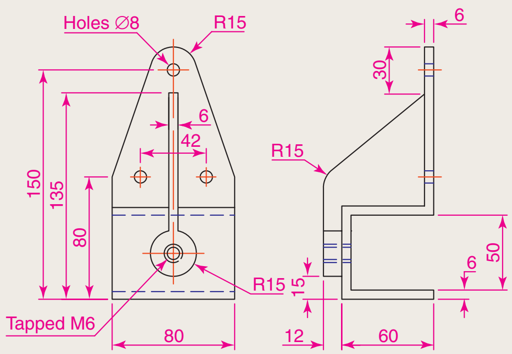

Fig. 12.52 Exercise 6

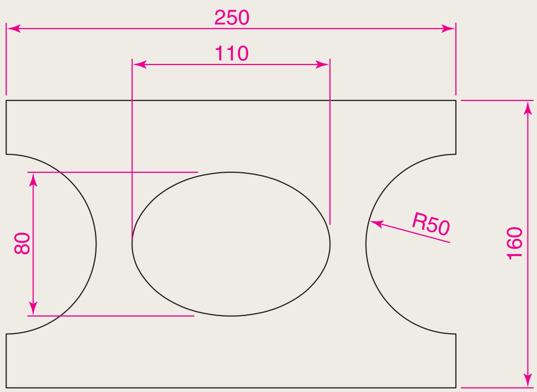

Fig. 12.53 Exercise 7

8. Working to the details given in the orthographic projection Fig. 12 54, construct a 3D model of the assembly. After constructing the pline outline(s) required for the solid(s) of revolution, use the **Revolve** tool to form the 3D solid.

9. Working to the polylines shown in Fig. 12.55 construct the **Sweep** shown in Fig. 12.56.

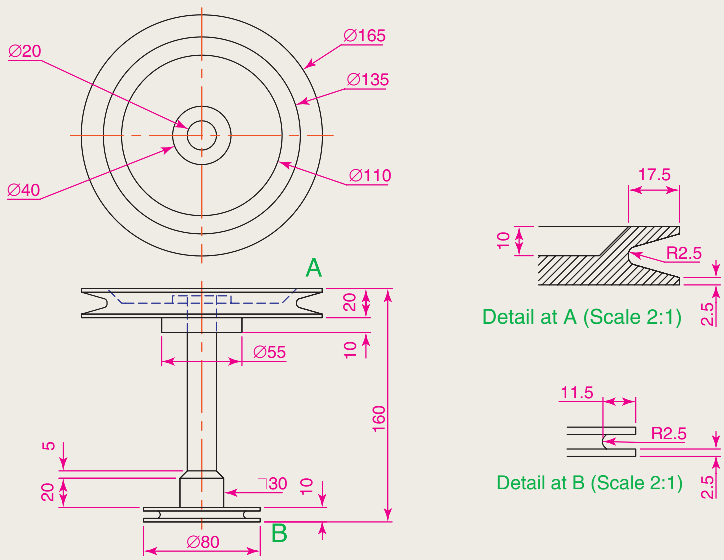

Fig. 12.54 Exercise 8

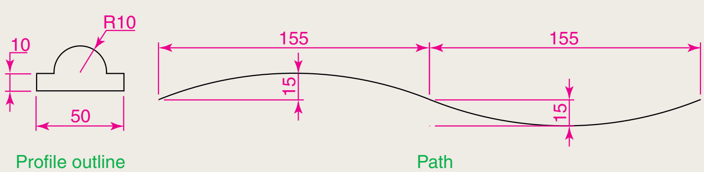

Fig. 12.55 Exercise 9 – profile and path dimensions

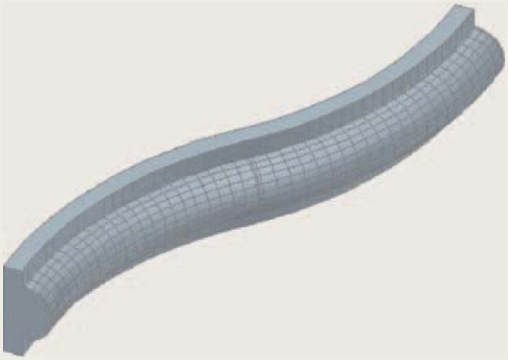

Fig. 12.56 Exercise 9

10. Construct the cross-sections as shown in Fig. 12 57 working to suitable dimensions. From the cross-sections construct the lofts shown in Fig. 12 58. The lofts are topped with a sphere constructed using the **Sphere** tool.

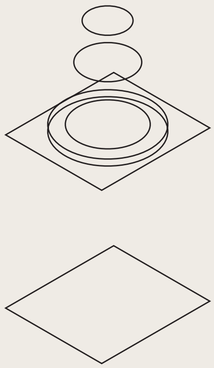

Fig. 12.57 The cross-sections for Exercise 10

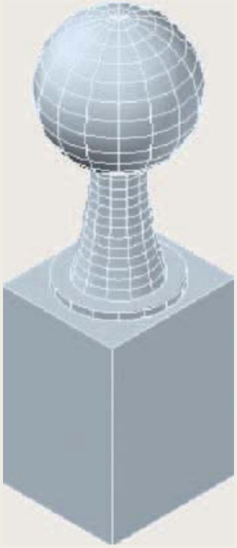

Fig. 12.58 Exercise 10

Chapter 13

3D models in viewports

AIM OF THIS CHAPTER

The aim of this chapter is to give examples of 3D solid models constructed in multiple viewport settings.

Setting up viewport systems

One of the better methods of constructing 3D models is in different multiple viewports. This allows what is being constructed to be seen from a variety of viewing positions. To set up multiple viewports:

1. In a **3D Modeling** workspace *click* **New** in the **View/Viewports** panel (Fig. 13.1). The **Viewports** dialog appears (Fig. 13.2).

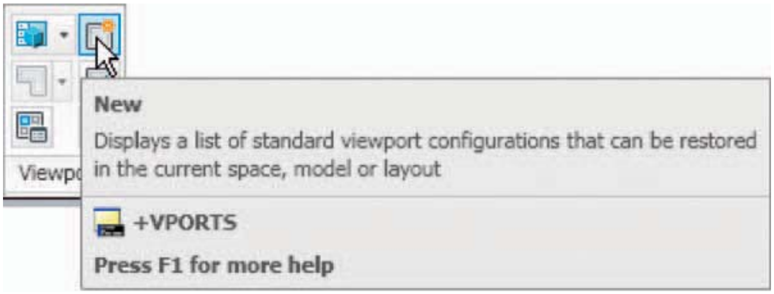

Fig. 13.1 Selecting **New** from the **View/Viewports** panel

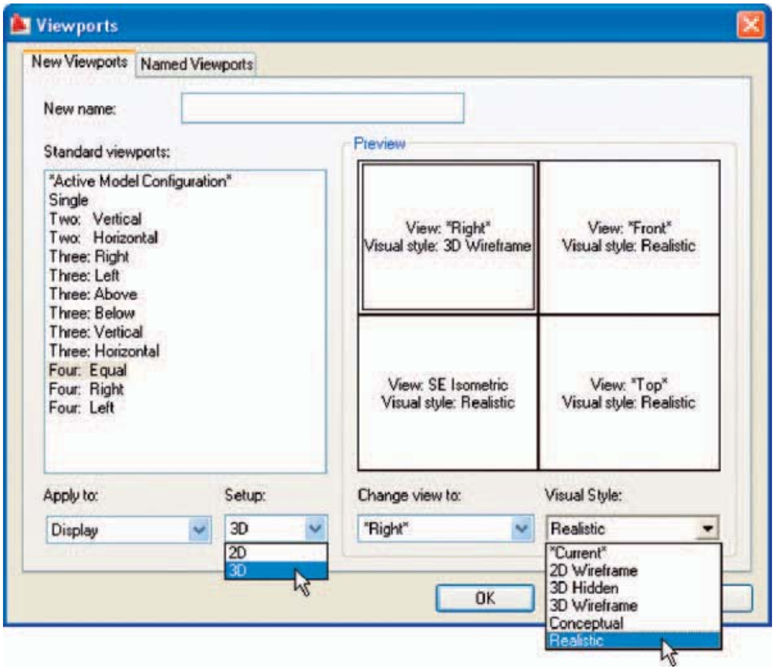

Fig. 13.2 The **Viewports** dialog

2. A number of named viewports systems appear in the **Standard Viewports** list in the dialog.
3. *Click* the name **Four: Equal**, followed by a *click* on **3D** in the **Setup** pop-up list. A preview of the **Four: Equal** viewports screen appears showing the views appearing in each of the four viewports.
4. *Click* in each viewport in the dialog in turn, followed by selecting **Realistic** from the **Visual Style** pop-up list.
5. *Click* the **OK** button of the dialog and the AutoCAD 2010 drawing area appears showing the four viewport layout.
6. *Click* in each viewport in turn and **Zoom** to **1**.

The result is shown in Fig. 13.3.

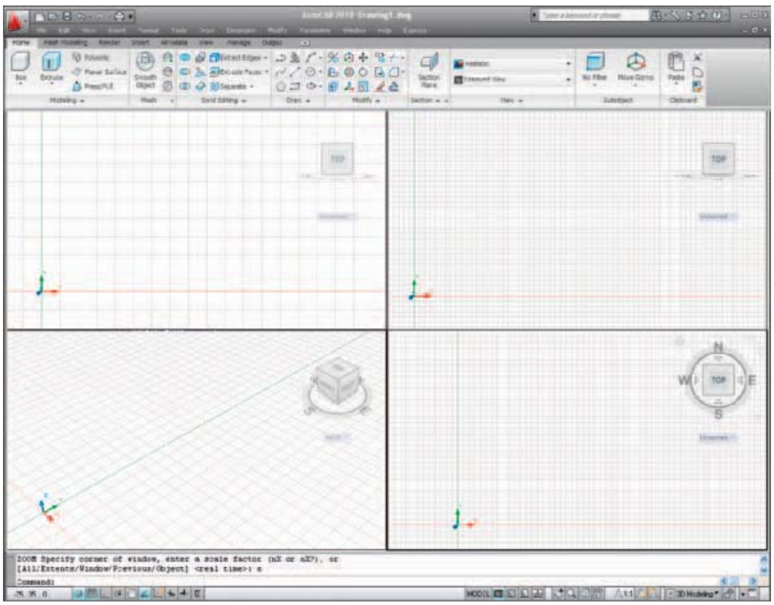

Fig. 13.3 The **Four: Equal** viewports layout

First example – Four: Equal viewports (Fig. 13.7)

Figure 13.4 shows a first angle orthographic projection of a support. To construct a **Scale 1:1** 3D model of the support in a **Four: Equal** viewport setting:

1. *Click* **View** in the **View/Viewports** panel. In the **Viewports** dialog make sure the **3D** option is selected from the **Setup** pop-up list and **Realistic** from the **Visual Style** pop-up menu and *click* the **OK** button of the dialog. The AutoCAD 2010 drawing area appears in a **Four: Equal** viewport setting.

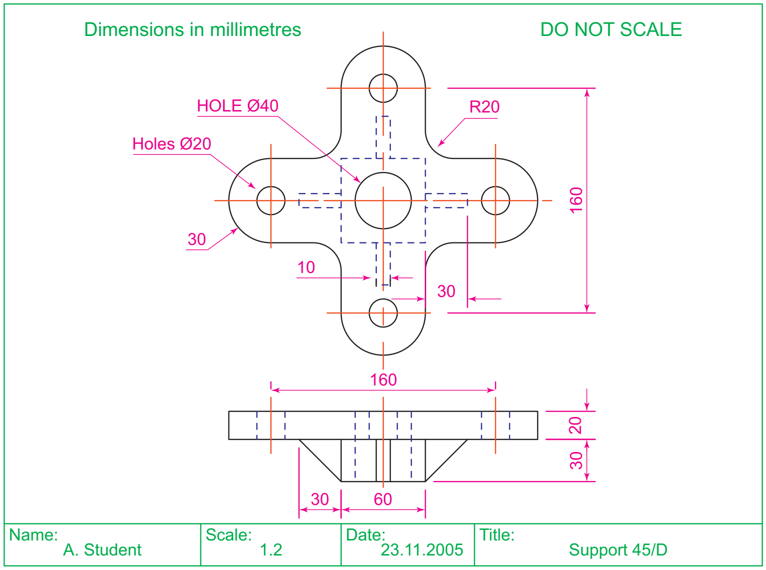

Fig. 13.4 Orthographic projection of the support for the first example

2. *Click* in each viewport in turn, making the selected viewport active, and **Zoom** to **1**.
3. Using the **Polyline** tool, construct the outline of the plan view of the plate of the support, including the holes in the **Top** viewport (Fig. 13.5). Note the views in the other viewports.

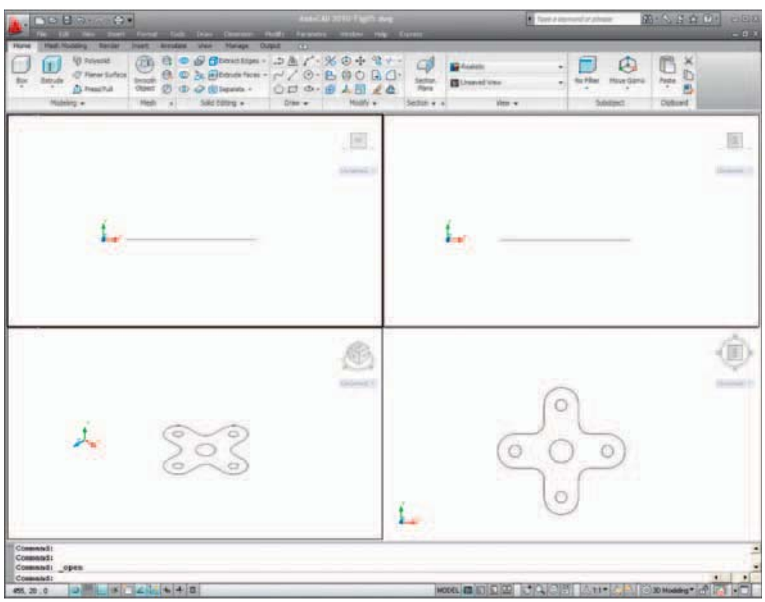

Fig. 13.5 First example – the view outlines

4. Call the **Extrude** tool from the **Home/Modeling** panel and extrude the plan outline and the circles to a height of **20**.
5. With **Subtract** from the **Home/Solids Editing** panel, subtract the holes from the plate (Fig. 13.6).

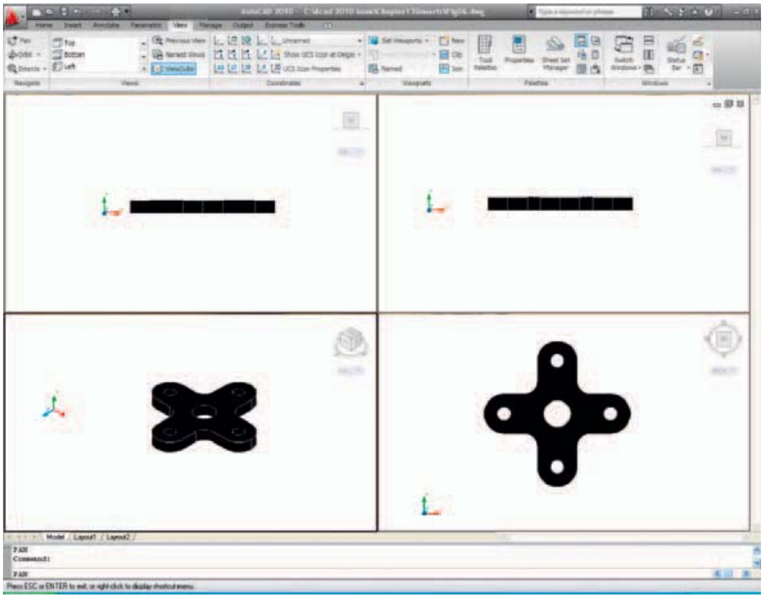

Fig. 13.6 First example – the four views after using the **Extrude** and **Subtract** tools

6. Call the **Box** tool and in the centre of the plate construct a box of Width = **60**, Length = **60** and Height = **30**.
7. Call the **Cylinder** tool and in the centre of the box construct a cylinder of Radius = **20** and of Height = **30**.
8. Call **Subtract** and subtract the cylinder from the box.
9. *Click* in the **Right** viewport. With the **Move** tool, move the box and its hole into the correct position with regard to the plate.
10. With **Union**, form a union of the plate and box.
11. *Click* in the **Front** viewport and construct a triangle of one of the webs attached between the plate and the box. With **Extrude**, extrude the triangle to a height of **10**. With the **Mirror** tool, mirror the web to the other side of the box.
12. *Click* in the **Right** viewport and, with the **Move** tool, move the two webs into their correct position between the box and plate. Then, with **Union**, form a union between the webs and the 3D model.
13. In the **Right** viewport, construct the other two webs and in the **Front** viewport, move, mirror and union the webs as in steps **11** and **12**.

Figure 13.7 shows the resulting 4-viewport scene.

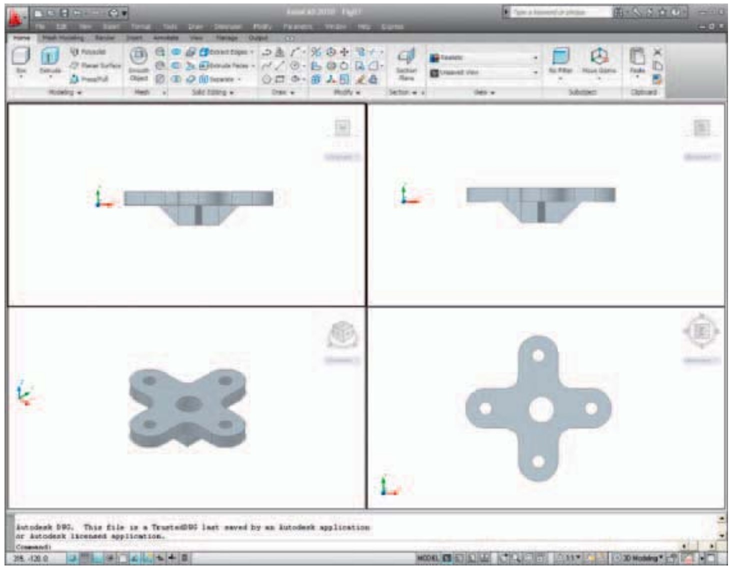

Fig. 13.7 First example – **Four: Equal viewports**

Second example – Four: Left viewports (Fig. 13.9)

1. Open the **Four: Left** viewport layout from the **Viewports** dialog.
2. Make a new layer of colour magenta and make that layer current.
3. In the **Top** viewport construct an outline of the web of the Support Bracket shown in Fig. 13.8. With the **Extrude** tool, extrude the parts of the web to a height of **20**.

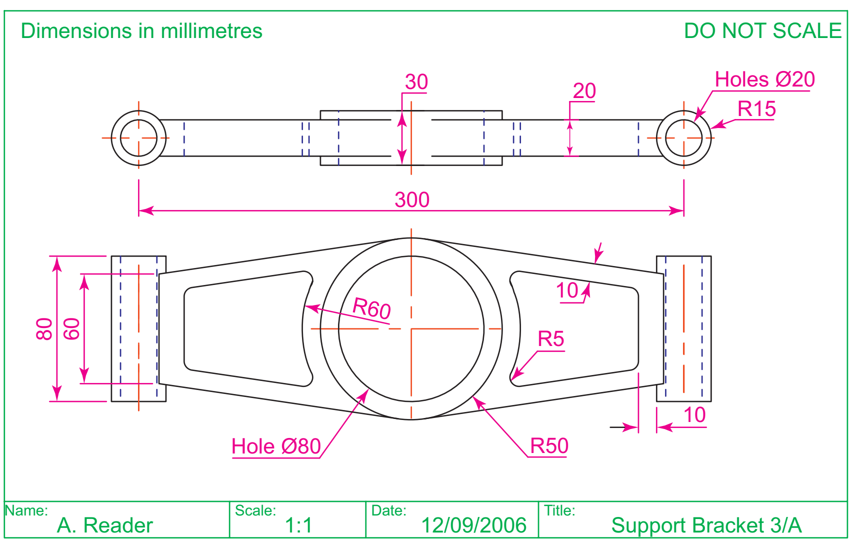

Fig. 13.8 Working drawing for the second example

4. With the **Subtract** tool, subtract the holes from the web.
5. In the **Top** viewport, construct two cylinders central to the extrusion, one of radius **50** and height **30**, the second of radius **40** and height **30**. With the **Subtract** tool, subtract the smaller cylinder from the larger.
6. *Click* in the **Front** viewport and move the cylinders vertically by **5** units. With **Union** form a union between the cylinders and the web.
7. Still in the **Front** viewport and at one end of the union, construct two cylinders, the first of radius **10** and height **80**, the second of radius **15** and height **80**. Subtract the smaller from the larger.
8. With the **Mirror** tool, mirror the cylinders to the other end of the union.
9. Make the **Top** viewport current and, with the **Move** tool, move the cylinders to their correct position at the ends of the union. Form a union between all parts on screen.
10. Make the **Isometric** viewport current. From the **Home/View** panel select **Conceptual**.

Figure 13.9 shows the result.

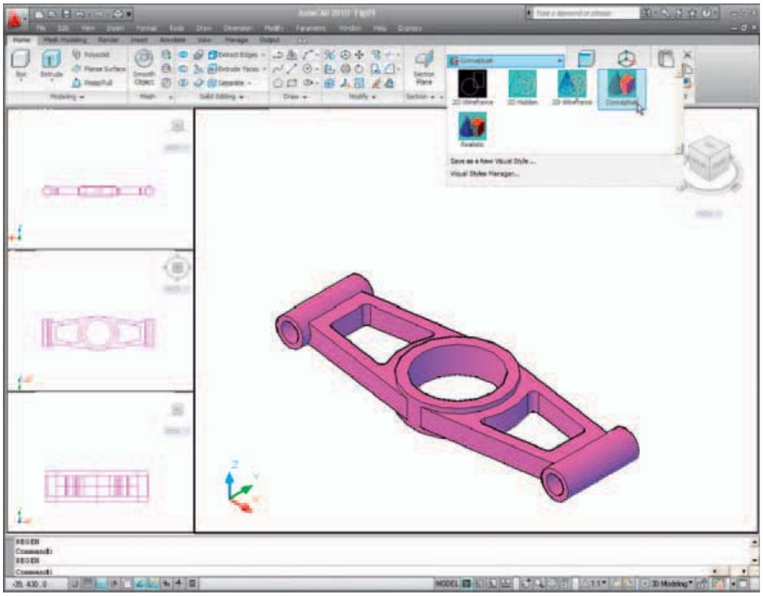

Fig. 13.9 Second example – **Four: Left viewports**

Third example – Three: Right viewports (Fig. 13.11)

1. Open the **Three: Right** viewport layout from the **Viewports** dialog. Make sure the **3D** setup is chosen.
2. Make a new layer of colour **Green** and make that layer current.

3. In the **Front** viewport (top left-hand), construct a pline outline to the dimensions in Fig. 13.10.
4. Call the **Revolve** tool from the **Home/Modeling** panel and revolve the outline through 360°.
5. In each of the three viewports in the **Home/View** panel select **Conceptual** from its pop-up list.

The result is shown in Fig. 13.11.

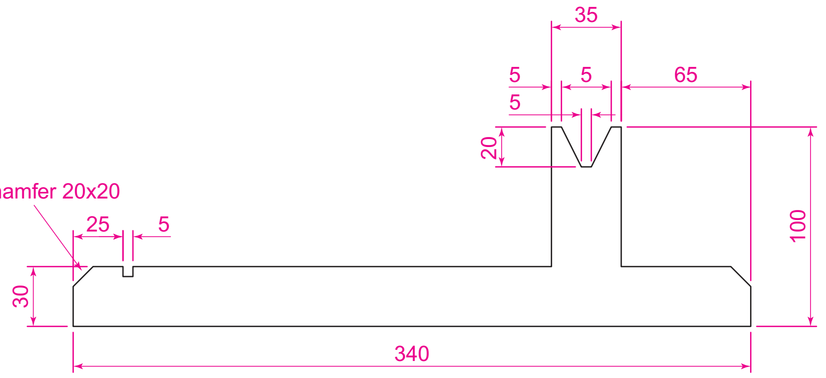

Fig. 13.10 Third example – outline for solid of revolution

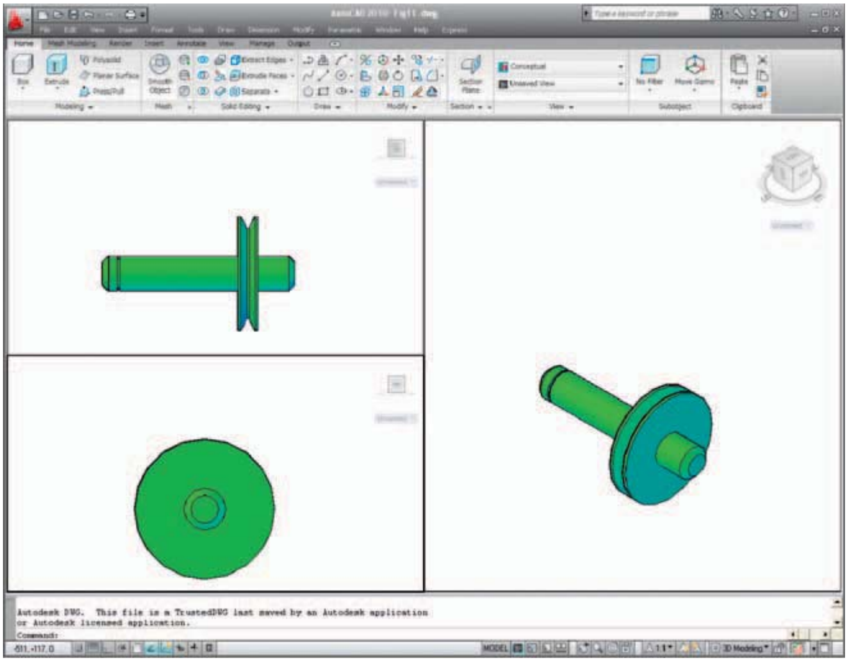

Fig. 13.11 Third example – **Three: Right viewports**

Notes

1. When working in viewport layouts such as in the above three examples, it is important to make good use of the **Zoom** tool, mainly because the viewports are smaller than the single viewport when working in AutoCAD 2010.
2. As in all other forms of constructing drawings in AutoCAD 2010 frequent toggling of **SNAP**, **ORTHO** and **GRID** will allow speedier and more accurate working.

REVISION NOTES

1. Outlines suitable for use when constructing 3D models can be constructed using the 2D tools such as **Line**, **Arc**, **Circle** and **polyline**. Such outlines must be changed either to closed polylines or to regions before being incorporated in 3D models.
2. The use of multiple viewports can be of value when constructing 3D models in that various views of the model appear, enabling the operator to check the accuracy of the 3D appearance throughout the construction period.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/ 978-1-85617-868-6

1. Using the **Cylinder**, **Box**, **Sphere**, **Wedge** and **Fillet** tools, together with the **Union** and **Subtract** tools and working to any sizes thought suitable, construct the "head" as shown in the **Three: Right** viewport in Fig. 13.12.

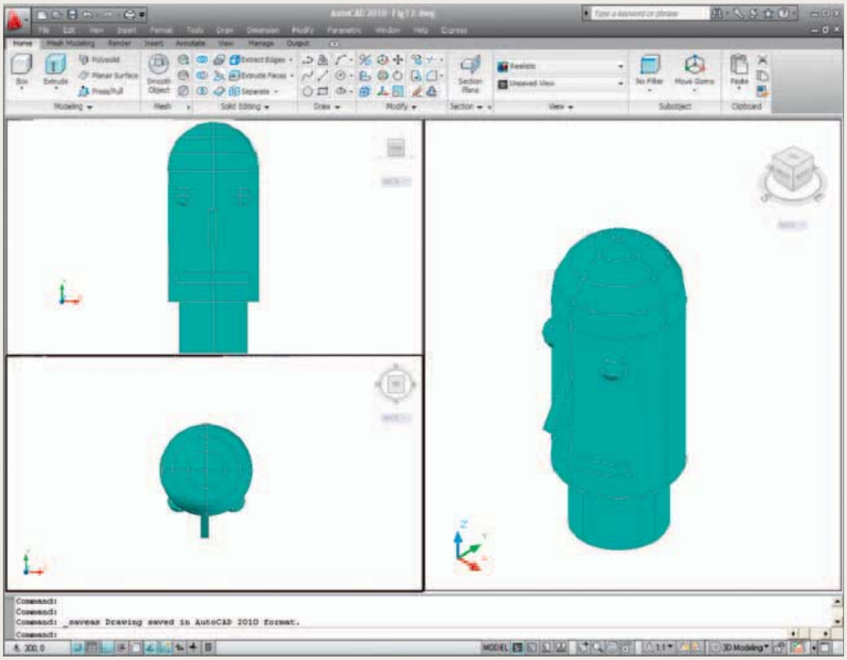

Fig. 13.12 Exercise 1

2. Using the tools **Sphere**, **Box**, **Union** and **Subtract** and working to the dimensions given in Fig. 13.14, construct the 3D solid model as shown in the isometric drawing Fig. 13.13.

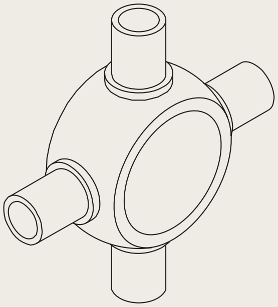

Fig. 13.13 Exercise 2

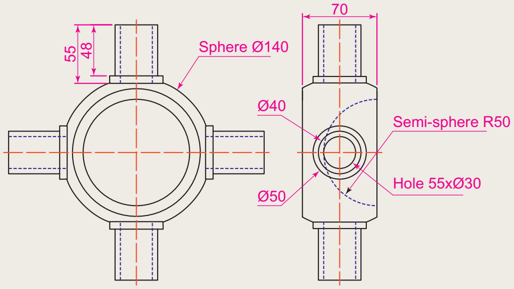

Fig. 13.14 Exercise 2 – working drawing

3. Each link of the chain shown in Fig. 13.15 has been constructed using the tool **Extrude** and extruding a small circle along an elliptical path. Copies of the link were then made, half of which were rotated in a **Right** view and

then moved into their position relative to the other links. Working to suitable sizes construct a link and from the link construct the chain as shown.

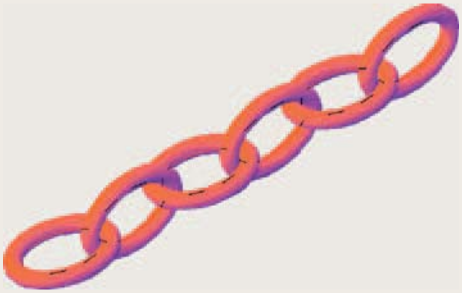

Fig. 13.15 Exercise 3

4. A two-view orthographic projection of a rotatable lever from a machine is given in Fig. 13.16 together with an isometric drawing of the 3D model constructed to the details given in the drawing Fig. 13.17. Construct the 3D model drawing in a **Four: Equal** viewport setting.

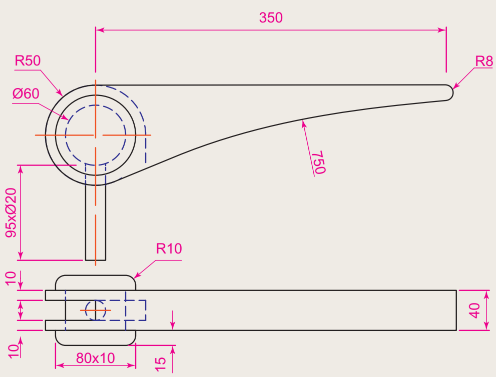

Fig. 13.16 Exercise 4 – orthographic projection

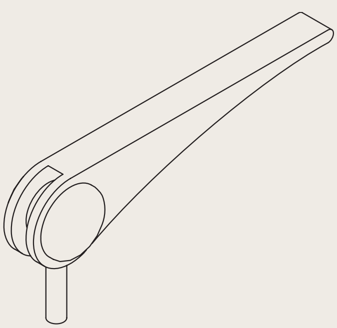

Fig. 13.17 Exercise 4

5. Working in a **Three: Left** viewport setting, construct a 3D model of the faceplate to the dimensions given in Fig. 13.18. With the **Mirror** tool, mirror the model to obtain an opposite-facing model. In the **Isometric** viewport call the **Hide** tool (Fig. 13.19).

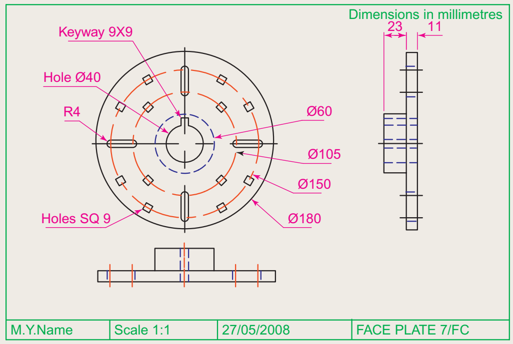

Fig. 13.18 Exercise 5 – dimensions

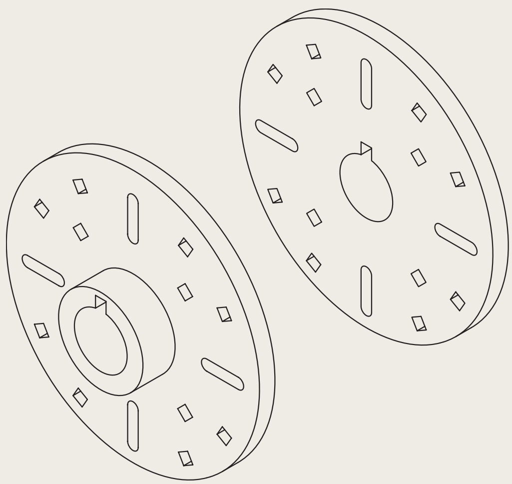

Fig. 13.19 Exercise 5

Chapter 14

The modification of 3D models

AIMS OF THIS CHAPTER

The aims of the chapter are:

1. To demonstrate how 3D models can be saved as blocks for insertion into other drawings via the **DesignCenter**.
2. To show how a library of 3D models in the form of blocks can be constructed to enable the models to be inserted into other drawings.
3. To give examples of the use of the tools from the **Home/Modify** panel:
   3D Array – **Rectangular** and **Polar 3D arrays**.
   3D Mirror.
   3D Rotate.
4. To give examples of the use of the **Section** tool from the **Home/Section** panel.
5. To give examples of the use of the **Helix** tool.
6. To give an example of construction involving **Dynamic Input**.
7. To show how to obtain different views of 3D models in 3D space using the **ViewCube**, by selection from the **Home/View Panel** and using **Viewpoint Presets**.
8. To give simple examples of surfaces using **Extrude**.

Creating 3D model libraries

In the same way as 2D drawings of parts such as electronics symbols, engineering parts, building symbols and the like can be saved in a file as blocks and then opened into another drawing by *dragging* the appropriate block drawing from the DesignCenter, so can 3D models.

First example – inserting 3D blocks (Fig. 14.4)

1. Construct 3D models of the parts for a lathe milling wheel holder to details as given in Fig. 14.1, each on a layer of different colours.

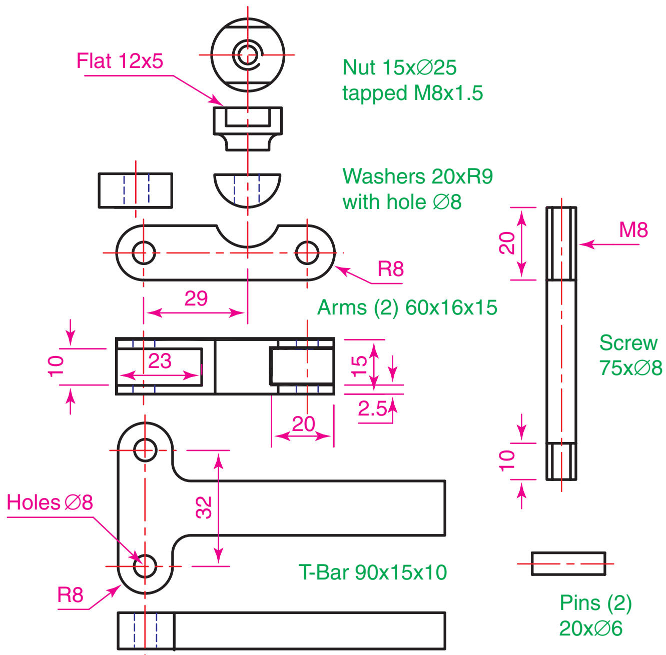

Fig. 14.1 The components of a lathe milling wheel holder

2. Save each of the 3D models of the parts to file names as given in Fig. 14.1 as blocks using **Create** from the **Insert/Block** panel. Save all seven blocks and delete the drawings on screen. Save the drawing with its blocks to a suitable file name (**Fig01.dwg**).
3. Set up a **Four: Equal** viewports setting.
4. Open the **DesignCenter** from the **View/Palettes** panel (Fig. 14.2) or by pressing the **Ctrl** and **2** keys of the keyboard.

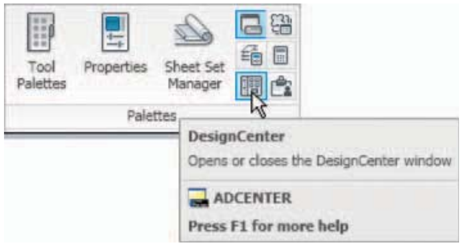

Fig. 14.2 Calling the **DesignCenter** from the **View/Palettes** panel

5. In the **DesignCenter** *click* the directory **Chapter14**, followed by another *click* on **Fig01.dwg** and yet another *click* on **Blocks**. The saved blocks appear as icons in the right-hand area of the **DesignCenter**.

6. *Drag and drop* the blocks one by one into one of the viewports on screen. Figure 14.3 shows the **Nut** block ready to be *dragged* into the **Right** viewport. As the blocks are *dropped* on screen, they will need moving into their correct positions in suitable viewports using the **Move** tool from the **Home/Modify** panel.

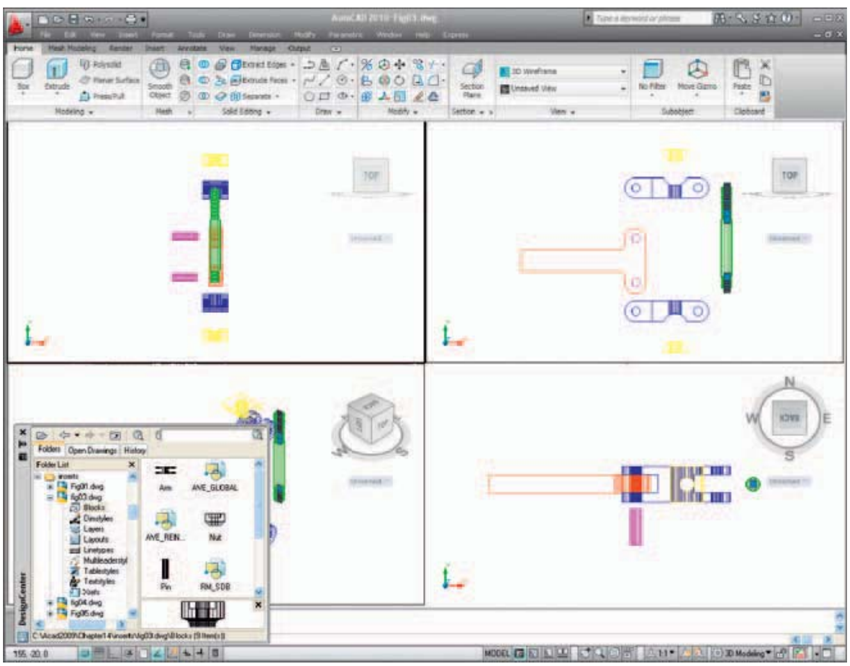

Fig. 14.3 First example – **Inserting 3D blocks**

7. Using the **Move** tool, move the individual 3D models into their final places on screen and shade the **Isometric** viewport using **Conceptual** shading from the **Home/View** panel (Fig. 14.4).

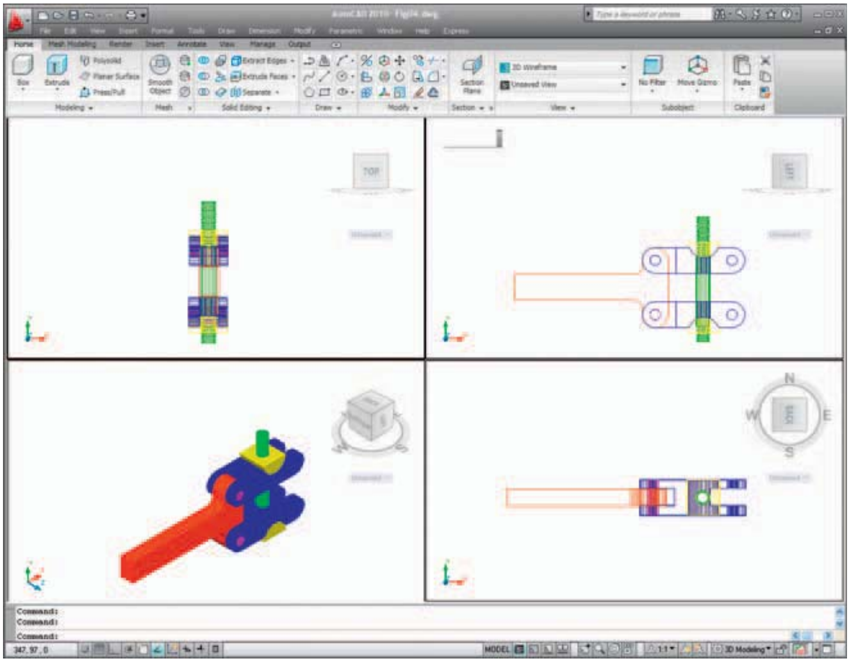

Fig. 14.4 First example – **Inserting 3D blocks**

Notes

1. It does not matter which of the four viewports any one of the blocks is *dragged* and *dropped* into. The part automatically assumes the view of the viewport.

2. If a block destined for layer **0** is *dragged* and *dropped* into the layer **Centre** (which in our **acadiso.dwt** is of colour **red** and of linetype **CENTER2**), the block will take on the colour (red) and linetype of that layer (**CENTER2**).

3. In this example, the blocks are 3D models and there is no need to use the **Explode** tool option.

Second example – a library of fastenings (Fig. 14.6)

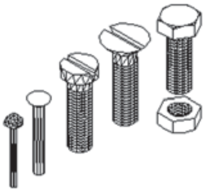

Fig. 14.5 Second example – the five fastenings

1. Construct 3D models of a number of engineering fastenings. The number constructed does not matter. In this example only five have been constructed – a 10 mm round-head rivet, a 20 mm countersunk-head rivet, a cheese-head bolt, a countersunk-head bolt and a hexagonal-head bolt together with its nut (Fig. 14.5). With the **Create** tool save each separately as a block, erase the original drawings and save the file to a suitable file name – in this example **Fig05.dwg**.

2. Open the **DesignCenter**, *click* on the **Chapter 14** directory, followed by a *click* on **Fig05.dwg**. Then *click* again on **Blocks** in the content list of **Fig05.dwg**. The five 3D models of fastenings appear as icons in the right-hand side of the **DesignCenter** (Fig. 14.6).

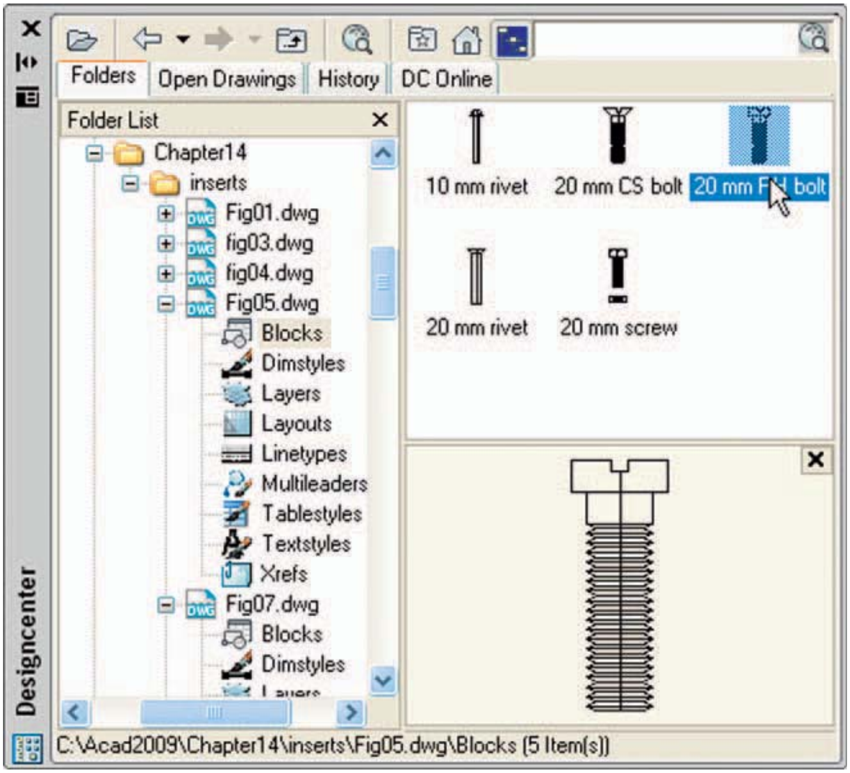

Fig. 14.6 Second example – a library of fastenings

3. Such blocks of 3D models can be *dragged and dropped* into position in any engineering drawing where the fastenings are to be included.

Constructing a 3D model (Fig. 14.9)

A three-view projection of a pressure head is shown in Fig. 14.7. To construct a 3D model of the head:

1. Set the **ViewCube/Front** view.
2. Construct the outline to be formed into a solid of revolution (Fig. 14.8) on a layer colour **magenta** and, with the **Revolve** tool, produce the 3D model of the outline.

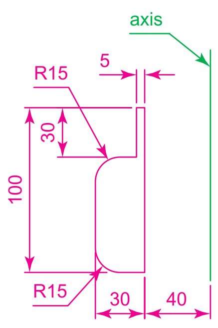

Fig. 14.8 Example of constructing a 3D model – outline for solid of revolution

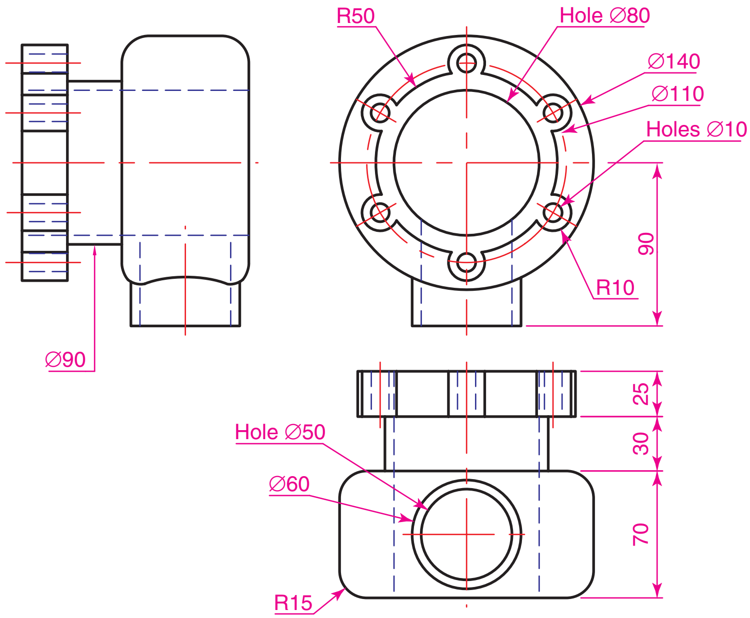

Fig. 14.7 Orthographic drawing for the example of constructing a 3D model

3. Set the **ViewCube/Top** view and with the **Cylinder** tool, construct cylinders as follows:
   In the centre of the solid – radius **50** and height **50**.
   With the same centre – radius **40** and height **40**. Subtract this cylinder from that of radius **50**.
   At the correct centre – radius **10** and height **25**.
   At the same centre – radius **5** and height **25**. Subtract this cylinder from that of radius **10**.
4. With the **Array** tool, form a polar **6** times array of the last two cylinders based on the centre of the 3D model.
5. Set the **ViewCube/Front** view.
6. With the **Move** tool, move the array and the other two cylinders to their correct positions relative to the solid of revolution so far formed.
7. With the **Union** tool form a union of the array and other two solids.
8. Set the **ViewCube/Right** view.
9. Construct a cylinder of radius **30** and height **25** and another of radius **25** and height **60** central to the lower part of the 3D solid so far formed.
10. Set the **ViewCube/Top** view and with the **Move** tool move the two cylinders into their correct position.

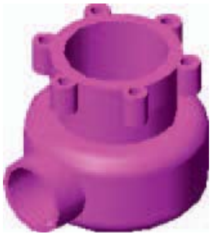

Fig. 14.9 Example of constructing a 3D model

11. With the **Union** tool, form a union between the radius **30** cylinder and the 3D model and with the **Subtract** tool, subtract the radius **25** cylinder from the **3D** model.
12. *Click* **Conceptual** in the **Home/View** panel list.

The result is given in Fig. 14.9.

Note

This 3D model could equally as well have been constructed in a three- or four-viewports setting.

The 3D Array tool

First example – a Rectangular Array (Fig. 14.12)

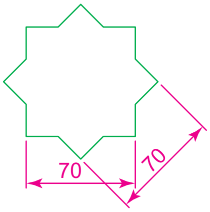

Fig. 14.10 Example – **3D Array** – the star pline

1. Construct the star-shaped pline on a layer colour **green** (Fig. 14.10) and extrude it to a height of **20**.
2. *Click* on the **3D Array** icon in the **Modify/3D Operations** drop-down menu (Fig. 14.11). The command line shows:

```
Command:_3darray
Select objects:pick the extrusion 1 found
Select objects:right-click
Enter the type of array [Rectangular/Polar]
  <R>:right-click
Enter the number of rows (-) <1>:enter 3
  right-click
Enter the number of columns (III):enter 3
  right-click
Enter the number of levels (...):enter 4
  right-click
Specify the distance between rows (-):enter 100
  right-click
Specify the distance between columns (III):enter
  100 right-click
Specify the distance between levels (...):enter
  300 right-click
Command:
```

3. Place the screen in the **ViewCube/Isometric** view.
4. Shade using the **Home/View/Conceptual** visual style (Fig. 14.12).

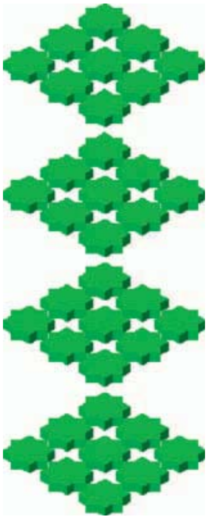

Fig. 14.12 First example – a **3D Rectangular Array**

Fig. 14.11 Selecting **3D Array** from the **Modify/3D Operations** drop-down menu

Second example – a Polar Array (Fig. 14.13)

1. Use the same star-shaped 3D model.
2. Call the **3D Array** tool again. The command line shows:

```
Command:_3darray
Select objects:pick the extrusion 1 found
Select objects:right-click
Enter the type of array [Rectangular/Polar]
  <R>:enter p (Polar)right-click
Enter number of items in the array: 12
Specify the angle to fill (+=ccw), -=cw)
  <360>:right-click
Rotate arrayed objects? [Yes/No] <Y>:
  right-click
Specify center point of array: 235,125
Specify second point on axis of rotation:
  300,200
Command:
```

3. Place the screen in the **ViewCube/Isometric** view.
4. Shade using the **Home/View/Conceptual** visual style (Fig. 14.13).

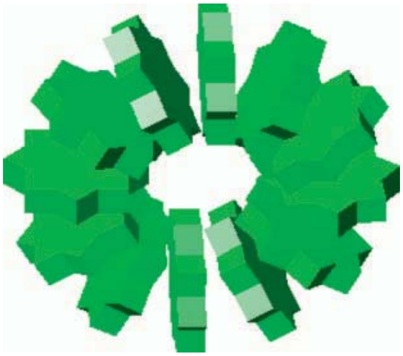

Fig. 14.13 Second example – a **3D Polar Array**

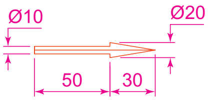

Fig. 14.14 Third example – a **3D Polar Array** – the 3D model to be arrayed

Third example – a Polar Array (Fig. 14.15)

1. Working on a layer of colour **red**, construct a solid of revolution in the form of an arrow to the dimensions as shown in Fig. 14.14.
2. *Click* **3D Array** from the **Modify/3D Operations** drop-down menu. The command line shows:

```
Command:_3darray
Select objects:pick the arrow 1 found
Select objects:right-click
Enter the type of array [Rectangular/Polar]
  <R>:enter p right-click
Enter the number of items in the array:enter 12
  right-click
Specify the angle to fill (+=ccw, -=cw)
  <360>:right-click
Rotate arrayed objects? [Yes/No] <Y>:
  right-click
Specify center point of array:enter 40,170,20
  right-click
Specify second point on axis of rotation:enter
  60,200,100 right-click
Command:
```

3. Place the array in the **ViewCube/Isometric** view and shade to **Visual Styles/Realistic**. The result is shown in Fig. 14.15.

Fig. 14.15 Third example – a **3D Polar Array**

The 3D Mirror tool

First example – 3D Mirror (Fig. 14.18)

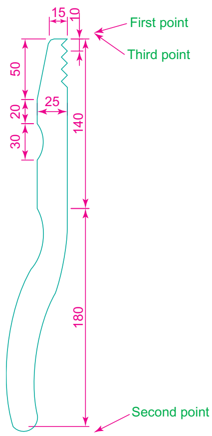

Fig. 14.16 First example – **3D Mirror –** outline of object to be mirrored

1. Working on a layer colour **green**, construct the outline Fig. 14.16.
2. Extrude the outline to a height of **20**.
3. Extrude the region to a height of **5** and render. A **Conceptual** style shading is shown in Fig. 14.17 (left-hand drawing).

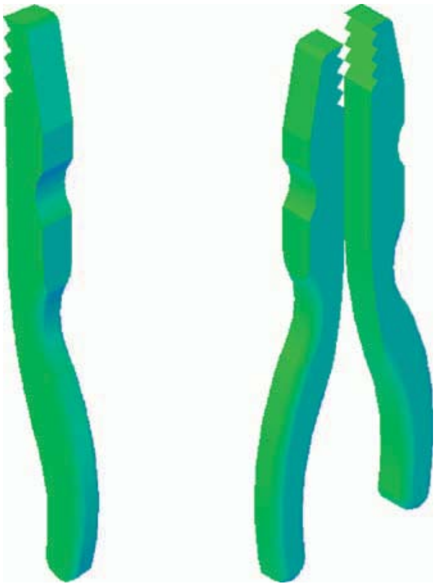

Fig. 14.17 First example – **3D Mirror –** before and after mirror

4. *Click* on **3D Mirror** in the **Modify 3D Operations** drop-down menu. The command line shows:

```
Command:_3dmirror
Select objects:pick the extrusion 1 found
Select objects:right-click
Specify first point of mirror plane (3 points):pick
Specify second point on mirror plane:pick
Specify third point on mirror plane or [Object/
  Last/Zaxis/View/XY/YZ/ZX/3points]:enter .xy
  right-click
of (need Z):enter 1 right-click
Delete source objects? [Yes/No]:
  <N>:right-click
Command:
```

The result is shown in the right-hand illustration of Fig. 14.17.

Second example – 3D Mirror (Fig. 14.19)

1. Construct a solid of revolution in the shape of a bowl in the **ViewCube/Front** view working on a layer of colour **yellow** (Fig. 14.18).

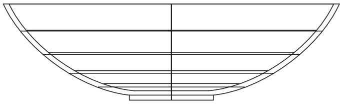

Fig. 14.18 Second example – **3D Mirror** – the 3D model

2. *Click* **3D Mirror** in the **Modify/3D Operations** drop-down menu. The command line shows:

```
Command:_3dmirror
Select objects:pick the bowl 1 found
Select objects:right-click
Specify first point on mirror plane (3 points):
  pick
Specify second point on mirror plane:pick
Specify third point on mirror plane:enter .xy
  right-click
(need Z):enter 1 right-click
Delete source objects:? [Yes/No]: <N>:right-click
Command:
```

The result is shown in Fig. 14.19.

3. Place in the **ViewCube/Isometric** view.
4. Shade using the **Home/View/Conceptual** visual style (Fig. 14.19).

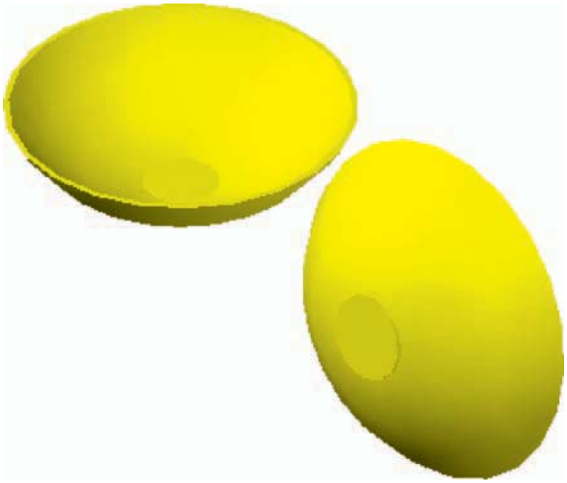

Fig. 14.19 Second example – **3D Mirror** – the result in a front view

The 3D Rotate tool

Example – 3D Rotate (Fig. 14.20)

1. Use the same 3D model of a bowl as for the last example. Call the **3D Rotate** tool from the **Modify/3D Operations** drop-down menu. The command line shows:

```
Command:pick 3D Rotate from the Modify drop-down
  menu
3DROTATE
Current positive angle in UCS:
  ANGDIR=counterclockwise ANGBASE=0
Select objects:pick the bowl 1 found
Select objects:right-click
Specify base point:pick the centre bottom of the bowl
Specify rotation angle or [Copy/Reference] <0>:
  enter 60 right-click
Command
```

3. Place in the **ViewCube/Isometric** view and in **Conceptual** shading.

The result is shown in Fig. 14.20.

Fig. 14.20 Example – **3D Rotate**

The Slice tool

First example – Slice (Fig. 14. 24)

1. Construct a 3D model of the rod link device shown in the two-view projection Fig. 14.21 on a layer colour **green**.

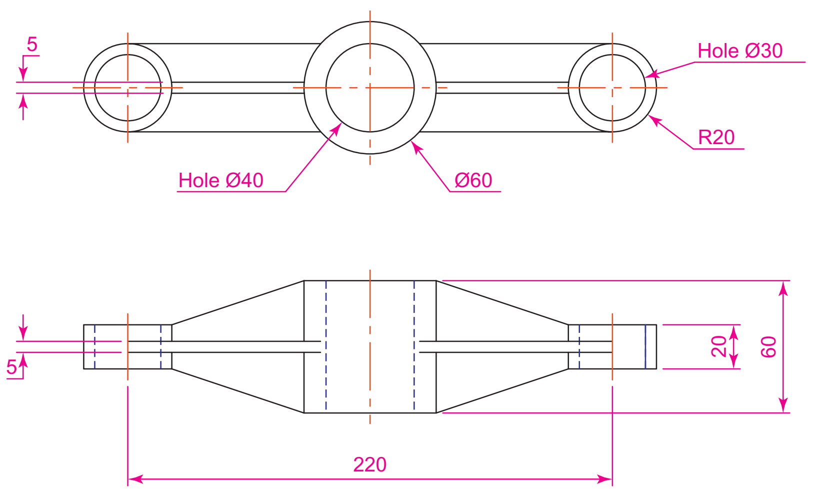

Fig. 14.21 First example – **Slice –** the two-view drawing

2. Place the 3D model in the **ViewCube/Top** view.
3. *Call* the **Slice** tool from the **Home/Solid Editing** panel (Fig. 14.22).

Fig. 14.22 The **Slice** tool icon from the **Home/Solid Editing** panel

The command line shows:

```
Command:_slice
Select objects:pick the 3D model
Select objects to slice:right-click
Specify start point of slicing plane or [planar
  Object/Surface/Zaxis/View/XY/YZ/ZX/3points]
  <3points>:pick
Specify second point on plane:pick
Specify a point on desired side or [keep Both
  sides] <Both>:right-click
Command:
```

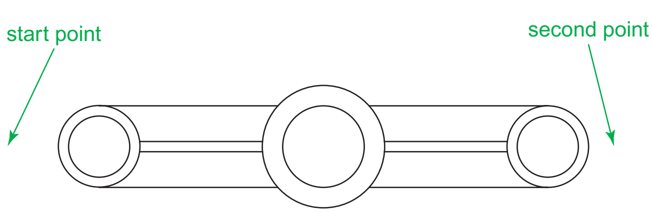

Figure. 14.23 First example – **Slice –** the *pick* points

Figure 14.23 shows the *picked* points.

Fig. 14.24 First example – **Slice**

4. With the **Move** tool, move the lower half of the sliced model away from the upper half.
5. Place the 3D model(s) in the **ViewCube/Isometric** view.
6. Shade in **Conceptual** visual style. The result is shown in Fig. 14.24.

Second example – Slice (Fig. 14.25)

1. Construct the closed pline (left-hand drawing Fig. 14.25) and, with the **Revolve** tool, form a solid of revolution from the pline.
2. With the **Slice** tool and working to the same sequence as for the first **Slice** example, form two halves of the 3D model and render.

The right-hand illustration of Fig. 14.25 shows the result.

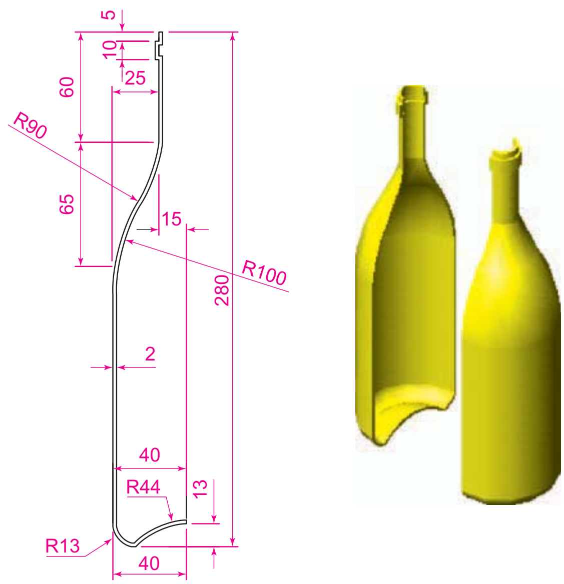

Fig. 14.25 Second example – **Slice**

The Section Plane tool

Example – Section Plane (Fig. 14.28)

1. Construct a 3D model to the information given in Fig. 14.27 on layers of different colours. Note there are three objects in the model – a box, a lid and a cap.
2. Place the model in the **Front** view, **Zoom** to **1** and **Move** its parts apart.
3. Make a new layer **Hatch** of colour **magenta**.
4. Place the model in a **Top** view.
5. *Click* the **Section Plane** tool icon in the **Home/Section** panel (Fig. 14.26). The command line shows:

```
Command:_sectionplane Select face or any point to
  locate section line or [Draw section/
  Orthographic]:enter o right-click
```

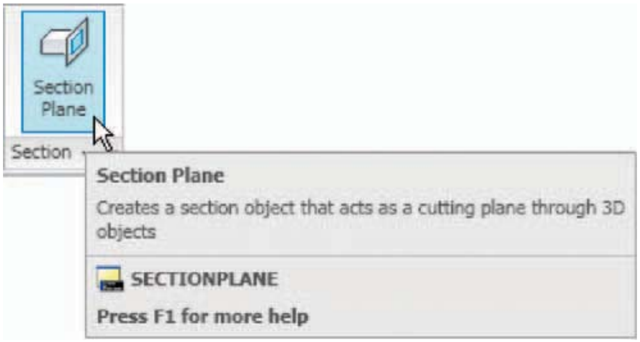

Fig. 14.26 Example – **Section Plane** tool in the **Home/Section** panel

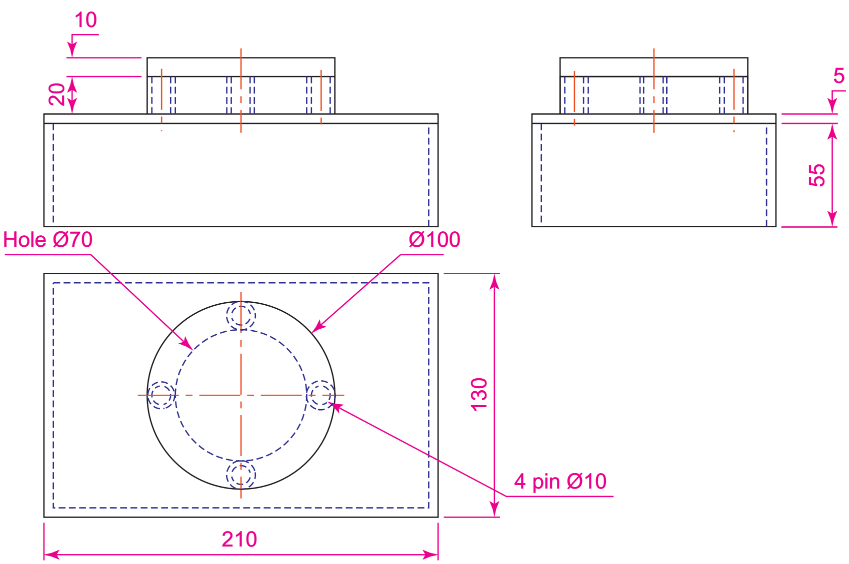

Fig. 14.27 Example – **Section Plane –** orthographic projection

```
Align section to: [Front/Back/Top/Bottom/Left/
  Right] <Top>:enter f right-click
Command:
```

The result is shown in Fig. 14.28.

6. At the command line *enter* **sectionplanesettings**. The **Section Settings** dialog appears. *Click* the **Select Section Plane** icon in the dialog. The dialog disappears. *Click* the section plane. The dialog reappears (Fig. 14.29).
7. Make settings in the dialog as shown and *click* the dialog's **OK** button.

The result is shown in Fig. 14.30.

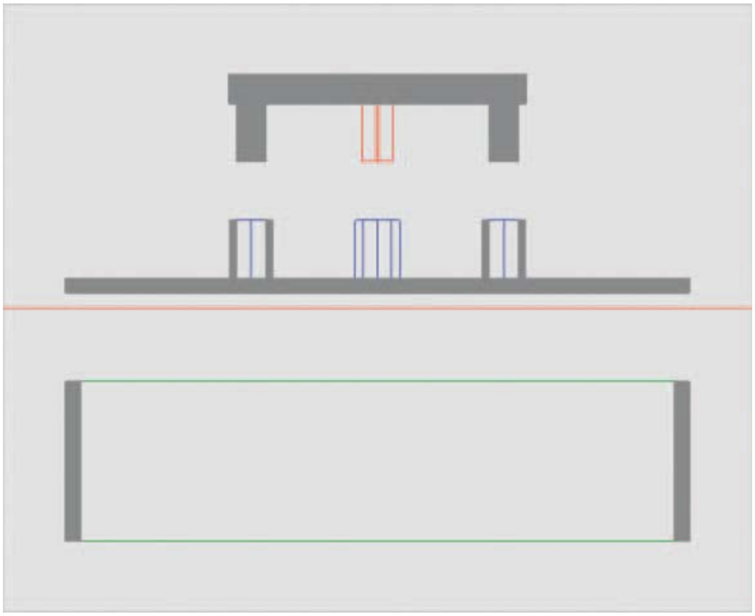

Fig. 14.28 Example **Section Plane** – the section plane in a **ViewCube/Front** view

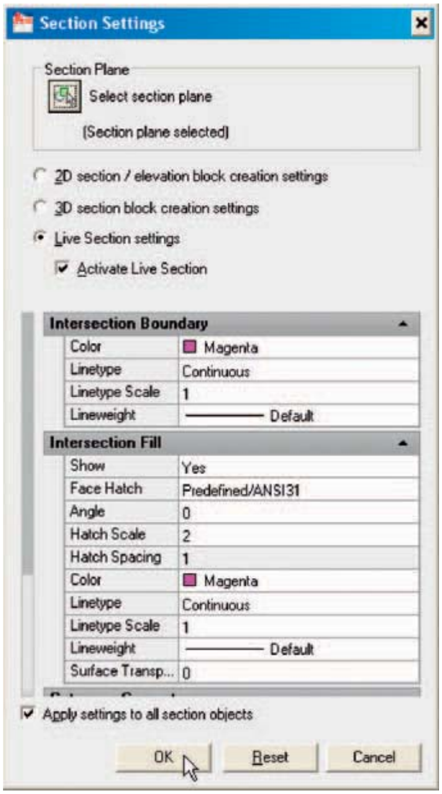

Fig. 14.29 The **Section Settings** dialog

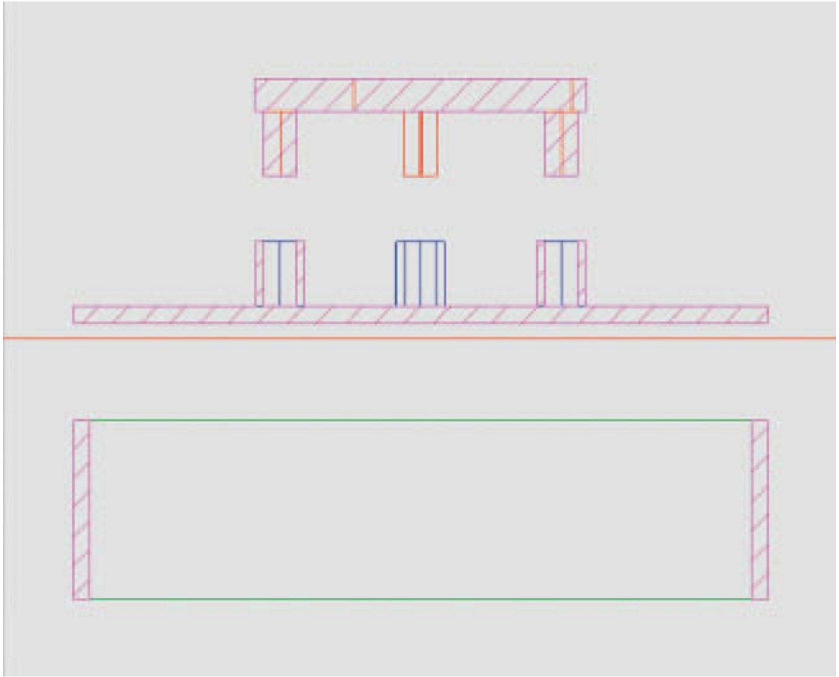

Fig. 14.30 Example – **Section Plane**

Views of 3D models

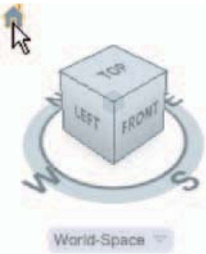

Fig. 14.31 The **ViewCube** in its isometric position

Some of the possible viewing positions of a 3D model which can be obtained by using the **ViewCube** have already been seen in this book. Figure 14.33 shows the viewing positions of the 3D model of the arrow (Fig. 14.32) using the viewing positions from the **ViewCube**. A *click* on the house icon at the top left-hand of the **ViewCube** presents an isometric view (Fig. 14.31).

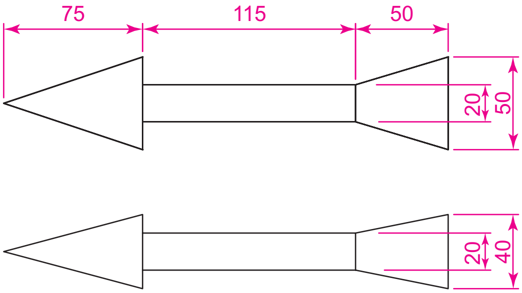

Fig. 14.32 Two views of the arrow

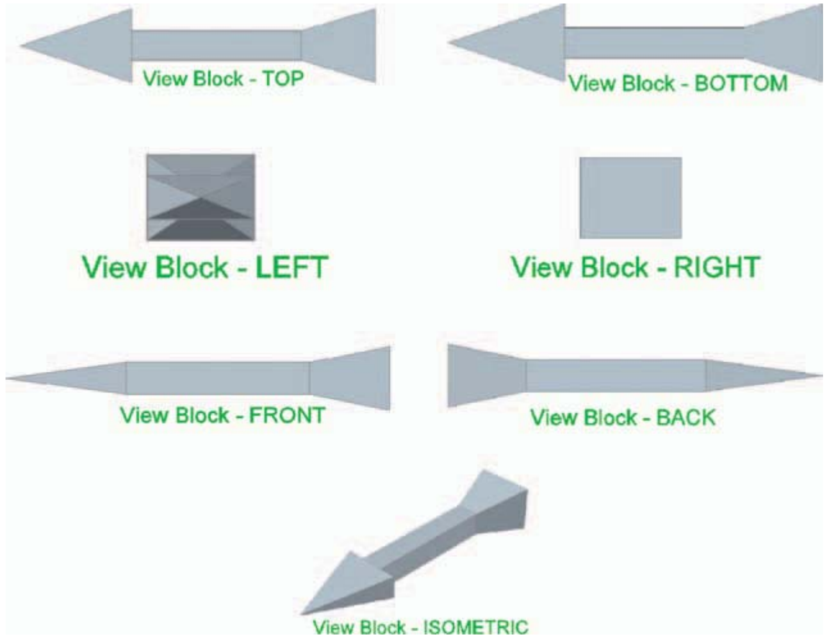

Fig. 14.33 The views using the **ViewCube**

The Viewpoint Presets dialog

Other methods of obtaining a variety of viewing positions of a 3D model are:

1. The **UCS**, described in a later chapter.
2. By selection from the **Unsaved View** pop-up menu in the **Home/View** panel (Fig. 14.34).
3. Using the **Viewpoint Presets** dialog called with a *click* on view names in the **View/3D Views** drop-down menu (Fig. 14.35).

The **Viewpoint Presets** dialog appears with a 3D model on screen. *Entering* figures for degrees in the **X Axis** and **XY Plane** fields followed by a *click* on the dialog's **OK** button causes the model to take up the viewing position indicated by these two angles.

Note

In the **Viewpoint Presets** dialog the **Relative to UCS** radio button must be checked on to allow the 3D model to position along the two angles.

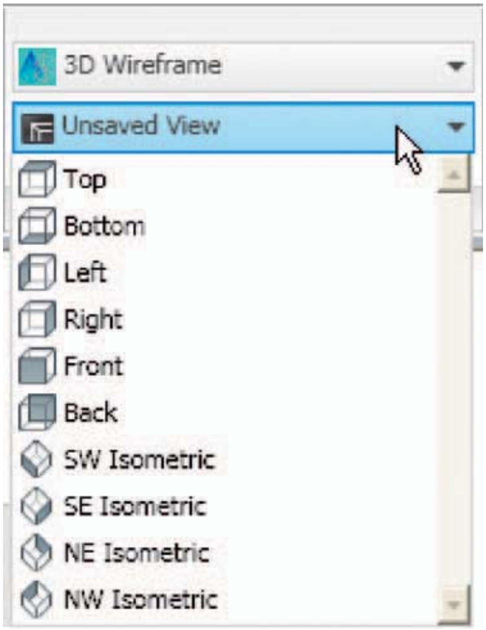

Fig. 14.34 Calling views from the **Home/View** panel

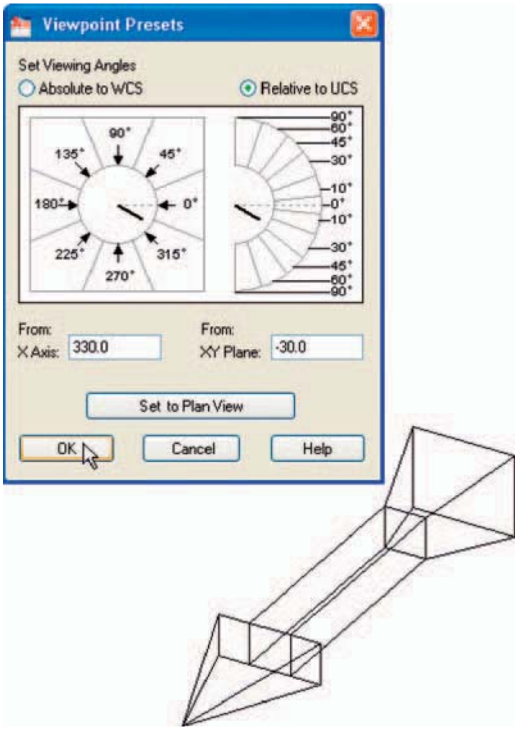

Fig. 14.35 Example – **Viewpoint Presets**

Example – Viewpoint Presets

1. With the 3D model of the arrow on screen, *click* **Viewpoint Presets...** in the **3D Views** sub-menu of the **Views** drop-down menu. The dialog appears.
2. *Enter* **330.0** in the **From X Axis** and **–30.0** in the **From XY Plane** fields and *click* the **OK** button of the dialog.
3. The 3D model takes up the viewing position indication by the two angles (Fig. 14.35).

Using Dynamic Input to construct a helix

As with all other tools (commands) in AutoCAD 2010 a helix can be formed working with the **Dynamic Input** (**DYN**) system. Figure 14.37 shows the stages (**1** to **5**) in the construction of the helix in the second example.

Set **DYN** on with a *click* on its button in the status bar.

1. *Click* the **Helix** tool icon in the **Home/Draw** panel (Fig. 14.36). The first of the **DYN** prompts appears. *Enter* the following at the command line using the **down** key of the keyboard when necessary.

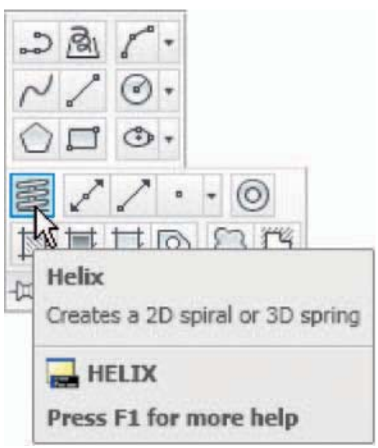

Fig. 14.36 The **Helix** tool in the **Home/Draw** panel

```
Command:_Helix
Number of turns = 10 Twist = CCW
Specify center point of base:enter 95,210
Specify base radius or [Diameter]:enter 55
Specify top radius or [Diameter]:enter 35
```

```
Specify helix height or [Axis endpoint/Turns/Turn
  Height/Twist]:enter 100
Command:
```

Figure 14.37 shows the sequence of **DYN** tooltips and the completed helix.

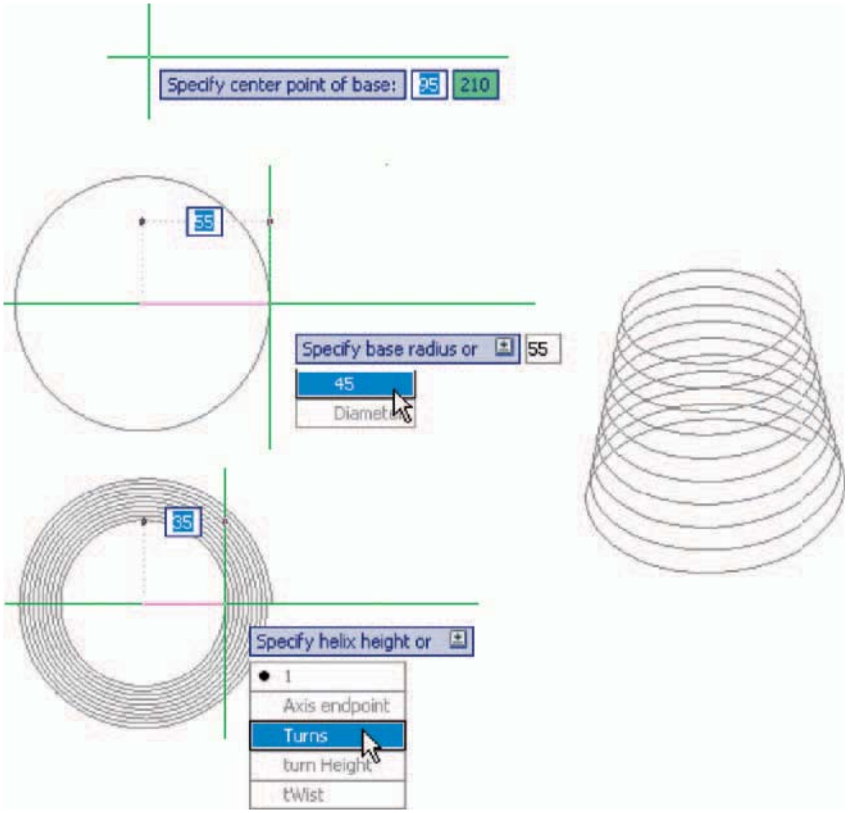

Fig. 14.37 Constructing the helix for the second example with the aid of **DYN**

3D surfaces

As mentioned on page 243 surfaces can be formed using the **Extrude** tool on lines and polylines. Two examples are given below in Figures 14.39 and 14.41.

First example – 3D Surface (Fig. 14.39)

1. In the **ViewCube/Top** view, on a layer colour **magenta**, construct the polyline Fig. 14.38.
2. In the **ViewCube/Isometric** view, call the **Extrude** tool from the **Home/Modeling** control and extrude the polyline to a height of **80.** The result is shown in Fig. 14.39.

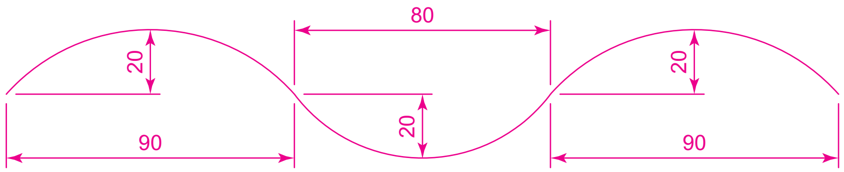

Fig. 14.38 First example – **3D Surface –** polyline to be extruded

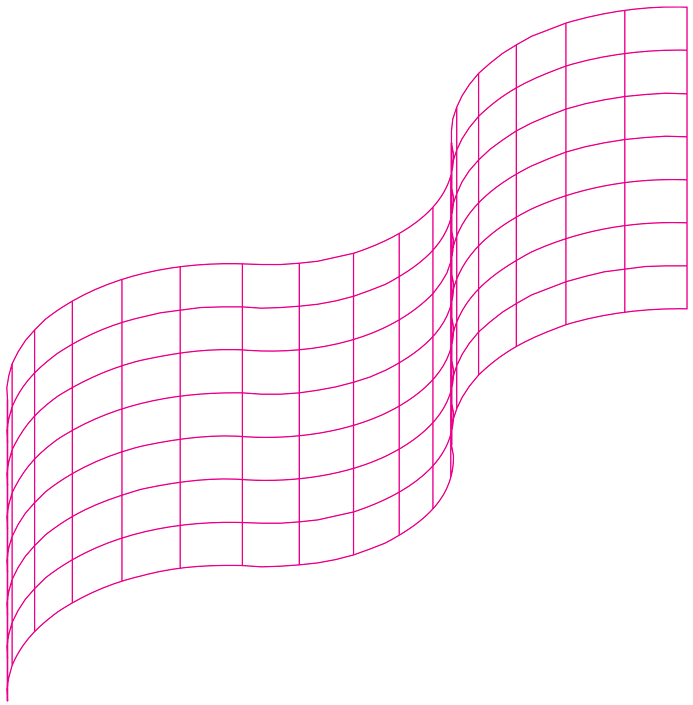

Fig. 14.39 First example – **3D Surface**

Second example – 3D Surface (Fig. 14.41)

1. In the **Top** view on a layer colour **red** construct the circle Fig. 14.40. Using the **Break** tool break the circle as shown.

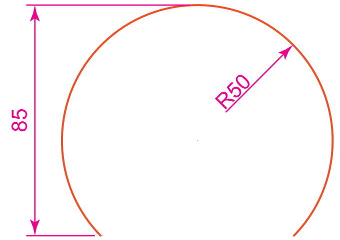

Fig. 14.40 Second example – **3D Surface – t**he part circle to be extruded

2. In the **ViewCube/Isometric** view, call the **Extrude** tool and extrude the part circle to a height of **80**. Shade in the **Realistic** visual style.

The result is shown in Fig. 14.41.

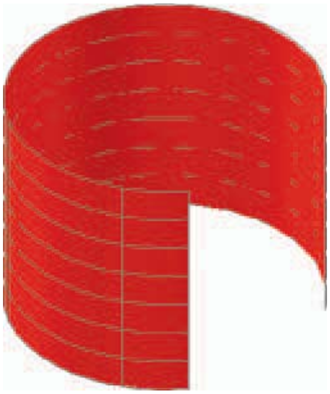

Fig. 14.41 Second example – **3D Surface**

REVISION NOTES

1. 3D models can be saved as blocks in a similar manner to the method of saving 2D drawings as blocks.
2. Libraries can be made up from 3D model drawings.
3. 3D models saved as blocks can be inserted into other drawings via the **DesignCenter**.
4. Arrays of 3D model drawings can be constructed in 3D space using the **3D Array** tool.
5. 3D models can be mirrored in 3D space using the **3D Mirror** tool.
6. 3D models can be rotated in 3D space using the **3D Rotate** tool.
7. 3D models can be cut into parts with the **Slice** tool.
8. Sectional views can be obtained from 3D models using the **Section Plane** and **Section Settings** dialog.
9. Helices can be constructed using the **Helix** tool.
10. Both the **ViewCube** and **Viewpoint Presets** can be used for the placing of 3D models in different viewing positions in 3D space.
11. The **Dynamic Input** (**DYN**) method of construction can be used equally well when constructing 3D model drawings as when constructing 2D drawings.
12. 3D surfaces can be formed from polylines or lines with **Extrude**.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/ 978-1-85617-868-6

1. Figure 14.42 shows a shaded view of the 3D model for this exercise. Figure 14.43 is a three-view projection of the model. Working to the details given in Fig. 14.43, construct the 3D model.

Fig. 14.42 Exercise 1 – a three-view projection

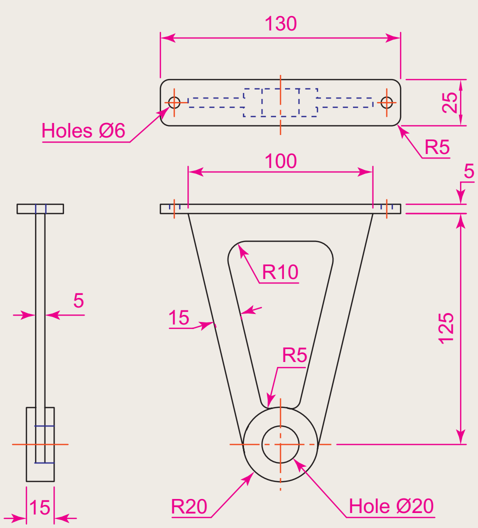

Fig. 14.43 Exercise 1 – a shaded view

2. Construct a 3D model drawing of the separating link shown in the two-view projection (Fig. 14.44). With the **Slice** tool, slice the model into two parts and remove the rear part. Place the front half in an isometric view using the **ViewCube.** Shade the resulting model.

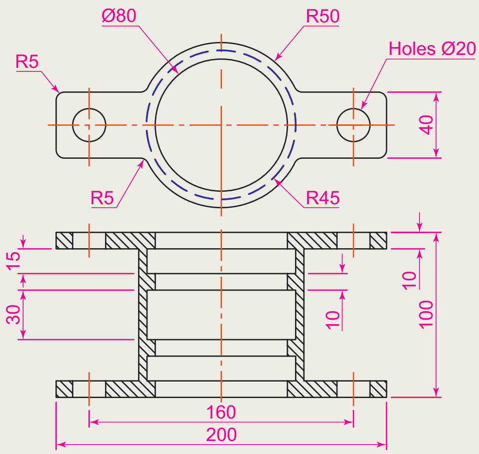

Fig. 14.44 Exercise 2

3. Working to the dimensions given in the two orthographic projections (Fig. 14.46), and working on two layers of different colours, construct an assembled 3D model of the one part inside the other.

With the **Slice** tool, slice the resulting 3D model into two equal parts, and place in an isometric view. Shade the resulting model in **Realistic** mode as shown in Fig. 14.45.

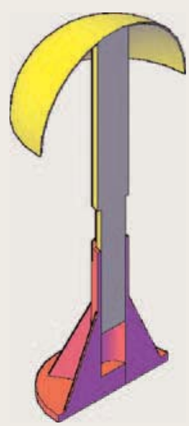

Fig. 14.45 Exercise 3

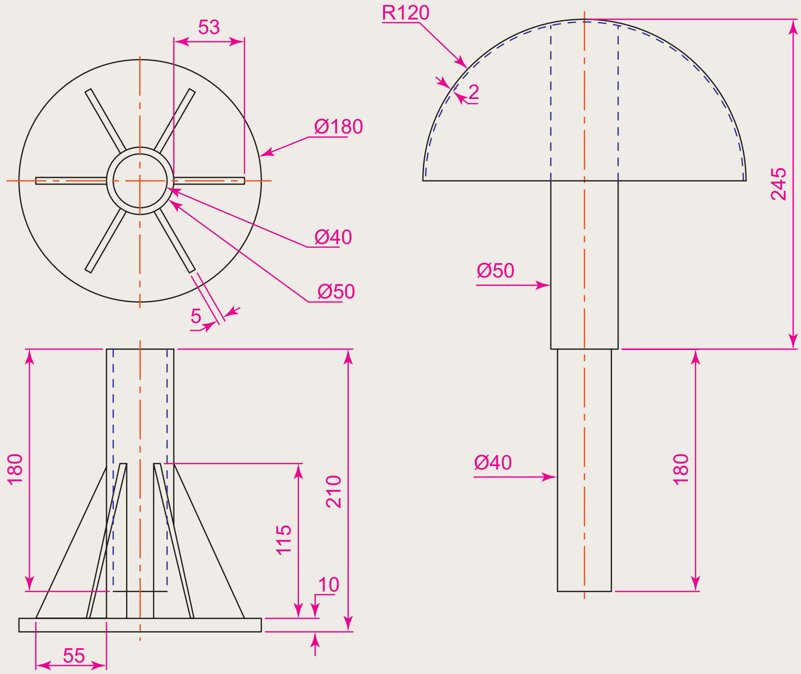

Fig. 14.46 Exercise 3 – orthographic projections

4. Construct a solid of revolution of the jug shown in the orthographic projection (Fig. 14.47). Construct a handle from an extrusion of a circle along a semicircular path. Union the two parts.

Place the 3D model in a suitable isometric view and render.

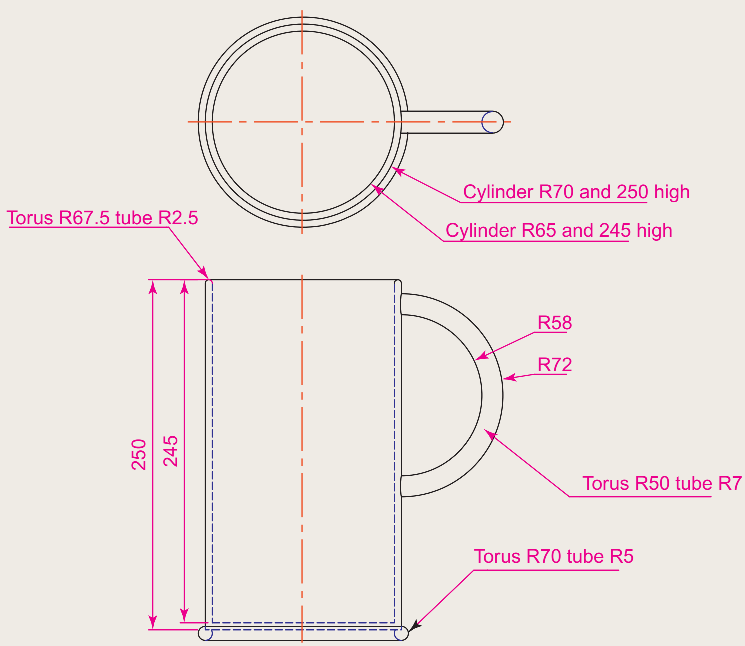

Fig. 14.47 Exercise 4

5. In the **Top** view on a layer colour **blue** construct the four polylines Fig. 14.48. Call the **Extrude** tool and extrude the polylines to a height of **80** and place in the isometric view. Then call **Visual Styles/Conceptual** shading (Fig. 14.49).

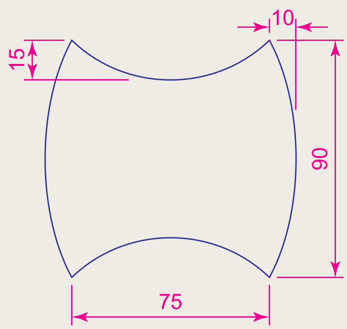

Fig. 14.48 Exercise 5 – outline to be extruded

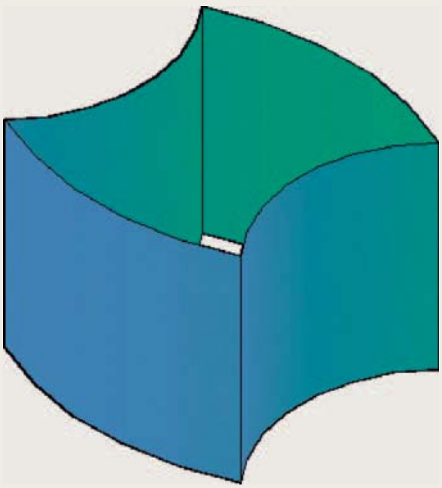

Fig. 14.49 Exercise 5

5. In the **Right** view construct the lines and arc Fig. 14.50 on a layer colour **green**. Extrude the lines and arc to a height of **180**, place in the isometric view and in the shade style **Visual Styles/Realistic** (Fig. 14.51).

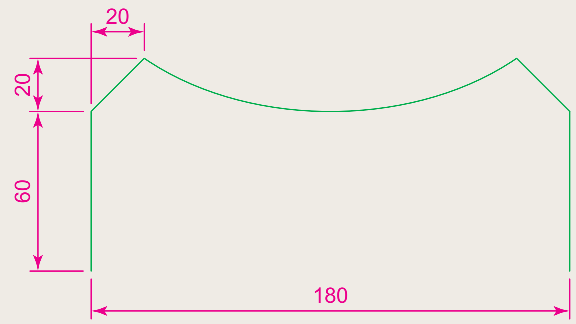

Fig. 14.50 Exercise 6 – outline to be extruded

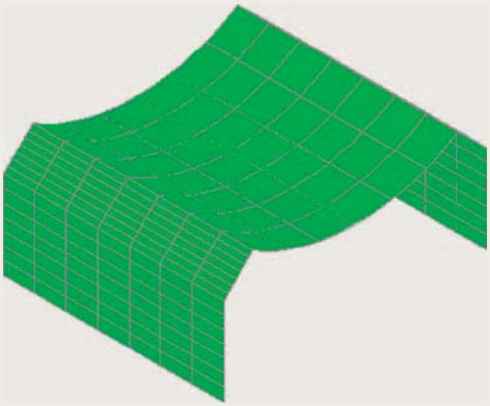

Fig. 14.51 Exercise 5

Chapter 15

Rendering

AIMS OF THIS CHAPTER

The aims of this chapter are:

1. To construct a template for 3D modelling to be used as the drawing window for further work in 3D in this book.
2. To introduce the use of the **Render** tools in producing photographic-like images of 3D solid models.
3. To show how to illuminate a 3D solid model to obtain good lighting effects when rendering.
4. To give examples of the rendering of 3D solid models.
5. To introduce the idea of adding materials to 3D solid models in order to obtain a realistic appearance to a rendering.
6. To demonstrate the use of the forms of shading available using **Visual Styles** shading.
7. To demonstrate methods of printing rendered 3D solid models.

Setting up a new 3D template

In this chapter we will be constructing all 3D model drawings in the **acadiso3D.dwt** template.

1. *Click* the **Workspace Switching** button and *click* **3D Modeling** from the menu which appears (Fig. 15.1).

Fig. 15.1 *Click* **3D Modeling** in the **Workspace Settings** menu

2. The AutoCAD window (Fig. 15.2) appears.

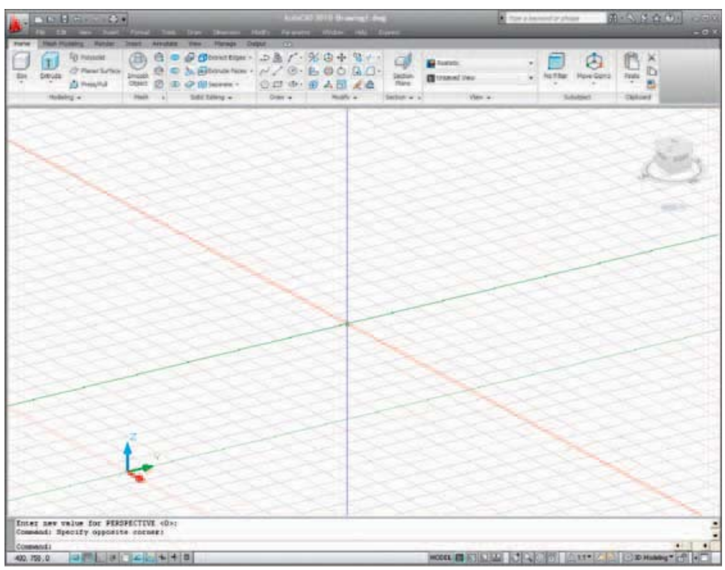

Fig. 15.2 The **3D Modeling** workspace

3. At the command line *enter:*

Command: *enter* perspective <1>: *enter* 0
Command:

4. Open the **Options dialog** with a *right-click* in the Command palette, followed by a *click* on **Options...** in the menu which appears.

5. *Click* the **Colors** button. The **Drawing Window Colors** dialog appears. Set **Uniform Background** colour to **white** (Fig. 15.3).

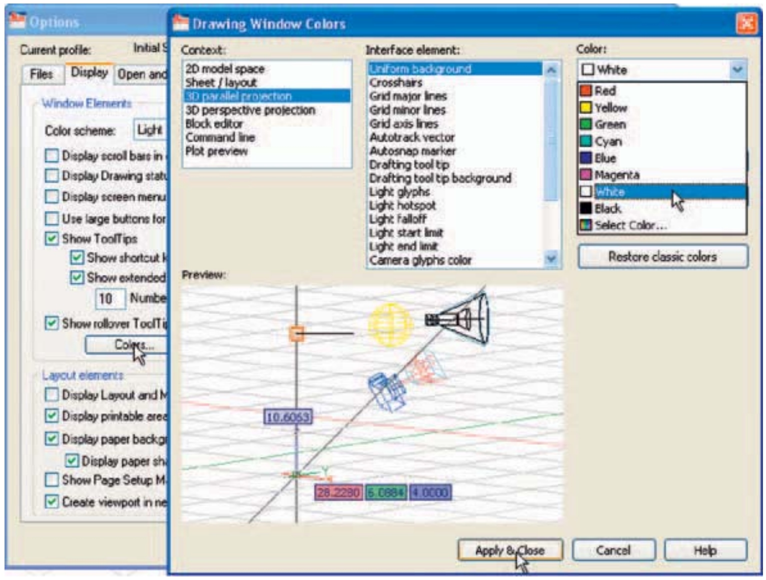

Fig. 15.3 In the **Options** dialog set all background colours to **white**

Note

The reader may prefer to retain the original background colours from the **Options** dialog. The colour **white** for backgrounds is used in this book for the clarity of illustrations.

6. Set **Units** to a **Precision** of **0**, **Snap** to **5** and **Grid** to **10**. Set **Limits** to **420,297**. **Zoom** to **All**.
7. In the **Options** dialog *click* the **Files** tab and *click* **Default Template File Name for QNEW** (Fig. 15.4) followed by a *double-click* on the file name which appears. This brings up the **Select Template** dialog, from which the **acadiso3d.dwt** can be selected. Now when AutoCAD 2010 is opened from the Windows desktop, the **acadiso3D.dwt** template will open.
8. Set up five layers of different colours. In my template these have been named after the colours (Fig. 15.5).
9. Save the template to the name **acadiso3D** and then *enter* a suitable description in the **Template Definition** dialog.

Note

Figure 15.2 shows the screen is in **Parallel** projection. Some operators may prefer the screen to be set to **Perspective** projection.

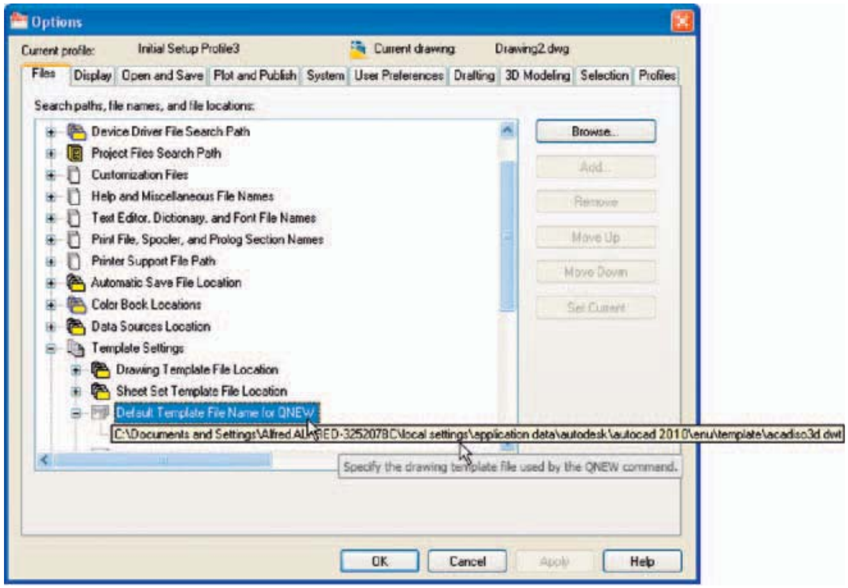

Fig. 15.4 Setting the default template setting in the **Options** dialog

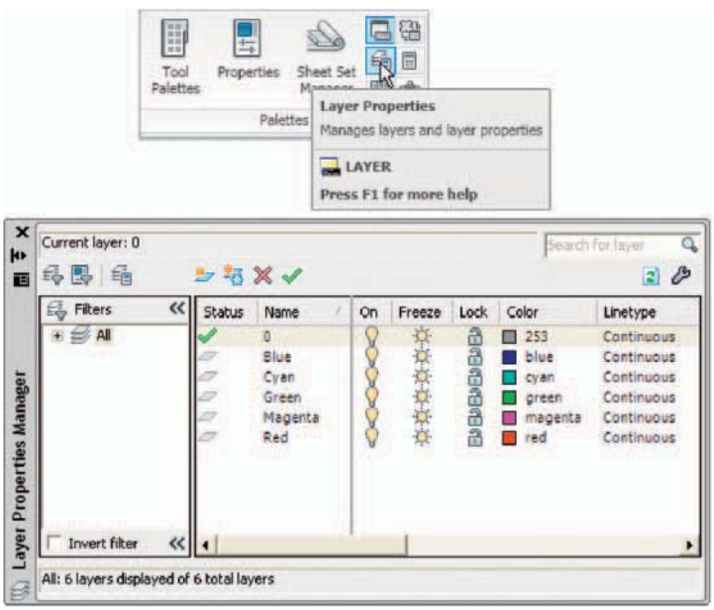

Fig. 15.5 Set up five new layers

Palettes

Click the **Tool Palettes** button in the **View/Palettes** panel (Fig. 15.6). The **Tool Palettes – All Palettes** palette appears *docked* at the right-hand edge of the AutoCAD window (Fig. 15.7). *Drag* the palette away from its *docked* position. *Right-click* in the title bar of the palette and a *right-click* menu appears (Fig. 15.8). In Fig. 15.7 the **Draw** palette is showing.

Fig. 15.6 *Click* the **Tool Palettes** button in the **View/Palettes** panel

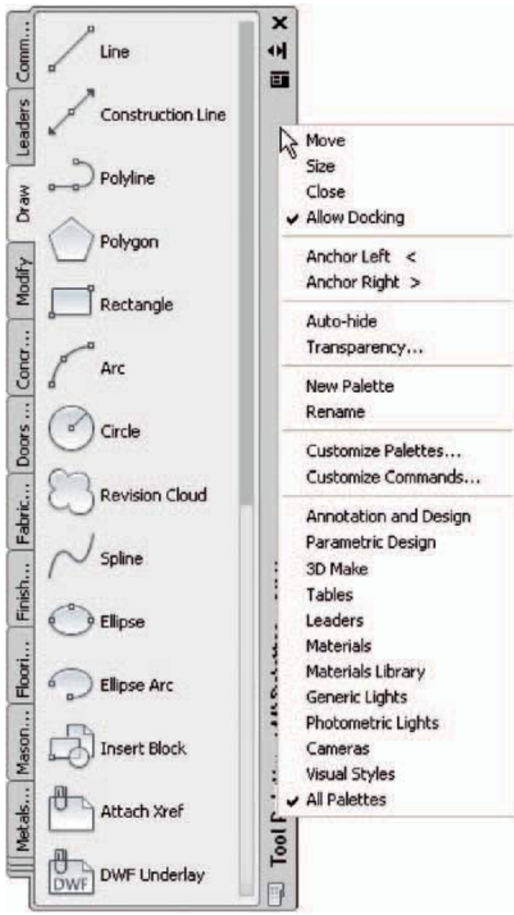

Fig. 15.7 The **Tool Palettes – All Palettes** palette with its *right-click* menu

To choose the tool palette required for the work in hand, either *click* on the name of the required palette in the tabs at the right-hand side of **All Palettes** palette or, if the required name is not showing, select the palette name from the *right-click* menu appearing with a *right-click* in the bottom left-hand corner of the **All Palettes** palette (Fig. 15.8).

The **All Palettes** palette can be *docked* against the side of the AutoCAD window if needed.

CHAPTER 15

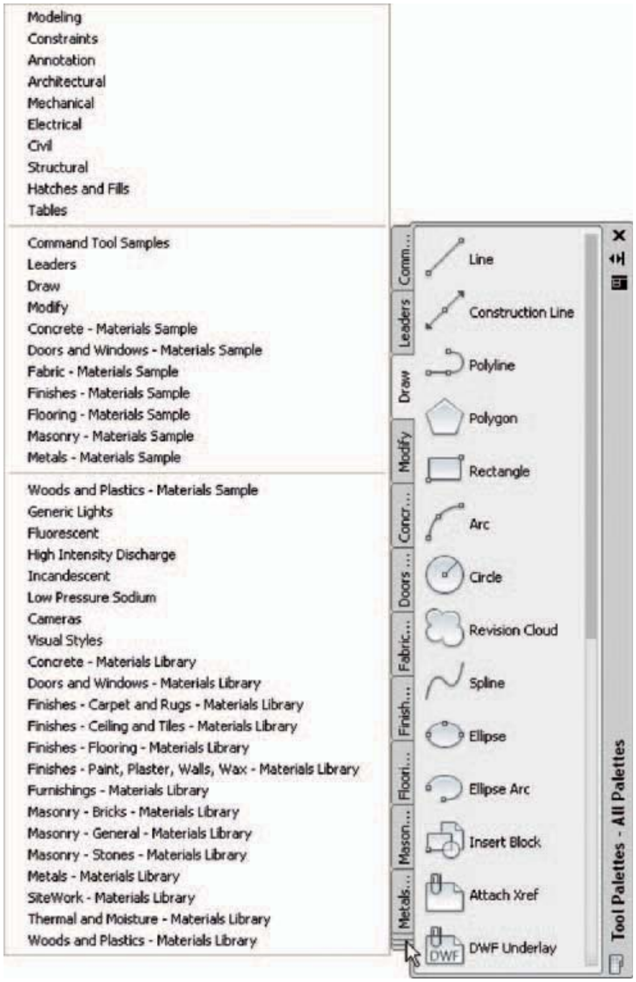

Fig. 15.8 The *right-click* menu from the **All Palettes** palette

Applying materials to a model

Materials can be applied to a 3D model directly from icons in a selected palette. Three examples follow – applying a masonry material, applying a wood material and applying a metal material.

Examples of applying materials

In the three examples which follow lighting effects are obtained by turning **Sun Status** on by *clicking* the **Sun Status** icon in the **Render/ Sun & Location** panel (Fig. 15.9). The **Lighting – Viewport Lighting Mode** dialog appears (Fig. 15.10). *Click* **Turn off default lighting (recommended)**.

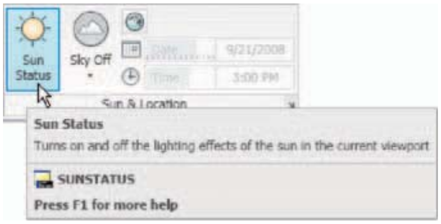

Fig. 15.9 The **Sun Status** icon in the **Render/Sun & Location** panel

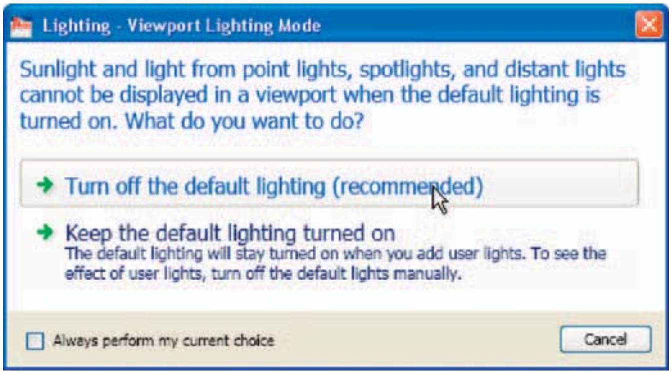

Fig. 15.10 The **Lighting – Viewport Lighting Mode** dialog

When the material has been applied, *click* **Render Region** from the sub-panel of the **Render/Render** panel (Fig. 15.11) and after selecting a window surrounding the model, the model will render.

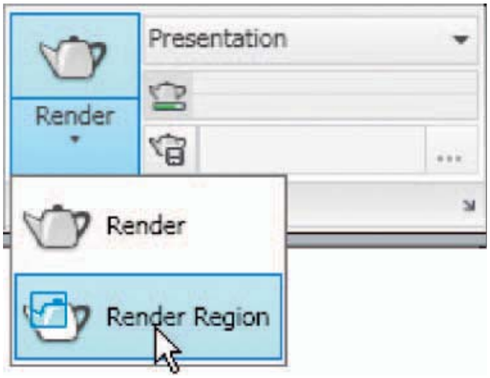

Fig. 15.11 The **Render Region** from the **Render/Render** panel and its sub-panel

First example – applying a masonry material (Fig. 15.12)

Construct the necessary 3D model. In the **All Palettes** palette *click* the tab labelled **Masonry – Materials Sample**. *Drag* the icon representing the material to be applied on to the model. Then render the model. Fig. 15.12 shows the resulting rendering.

CHAPTER 15

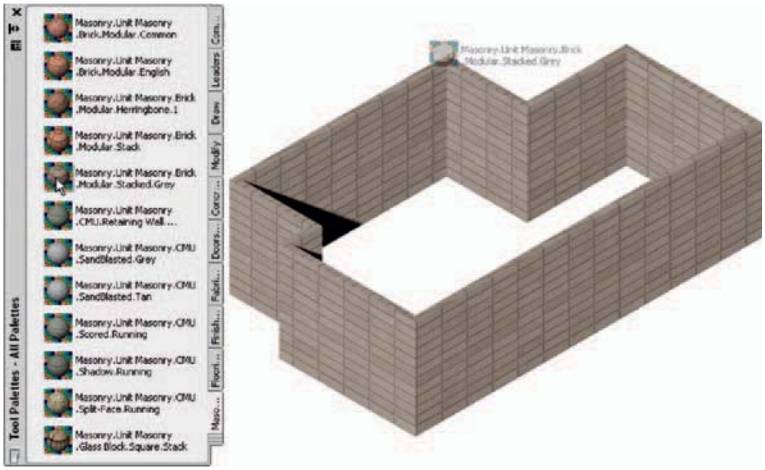

Fig. 15.12 First example – applying a masonry material

Second example – applying a metal material (Fig. 15.13)

Construct the necessary 3D model. From the **All Palettes** palette *click* the tab labelled **Metals – Materials Sample**. *Drag* the icon representing the material on to the model. Then render the model. The rendering is shown in Fig. 15.13.

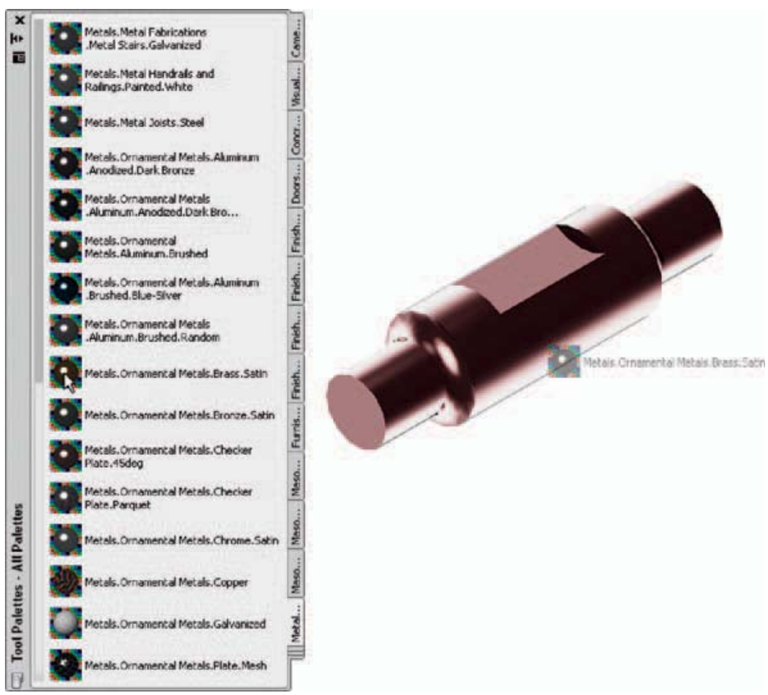

Fig. 15.13 Second example – applying a metal material

Third example – applying a wood material (Fig. 15.14)

Construct the necessary 3D model. In the **All Palettes** palette *click* the tab labelled **Woods and Plastics – Materials Sample**. *Drag* the icon representing the material on to the model. Then render the model. The rendering is shown in Fig. 15.14.

Fig. 15.14 Third example – applying a wood material

Modifying an applied material

If the result of applying a material direct to a model from the selected materials palette is not satisfactory, modifications to the applied material can be made. In the case of the second example, *enter* **materials** at the command line and the **Materials** palette appears showing the **Available**

Materials in Drawing palette (Fig. 15.15). Features such as colour of the applied material, tiling, or different texture maps of the material (or materials) applied to a model can be amended as wished from this palette.

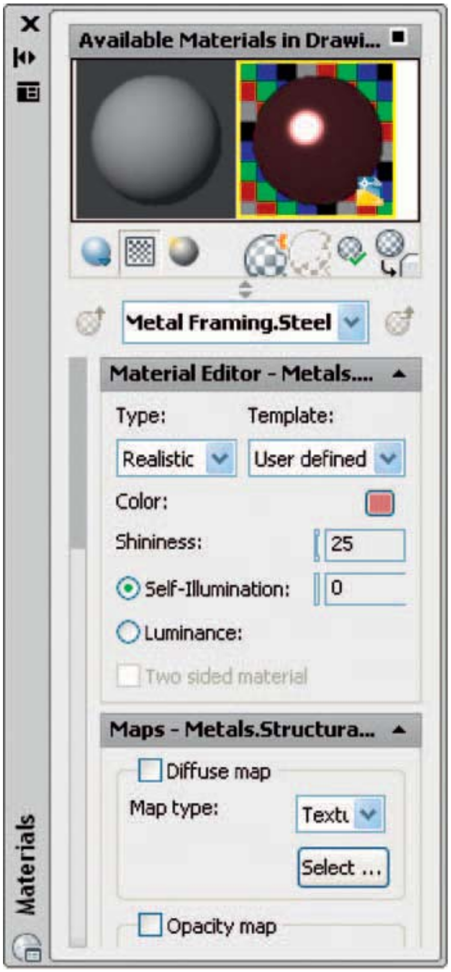

Fig. 15.15 The **Materials** palette showing **Available Materials in Drawing**

Fourth example – available materials in drawing (Fig. 15.16)

As an example Fig. 15.16 shows the nine materials applied to various parts of a 3D model of a hut in a set of fields surrounded by fences. The **Available Materials in Drawing** are shown, together with the **Material Editor** for the top left-hand material (outlined in yellow). A *click* on a material in the **Available Materials in Drawing** brings up details of that selected material.

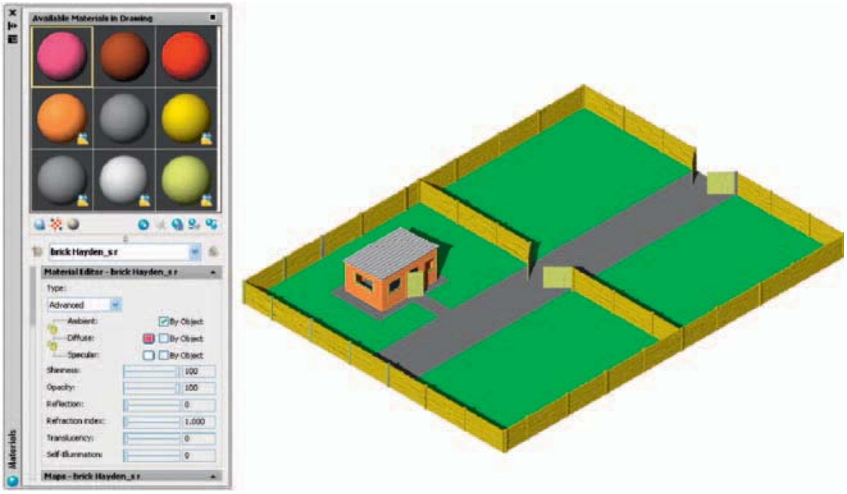

Fig. 15.16 An example of materials applied to parts of a 3D model

The Render tools and dialogs

The tool icons and menus in the **Render/Render** sub-panel are shown in Fig. 15.17.

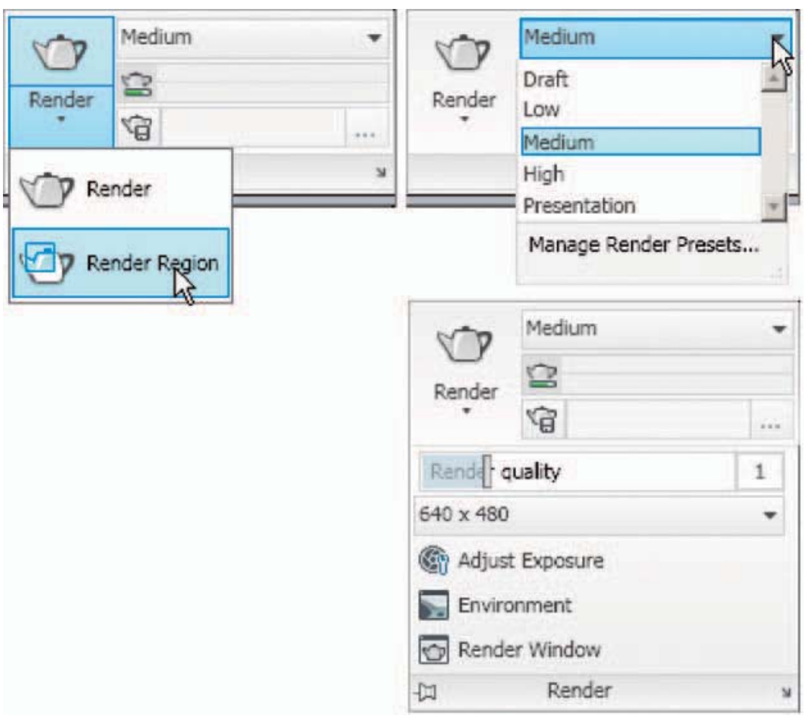

Fig. 15.17 The tools and menus in the **Render/Render** panel

The Lights tools

The different forms of lighting from light palettes are shown in Fig. 15.19. There are a large number of different types of lighting available when using AutoCAD 2010, among which those most frequently used are:

Default lighting. Depends on the setting of the set variable **LIGHTINGUNITS**. Set to **1** and one **distant** light illuminates the scene. Set to **2** and two **distant** lights illuminate the scene. Settings can also be made in the flyout from the **Render/Lights** panel (Fig. 15.18).

Point lights shed light in all directions from the position in which the light is placed (Fig. 15.18).

Distant lights send parallel rays of light from their position in the direction chosen by the operator (Fig. 15.18).

Spot lights illuminate as if from a spotlight. The light is in a direction set by the operator and is in the form of a cone, with a "hotspot" cone giving a brighter spot on the model being lit (Fig. 15.18).

Sun light which can be edited as to position (Fig. 15.18).

Sky background and illumination (Fig. 15.18).

A variety of lights of differing types in which lights of a selected wattage can be placed in a lighting scene. The set variable **LIGHTINGUNITS** must be set to **1** or **2** for these lights to function (Fig. 15.19).

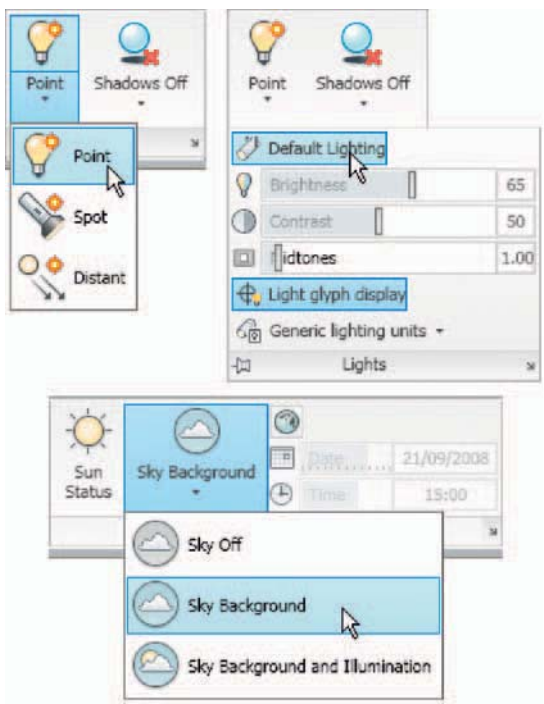

Fig. 15.18 **Light** buttons in the **Render/Lights** and **Render/Sun & Location** panels

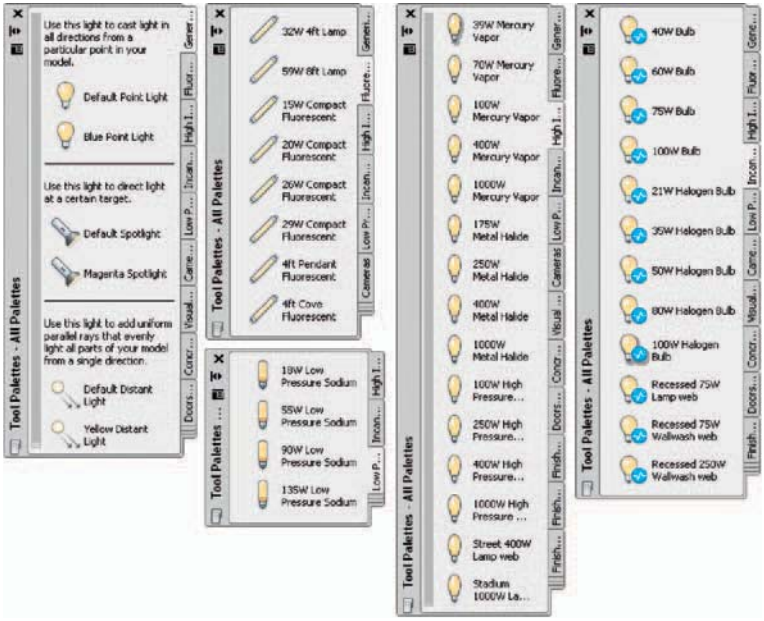

Fig. 15.19 The lighting tool palettes

Placing lights to illuminate a 3D model

In this book examples of lighting methods shown in examples will only be concerned with the use of **Point**, **Direct** and **Spot** lights, together with **Default lighting**.

Any number of the three types of lights – **Point**, **Distant** and **Spot** – can be positioned in 3D space as wished by the operator.

In general, good lighting effects can be obtained by placing a **Point** light high above the object(s) being illuminated, with a **Distant** light placed pointing towards the object at a distance from the front and above the general height of the object(s) and with a second **Distant** light pointing towards the object(s) from one side and not as high as the first **Distant** light. If desired **Spot** lights can be used either on their own or in conjunction with the other two forms of lighting.

Setting rendering background colour

The default background colour for rendering in the acadiso3D template is black by default. In this book, all renderings are shown on a white background in the viewport in which the 3D model drawing was constructed. To set the background to white for renderings:

1. At the command line:

Command:*enter* view *right-click*

The **View Manager** dialog appears (Fig. 15.20). *Click* **Model View** in its **Views** list, followed by a *click* on the **New...** button.

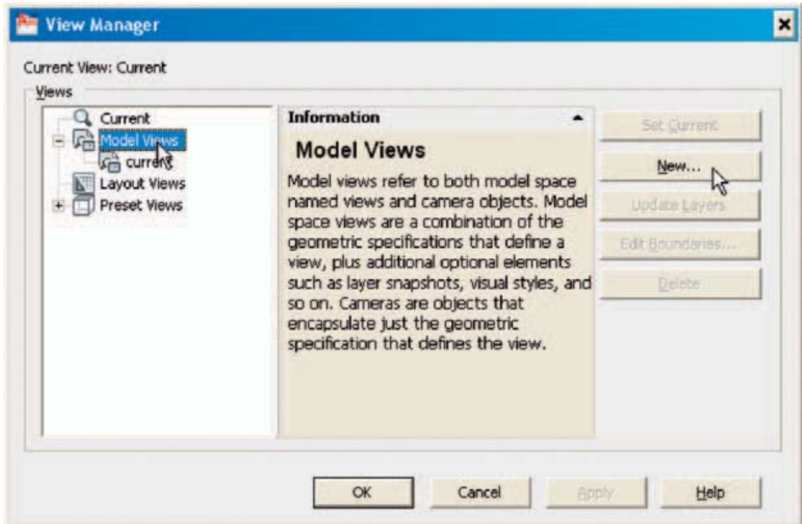

Fig. 15.20 The **View Manager** dialog

2. The **New View/Shot Properties** dialog (Fig. 15.21) appears. *Enter* **current** (or similar) in the **View name** field. In the **Background** pop-up list *click* **Solid**. The **Background** dialog appears (Fig. 15.22).

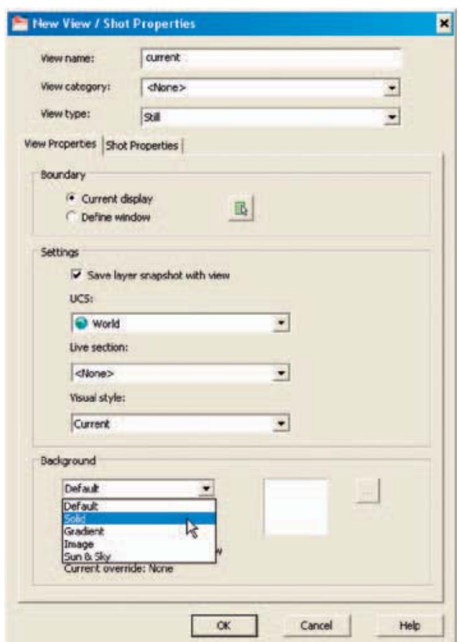

Fig. 15.21 The **New View/Shot Properties** dialog

3. In the **Background** dialog *click* in the **Color** field. The **Select Color** dialog appears (Fig. 15.22).

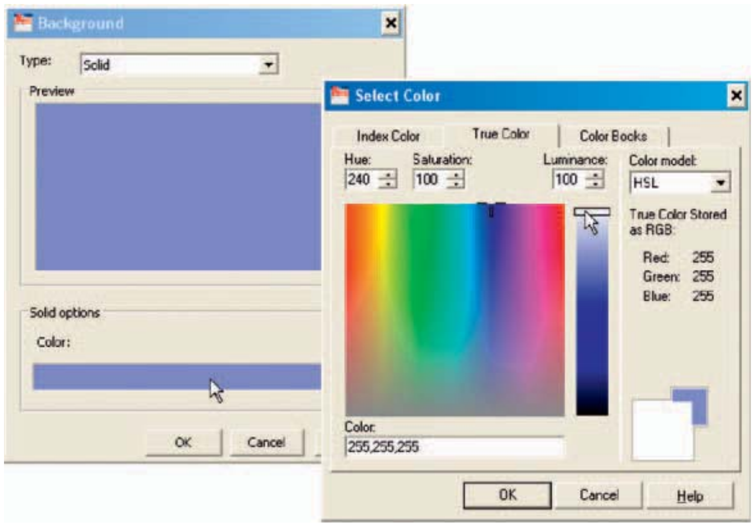

Fig. 15.22 The **Background** and **Select Color** dialogs

4. In the **Select Color** dialog *drag* the slider as far upwards as possible to change the colour to white (**255,255,255**). Then *click* the dialog's **OK** button. The **Background** dialog reappears showing white in the **Color** and **Preview** fields. *Click* the **Background** dialog's **OK** button.
5. The **New View/Shot Properties** dialog reappears showing **current** highlighted in the **Views** list. *Click* the dialog's **OK** button.
6. The **View Manager** dialog reappears. *Click* the **Set Current** button, followed by a *click* on the dialog's **OK** button (Fig. 15.23).

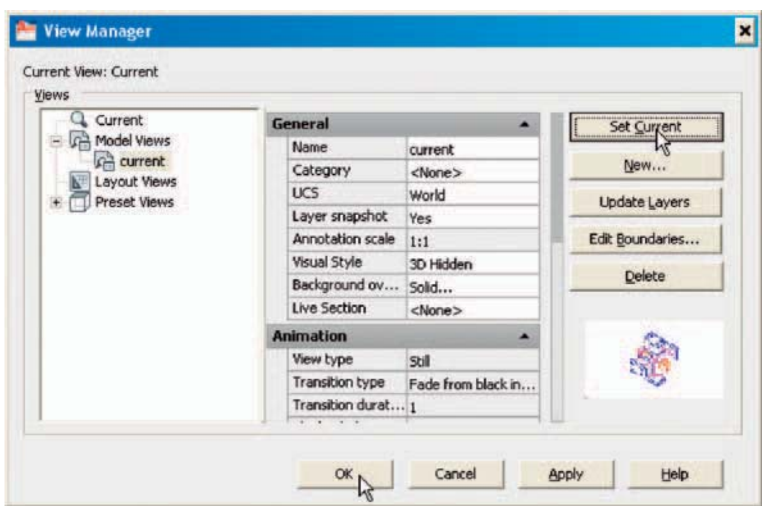

Fig. 15.23 The **View Manager** dialog reappears

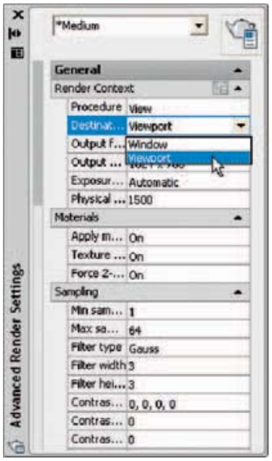

Fig. 15.24 The **Advanced Render Settings** palette

7. *Enter* **rpref** at the command line. The **Advanced Render Settings** palette appears.
8. In the **Render Context** field *click* the arrow to the right of **Window** and in the pop-up menu which appears *click* **Viewport** as the rendering destination (Fig. 15.24).
9. Close the palette and save the screen with the new settings as the template **3dacadiso.dwt**. This will ensure renderings are made in the workspace in which the 3D model was – on a white background.

First example – Rendering (Fig. 15.37)

1. Construct a 3D model of the wing nut shown in the two-view projection Fig. 15.25.
2. Place the 3D model in the **ViewCube/Top** view (Fig. 15.26), **Zoom** to **1** and, with the **Move** tool, move the model to the upper part of the AutoCAD drawing area.
3. *Click* the **Point Light** tool icon in the **Render/Lights** panel (Fig. 15.27). The warning window Fig. 15.28 appears. *Click* **Turn off Default Lighting** in the window.
4. A **New Point Light** icon appears (depending upon the setting of the **Light Glyph Setting** in the **Drafting** area of the **Options** dialog) and the command line shows:

```
Command:_pointlight
Specify source location <0,0,0>:enter .xy right-
  click of click at centre of model (need Z):
  enter 500 right-click
```

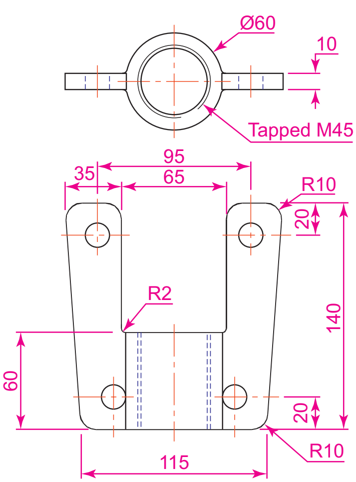

Fig. 15.25 First example – **Rendering –** two-view projection

Fig. 15.26 Place the model in the **ViewCube/Top** view

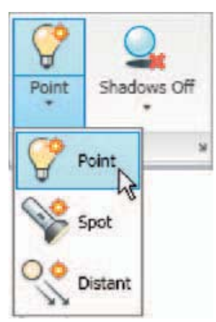

Fig. 15.27 The **Point Light** icon in the **Render/Lights** panel

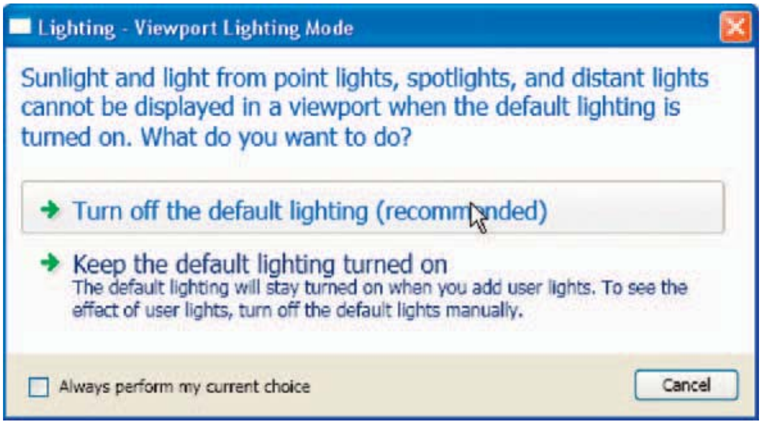

Fig. 15.28 The **Lighting – Viewport Lighting Mode** warning window

```
Enter an option to change [Name/Intensity/Status/
  shadoW/Attenuation/Color/eXit]
<eXit>:enter n (Name) right-click
Enter light name <Pointlight1>:right-click
Enter an option to change [Name/Intensity/
  Status/shadoW/Attenuation/Color/eXit]
  <eXit>:right-click
Command:
```

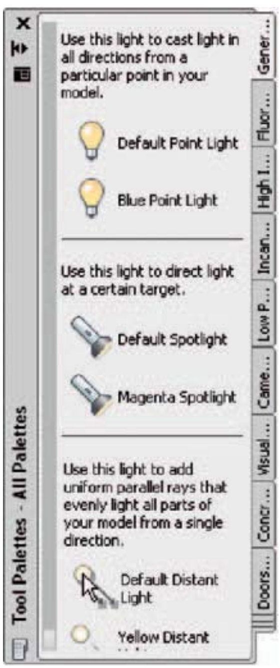

Fig. 15.29 The **Generic Lights** palette showing the **Default Distant Light** selected

5. There are several methods by which **Distant** lights can be called: by selecting **Default Distant Light** from the **Generic Lights** palette (Fig. 15.29), with a *click* the on the **Distant** icon in the **Render/Lights** panel, or by *entering* **distantlight** at the command line.

No matter which method is adopted the **Lighting – Viewport Lighting Mode** dialog (Fig. 15.30) appears. *Click* **Turn off default lighting (recommended)**. The **Lighting – Photometric Distant Lights** dialog appears (Fig. 15.30). *Click* **Allow distant lights** in this dialog and the command line shows:

```
Command:_distantlight
Specify light direction FROM <0,0,0> or
[Vector]:enter .xy right-click of click
to the left and below the 3D model (need
Z)enter 400 right-click
Specify light direction TO <1,1,1>:enter
.xy right-click of click at centre of mode
(need Z)
enter 70 right-click
Enter an option to change [Name/Intensity
```

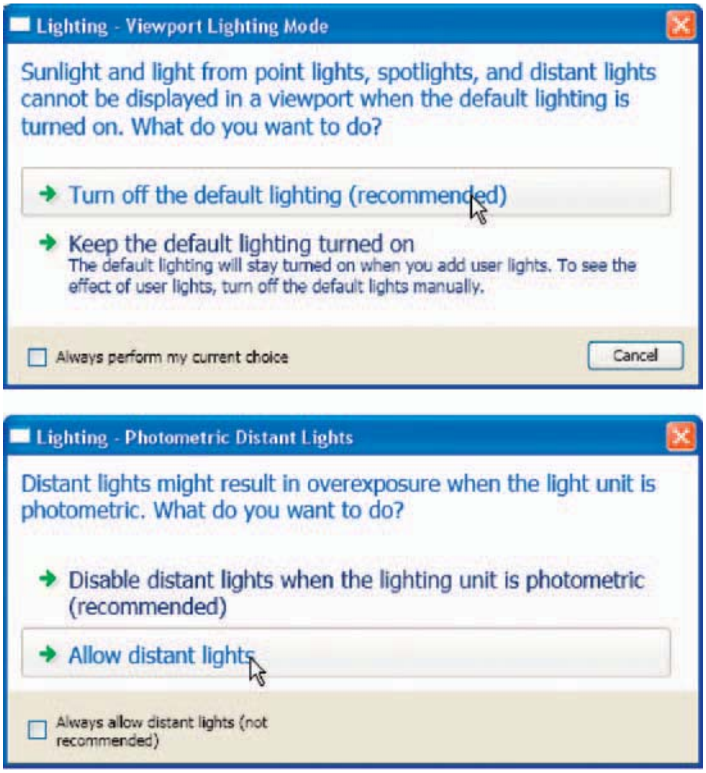

Fig. 15.30 The **Distant Lights** dialogs

```
factor/Status/Photometry/shadoW/filterColor/eXit]
  <eXit>:enter n (Name) right-click
Enter light name <Distantlight1>:right-click
Enter an option to change [Name/Intensity
factor/Status/Photometry/shadoW/filterColor/eXit]
  <eXit>:right-click
Command:
```

6. Place another **Distant Light** (**Distantlight2**) in the same position **TO** and **FROM** the front and below the model at **Z** of **300**.
7. When the model has been rendered, if a light requires to be changed in intensity, shadow, position or colour, *click* **Lights in Model** in the **View/3D Palettes** panel (Fig. 15.31) and the **Lights in Model Palette** appears (Fig. 15.32). *Double-click* a light name and the **Properties**

Note

In this example the **Intensity factor** has been set at **1** for lights. This is possible because the lights are close to the model. In larger-size models the **Intensity factor** may have to be set to a higher figure.

Fig. 15.31 Selecting **Lights in Model Palette** from the **View/3D Palettes** panel

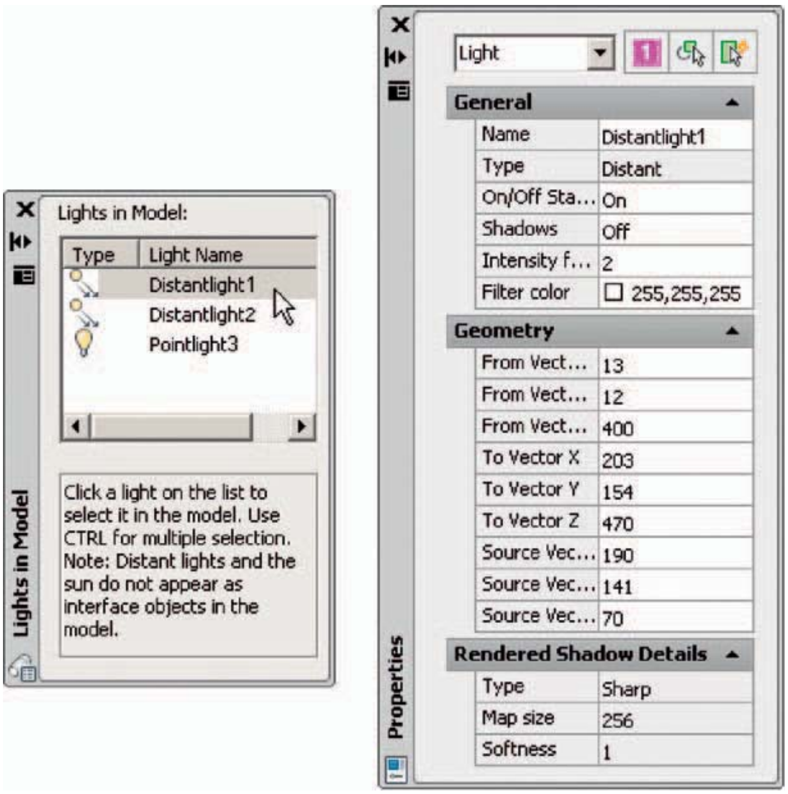

Fig. 15.32 The **Lights in Model** and **Properties** palettes

palette for the light appears in which modifications can be made (Fig. 15.32). Amendments can be made as thought necessary.

Adding a material to the model

1. In the **Metals – Materials Library** palette select **Metals, Structural Metal Framing**, Steel and apply it to the 3D model (Fig. 15.33).
2. *Click* the **Materials** button in the **View/3D Palettes** panel. The **Materials** palette appears showing an icon of the applied material (Fig. 15.34). In the palettes *click* the **Diffuse color** button and from the **Select Color** dialog which appears select a suitable colour for the model.

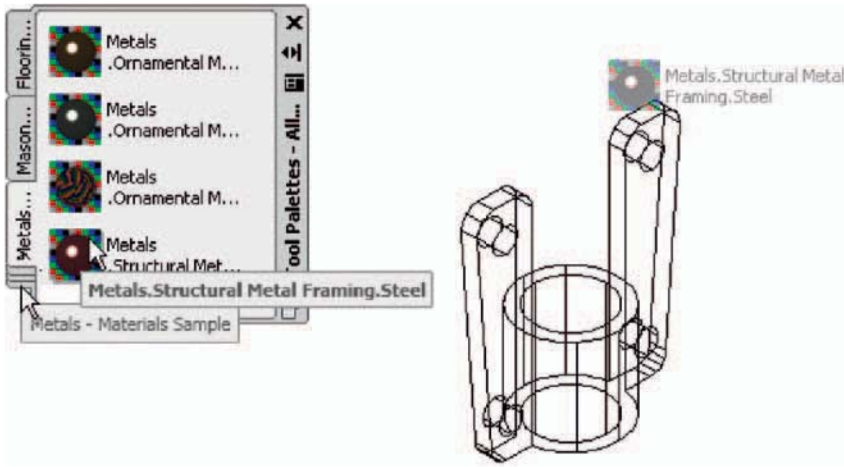

Fig. 15.33 **Metals, Structural Metal Framing, Steel** applied to the model

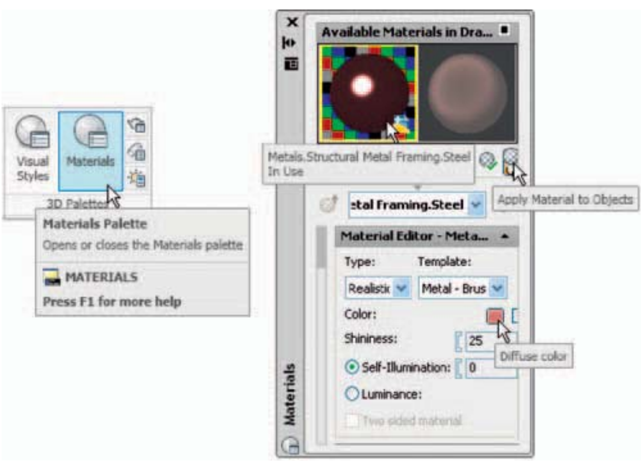

Fig. 15.34 The **Materials** pallete showing the applied material

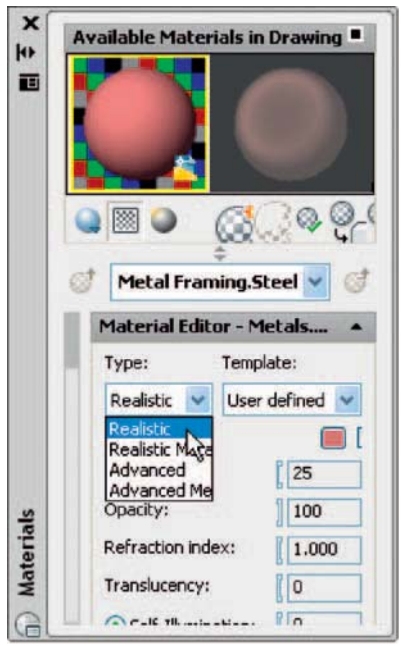

Fig. 15.35 Select **Realistic** in the **Type** drop-down menu

3. *Click* **Apply Material to Objects** icon (Fig. 15.34).
4. *Click* any part of the 3D model to apply the material to the model.
5. *Right-click* in the **Type** field of the **Material Editor** section of the palette and select **Realistic** in the *right-click* menu (Fig. 15.35).
6. Select **Presentation** from the **Render Presets** menu in the sub **Render/ Render** panel (Fig. 15.36).
7. Render the 3D model again and if now satisfied save to a suitable file name.

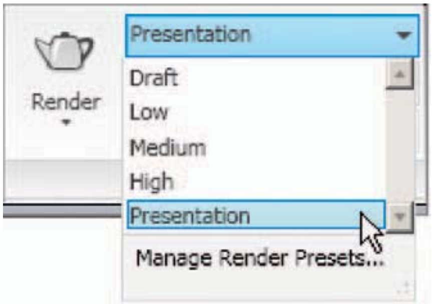

Fig. 15.36 Setting the form of rendering to **Presentation**

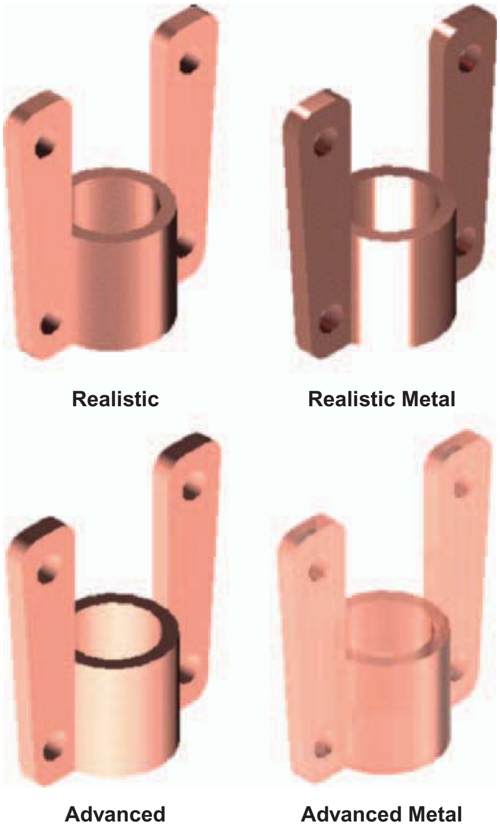

Fig. 15.37 First example – **Rendering**

Figure 15.37 shows four renderings in the four **Type** settings.

Note

The limited description of rendering given in these pages does not show the full value of different types of lights, materials and rendering methods. The reader is advised to experiment with the facilities available for rendering.

Second example – Rendering a 3D model (Fig. 15.39)

1. Construct 3D models of the two parts of the stand and support given in the projections in Fig. 15.38 with the two parts assembled together.
2. Place the scene in the **ViewCube/Top** view, **Zoom** to **1** and add lighting.
3. Add different materials to the parts of the assembly and render the result.

Figure 15.39 shows the resulting rendering.

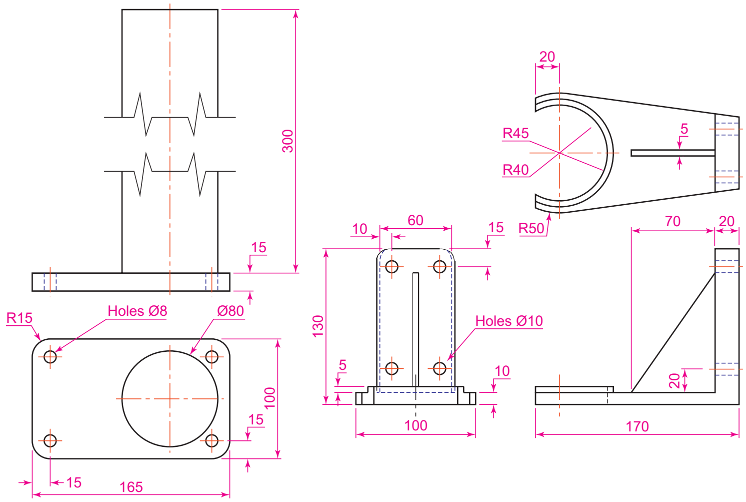

Fig. 15.38 Second example – **Rendering** – orthographic projection

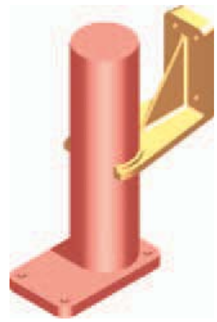

Fig. 15.39 Second example – **Rendering**

Third example – Rendering (Fig. 15.40)

Figure 15.40 is an exploded, rendered 3D model of a pumping device from a machine and Fig 15.41 is a third angle orthographic projection of the device.

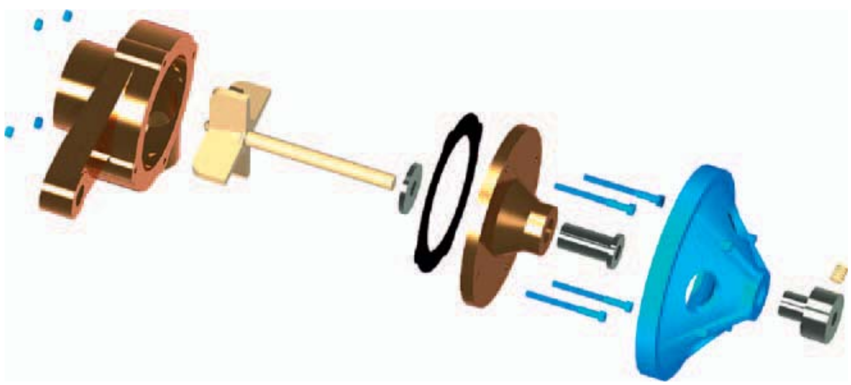

Fig. 15.40 Third example – **Rendering**

Free Orbit

Example – Free Orbit (Fig. 15.43)

With the second example on screen select **Conceptual** shading from the **Visual Styles** pop-up list in the **Home/View** panel (Fig. 15.42).

Click the **Free Orbit** button in the **View/Navigate** panel (Fig. 15.43). An orbit cursor appears on screen. Moving the cursor under mouse control

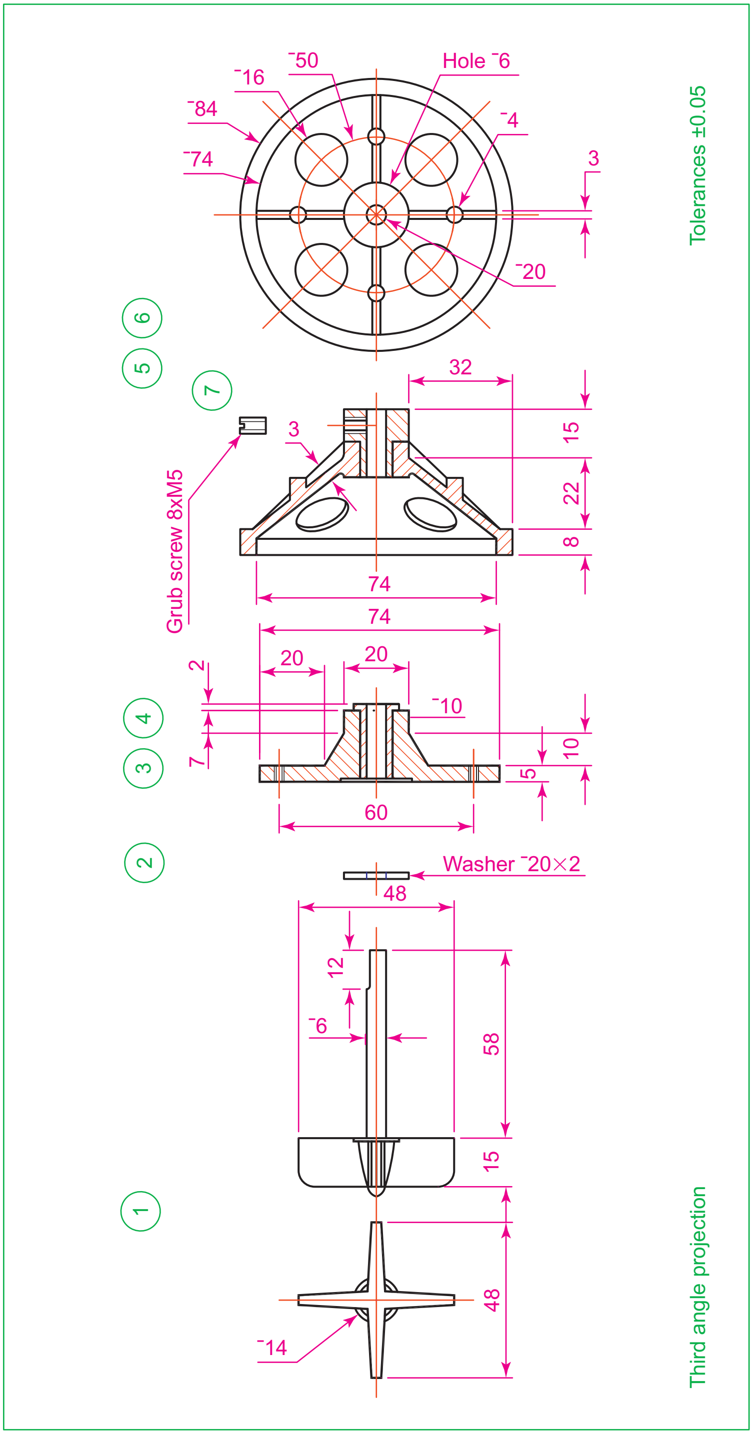

Fig. 15.41 Third example – **Rendering** exploded orthographic views

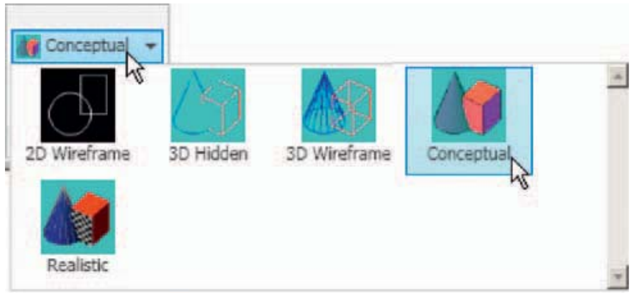

Fig. 15.42 The **Visual Styles** pop-up from the **Home/View** panel

allows the model on screen to be placed in any desired viewing position. Figure 15.43 shows an example of a **Free Orbit**.

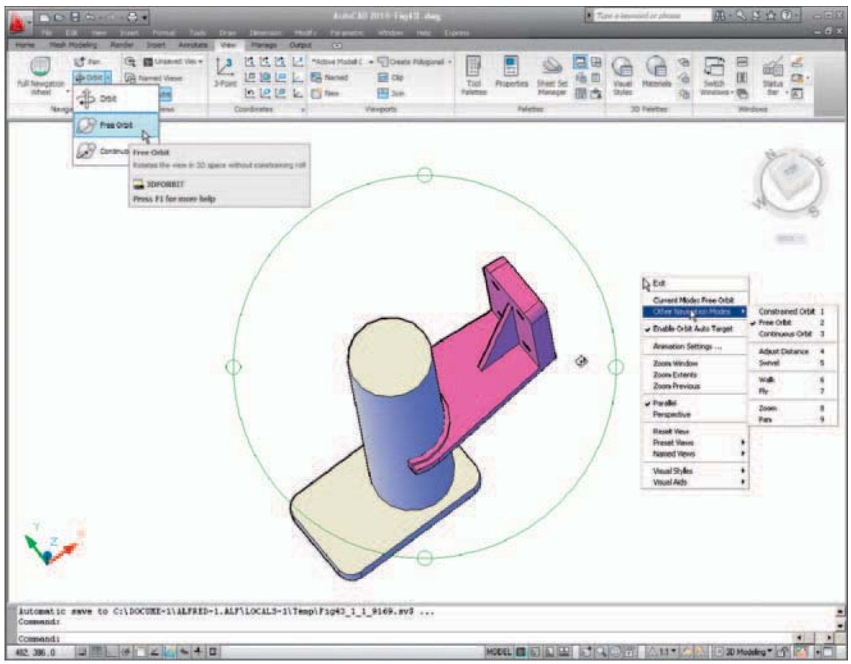

Fig. 15.43 Example – **Free Orbit**

Right-click anywhere on screen and a right-click menu appears (Fig. 15.43) from which choices may be made.

Producing hardcopy

Printing or plotting a drawing on screen from AutoCAD 2010 can be carried out from either **Model Space** or from **Paper Space**. In versions of AutoCAD before AutoCAD 2004, it was necessary to print or plot from **Pspace**.

First example – printing (Fig. 15.45)

Note

This example is of a drawing which has been acted upon by the **Visual Styles/Realistic** shading mode.

1. With a drawing to be printed or plotted on screen *click* the **Plot** tool icon in the **Quick Access** toolbar (Fig. 15.44).

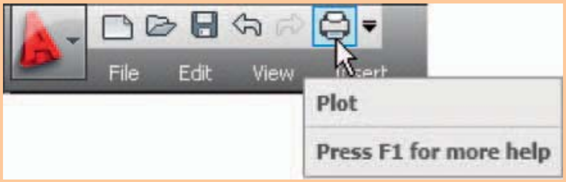

Fig. 15.44 The **Plot** icon in the **Quick Access** toolbar

2. The **Plot** dialog appears. Set the **Printer/Plotter** to a printer or plotter currently attached to the computer and the **Paper Size** to a paper size to which the printer/plotter is set.
3. *Click* the **Preview** button of the dialog and if the preview is OK (Fig. 15.45), *right-click* and in the right-click menu which appears, *click* **Plot**. The drawing plots, producing the necessary "hardcopy".

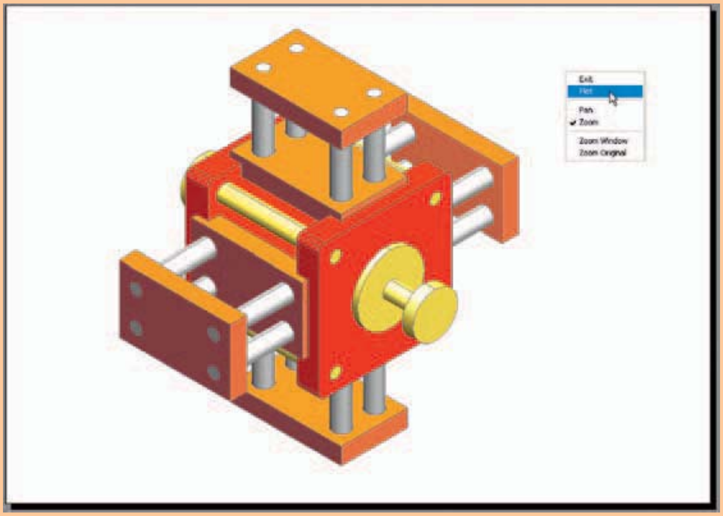

Fig. 15.45 First example – **Print Preview** – printing a single copy

Second example – multiple-view copy (Fig. 15.46)

The 3D model to be printed is a **Realistic** view of a 3D model. To print a multiple-view copy:

1. Place the drawing in a **Four: Equal** viewport setting.
2. Make a new layer **vports** of colour cyan and make it the current layer.
3. *Click* the **Layout** button in the status bar. At the command line:

```
Command:enter mv (MVIEW)right-click
MVIEW
Specify corner of viewport or [ON/OFF/Fit/
  Shadeplot/Lock/Object/Polygonal/Restore/
  LAyer/2/3/4] <Fit>:enter r Restore)right-click
Enter viewport configuration name or [?]
  <*Active>:right-click
Specify first corner or [Fit] <Fit>:right-click
Command:
```

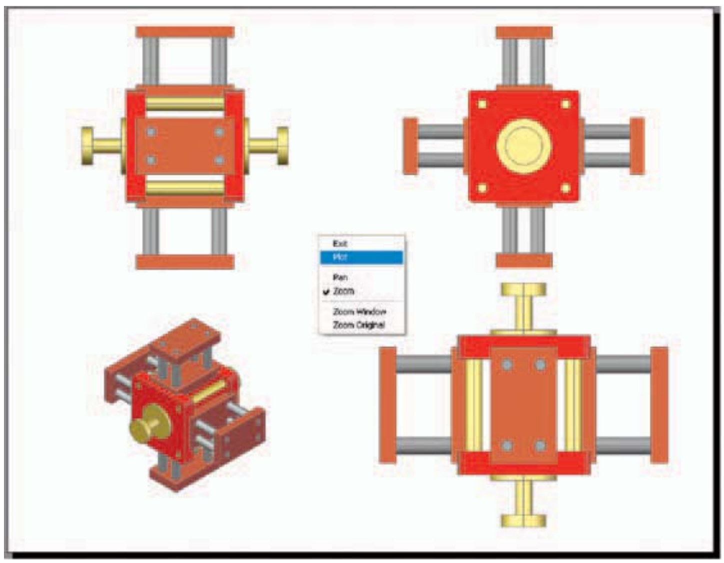

Fig. 15.46 Second example – multiple view copy

The drawing appears in **Paper Space**. The views of the 3D model each appear within a cyan outline in each viewport.

4. Turn layer **vports** off. The cyan outlines of the viewports disappear.
5. *Click* the **Plot** tool icon in the **Output/Plot** toolbar. Make sure the correct **Printer/Plotter** and **Paper Size** settings are selected and *click* the **Preview** button of the dialog.

6. If the preview is satisfactory (Fig. 15.46), *right-click* and from the right-click menu *click* **Plot**. The drawing plots to produce the required four-viewport hardcopy.

Other forms of hardcopy

When working in AutoCAD 2010, several different forms of hardcopy in **Home/View** visual styles are possible. As an example a single-view plot review of the same 3D model is shown in the **Hidden** visual shading form (Fig. 15.47).

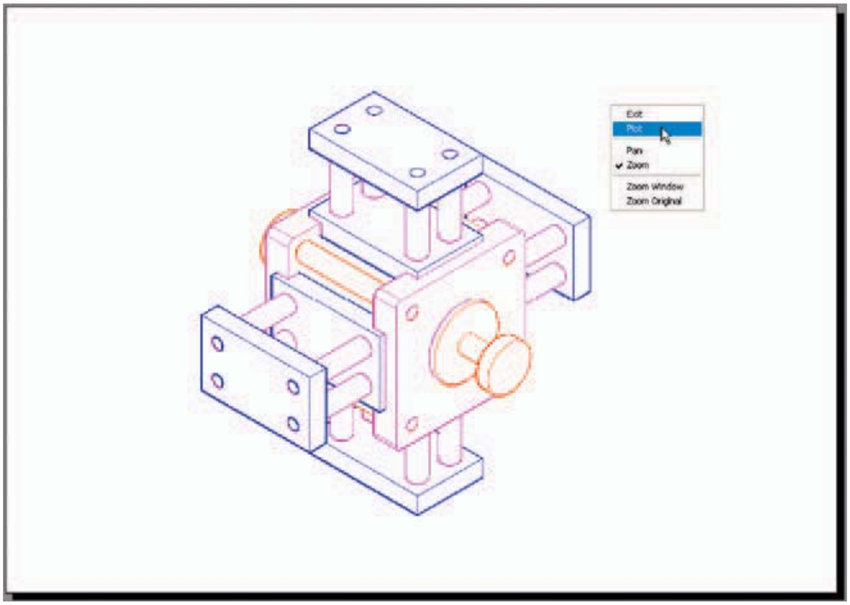

Fig. 15.47 An example of a **Hidden Style** plot **Preview**

Saving and opening 3D model drawings

3D model drawings are saved and/or opened in the same way as are 2D drawings. To save a drawing *click* **Save As...** in the **File** drop-down menu and save the drawing in the **Save Drawing As** dialog by *entering* a drawing file name in the **File Name** field of the dialog before *clicking* the **Save** button. To open a drawing which has been saved *click* **Open...** in the **File** drop-down menu, and in the **Select File** dialog which appears select a file name from the file list.

There are differences between saving a 2D and a 3D drawing, in that when a 3D model drawing is shaded by using a visual style from the **Home/View** panel, the shading is saved with the drawing.

REVISION NOTES

1. 3D models can be constructed in any of the workspaces – **2D Design & Annotation**, **Classic AutoCAD** or **3D Modeling**. In **Part 2** of this book 3D models are constructed in the **3D Modeling** workspace.
2. 3D model drawings can be constructed in either a **Parallel** projection or in a **Perspective** projection layout.
3. Material and light palettes can be selected from the **Tool Palettes – All Palettes** palette.
4. Materials can be modified from the **Materials** palette.
5. In this book, lighting of a scene with 3D models is by placing two **distant** lights in front of and above the models, with one positioned to the left and the other to the right and a **point** light above the centre of the scene.
6. There are many other methods of lighting a scene, in particular using **default** lighting or **sun** lighting.
7. Several **Render preset methods** of rendering are available, from **Draft** to **Presentation**.
8. The use of the **Orbit** tools allows a 3D model to be presented in any position.
9. Plotting or printing of either **Model** or **Layout** windows is possible.
10. Hardcopy can be from a single viewport or from multiple viewports. When printing or plotting 3D model drawings **Visual Style** layouts print as they appear on screen.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/978-1-85617-868-6

1. A rendering of an assembled lathe tool-holder is shown in Fig. 15.48. The rendering includes different materials for each part of the assembly.

   Working to the dimensions given in the parts orthographic drawing (Fig. 15.49), construct a 3D model drawing of the assembled lathe tool-holder on several layers of different colours, add lighting and materials and render the model in an isometric view.

   Shade with **3D Visual Styles/Hidden** and print or plot a **ViewCube/Isometric** view of the model drawing.

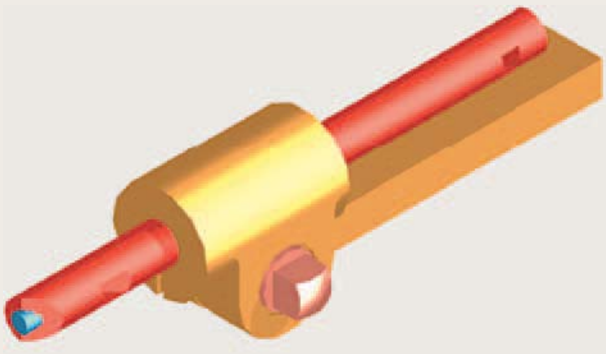

Fig. 15.48 Exercise 1

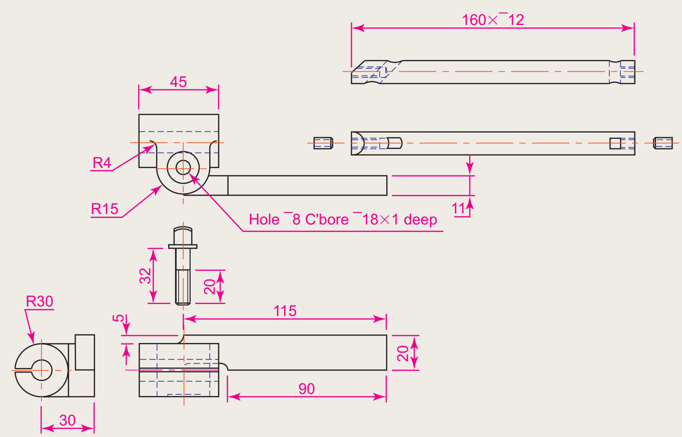

Fig. 15.49 Exercise 1 – parts drawings

2. Figure 15.50 is a rendering of a drip tray. Working to the sizes given in Fig. 15.51, construct a 3D model drawing of the tray. Add lighting and a suitable material, place the model in an isometric view and render.

Fig. 15.50 Exercise 2

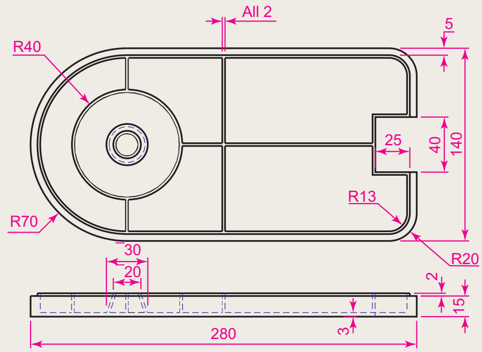

Fig. 15.51 Exercise 2 – two-view projection

3. A three-view drawing of a hanging spindle bearing in third angle orthographic projection is shown in Fig. 15.52. Working to the dimensions in the drawing construct a 3D model drawing of the bearing. Add lighting and a material and render the model.

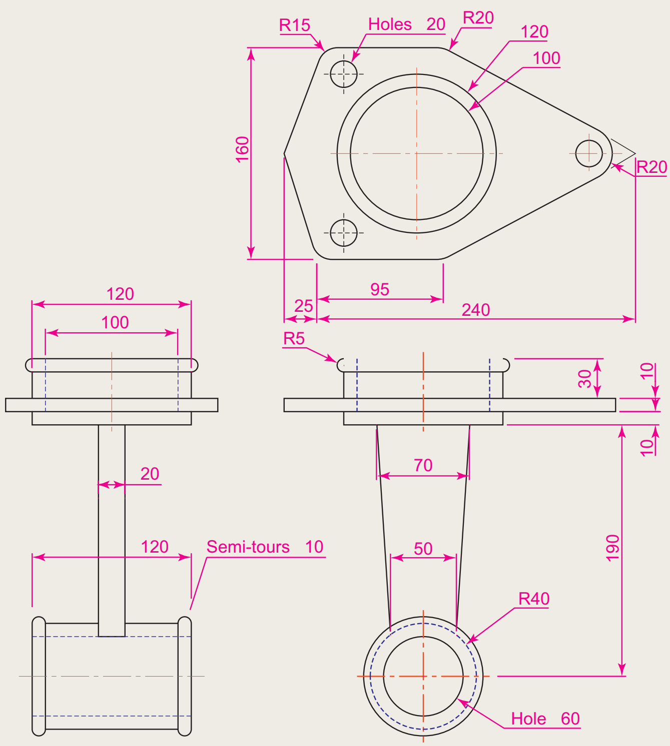

Fig. 15.52 Exercise 3

Chapter 16

Building drawing

AIMS OF THIS CHAPTER

The aims of this chapter are:

1. To show that AutoCAD 2010 is a suitable computer-aided design software package for the construction of building drawings.
2. To show that AutoCAD 2010 is a suitable CAD programme for the construction of 3D models of buildings.

Building drawings

There are a number of different types of drawings related to the construction of any form of building. In this chapter a fairly typical example of a set of building drawings is shown. These are seven drawings related to the construction of an extension to an existing two-storey house (44 Ridgeway Road). These show:

1. A site plan of the original two-storey house, drawn to a scale of **1:200** (Fig. 16.1).

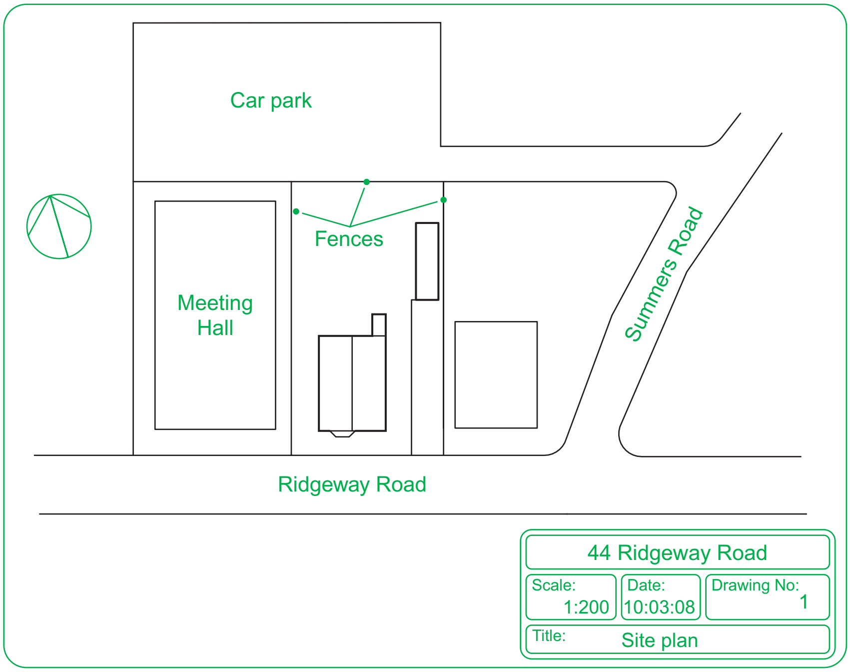

Fig. 16.1 A site plan

2. A site layout plan of the original house, drawn to a scale of **1:100** (Fig. 16.2).
3. Floor layouts of the original house, drawn to a scale of **1:50** (Fig. 16.3).
4. Views of all four sides of the original house drawn to a scale of **1:50** (Fig. 16.4).
5. Floor layouts including the proposed extension, drawn to a scale of **1:50** (Fig. 16.5).
6. Views of all four sides of the house including the proposed extension, drawn to a scale of **1:50** (Fig. 16.6).
7. A sectional view through the proposed extension, drawn to a scale of **1:50** (Fig. 16.7).

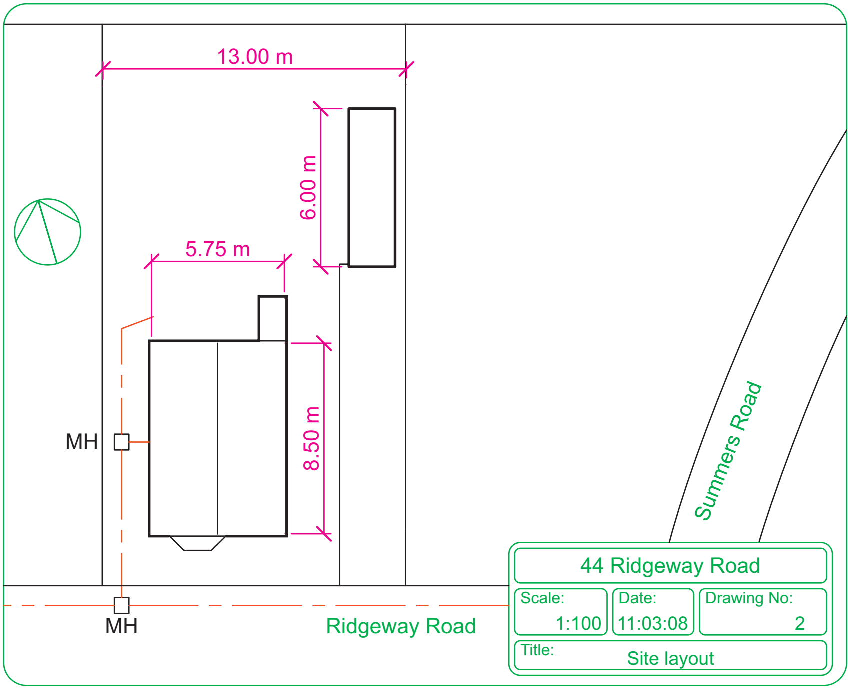

Fig. 16.2 A site layout plan

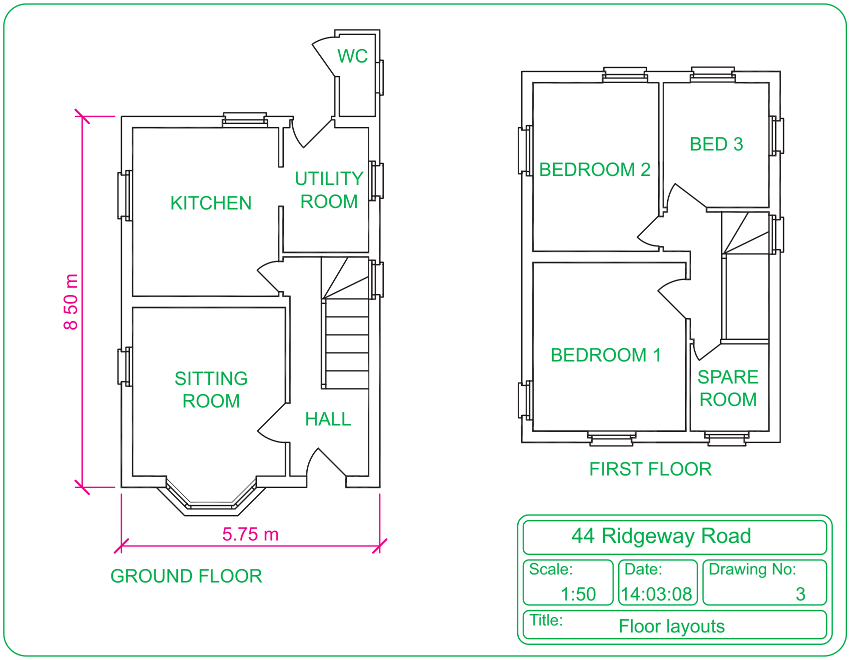

Fig. 16.3 Floor layouts drawing of the original house

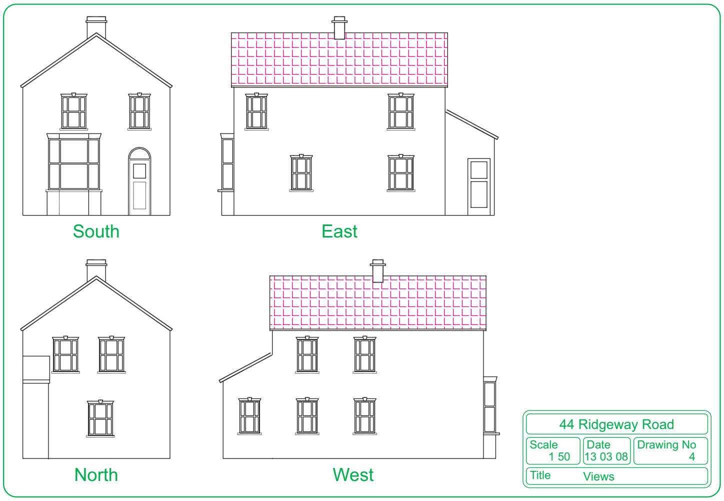

Fig. 16.4 Views of the original house

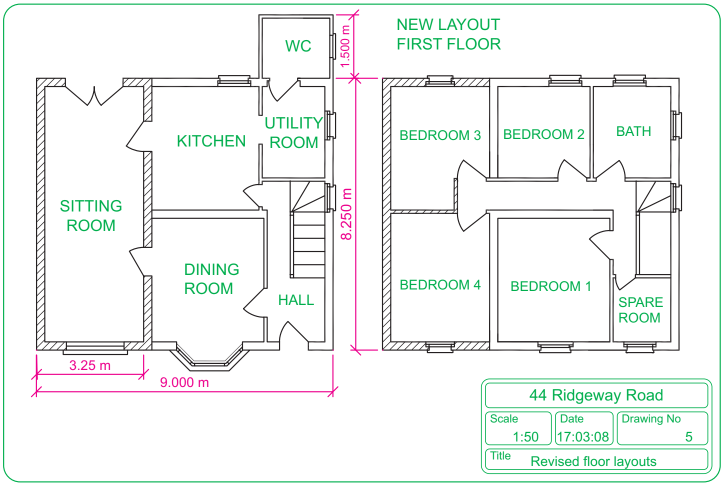

Fig. 16.5 Floor layouts drawing of the proposed extension

Note

1. Other types of drawings will be constructed such as drawings showing the details of parts such as doors, windows, floor structures etc. These are often shown in sectional views.

2. Although the seven drawings related to the proposed extension of the house at 44 Ridgeway Road are shown here as having been constructed on either A3 or A4 layouts, it is common practice to include several types of building drawings on larger sheets such as A1 sheets of a size 820 mm by 594 mm.

Fig. 16.6 Views including the proposed extension

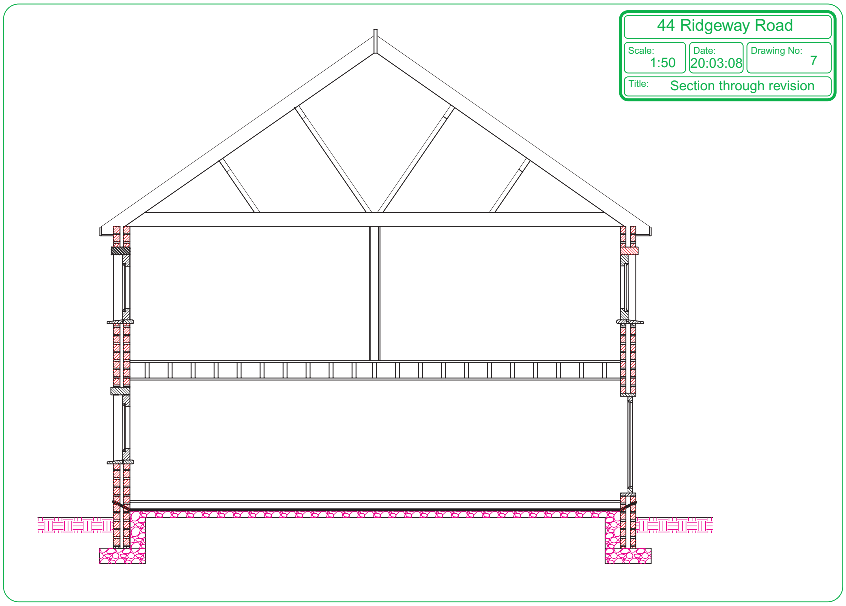

Fig. 16.7 A section through the proposed extension

Floor layouts

When constructing floor layout drawings it is advisable to build up a library of block drawings of symbols representing features such as doors, windows etc. These can then be inserted into layouts from the DesignCenter. A suggested small library of such block symbols in shown in Fig. 16.8.

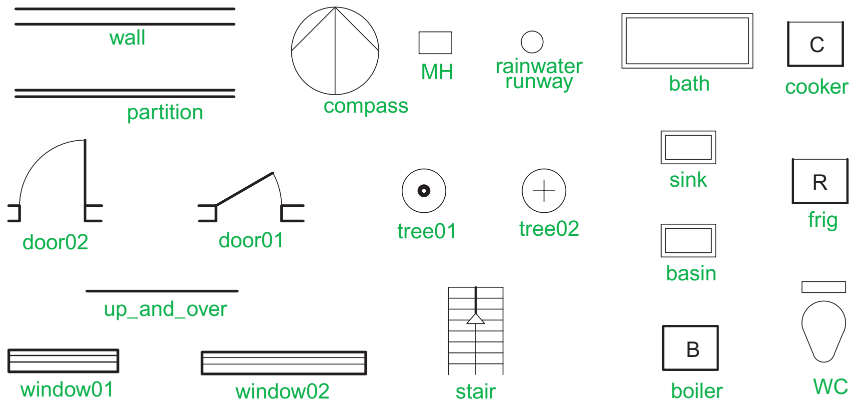

Fig. 16.8 A small library of building symbols

3D models of buildings

Details of shapes and dimensions for the first two examples are taken from the drawings of the building and its extension at 44 Ridgeway Road given in the Figures 16.2 to 16.6 on pages 325 to 327.

First example – 44 Ridgeway Road – original building

Details of this first example are taken from Figures 16.2 to 16.4 on pages 325 and 326.

The following steps describe the construction of a 3D model of 44 Ridgeway Road prior to the extension being added.

1. In the **Layer Properties Manager** palette – **Doors** (colour **red**), **Roof** (colour **green**), **Walls** (colour **blue**), **Windows** (colour **magenta**) (Fig. 16.9).
2. Set the screen to the **ViewCube/Front** view (Fig. 16.10).

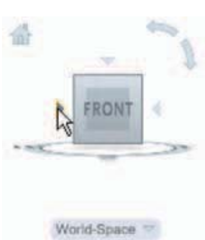

Fig. 16.10 Set screen to the **ViewCube/Front** view

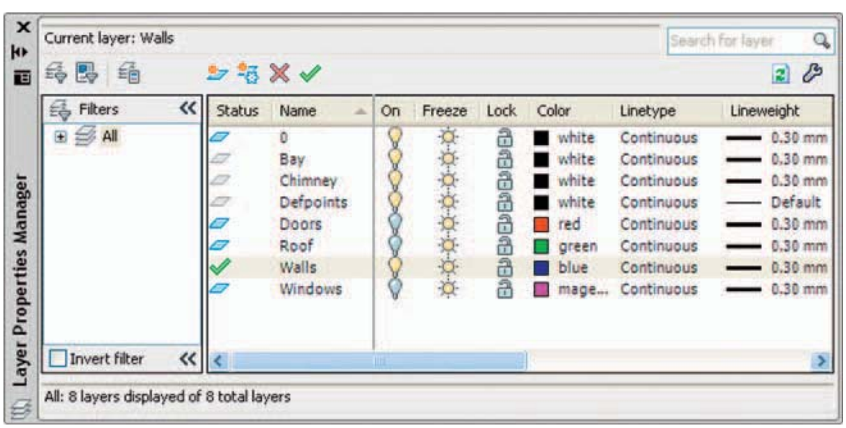

Fig. 16.9 First example – the layers on which the model is to be constructed

3. Set the layer **Walls** current and, working to a scale of **1:50**, construct outlines of the walls. Construct outlines of the bay, windows and doors inside the wall outlines.
4. **Extrude** the wall, bay, window and door outlines to a height of **1**.
5. **Subtract** the bay, window and door outlines from the wall outlines. The result is shown in Fig. 16.11.

Fig. 16.11 First example – the walls

6. Make the layer **Windows** current and construct outlines of three of the windows which are of different sizes. Extrude the copings and sills to a height of **1.5** and the other parts to a height of **1**. Form a union of the main outline, the coping and the sill. The window pane extrusions will have to be subtracted from the union. Fig. 16.12 shows the 3D models of the three windows in a **ViewCube/Isometric** view.

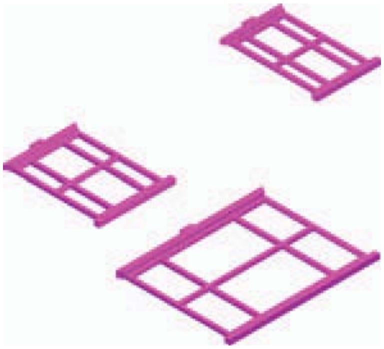

Fig. 16.12 First example – extrusions of the three sizes of windows

7. Move and copy the windows to their correct positions in the walls.
8. Make the layer **Doors** current and construct outlines of the doors and extrude to a height of **1**.

9. Make layer **Chimney** current and construct a 3D model of the chimney (Fig. 16.13).
10. Make the layer **Roofs** current and construct outlines of the roofs (main building and garage). See Fig. 16.14.

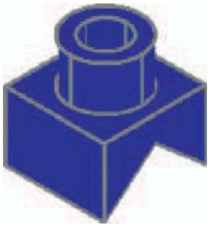

Fig. 16.13 First example – **Realistic** view of a 3D model of the chimney

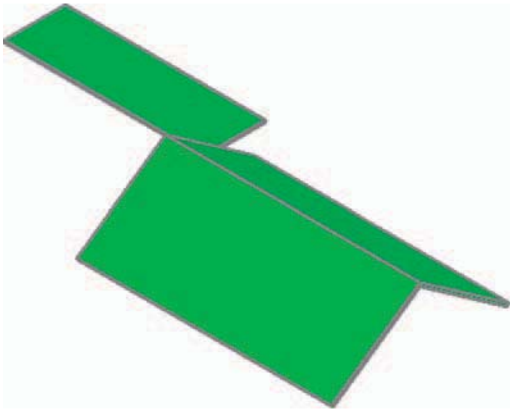

Fig. 16.14 First example – **Realistic** view of the roofs

11. On the layer **Bay** construct the bay and its windows.

Assembling the walls

1. Place the screen in the **ViewCube/Top** view (Fig. 16.15).
2. Make the layer **Walls** current and turn off all other layers other than **Windows**.
3. Placing a window around each wall in turn move and/or rotate and move the walls until they are in their correct position relative to each other.
4. Place in the **ViewCube/Isometric** view and using the **Move** tool, move the walls into their correct positions relative to each other. Fig 16.16 shows the walls in position in a **ViewCube/Top** view.

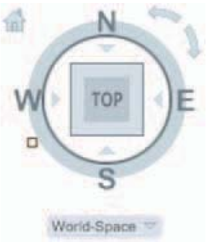

Fig. 16.15 Set screen to **ViewCube/Top** view

Fig. 16.16 First example – the four walls in their correct positions relative to each other in a **ViewCube/Top** view

5. Move the roof into position relative to the walls and move the chimney into position on the roof. Fig. 16.17 shows the resulting 3D model in a **ViewCube/Isometric** view (Fig. 16.18).

Fig. 16.17 First example – a **Realistic** view of the assembled walls, windows, bay, roof and chimney

Fig. 16.18 Set screen to a **ViewCube/Isometric** view

The garage

On layer **Walls** construct the walls and on layer **Windows** construct the windows. Fig. 16.19 is a **Realistic** visual style view of the 3D model as constructed so far.

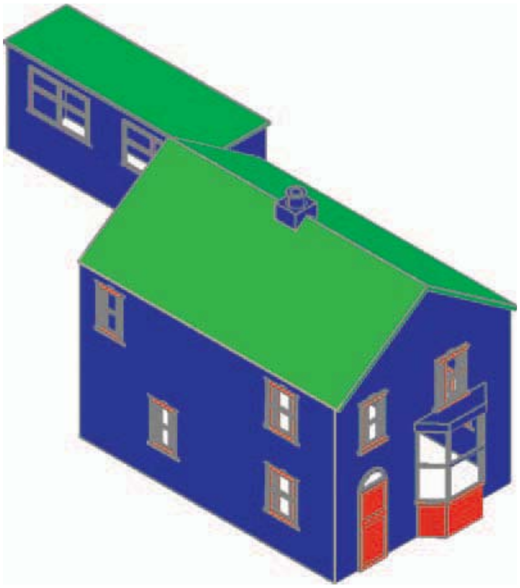

Fig. 16.19 First example – **Realistic** view of the original house and garage

Second example – extension to 44 Ridgeway Road

Working to a scale of **1:50** and taking dimensions from Figures 16.5 and 16.6 (page 326 and in a manner similar to the method of constructing the 3D model of the original building, add the extension to the original building. Fig. 16.20 shows a **Realistic** visual style view of the resulting 3D model. In this 3D model floors have been added – a ground and a first-storey floor constructed on a new layer **Floors** of colour **yellow**. Note the changes in the bay and front door.

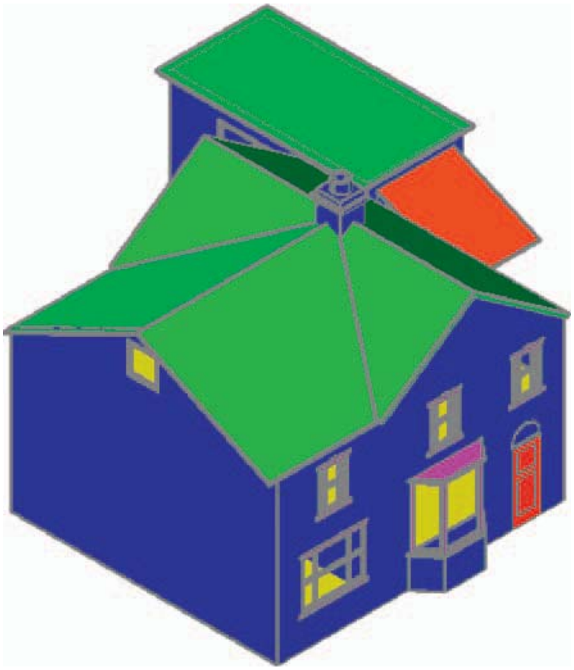

Fig. 16.20 Second example – a **Realistic** view of the building with its extension

Third example – small building in fields

Working to a scale of **1:50** from the dimensions given in Fig. 16.21, construct a 3D model of the hut following the steps given below.

The walls are painted concrete and the roof is corrugated iron.

In the **Layer Properties Manager** dialog make the new levels as follows:

Walls – colour **blue**
Road – colour **red**
Roof – colour **red**
Windows – colour **magenta**
Fence – colour **8**
Field – colour **green**

Following the methods used in the construction of the house in the first example, construct the walls, roof, windows and door of the small building in one of the fields. Fig. 16.22 shows a **Realistic** visual style view of a 3D model of the hut.

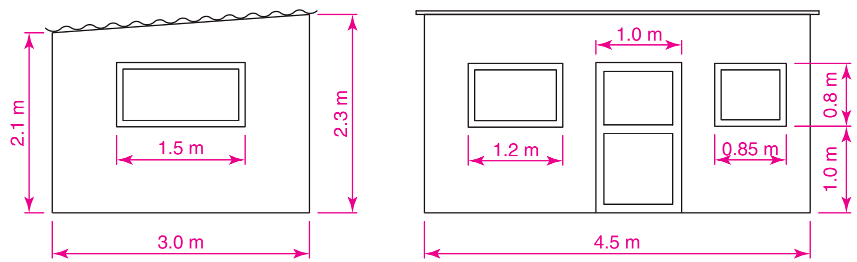

Fig. 16.21 Third example – front and end views of the hut

Fig. 16.22 Third example – a **Realistic** view of a 3D model of the hut

Constructing the fence, fields and road

1. Place the screen in a **Four: Equal** viewports setting.
2. Make the **Garden** layer current and in the **Top** viewport, construct an outline of the boundaries to the fields and to the building. Extrude the outline to a height of **0.5**.
3. Make the **Road** layer current and in the **Top** viewport, construct an outline of the road and extrude the outline to a height of **0.5**.
4. In the **Front** view, construct a single plank and a post of a fence and copy them a sufficient number of times to surround the four fields leaving gaps for the gates. With the **Union** tool form a union of all the posts and planks. Fig. 16.23 shows a part of the resulting fence in a **Realistic** visual style view in the **Isometric** viewport. With the **Union** tool form a union of all the planks and posts in the entire fence.
5. While still in the layer **Fence**, construct gates to the fields.
6. Make the **Road** layer current and construct an outline of the road. Extrude to a height of **0.5**.

Note

When constructing each of these features it is advisable to turn off those layers on which other features have been constructed.

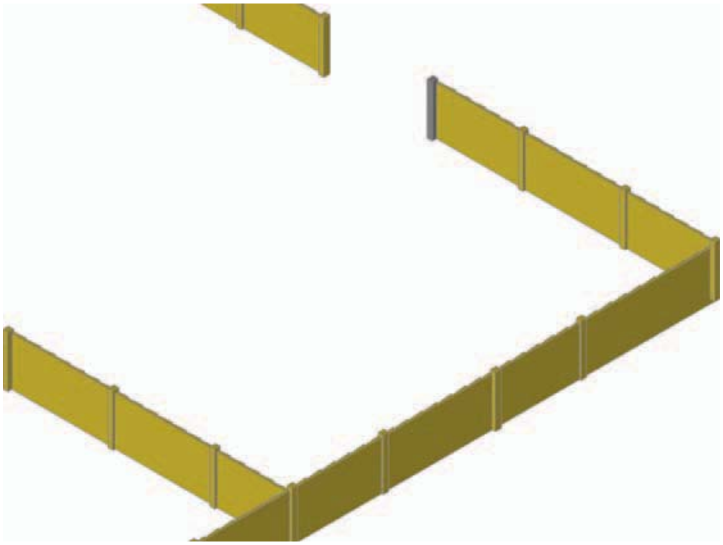

Fig. 16.23 Third example – part of the fence

Fig. 16.24 shows a **Conceptual** view of the hut in the fields with the road, fence and gates.

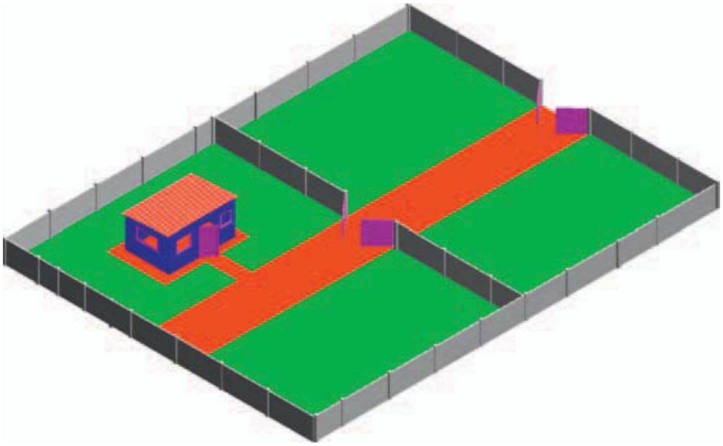

Fig. 16.24 Third example – the completed 3D model

Completing the second example

Working in a manner similar to the method used when constructing the roads, garden and fences for the third example, add the paths, garden area and fences and gates to the building 44 Ridgeway Road with its extension. Fig. 16.24 is a **Conceptual** visual style view of the resulting 3D model.

Material attachments and rendering-Second example

The following materials were attached to the various parts of the 3D model (Fig. 16.25). To attach the materials, all layers except the layer on which the objects to which the attachment of a particular material is being made are turned off, allowing the material in question to be attached only to the elements to which each material is to be attached.

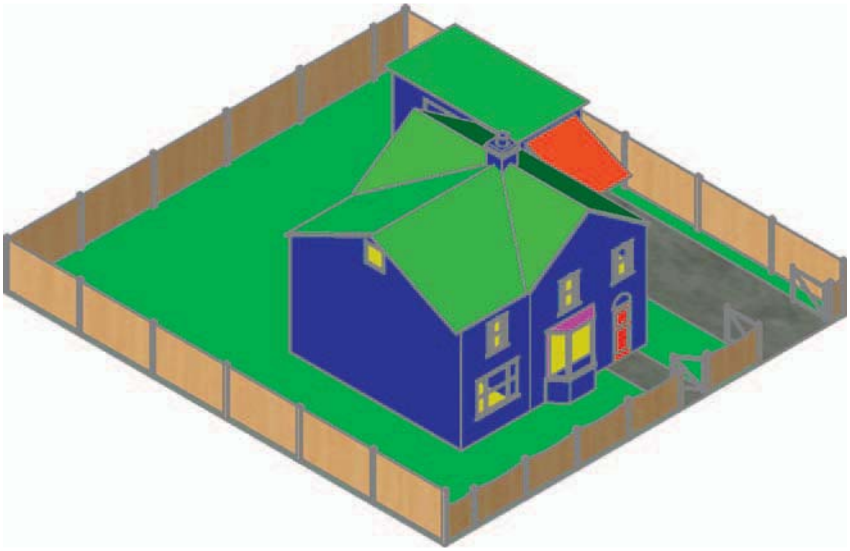

Fig. 16.25 Second example – the completed 3D model

Default: colour **7**.
Doors: **Wood – Hickory**
Fences: **Wood – Spruce**
Floors: **Wood – Hickory**
Garden: **Green**
Gates: **Wood – White**
Roofs: **Brick – Herringbone**
Windows: **Wood – White**

The 3D model was then rendered with **Output Size** set to **1024 × 768** and **Render Preset** set to **Presentation**, with **Sun Status** turned on. The resulting rendering is shown in Fig. 16.26.

Material attachments and rendering-Third example

Fig. 16.27 shows the third example after attaching materials and rendering.

Fig. 16.26 Second example – a rendering after attaching materials

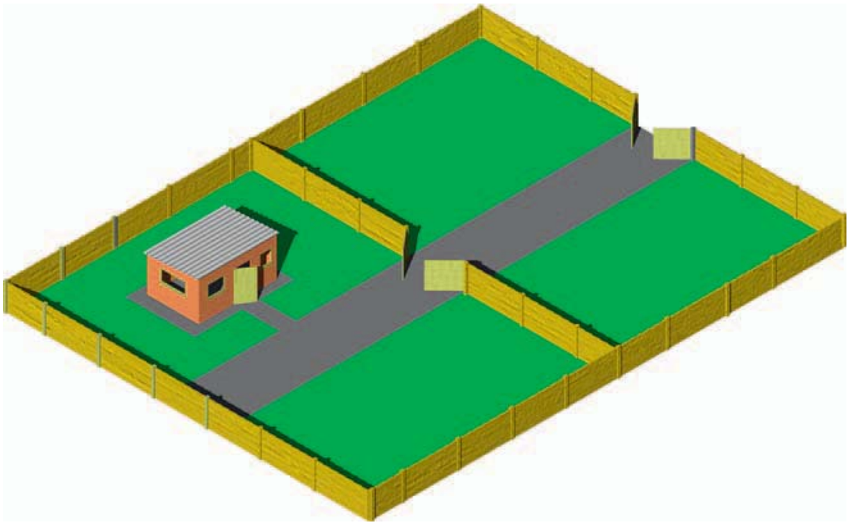

Fig. 16.27 Third example – 3D model after attaching materials and rendering

REVISION NOTES

1. There are a number of different types of building drawings – site plans, site layout plans, floor layouts, views, sectional views, detail drawings. AutoCAD 2010 is a suitable CAD programme to use when constructing building drawings.
2. AutoCAD 2010 is a suitable CAD programme for the construction of 3D models of buildings.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/ 978-1-85617-868-6

1. Fig. 16.28 is a site plan drawn to a scale of 1:200 showing a bungalow to be built in the garden of an existing bungalow. Construct the library of symbols shown in Fig. 16.8 on page 328 and by inserting the symbols from the DesignCenter construct a scale 1:50 drawing of the floor layout plan of the proposed bungalow.

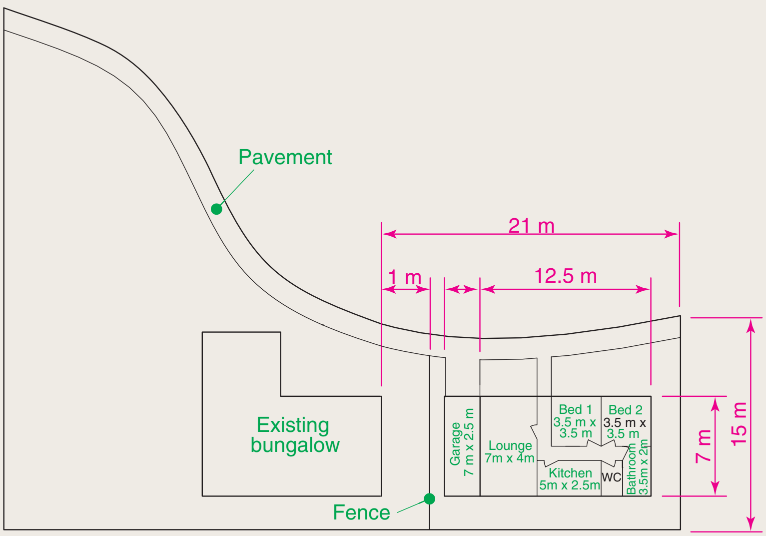

Fig. 16.28 Exercise 1

2. Fig. 16 29 is a site plan of a two-storey house in a building plot. Design and construct to a scale 1:50 a suggested pair of floor layouts for the two floors of the proposed house.

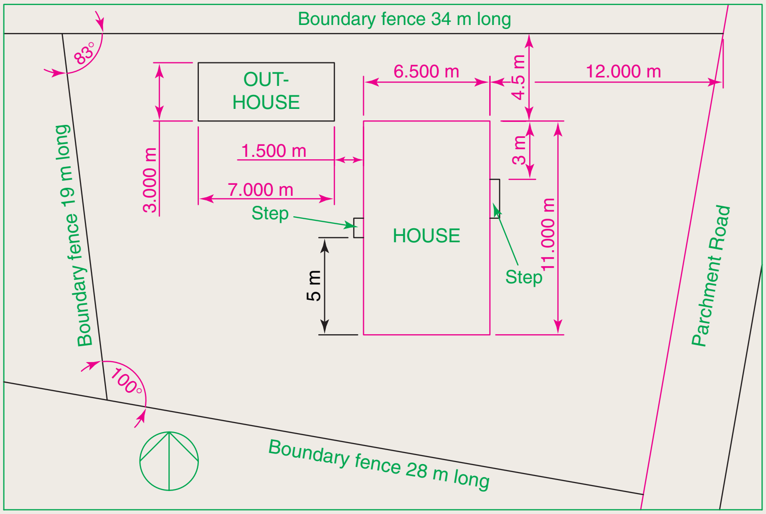

Fig. 16.29 Exercise 2

3. Fig. 16.30 shows a scale 1:100 site plan for the proposed bungalow 4 Caretaker Road. Construct the floor layout for the proposed house shown in the drawing Fig. 16 28.

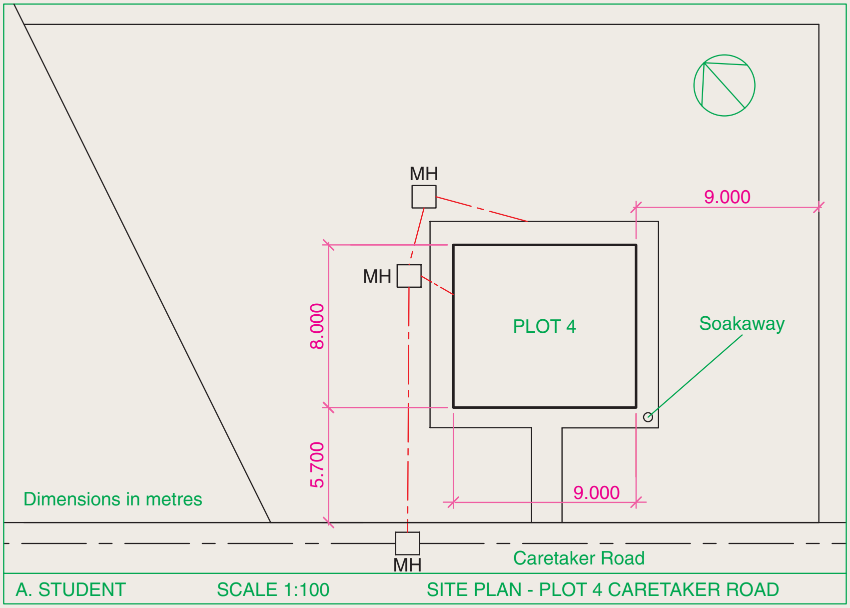

Fig. 16.30 Exercise 3 – site plan

4. Fig. 16.31 shows a building plan of the house in the site plan (Fig. 16.30). Construct a 3D model view of the house making an assumption as to the roofing and the heights connected with your model.

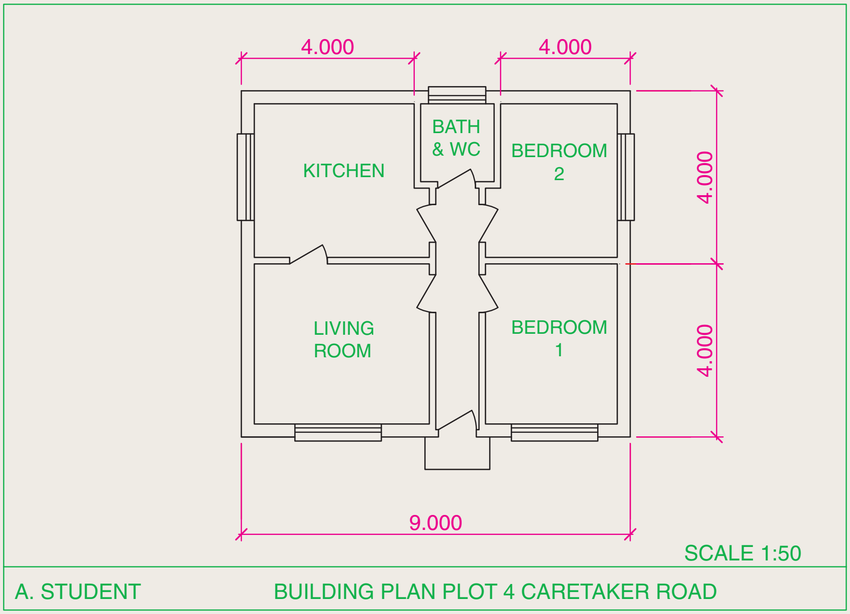

Fig. 16.31 Exercise 4 – a building plan

5. Fig. 16 32 is a three-view, dimensioned orthographic projection of a house. Fig. 16.33 is a rendering of a 3D model of the house. Construct the 3D model to a scale of 1:50, making estimates of dimensions not given in Fig. 16.32 and render using suitable materials.

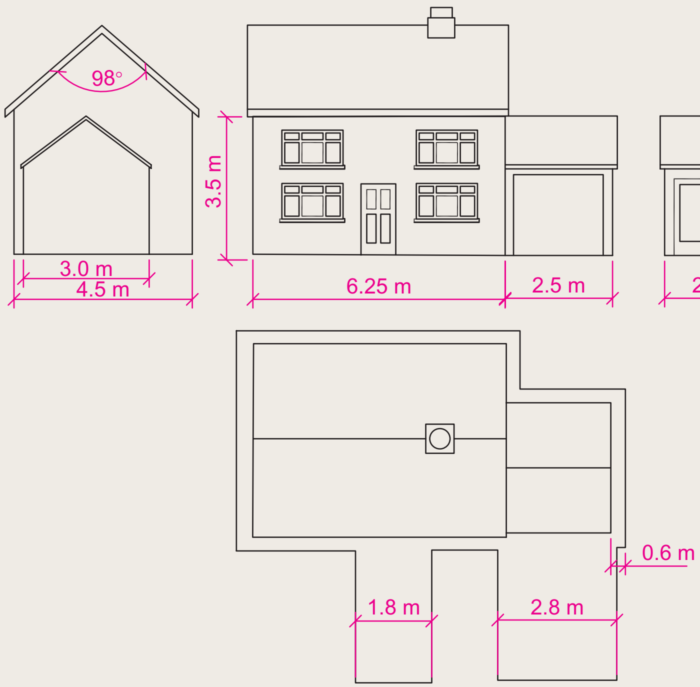

Fig. 16.32 Exercise 5 – orthographic views

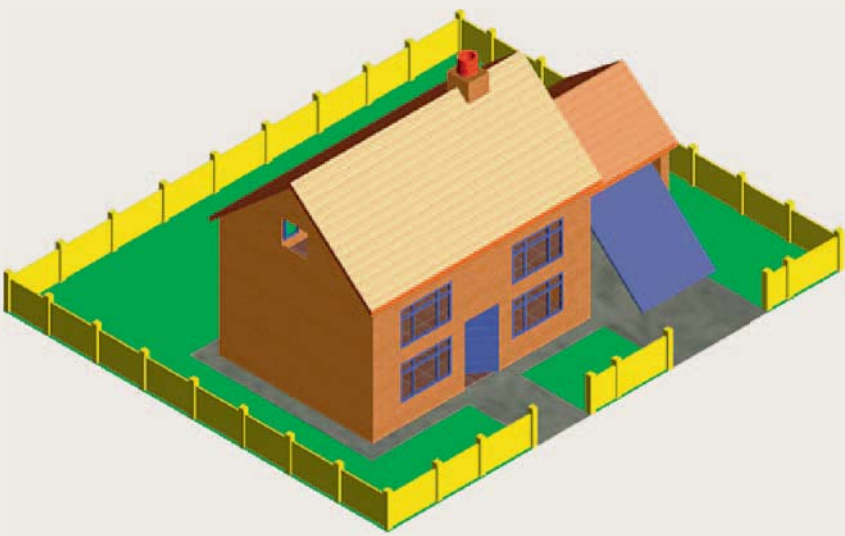

Fig. 16.33 Exercise 5 – the rendered model

6. Fig. 16.34 is a two-view orthographic projection of a small garage. Fig. 16.35 shows a rendering of a 3D model of the garage. Construct the 3D model of the garage working to a suitable scale.

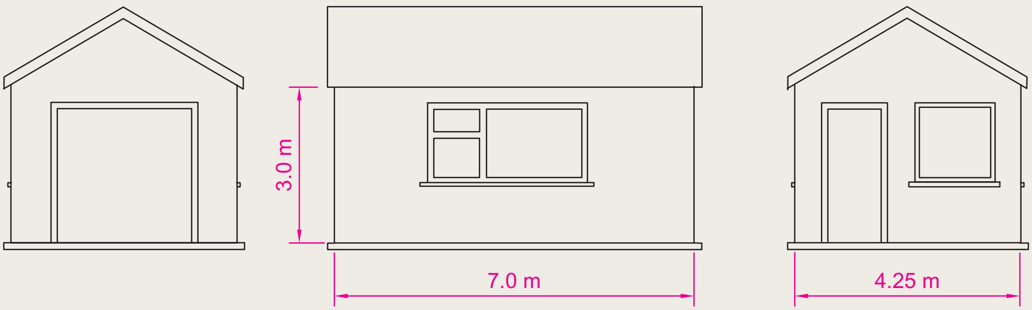

Fig. 16.34 Exercise 5 – orthographic views

Fig. 16.35 Exercise 5

Chapter 17

Three-dimensional space

AIMS OF THIS CHAPTER

The aim of this chapter is to show in examples the methods of manipulating 3D models in 3D space using the **UCS** tools from the **View/Coordinates** panel or from the command line.

3D space

So far in this book, when constructing 3D model drawings, they have been constructed on the AutoCAD 2010 coordinate system which is based upon three planes:

The **XY Plane –** the screen of the computer.
The **XZ Plane** at right angles to the **XY Plane** and as if coming towards the operator of the computer.
A third plane (**YZ**) is lying at right angles to both the other two planes (Fig. 17.1).

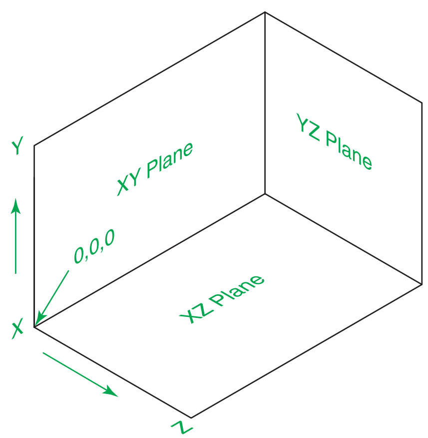

Fig. 17.1 The 3D space planes

In earlier chapters the **ViewCube** was described, which enables 3D objects which have been constructed on these three planes to be viewed from different viewing positions. Other methods of viewing a model in 3D space and placing the model in other viewing positions using the **Vpoint Presets** dialog and the **Orbit** tool have also been described.

The User Coordinate System (UCS)

Note

The **XY** plane is the basic **UCS** plane, which in terms of the **UCS** is known as the ***WORLD*** plane.

The **UCS** allows the operator to place the AutoCAD coordinate system in any position in 3D space using a variety of **UCS** tools (commands).

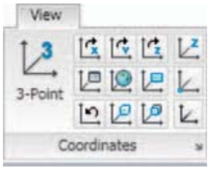

Fig. 17.2 The **View/Coordinates** panel

Features of the **UCS** can be called either by *entering* **ucs** at the command line, by selection of tools from the **View/Coordinates** panel (Fig. 17.2) or from the two **UCS** toolbars – **UCS** and **UCS II** (Fig. 17.3) called to screen from the **Tools/Toolbars** drop-down menu.

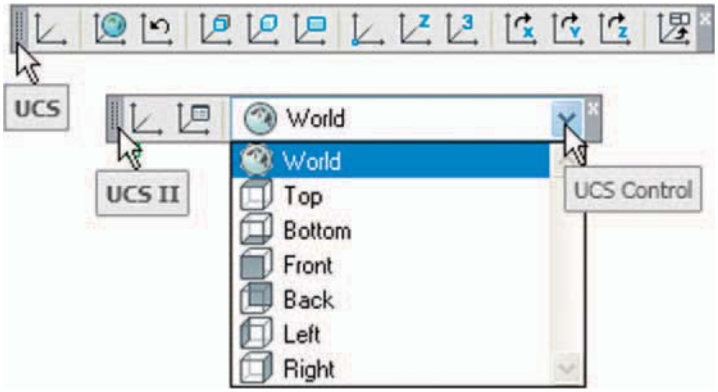

Fig. 17.3 The tools in the two **UCS** toolbars

If **ucs** is *entered* at the command line, it shows:

```
Command:enter ucs right-click
Current ucs name: *WORLD*
Specify origin of UCS or [Face/NAmed/OBject/
  Previous/View/World/X/Y/Z/ZAxis] <World>:
```

And from these prompts selections can be made.

The variable UCSFOLLOW

UCS planes can be set using any of the methods given above (Figs 17.2 and 17.3) or by *entering* **ucs** at the command line. No matter which method is used, the variable **UCSFOLLOW** must first be set on as follows:

```
Command:enter ucsfollow right-click
Enter new value for UCSFOLLOW <0>:enter
  1 right-click
Command:
```

The UCS icon

The **UCS** icon indicates the directions in which the three coordinate axes **X**, **Y** and **Z** lie in the AutoCAD drawing. When working in 2D, only the

X and **Y** axes are showing, but when the drawing area is in a 3D view all three coordinate arrows are showing, except when the model is in the **XY** plane. The icon can be turned off as follows:

```
Command:enter ucsicon right-click
Enter an option [ON/OFF/All/Noorigin/ORigin/
  Properties] <ON>:
```

To turn the icon off, *enter* **off** in response to the prompt line and the icon disappears from the screen.

The appearance of the icon can be changed by *entering* **p** (Properties) in response to the prompt line. The **UCS Icon** dialog appears in which changes can be made to the shape, line width and colour of the icon if wished.

Types of UCS icon

The shape of the icon can be varied partly when changes are made in the **UCS Icon** dialog but also according to whether the AutoCAD drawing area is in 2D, 3D or Paper Space (Fig. 17.4).

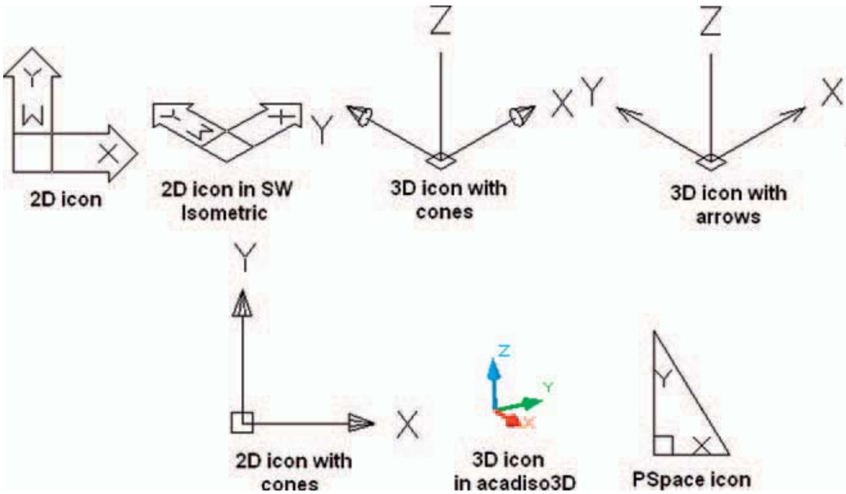

Fig. 17.4 Types of **UCS** icon

Examples of changing planes using the UCS

First example – changing UCS planes (Fig. 17.6)

1. Set **UCSFOLLOW** to **1** (ON).
2. Place the screen in **ViewCube/Front** and **Zoom** to **1**.
3. Construct the pline outline Fig. 17.5 and extrude to **120** high.
4. Place in **ViewCube/Isometric** view and **Zoom** to **1**.
5. With the **Fillet** tool, fillet corners to a radius of **20**.

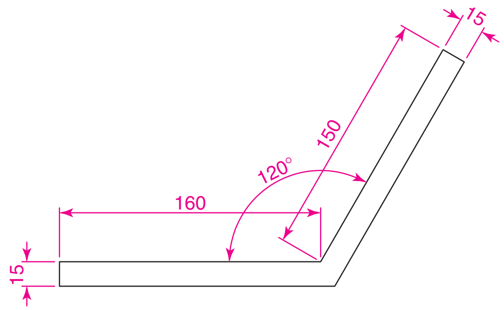

Fig. 17.5 First example – **changing UCS planes –** pline for extrusion

6. At the command line:

```
Command:enter ucs right-click
Current ucs name: *WORLD*
Specify origin of UCS or [Face/NAmed/OBject/
  Previous/View/World/X/Y/Z/ZAxis] <World>:
  enter f (Face) right-click
Select face of solid object:pick the sloping
  face - its outline highlights
Enter an option [Next/Xflip/Yflip] <accept>:
  right-click
Regenerating model.
Command:
```

And the 3D model changes its plane so that the sloping face is now on the new UCS plane. **Zoom** to **1**.

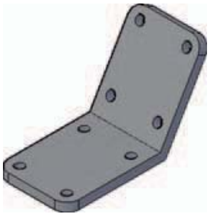

Fig. 17.6 First example – **changing UCS planes**

7. On this new UCS, construct four cylinders of radius 7.5 and height –15 (note the minus) and subtract them from the face.
8. *Enter* **ucs** at the command line again and *right-click* to place the model in the ***WORLD* UCS**.
9. Place four cylinders of the same radius and height into position in the base of the model and subtract them from the model.
10. Place the 3D model in a **ViewCube/Isometric** view and set in the **Home/View/Conceptual** visual style (Fig. 17.6).

Second example – UCS (Fig. 17.9)

The 3D model for this example is a steam venting valve – a two-view third angle projection of the valve is shown in Fig. 17.7.

1. Make sure that **UCSFOLLOW** is set to **1**.
2. Place in the **UCS *WORLD*** view. Construct the **120** square plate at the base of the central portion of the valve. Construct five cylinders for the holes in the plate. Subtract the five cylinders from the base plate.

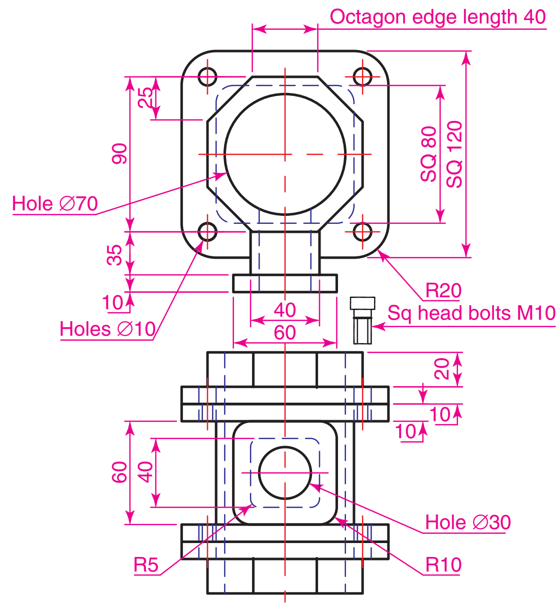

Fig. 17.7 Second example **UCS –** the orthographic projection of a steam venting valve

3. Construct the central part of the valve – a filleted **80** square extrusion with a central hole.
4. At the command line:

```
Command:enter ucs right-click
Current ucs name: WORLD*
Specify origin of UCS or [Face/NAmed/OBject/
  Previous/View/World/X/Y/Z/ZAxis] <World>:
  enter x right-click
Specify rotation angle about X axis <90>:
  right-click
Command:
```

and the model assumes a **Front** view.

5. With the **Move** tool, move the central portion vertically up by **10**.
6. With the **Copy** tool, copy the base up to the top of the central portion.
7. With the **Union** tool form a single 3D model of the three parts.
8. Make the layer **Construction** current.
9. Place the model in the **UCS *WORLD*** view. Construct the separate top part of the valve – a plate forming a union with a hexagonal plate and with holes matching those of the other parts.
10. Place the drawing in the **UCS X** view. Move the parts of the top into their correct positions relative to each other. With **Union** and **Subtract** complete the part. This will be made easier if the layer **0** is turned off.

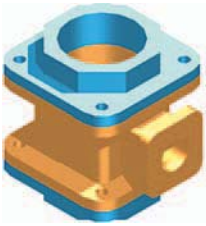

Fig. 17.8 Second example **UCS** – step **11** + rendering

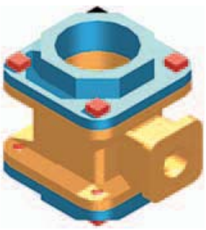

Fig. 17.9 Second example **UCS** – steps **12** and **13** + rendering

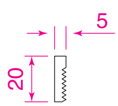

Fig. 17.10 Second example **UCS** – pline for the bolt

Fig. 17.11 Second example **UCS**

11. Turn layer **0** back on and move the top into its correct position relative to the main part of the valve. Then with the **Mirror** tool, mirror the top to produce the bottom of the assembly (Fig. 17.8).
12. While in the **UCS X** view construct the three parts of a 3D model of the extrusion to the main body.
13. In the **UCS *WORLD*** view, move the parts into their correct position relative to each other. **Union** the two filleted rectangular extrusions and the main body. **Subtract** the cylinder from the whole (Fig. 17.9).
14. In the **UCS X** view, construct one of the bolts as shown in Fig. 17.10, forming a solid of revolution from a pline. Then construct a head to the bolt and with **Union** add it to the screw.
15. With the **Copy** tool, copy the bolt 7 times to give 8 bolts. With **Move**, and working in the **UCS *WORLD*** and **X** views, move the bolts into their correct positions relative to the 3D model.
16. Add suitable lighting and attach materials to all parts of the assembly and render the model.
17. Place the model in the **ViewCube/Isometric** view.
18. Save the model to a suitable file name.
19. Finally move all the parts away from each other to form an exploded view of the assembly (Fig. 17.11).

Third example – UCS (Fig. 17.15)

1. Set **UCSFOLLOW** to **1**.
2. Place the drawing area in the **UCS X** view.
3. Construct the outline Fig 17.12 and extrude to a height of **120**.
4. *Click* the **3 Point** tool icon in the **View/Coordinates** panel (Fig. 17.13):

```
Command: _ucs
Current ucs name: *WORLD*
Specify origin of UCS or [Face/NAmed/OBject/
  Previous/View/World/X/Y/Z/ZAxis] <World>: _3
Specify new origin point <0,0,0>:pick point
  (Fig. 17.14)
Specify point on positive portion of X-axis:pick
  point (Fig. 17.14)
Specify point on positive-Y portion of the UCS XY
  plane <-142,200,0>:enter .xy right-click
of pick new origin point (Fig. 17.14) (need Z):
  enter 1 right-click
Regenerating model
Command:
```

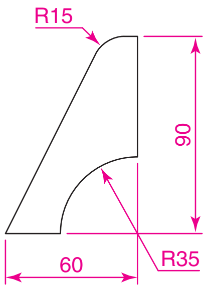

Fig. 17.12 Third example **UCS** – outline for 3D model

Fig. 17.14 shows the **UCS** points and the model regenerates in this new 3-point plane.

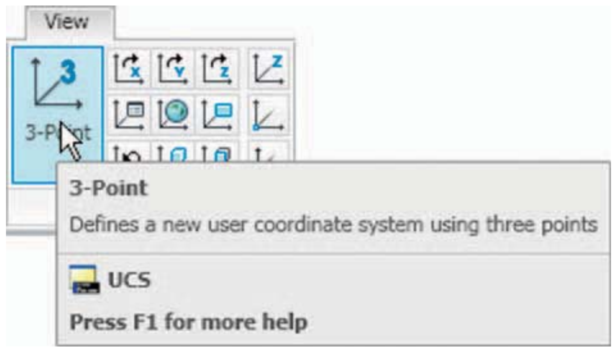

Fig. 17.13 The **UCS 3 Point** icon in the **View/Coordinates** panel

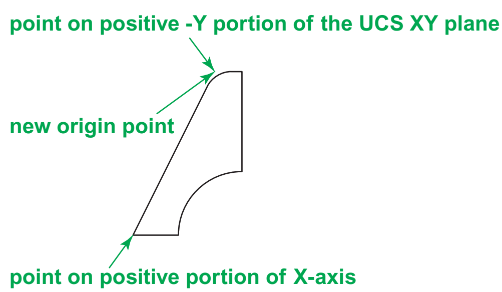

Fig. 17.14 Third example **UCS** – the three UCS points

Fig. 17.15 Third example **UCS**

5. On the face of the model construct a rectangle **80** × **50** central to the face of the front of the model, fillet its corners to a radius of **10** and extrude to a height of **10**.
6. Place the model in the **ViewCube/Isometric** view and fillet the back edges of the second extrusion to a radius of **10**.
7. Subtract the second extrusion from the first.
8. Add lights, and a suitable material and render the model (Fig. 17.15).

Fourth example – UCS (Fig. 17.17)

1. With the last example still on screen, place the model in the **UCS *WORLD*** view.
2. Call the **Rotate** tool from the **Home/Modify** panel and rotate the model through 225 degrees.

3. *Click* the **X** tool icon in the **View/Coordinates** panel (Fig. 17.16):

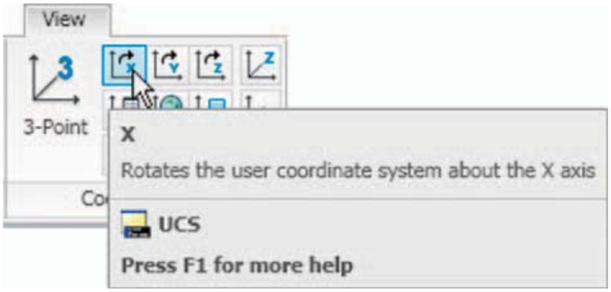

Fig. 17.16 The **UCS X** tool in the **View/Coordinates** panel

```
Command: _ucs
Current ucs name: *WORLD*
Specify origin of UCS or [Face/NAmed/OBject/
  Previous/View/World/X/Y/Z/ZAxis] <World>: _x
Specify rotation angle about X axis
  <90>: right-click
Regenerating model.
Command:
```

Fig. 17.17 Fourth example

4. Render the model in its new **UCS** plane (Fig. 17.17).

Saving UCS views

If a number of different **UCS** planes are used in connection with the construction of a 3D model, each view obtained can be saved to a different name and recalled when required. To save a **UCS** plane view in which a 3D model drawing is being constructed *enter* **ucs** at the command line:

```
Current ucs name: *NO NAME*
Specify origin of UCS or [Face/NAmed/OBject/
  Previous/View/World/X/Y/Z/ZAxis] <World>:
  enter s right-click
Enter name to save current UCS or [?]:enter New
  View right-click
Regenerating model
Command:
```

Click the **UCS, UCS Setting** arrow in the **View/Coordinates** panel and the **UCS** dialog appears. *Click* the **Named UCSs** tab of the dialog and the names of views saved in the drawing appear (Fig. 17.18).

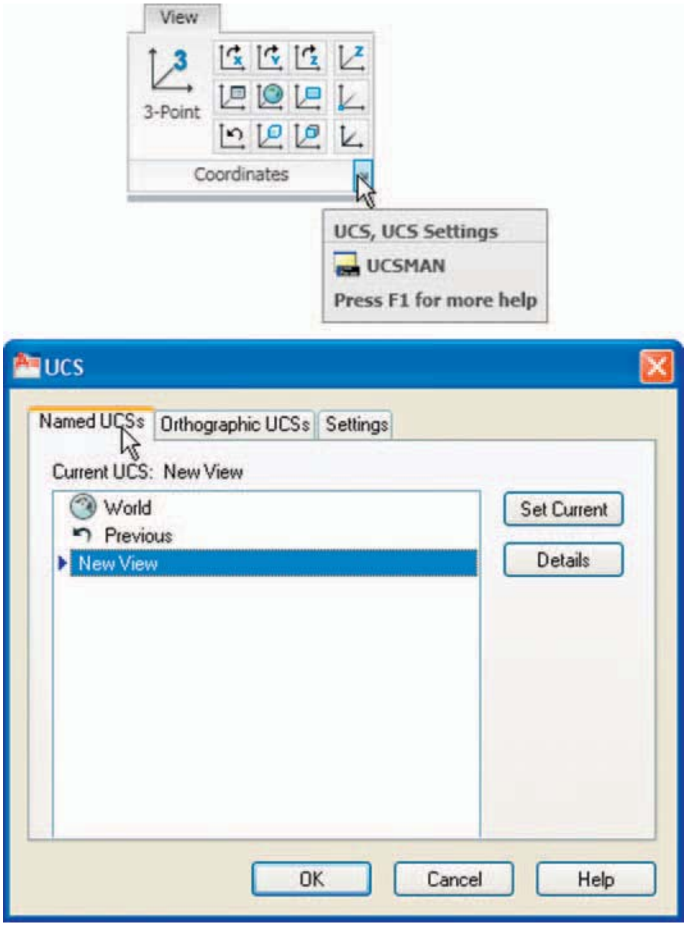

Fig. 17.18 The **UCS** dialog

Constructing 2D objects in 3D space

In previous chapters, there have been examples of 2D objects constructed with the **Polyline**, **Line**, **Circle** and other 2D tools to form the outlines for extrusions and solids of revolution. These outlines have been drawn on planes in the **ViewCube** settings.

First example – 2D outlines in 3D space (Fig. 17.21)

1. Construct a **3point UCS** to the following points:

```
Origin point: 80,90
X-axis point: 290,150
Positive-Y point: .xy of 80,90
(need Z):enter 1
```

2. On this **3point UCS** construct a 2D drawing of the plate to the dimensions given in Fig. 17.19, using the **Polyline**, **Ellipse** and **Circle** tools.
3. Save the **UCS** plane in the **UCS** dialog to the name **3point**.
4. Place the drawing area in the **ViewCube/Isometric** view (Fig. 17.20).
5. Make the layer **red** current
6. With the **Region** tool form regions of the 6 parts of the drawing and, with the **Subtract** tool, subtract the circles and ellipse from the main outline.
7. Place in the **Home/View/Realistic** visual style. Extrude the region to a height of **10** (Fig. 17.21).

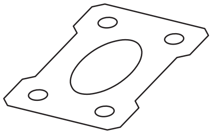

Fig. 17.20 First example – 2D outlines in 3D space – the outline in the **Isometric** view

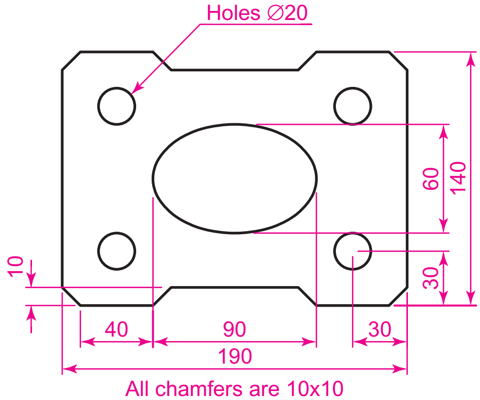

Fig. 17.19 First example – 2D outlines in 3D space

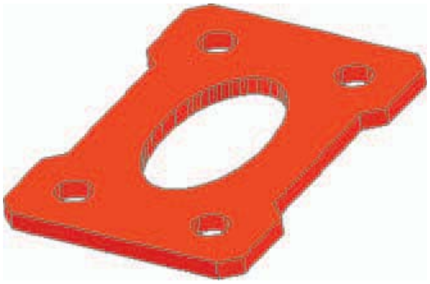

Fig. 17.21 First example – 2D outlines in 3D space

Second example – 2D outlines in 3D space (Fig. 17.25)

1. Place the drawing area in the **ViewCube/Front** view, **Zoom** to **1** and construct the outline shown in Fig. 17.22.
2. Extrude the outline to **150** high.
3. Place in the **ViewCube/Isometric** view and **Zoom** to **1**.

4. *Click* the **Face** tool icon in the **View/Coordinates** panel (Fig. 17.23) and place the 3D model in the **UCS** plane shown in Fig. 17.24, selecting the sloping face of the extrusion for the plane and again **Zoom** to **1**.
5. With the **Circle** tool draw five circles as shown in Fig. 17.24.
6. Form a region from the five circles and with **Union** form a union of the regions.
7. Extrude the region to a height of **–60** (note the minus) – higher than the width of the sloping part of the 3D model.
8. Place the model in the **ViewCube/Isometric** view and subtract the extruded region from the model.
9. With the **Fillet** tool, fillet the upper corners of the slope of the main extrusion to a radius of **30**.

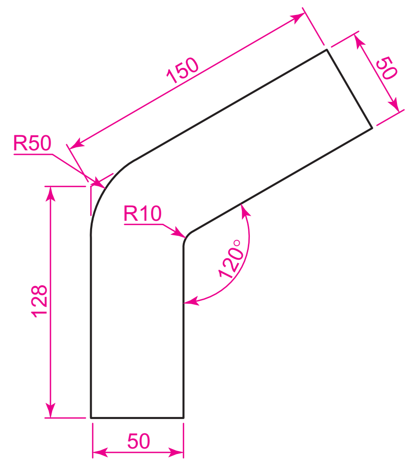

Fig. 17.22 Second example – **2D outlines in 3D space** – outline to be extruded

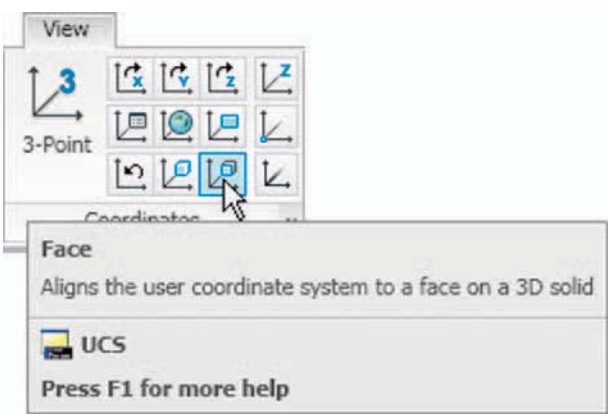

Fig. 17.23 The **Face** icon from the **View/Coordinates** panel

10. Place the model into another **UCS Face** plane and construct a filleted pline of sides **80** and **50** and filleted to a radius of **20**. Extrude to a height of **–60** and subtract the extrusion from the 3D model.
11. Place in the **ViewCube/Isometric** view, add lighting and a material.

The result is shown in Fig. 17.25.

Fig. 17.25 Second example – 2D outlines in 3D space

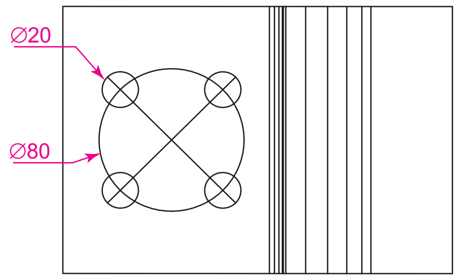

Fig. 17.24 Second example – 2D outlines in 3D space – the circles in the new **UCS** face

The Surfaces tools

The construction of 3D surfaces from lines, arc and plines has been dealt with – see pages 243 to 244 and 287 to 289. In this chapter examples of 3D surfaces constructed with the tools **Edgesurf**, **Rulesurf** and **Tabsurf** will be described. The tools can be called from the **Mesh Modeling/Primitives** panel. Fig. 17.26 shows the **Tabulated Surface** tool icon in the panel. The two icons to the right of that shown are the **Ruled Surface** and the **Edge Surface** tools. In this chapter these three surface tools will be called by *entering* their tool names at the command line.

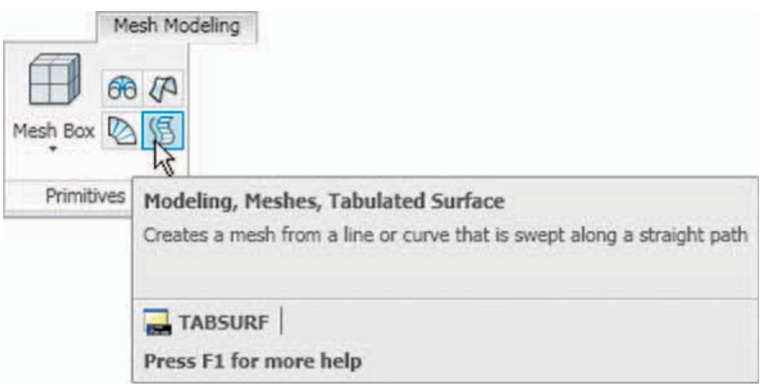

Fig. 17.26 The **Tabulated Surface** tool icon in the **Mesh Modeling/Primitives** panel

CHAPTER 17

Surface meshes

Surface meshes are controlled by the set variables **Surftab1** and **Surftab2**. These variables are set as follows:

```
At the command line:
Command:enter surftab1 right-click
Enter new value for SURFTAB1 <6>:enter 24
  right-click
Command:
```

The Edgesurf tool (Fig. 17.29)

1. Make a new layer colour **magenta**. Make that layer current.
2. Place the drawing area in the **View Cube/Right** view. **Zoom** to **All**.
3. Construct the polyline to the sizes and shape as shown in Fig. 17.27.
4. Place the drawing area in the **View Cube/Top** view. **Zoom** to **All**.
5. Copy the pline to the right by **250**.
6. Place the drawing in the **ViewCube/Isometric** view. **Zoom** to **All**.
7. With the **Line** tool, draw lines between the ends of the two plines using the **endpoint** osnap (Fig. 17.28). Note that if polylines are drawn they will not be accurate at this stage.
8. Set **SURFTAB1** to **32** and **SURFTAB2** to **64**.
9. At the command line:

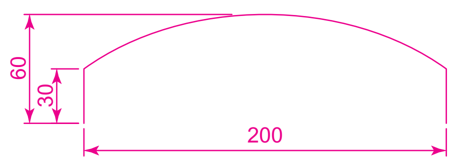

Fig. 17.27 Example – **Edgesurf –** pline outline

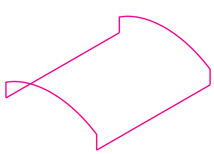

Fig. 17.28 Example – **Edgesurf** adding lines joining the plines

```
Command:enter edgesurf right-click
Current wire frame density: SURFTAB1=32
  SURFTAB2=64
Select object 1 for surface edge:pick one of the
  lines (or plines)
Select object 2 for surface edge:pick the next
  adjacent line (or pline)
Select object 3 for surface edge:pick the next
  adjacent line (or pline)
Select object 4 for surface edge:pick the last
  line (or pline)
Command:
```

The result is shown in Fig. 17.29.

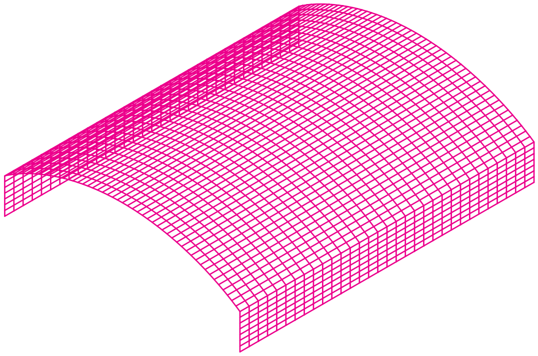

Fig. 17.29 Example – **Edgesurf**

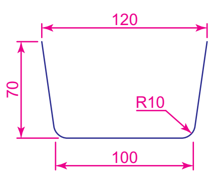

Fig. 17.30 **Rulesurf –** the outline

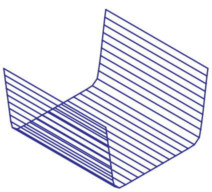

Fig. 17.31 Example – **Ruelsurf**

The Rulesurf tool (Fig. 17.29)

1. Make a new layer colour **blue** and make the layer current.
2. In the **ViewCube/Front** view construct the pline as shown in Fig. 17.30.
3. In the **3D Navigate/Top**, **Zoom** to **1** and copy the pline to a vertical distance of **120**.
4. Place in the **3D Navigate/Southwest Isometric** view and **Zoom** to **1**.
5. Set **SURFTAB1** to **32**.
6. At the command line:

```
Command:enter rulesurf right-click
Current wire frame density: SURFTAB1=32
Select first defining curve:pick one of the plines
Select second defining curve:pick the other pline
Command:
```

The result is given in Fig. 17.31

The Tabsurf tool (Fig. 17.32)

1. Make a new layer of colour **blue** and make the layer current.
2. Set **SURFTAB1** to **2**.
3. In the **ViewCube/Top** view construct a hexagon of edge length **35**.
4. In the **ViewCube/Front** view and in the centre of the hexagon construct a pline of height **100**.
5. Place the drawing in the **ViewCube/Isometric** view.
6. At the command line:

```
Command:enter tabsurf right-click
Current wire frame density: SURFTAB1=2
```

```
Select objects for path curve:pick the hexagon
Select object for direction vector:pick the pline
Command:
```

See Fig. 17.32.

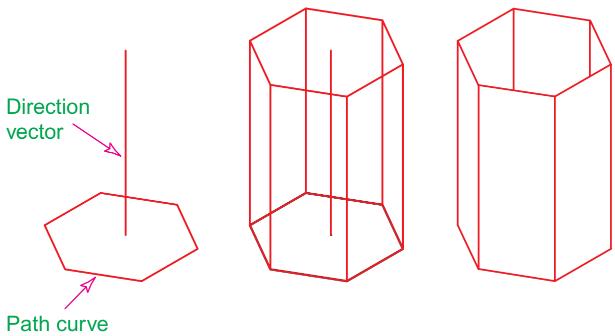

Fig. 17.32 Example – **Tabsurf**

REVISION NOTES

1. The **UCS** (User Coordinate System) tools can be called from the **View/Coordinates** panel, from the two toolbars **UCS** and **UCS II** or by *entering* **ucs** at the command line.
2. The variable **UCSFOLLOW** must first be set on (to **1**) before operations of the **UCS** can be brought into action.
3. There are several types of **UCS** icon – **2D** (different types), **3D** (different types), **Pspace**.
4. The position of the plane in 3D space on which a drawing is being constructed can be varied using tools from the **UCS** panel.
5. The planes on which drawings constructed on different planes in 3D space can be saved in the **UCS** dialog.
6. The tools **Edgesurf**, **Rulesurf** and **Tabsurf** can be used to construct surfaces in addition to surfaces which can be constructed from plines and lines using the **Extrude** tool.

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/ 978-1-85617-868-6

1. Fig. 17 33 is a rendering of a two-view projection of an angle bracket in which two pins are placed in holes in each of the arms of the bracket. Fig. 17 34 is a two-view projection of the bracket.

Construct a 3D model of the bracket and its pins.

Add lighting to the scene and materials to the parts of the model and render.

2. The two-view projection (Fig. 17.35) shows a stand consisting of two hexagonal prisms. Circular holes have been cut right through each face of the smaller hexagonal prism and rectangular holes with rounded ends have been cut right through the faces of the larger.

Construct a 3D model of the stand. When completed add suitable lighting to the scene. Then add a material to the model and render (Fig. 17 36).

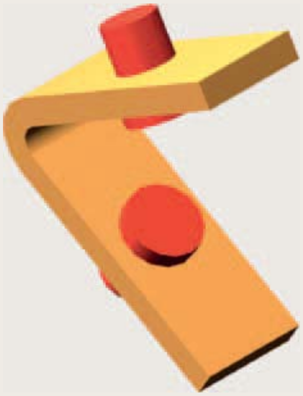

Fig. 17.33 Exercise 1 – a rendering

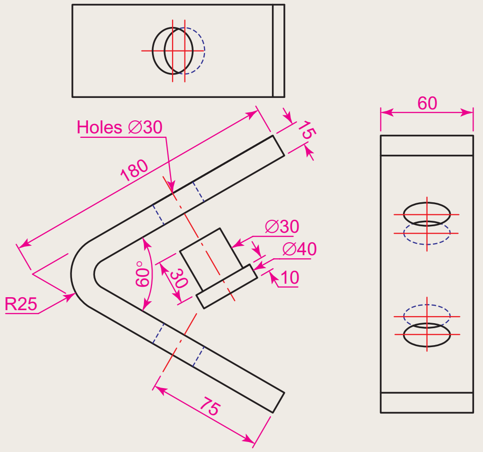

Fig. 17.34 Exercise 1 – details of shape and sizes

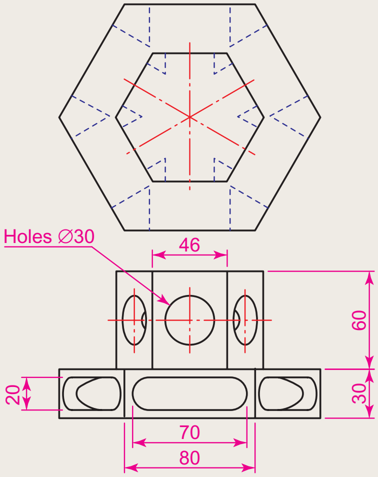

Fig. 17.35 Exercise 2 – details of shapes and sizes

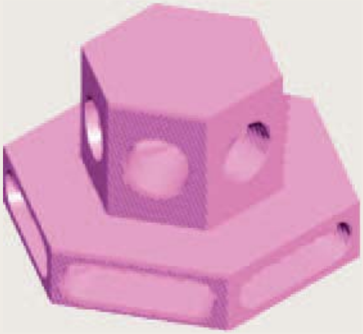

Fig. 17.36 Exercise 2 – a rendering

3. The two-view projection Fig. 17.37 shows a ducting pipe. Construct a 3D model drawing of the pipe. Place in a **SW Isometric** view, add lighting to the scene and a material to the model and render.

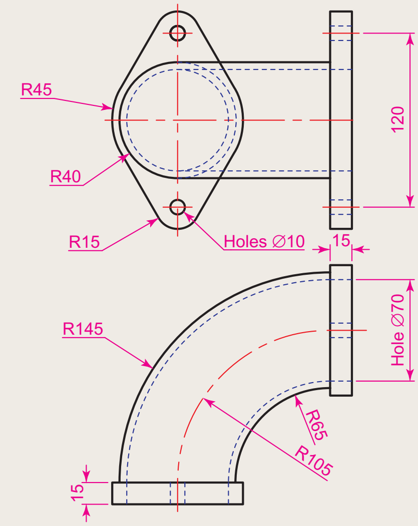

Fig. 17.37 Exercise 3 – details of shape and sizes

4. A point marking device is shown in two two-view projections in Fig. 17.38. The device is composed of three parts – a base, an arm and a pin. Construct a 3D model of the assembled device and add appropriate materials to each part. Then add lighting to the scene and render in a **SW Isometric** view (Fig. 17.39).

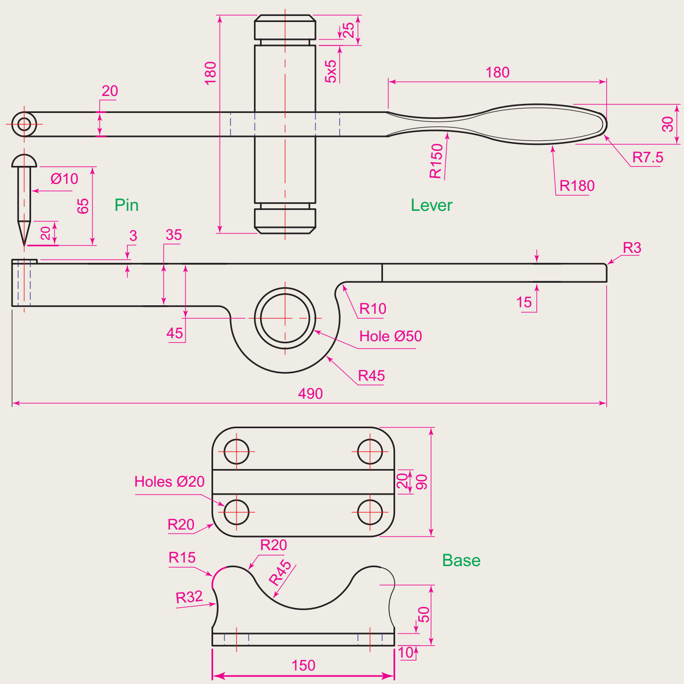

Fig. 17.38 Exercise 4 – details of shapes and sizes

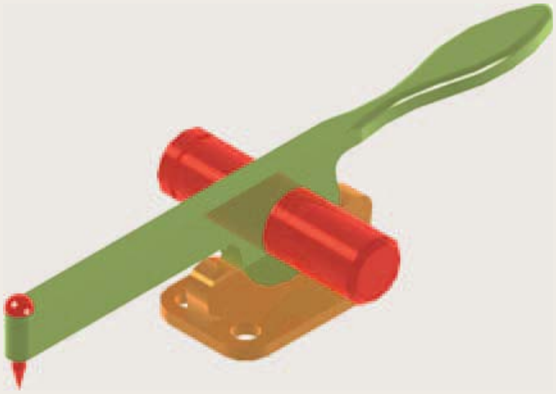

Fig. 17.39 Exercise 4 – a rendering

5. A rendering of a 3D model drawing of the connecting device shown in the orthographic projection Fig. 17.41 is given in Fig. 17.40. Construct the 3D model drawing of the device and add suitable lighting to the scene.

   Then place in the **ViewCube/Isometric** view, add a material to the model and render.

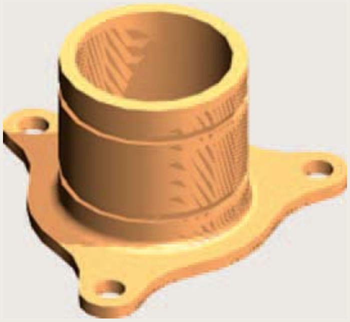

Fig. 17.40 Exercise 5 – a rendering

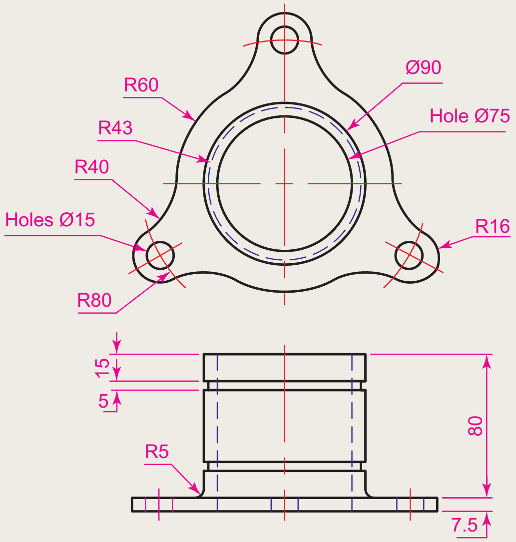

Fig. 17.41 Exercise 5 – two-view drawing

6. A fork connector and its rod are shown in a two-view projection in Fig. 17.42. Construct a 3D model drawing of the connector with its rod in position. Then add lighting to the scene, place in the **ViewCube/Isometric** viewing position, add materials to the model and render.

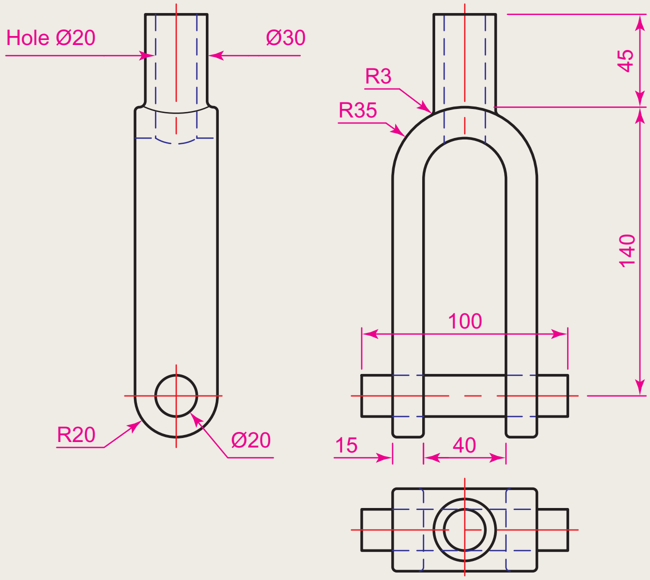

Fig. 17.42 Exercise 6

7. An orthographic projection of the parts of a lathe steady is given in Fig. 17.43. From the dimensions shown in the drawing, construct an assembled 3D model of the lathe steady.

When the 3D model has been completed, add suitable lighting and materials and render the model Fig. 17.44.

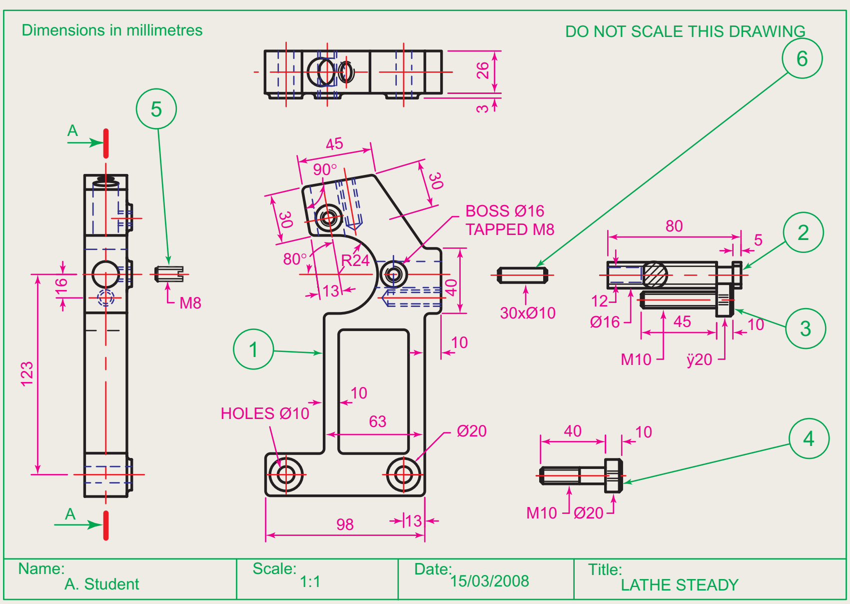

Fig. 17.43 Exercise 7 – details

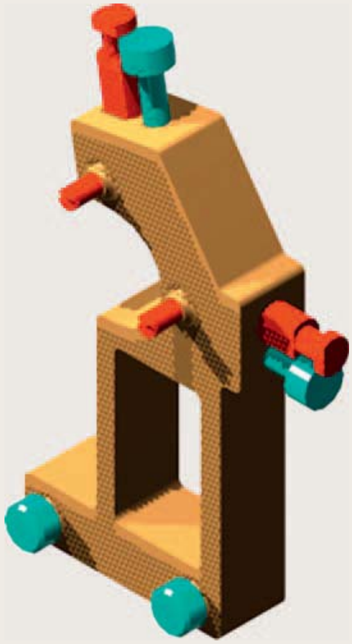

Fig. 17.44 Exercise 7 – a rendering

8. Construct suitable polylines to sizes of your own discretion in order to form the two surfaces to form the box shape shown in Fig. 17.45 with the aid of the **Rulesurf** tool. Add lighting and a material and render the surfaces formed. Construct another three **Edgesurf** surfaces to form a lid for the box. Place the surface in a position above the box, add a material and render (Fig. 17.46).

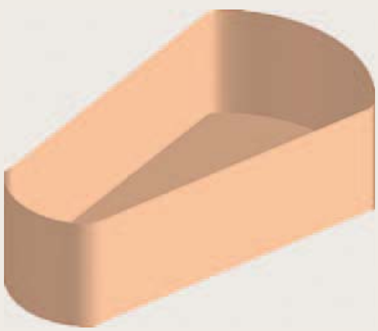

Fig. 17.45 Exercise 8 – the box

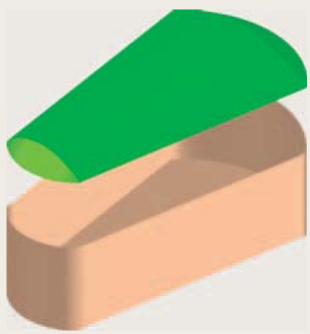

Fig. 17.46 The box and its lid

9. Fig. 17.47 shows a polyline for each of the 4 objects from which the surface shown in Fig. 17.48 was obtained. Construct the surface and shade in **Realistic** shading.

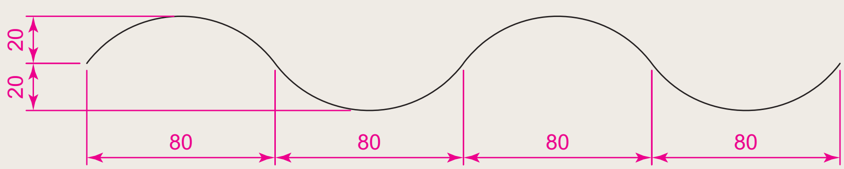

Fig. 17.47 Exercise 9 – one of the polylines from which the surface was obtained

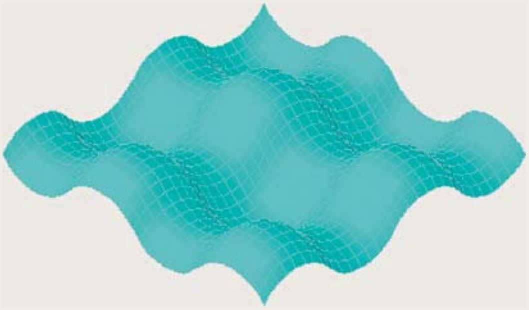

Fig. 17.48 Exercise 9

10. The surface model for this exercise was constructed from 3 **Edgesurf** surfaces working to the suggested outlines for the surface as shown in Fig. 17.51. The sizes of the outlines of the objects in each case are left to your discretion. Fig. 17.49 shows the completed surface model. Fig. 17.50 shows the three surfaces of the model separated from each other.

Fig. 17.49 Exercise 10

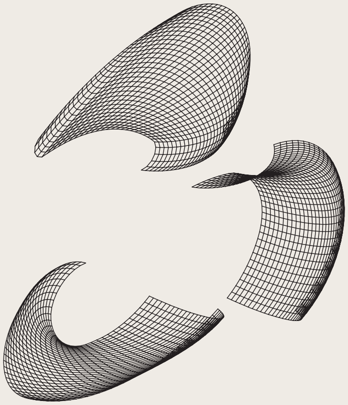

Fig. 17.50 The three surfaces

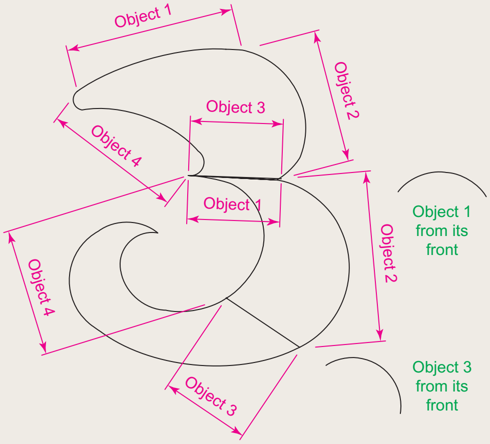

Fig. 17.51 Outlines for the three surfaces

11. Fig. 17 52 shows in a **View Block/Isometric** view a semicircle of radius **25** constructed in the **View Cube/Top** view on a layer of colour **magenta** with a semicircle of radius **75** constructed on the **View Block/Front** view with its left-hand end centred on the semicircle. Fig. 17.53 shows a surface constructed from the two semicircles in a **Visual Styles/Realistic** mode.

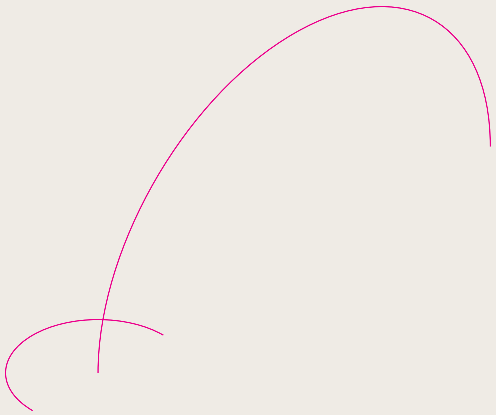

Fig. 17.52 Exercise 11 – the circle and semicircle

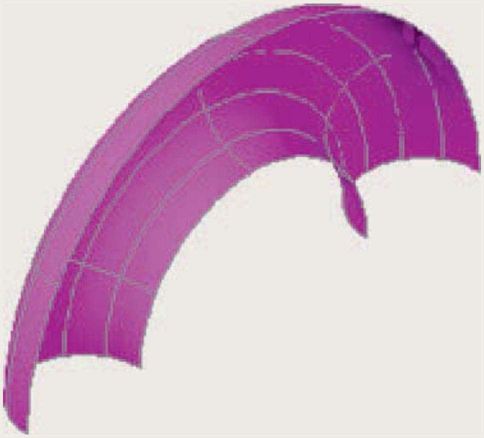

Fig. 17.53 Exercise 11

Chapter 18

Editing 3D solid models

AIMS OF THIS CHAPTER

The aims of this chapter are:

1. To introduce the use of tools from the **Solid Editing** panel.
2. To show examples of a variety of 3D solid models.

The Solid Editing Tools

Fig. 18.1 The **Solid Editing** panel

The **Solid Editing** tools can be selected from the **Home/Solid Editing** panel (Fig. 18.1) or from the **Solid Editing** toolbar, called to screen from the **Tools/Toolbars/AutoCAD** drop-down menu (Fig. 18.2).

Fig. 18.2 The **Solid Editing** toolbar

Examples of the results of using some of the **Solid Editing** tools are shown in this chapter. These tools are of value if the design of a 3D solid model requires to be changed (edited), although some have a value in constructing parts of 3D solids which cannot easily be constructed using other tools.

First example – Extrude Faces tool (Fig. 18.3)

1. Set **ISOLINES** to **24**.
2. In the **ViewCube/Right** construct a cylinder of radius **30** and height **30** (Fig. 18.3).
3. In the **ViewCube/Front** construct the pline Fig. 18.3. Mirror the pline to the other end of the cylinder.

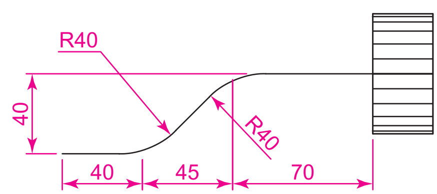

Fig. 18.3 First example – **Extrude Faces** tool **–** first stages

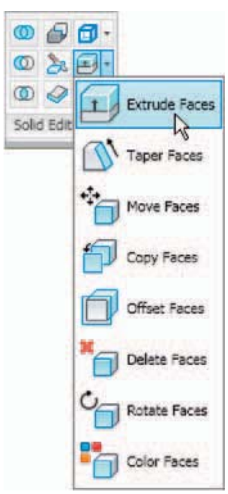

Fig. 18.4 The **Extrude Faces** tool from the **Home/Solid Editing** panel

4. In the **ViewCube/Top** move the pline to lie central to the cylinder.
5. Place the screen in the **ViewCube/Isometric**.
6. *Click* the **Extrude Faces** tool icon in the **Home/Solid Editing** panel (Fig. 18.4). The command line shows:

```
Command:_solidedit
Solids editing automatic checking: SOLIDCHECK=1
Enter a solids editing option [Face/Edge/Body/
  Undo/eXit] <eXit>: _face
Enter a face editing option
[Extrude/Move/Rotate/Offset/Taper/Delete/Copy/
  coLor/mAterial/Undo/eXit] <eXit>: _extrude
```

Fig. 18.5 First example – **Extrude Faces** tool

```
Select faces or [Undo/Remove]:pick the cylinder 2
  faces found.
Select faces or [Undo/Remove/ALL]:enter
  r right-click
Remove faces or [Undo/Add/ALL]:right-click
Specify height of extrusion or [Path]:enter p
  (Path) right-click
Select extrusion path:pick the left-hand path pline
Solid validation started.
Solid validation completed.
Enter a face editing option
[Extrude/Move/Rotate/Offset/Taper/Delete/Copy/
  coLor/mAterial/Undo/eXit] <eXit>:right-click
Command:
```

7. Repeat the operation using the pline at the other end of the cylinder as a path.
8. Add lights and a material and render the 3D model (Fig. 18.5).

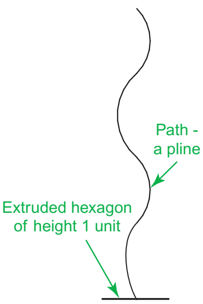

Fig. 18.6 Second example – **Extrude Faces tool –** pline for path

Note

Note the prompt line which includes the statement **SOLIDCHECK = 1**. If the variable **SOLIDCHECK** is set on (to **1**) the prompt lines include the lines **SOLIDCHECK = 1**, **Solid validation started** and **Solid validation completed**. If set to **0** these two lines do not show.

Second example – Extrude Faces tool (Fig. 18.7)

1. Construct a hexagonal extrusion just **1** unit high in the **ViewCube/Top**.
2. Change to the **ViewCube/Front** and construct the curved pline in Fig. 18.6.
3. Back in the **ViewCube/Top** view, move the pline to lie central to the extrusion.
4. Place in the **ViewCube/Isometric** and extrude the top face of the extrusion along the path of the curved pline.
5. Add lighting and a material to the model and render (Fig. 18.7).

Fig. 18.7 Second example – **Extrude Faces** tool

Note

This example shows that a face of a 3D solid model can be extruded along any suitable path curve. If the polygon on which the extrusion had been based had been turned into a region, no extrusion could have taken place. The polygon had to be extruded to give a face to a 3D solid.

Third example – Move Faces tool (Fig. 18.8)

1. Construct the 3D solid drawing shown in the left-hand drawing of Fig. 18.8 from three boxes which have been united using the **Union** tool.
2. *Click* on the **Move Faces** tool in the **Home/Solid Editing** panel (see Fig. 18.4, page 366). The command line shows:

```
Command:_solidedit
[prompts]_face
Enter a face editing option
[prompts]:_move
Select faces or [Undo/Remove]:pick the model face
  4 face found.
Select faces or [Undo/Remove/ALL]:right-click
Specify a base point or displacement:pick
Specify a second point of displacement:pick
[further prompts]:
```

And the *picked* face is moved – right-hand drawing of Fig. 18.8.

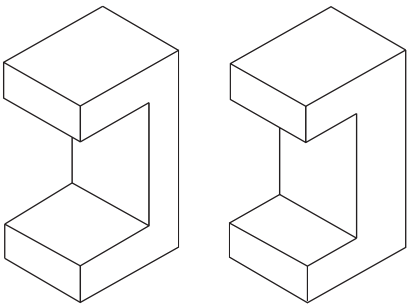

Fig. 18.8 Third example – **Solid, Move Faces** tool

Fourth example – Offset Faces (Fig. 18.9)

1. Construct the 3D solid drawing shown in the left-hand drawing of Fig. 18.9 from a hexagonal extrusion and a cylinder which have been united using the **Union** tool.
2. *Click* on the **Offset Faces** tool icon in the **Home/Solid Editing** toolbar (see Fig. 18.4, page 366). The command line shows:

```
Command:_solidedit
[prompts]:_face
[prompts]
[prompts]:_offset
Select faces or [Undo/Remove]:pick the bottom face
  of the 3D model 2 faces found.
```

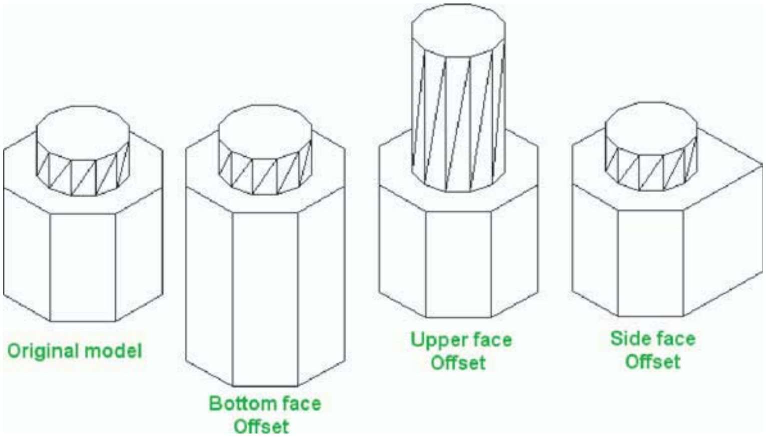

Fig. 18.9 Fourth example – **Offset Faces** tool

```
Select faces or [Undo/Remove/All]:enter
  r right-click
Select faces or [Undo/Remove/All]:pick highlighted
  faces other than the bottom face 2 faces found,
  1 removed
Select faces or [Undo/Remove/All]:right-click
Specify the offset distance:enter 30 right-click
```

3. Repeat, offsetting the upper face of the cylinder by **50** and the right-hand face of the lower extrusion by **15**.

The results are shown in Fig. 18.9.

Fifth example – Taper Faces tool (Fig. 18.10)

1. Construct the 3D model as in the left-hand drawing of Fig. 18.10. Place in **ViewCube/Isometric**.
2. Call **Taper Faces**. The command line shows:

```
Command:_solidedit
[prompts]:_face
```

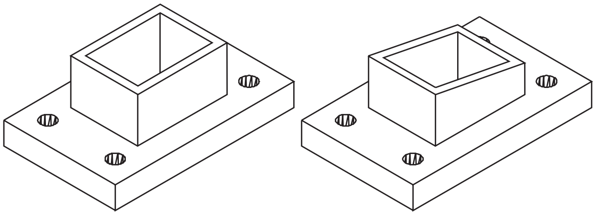

Fig. 18.10 Fifth example – **Taper Faces** tool

```
[prompts]
[prompts]:_taper
Select faces or [Undo/Remove]:pick the upper face
  of the base 2 faces found.
Select faces or [Undo/Remove/All]:enter r right-click
Select faces or [Undo/Remove/All]:pick highlighted
  faces other than the upper face 2 faces found,
  1 removed
Select faces or [Undo/Remove/All]:right-click
Specify the base point:pick a point on left-hand
  edge of the face
Specify another point along the axis of
  tapering:pick a point on the right-hand edge of
  the face
Specify the taper angle:enter 10 right-click
```

And the selected face tapers as indicated in the right-hand drawing (Fig. 18.10).

Sixth example – Copy Faces tool (Fig. 18.12)

1. Construct a 3D model to the sizes as given in Fig. 18.11.

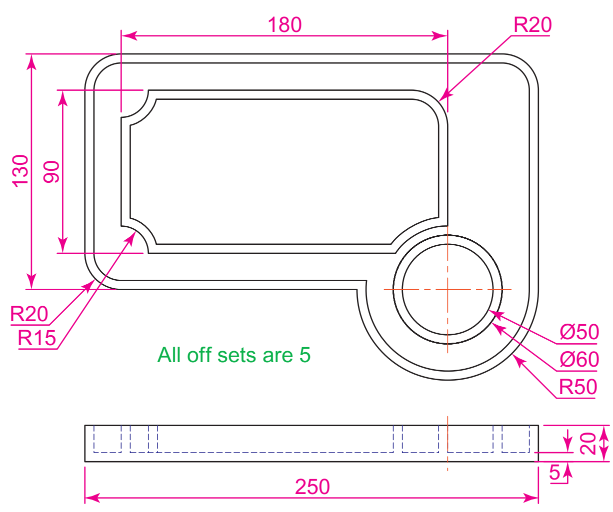

Fig. 18.11 Sixth example – **Copy Faces** tool – details of the 3D solid model

2. *Click* on the **Copy Faces** tool in the **Home/Solid Editing** toolbar (see Fig. 18.4, page 366). The command line shows:

```
Command:_solidedit
[prompts]:_face
```

Fig. 18.12 Sixth example – **Copy Faces** tool

```
[prompts]
[prompts]:_copy
Select faces or [Undo/Remove]:pick the upper face
  of the solid model 2 faces found.
Select faces or [Undo/Remove/All]:enter r
  right-click
Select faces or [Undo/Remove/All]:pick highlighted
  face not to be copied 2 faces found, 1 removed
Select faces or [Undo/Remove/All]:right-click
Specify a base point or displacement:pick anywhere
  on the highlighted face
Specify a second point of displacement:pick a
  point some 50 units above the face
```

3. Add lights and a material to the 3D model and its copied face and render (Fig. 18.12).

Seventh example – Color Faces tool (Fig. 18.14)

1. Construct a 3D model of the wheel to the sizes as shown in Fig. 18.13.
2. *Click* the **Color Faces** tool icon in the **Home/Solid Editing** toolbar (see Fig. 18.4, page 366). The command line shows:

```
Command:_solidedit
[prompts]:_face
```

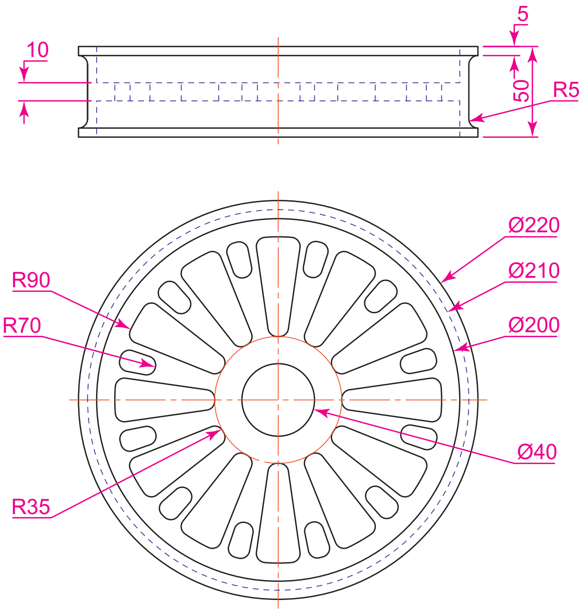

Fig. 18.13 Seventh example – **Color Faces** tool – details of the 3D model

```
[prompts]
[prompts]:_color
Select faces or [Undo/Remove]:pick the inner face
  of the wheel 2 faces found
Select faces or [Undo/Remove/All]:enter r
  right-click
Select faces or [Undo/Remove/All]:pick highlighted
  faces other than the required face 2 faces
  found, 1 removed
Enter new color <ByLayer>:enter 1 (which is
  red) right-click
```

3. Add lights and a material to the edited 3D model and render (Fig. 18.14).

Fig. 18.14 Seventh example – **Color Faces** tool

Examples of more 3D models

These 3D models can be constructed in the **acadiso3D.dwt** screen. The descriptions of the stages needed to construct these 3D models have been reduced from those given in earlier pages, in the hope that readers have already acquired a reasonable skill in the construction of such drawings.

First example (Fig. 18.16)

1. **Front** view. Construct the three extrusions for the back panel and the two extruding panels to the details given in Fig. 18.15.
2. **Top** view. Move the two panels to the front of the body and union the three extrusions. Construct the extrusions for the projecting parts holding the pin.

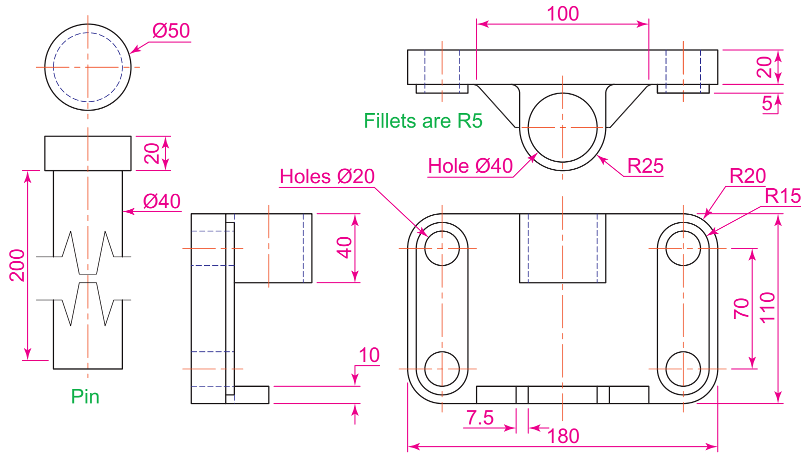

Fig. 18.15 First example – **3D models –** details of sizes and shapes

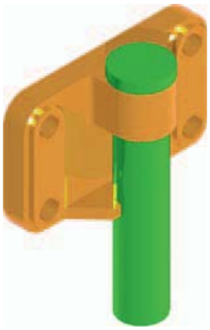

Fig. 18.16 First example – **3D models**

3. **Front** view. Move the two extrusions into position and union them to the back.
4. **Top** view. Construct two cylinders for the pin and its head.
5. **Top** view. Move the head to the pin and union the two cylinders.
6. **Front** view. Move the pin into its position in the holder. Add lights and materials.
7. **Isometric** view. Render. Adjust lighting and materials as necessary (Fig. 18.16).

Second example (Fig. 18.18)

1. **Top**. Construct polyline outlines for the body extrusion and the solids of revolution for the two end parts using the dimensions in Fig. 18.17. Extrude the body and subtract its hole and using the **Revolve** tool form the two end solids of revolution.

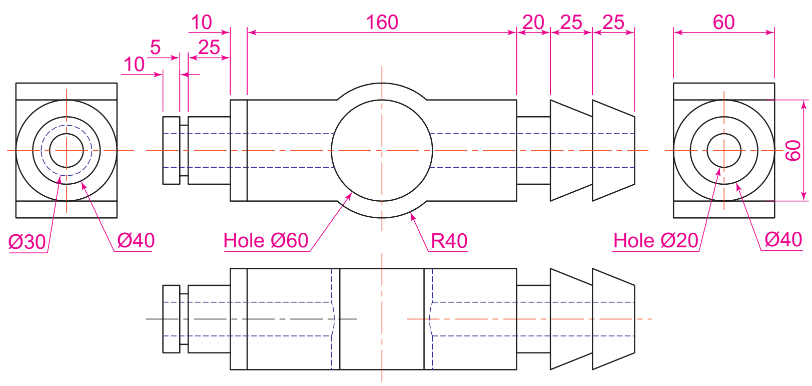

Fig. 18.17 Second example – **3D models –** dimensions

2. **Right**. Move the two solids of revolution into their correct positions relative to the body and union the three parts. Construct a cylinder for the hole through the model.
3. **Front**. Move the cylinder to its correct position and subtract from the model.
4. **Top**. Add lighting and a material.
5. **Isometric**. Render (Fig. 18.18).

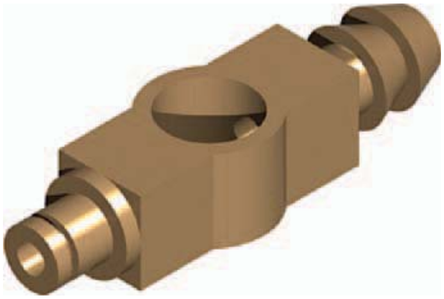

Fig. 18.18 Second example – **3D models**

Third example (Fig. 18.20)

1. **Front**. Construct the three plines needed for the extrusions of each part of the model (details Fig. 18.19). Extrude to the given heights. Subtract the hole from the **20** high extrusion.
2. **Top**. Move the **60** extrusion and the **10** extrusion into their correct positions relative to the **20** extrusion. With **Union** form a single 3D model from the three extrusions.
3. Add suitable lighting and a material to the model.
4. **Isometric**. Render (Fig. 18.20).

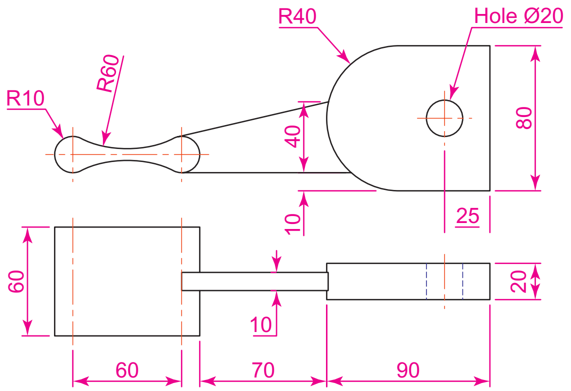

Fig. 18.19 Third example – **3D models –** details of shapes and sizes

Fig. 18.20 Third example – **3D models**

Fourth example (Fig. 18.21)

1. **Front**. Construct the polyline – left-hand drawing in Fig. 18.21.
2. With the **Revolve** tool from the **Home/3D Modeling** panel construct a solid of revolution from the pline.
3. **Top**. Add suitable lighting for a coloured glass material.
4. **Isometric**. Render – right-hand illustration Fig. 18.21.

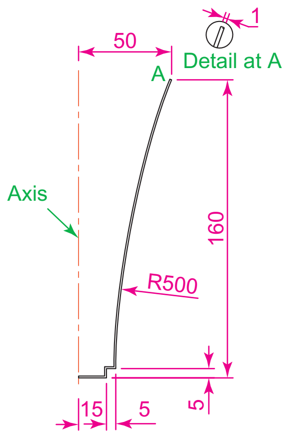

Fig. 18.21 Fourth example – **3D models**

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/ 978-1-85617-868-6

1. Working to the shapes and dimensions as given in the orthographic projection Fig. 18.22, construct the exploded 3D model as shown in Fig. 18.23. When the model has been constructed add suitable lighting and apply materials, followed by rendering.

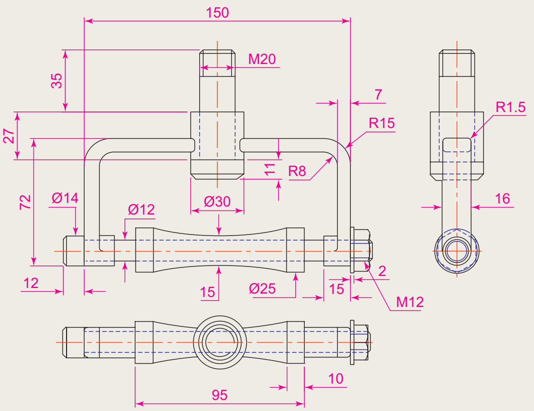

Fig. 18.22 Exercise 1-orthographic projection

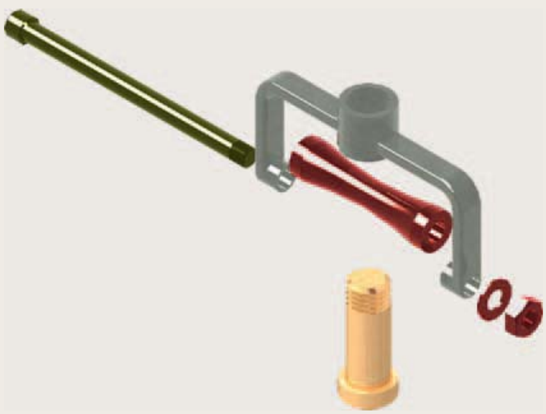

Fig. 18.23 Exercise 1 – rendered 3D model

2. Working to the dimensions given in the orthographic projections of the three parts of this 3D model (Fig. 18.24), construct the assembly as shown in the rendered 3D model Fig. 18.25.

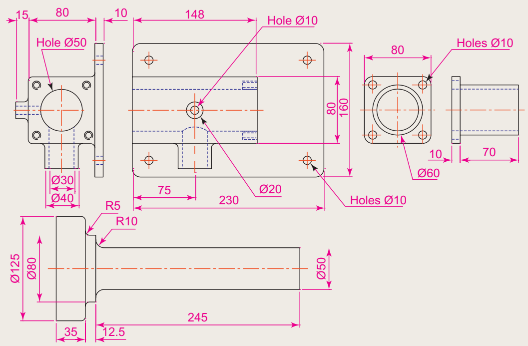

Fig. 18.24 Exercise 2 – details of shapes and sizes

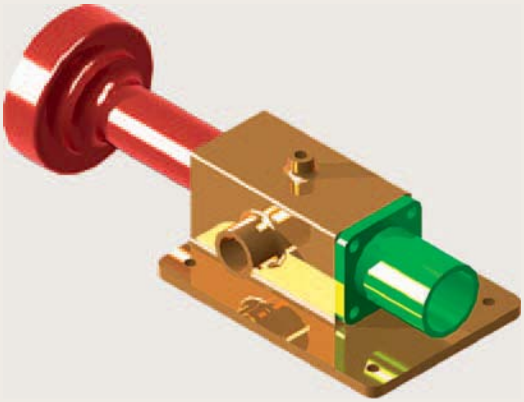

Fig. 18.25 Exercise 2

Add suitable lighting and materials, place in one of the isometric viewing positions and render the model.

3. Construct the 3D model shown in the rendering Fig. 18.26 from the details given in the parts drawing Fig. 18.27.

Fig. 18.26 Exercise 3

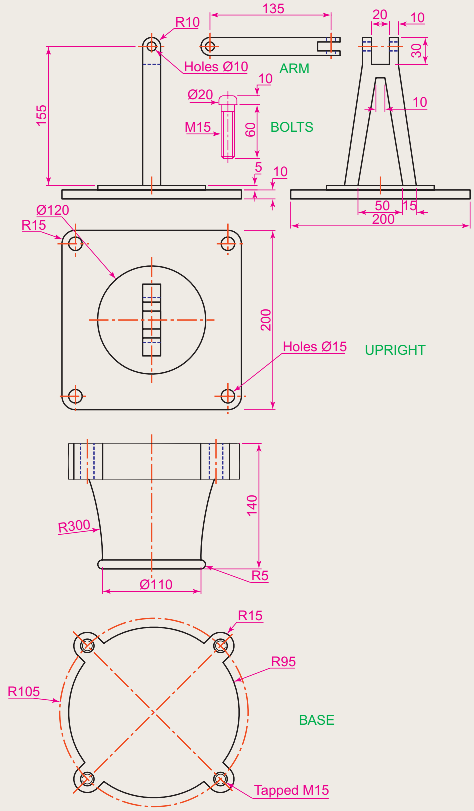

Fig. 18.27 Exercise 3 – the parts drawing

4. A more difficult exercise.
A rendered 3D model of the parts of an assembly are shown in Fig. 18.28.
Working to the details given in the three orthographic projections Figures 18.28, 18.29 and 18.30, construct the two parts of the 3D model, place them in suitable positions relative to each other, add lighting and materials and render the model (Fig. 18.31).

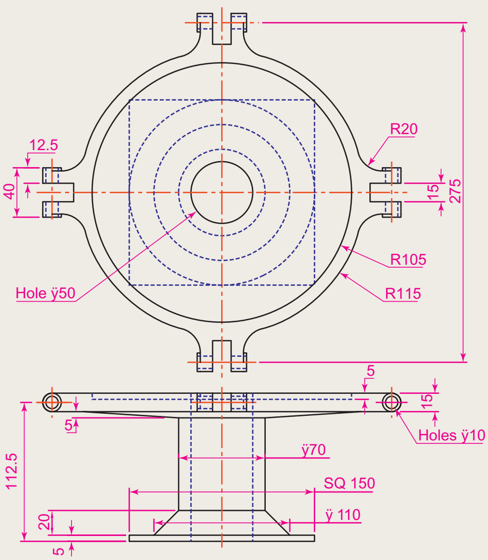

Fig. 18.28 Exercise 4 – first orthographic projection

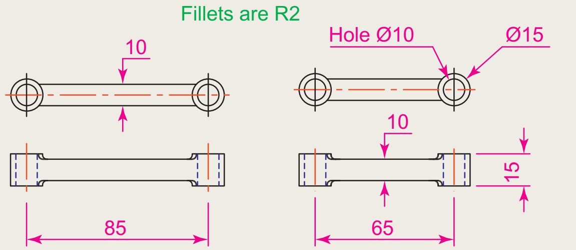

Fig. 18.29 Exercise 4 – second orthographic projection

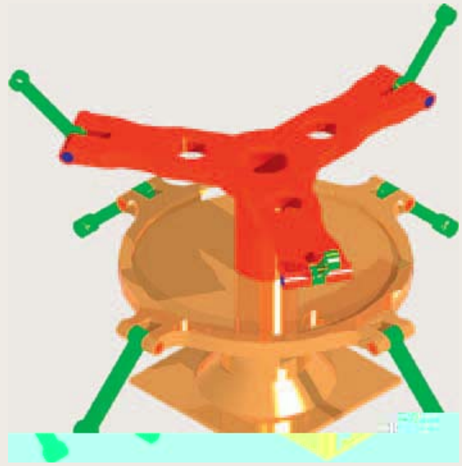

Fig. 18.31 Exercise 4

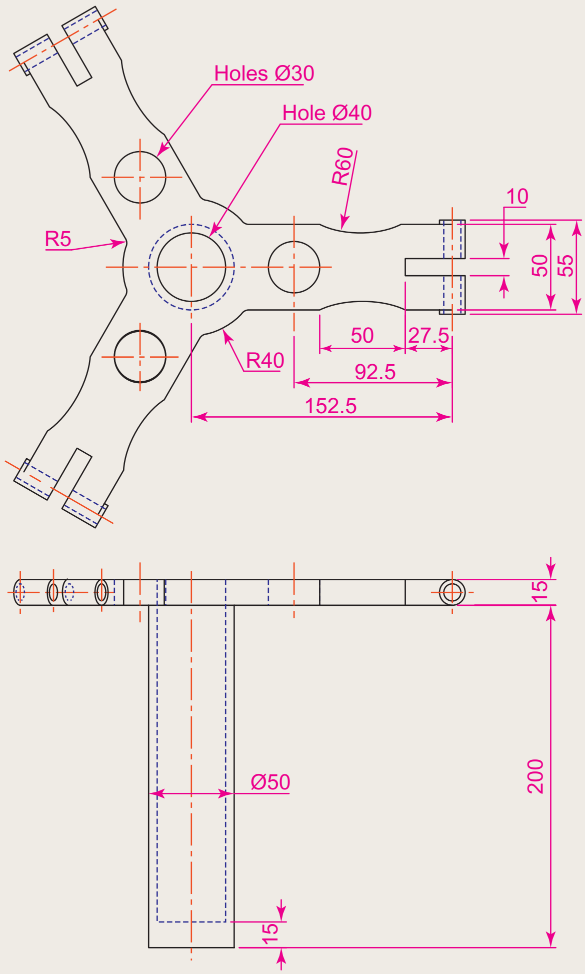

Fig. 18.30 Exercise 4 – third orthographic projections

Chapter 19

Other features of 3D modelling

AIMS OF THIS CHAPTER

The aims of this chapter are:

1. To give a further example of placing raster images in an AutoCAD drawing.
2. To give examples of methods of printing or plotting not given in previous chapters.
3. To give examples of polygonal viewports.

Raster Images in AutoCAD drawings

Example – Raster image in a drawing (Fig. 19.5)

This example shows the raster file **Fig05.bmp** of the 3D model constructed to the details given in the drawing Fig. 19.1.

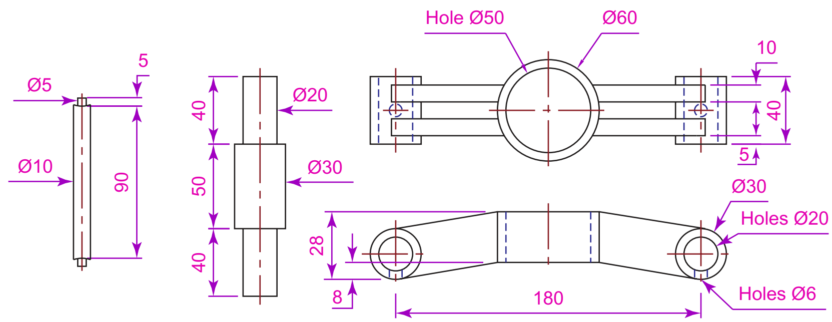

Fig. 19.1 **Raster image in a drawing –** drawing into which file is to be inserted

Raster images are graphics images in files with file names ending with the extensions ***.bmp**; ***.pcx**; ***.tif** and the like. The types of graphics files which can be inserted into AutoCAD drawings can be seen by first *clicking* on the **External References Palette** icon in the **View/Palettes** panel (Fig. 19.2).

Fig. 19.2 Selecting **External References Palette** from the **View/Palettes** panel

Fig. 19.3 The **External References** palette

Then select **Attach Image…** from the pop-up menu brought down with a *click* on the left-hand icon at the top of the palette which brings the **Select Image File** dialog (Fig. 19.3) which brings the **Select Reference File** dialog on screen (Fig. 19.4).

In the dialog select the required raster file (in this example **Fig05.bmp**) and *click* the **Open** button. The **Attach Image** dialog appears showing

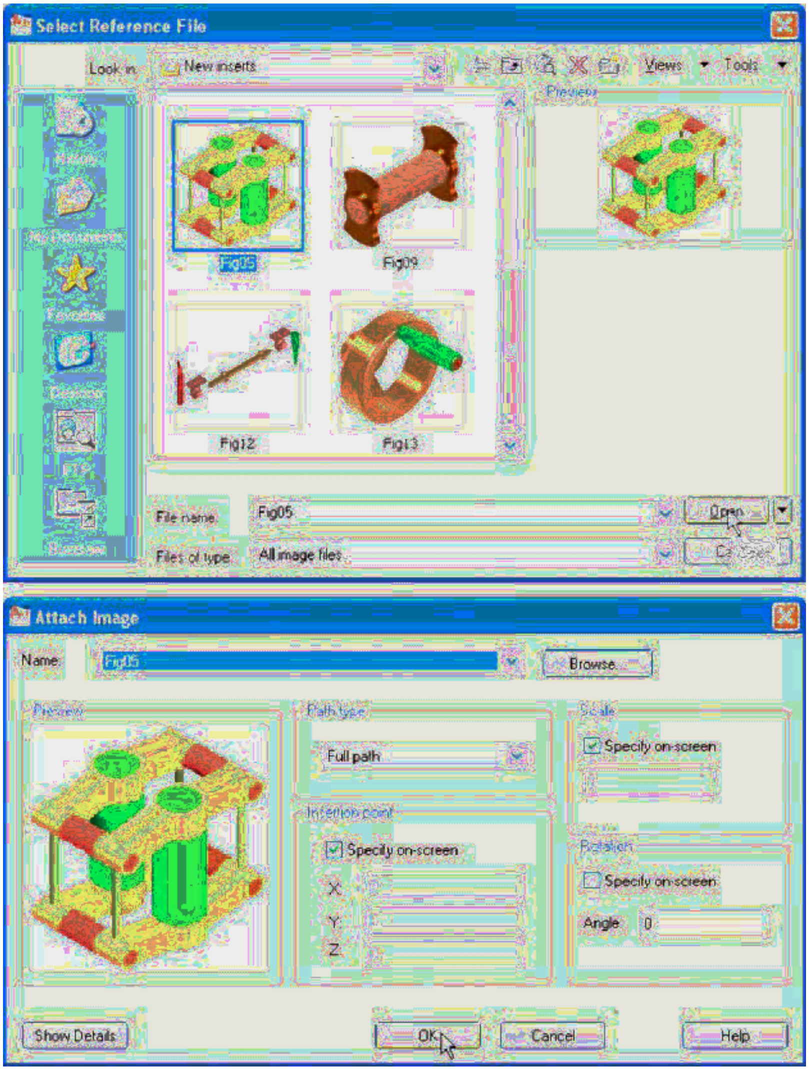

Fig. 19.4 **Raster image in a drawing** – the **Select Reference File** and **Attach Image** dialogs

the selected raster image. If satisfied *click* the **OK** button. The dialog disappears and the command line shows:

```
Command: _IMAGEATTACH
Specify insertion point <0,0>:pick
Base image size: Width: 1.000000, Height:
  1.041958, Millimetres
Specify scale factor <1>:enter 60 right-click
Command:
```

And the image is attached on screen at the *picked* position.

How to produce a raster image

1. Construct the 3D model to the shapes and sizes given in Fig. 19.1 working in four layers each of a different colour.
2. Place in the **ViewCube/Isometric** view.
3. Shade the 3D model in **Realistic** visual style.
4. **Zoom** the shaded model to a suitable size and press the **Print Scr** key of the keyboard.
5. Open the Windows **Paint** application and *click* **Edit** in the menu bar, followed by another *click* on **Paste** in the drop-down menu. The whole AutoCAD screen which includes the shaded 3D assembled model appears.
6. *Click* the **Select** tool icon in the toolbar of **Paint** and window the 3D model. Then *click* **Copy** in the **Edit** drop-down menu.
7. *Click* **New** in the **File** drop-down menu, followed by a *click* on **No** in the warning window which appears.
8. *Click* **Paste** in the **Edit** drop-down menu. The shaded 3D model appears. *Click* **Save As…** from the **File** drop-down menu and save the bitmap to a suitable file name – in this example **Fig05.bmp**.
9. Open the orthographic projection drawing Fig. 19.1 in AutoCAD.
10. Following the details given on page 380 attach **Fig05.bmp** to the drawing at a suitable position (Fig. 19.5).

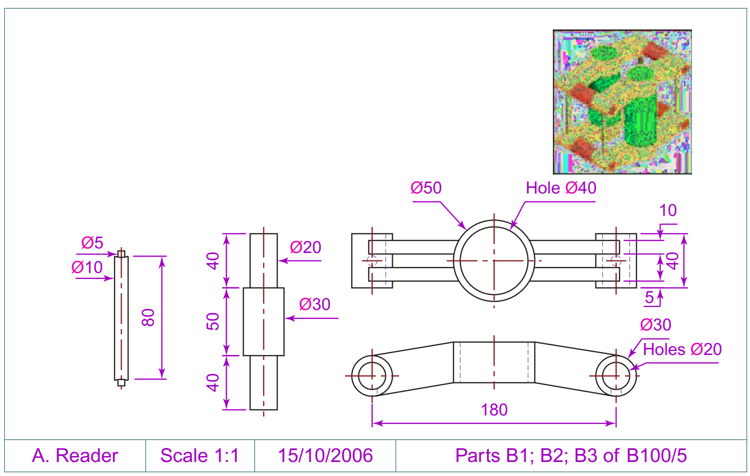

Fig. 19.5 Example – **Raster image in a drawing**

Notes

1. It will normally be necessary to *enter* a scale in response to the prompt lines otherwise the raster image may appear very small on screen. If it does it can be zoomed anyway.
2. Place the image in position in the drawing area. In Fig. 19.5 the orthographic projections have been placed within a margin and a title block has been added.

Printing/plotting

Hardcopy (prints or plots on paper) from a variety of different types of AutoCAD drawings of 3D models can be obtained. Some of this variety has already been shown on pages 317 to 319 in Chapter 15.

First example – Printing/plotting (Fig. 19.8)

If an attempt is made to print a multiple viewport screen in **Model Space** with all viewport drawings appearing in the plot, only the current viewport will be printed. To print or plot all viewports:

1. Open a 4-viewport screen of the assembled 3D model shown in the first example (Fig. 19.5).
2. Make a new layer **vports** of colour **yellow**. Make this layer current.
3. *Click* the **Layout1** button in the status bar (Fig. 19.6). The screen changes to a **PSpace** layout.

Fig. 19.6 First example – the **Layout1** button in the status bar

4. Erase the yellow outline and the view is erased.
5. At the command line:

```
Command:enter mv
MVIEW
Specify corner of viewport or
[ON/OFF/Fit/Shadeplot/Lock/Object/Polygonal/
  Restore/LAyer/2/3/4] <Fit>:enter r right-click
Enter viewport configuration name or [?]
  <*Active>:right-click
Specify first corner or [Fit] <Fit>:right-click
Command:
```

6. Turn layer **vports** off
7. *Click* the **Plot** tool icon in the **Quick Access** bar (Fig. 19.7). A **Plot** dialog appears.
8. Check that the printer/plotter is correct and the paper size is also correct.
9. *Click* the **Preview** button. The full preview of the plot appears (Fig. 19.8).
10. *Right-click* anywhere in the drawing and *click* on **Plot** in the right-click menu which then appears.
11. The drawing plots (or prints).

Fig. 19.7 The **Plot** tool icon in the **Quick Access** toolbar

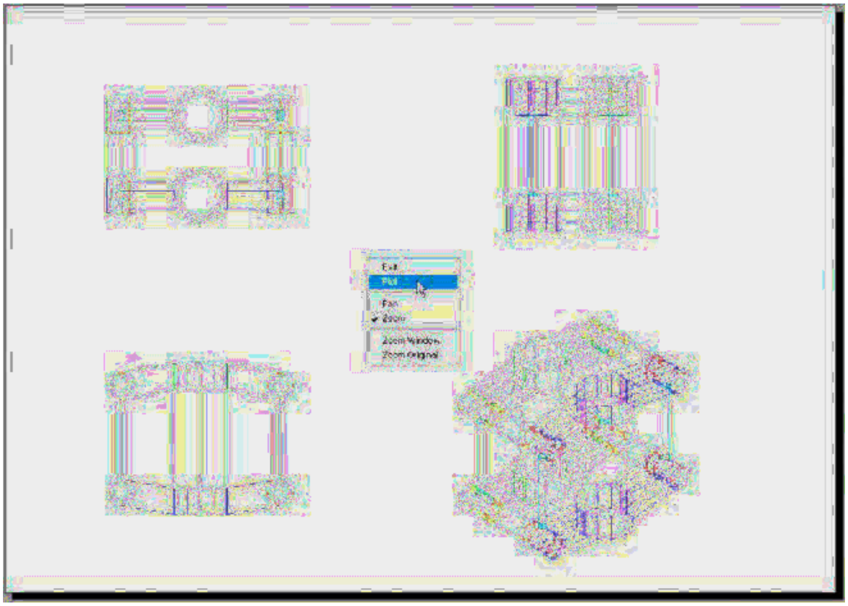

Fig. 19.8 First example – **Printing/plotting**

Second example – Printing/plotting (Fig. 19.9)

1. Open the orthographic drawing with its raster image Fig. 19.5.
2. While still in **Model Space** *click* the **Plot** tool icon. The **Plot** dialog appears. Check that the required printer/plotter and paper size have been chosen.
3. *Click* the **Preview** button.
4. If satisfied with the preview (Fig. 19.9), *right-click* and in the menu which appears *click* the name **Plot**. The drawing plots.

Third example – Printing/plotting (Fig. 19.10)

1. Open the 3D model drawing of the assembly shown in Fig. 19.8 in a single **ViewCube/Isometric** view.

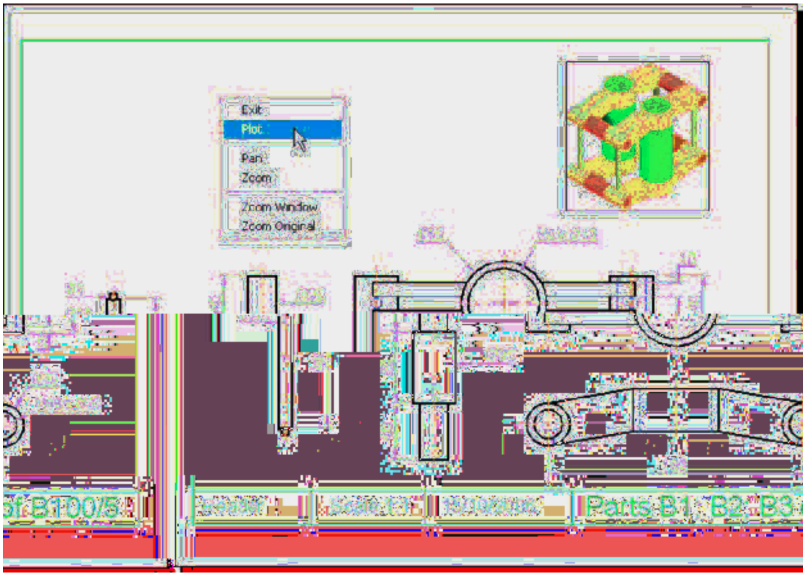

Fig. 19.9 Second example – **Printing/plotting**

2. While in **MSpace**, *click* the **Plot** tool icon. The **Plot** dialog appears.
3. Check that the plotter device and sheet sizes are correct. *Click* the **Preview** button.
4. If satisfied with the preview (Fig. 19.10) *right-click* and *click* on **Plot** in the menu which appears. The drawing plots.

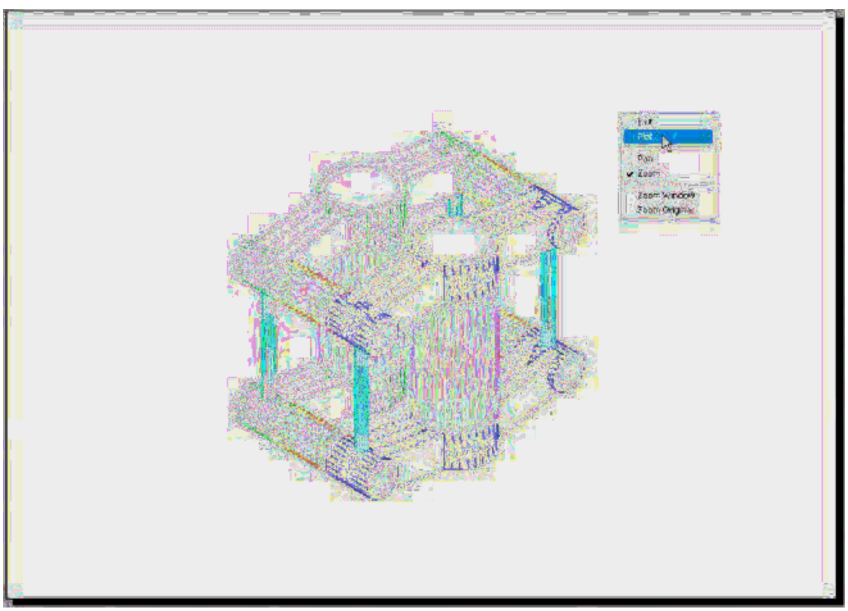

Fig. 19.10 Third example – **Printing/plotting**

Fourth example – Printing/plotting

Fig. 19.11 shows a **Plot Preview** of the 3D solid model in Fig. 18.31 from page 378.

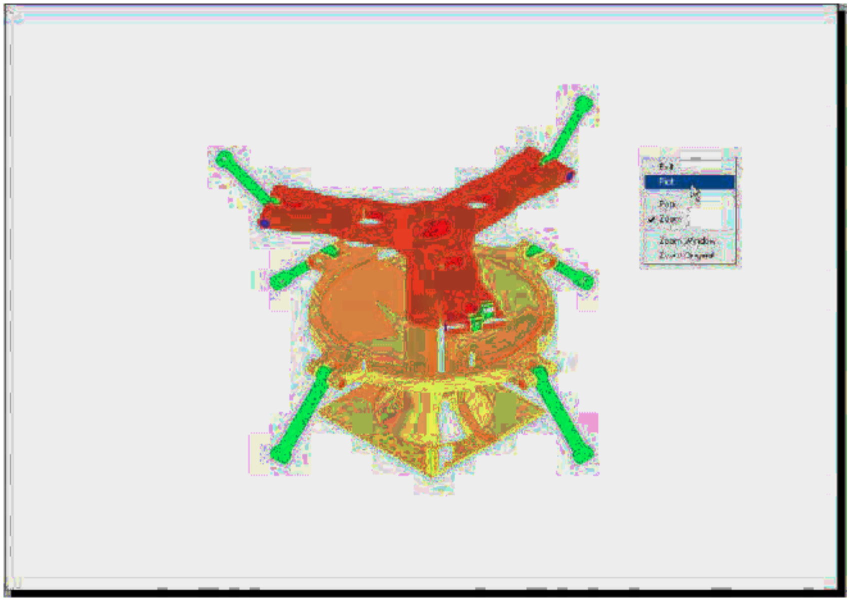

Fig. 19.11 Fourth example – **Printing/plotting**

Polygonal viewports (Fig. 19.12)

The example to illustrate the construction of polygonal viewports is based upon Exercise 6. When the 3D model for this exercise has been completed in **Model Space**:

1. Make a new layer **vports** of colour **blue** and make this layer current.
2. *Click* the **Layout1** button in the status bar.
3. Erase the viewport with a *click* on its bounding line. The outline and its contents are erased.
4. At the command line:

```
Command:enter mv right-click
[prompts]:enter 4 right-click
[prompts]:right-click
Regenerating model.
Command:
```

And the model appears in a 4-viewport layout.

5. *Click* the **Model** button. With a *click* in each viewport in turn and using the **ViewCube** settings set viewports in **Front**, **Right**, **Top** and **Isometric** views respectively.
6. **Zoom** each viewport to **All**.
7. *Click* the **Layout1** button to turn back to **PSpace**.
8. Enter **mv** at the command line, which shows:

```
Command:enter mv right-click
MVIEW
[prompts]:enter p (Polygonal) right-click
Specify start point: In the top right viewport
  pick one corner of a square
Specify next point or [Arc/Close/Length/Undo]:pick
  next corner for the square
Specify next point or [Arc/Close/Length/Undo]:
  pick next corner for the square
Specify next point or [Arc/Close/Length/
  Undo]:enter c (Close)right-click
Regenerating model.
Command:
```

And a square viewport outline appears in the top right viewport within which is a copy of the model.

9. Repeat in each of the viewports with different shapes of polygonal viewport outlines (Fig. 19.11).
10. *Click* the **Model** button.
11. In each of the polygonal viewports make a different isometric view. In the bottom right viewport change the view using the **3D Orbit** tool.
12. Turn the layer **vports** off. The viewport borders disappear (Fig. 19.13).
13. *Click* the **Plot** icon. Make plot settings in the **Plot** dialog. *Click* on the **Preview** button of the **Plot** dialog. The **Preview** appears (Fig. 19.12).

The Navigation Wheel

The **Navigation Wheel** can be called from the **View/Navigate** panel as shown in Fig. 19.14. The reader is advised to experiment with the **Navigation Wheel** in its various forms. See Fig. 19.14.

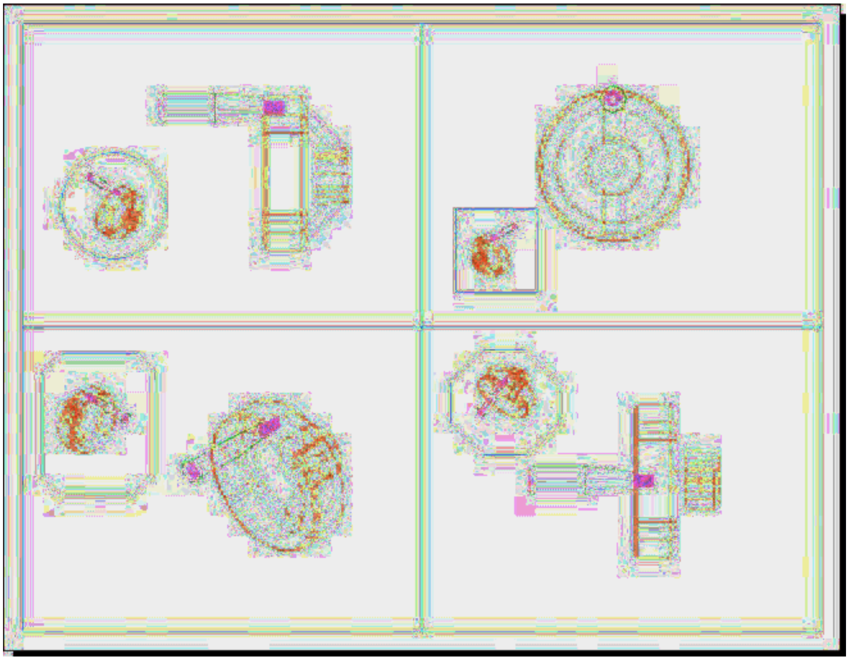

Fig. 19.12 **Polygonal viewports –** plot preview

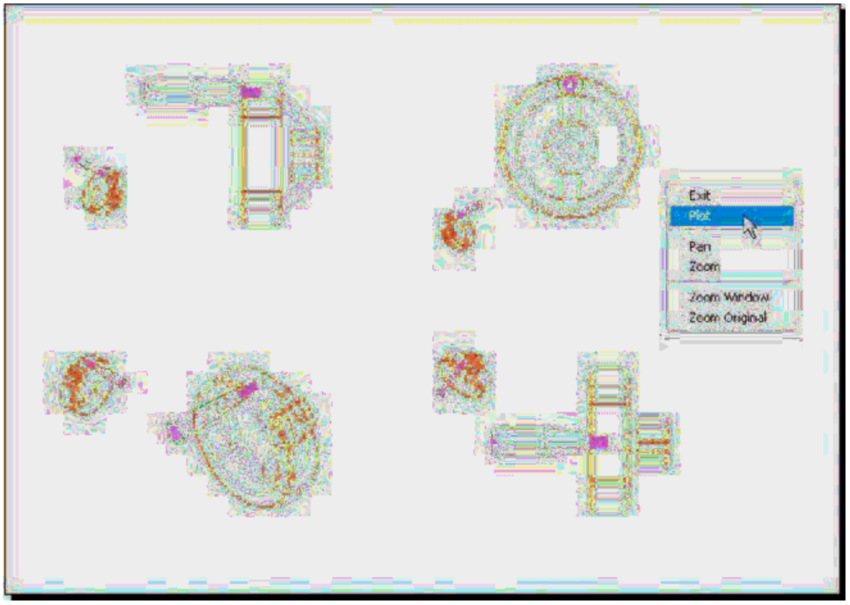

Fig. 19.13 **Polygonal viewports –** plot preview after turning the layer **vports** off

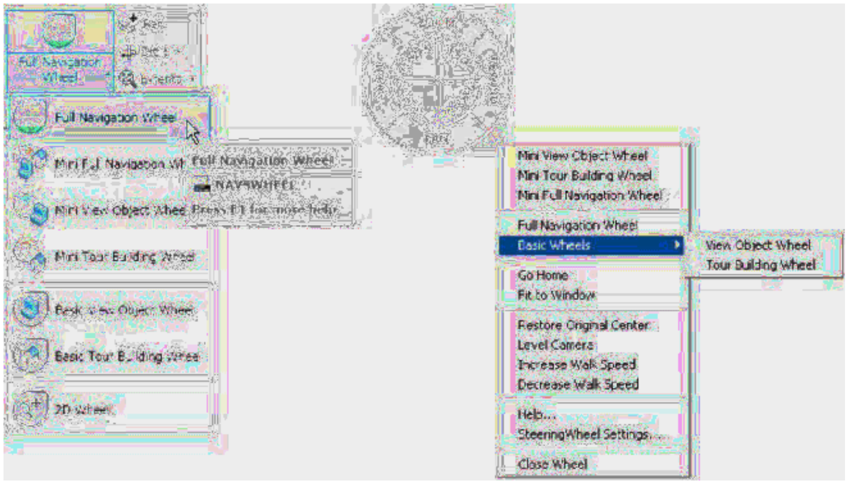

Fig. 19.14 The **Navigation Wheel**

The Mesh tools

Fig. 19.15 shows a series of illustrations showing the actions of the **Mesh** tools and the three 3D tools **3dmove**, **3dscale** and **3drotate**. The illustrations show:

1. A box constructed using the **Box** tool.
2. The box acted upon by the **Smooth Object** tool from the **Home/Mesh** panel.
3. The box acted upon by the **Smooth Mesh** tool.
4. The box acted upon by the **Mesh Refine** tool.
5. The **Smooth Refined** box acted upon by the **3dmove** tool.
6. The **Smooth Refined** box acted upon by the **3dscale** tool.
7. The **Smooth Refined** box acted upon by the **3drotate** tool. Note the gizmos shown in Fig. 19.15.

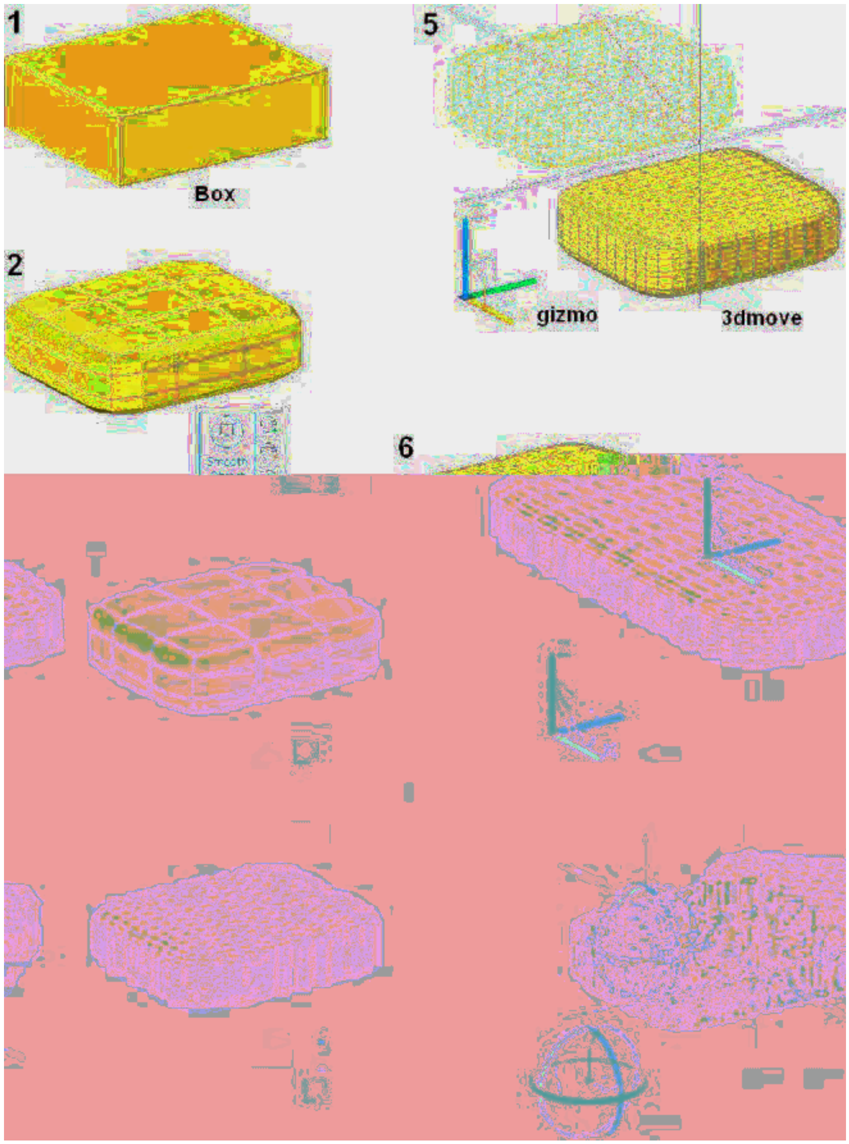

Fig. 19.15 **Mesh, 3dmove, 3dscale** and **3drotate** tools

Exercises

Methods of constructing answers to the following exercises can be found in the free website:

http://books.elsevier.com/companions/ 978-1-85617-868-6

1. Working to the shapes and sizes given in Fig. 19.16, construct an assembled 3D model drawing of the spindle in its two holders, add lighting and apply suitable materials and render (Fig. 19.17).

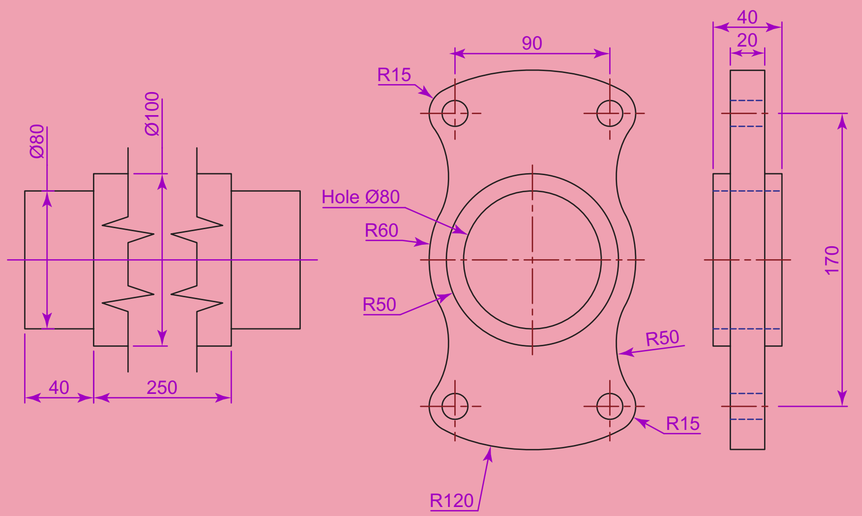

Fig. 19.16 Exercise 1 – details of shapes and sizes

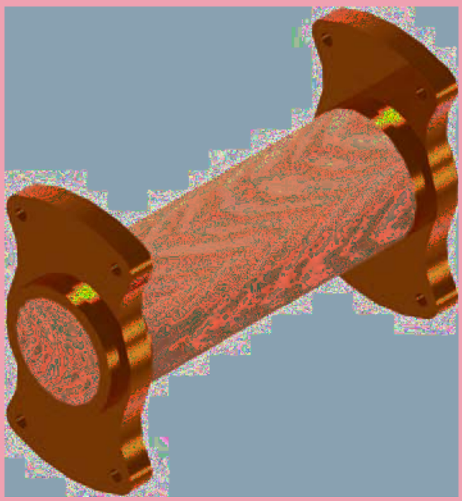

Fig. 19.17 Exercise 1

2. Fig. 19.18 shows a rendering of the model for this exercise and Fig. 19.19 an orthographic projection giving shapes and sizes for the model. Construct the 3D model, add lighting, apply suitable materials and render.

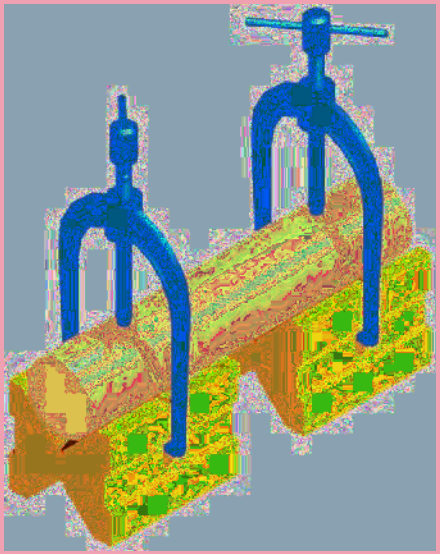

Fig. 19.18 Exercise 2

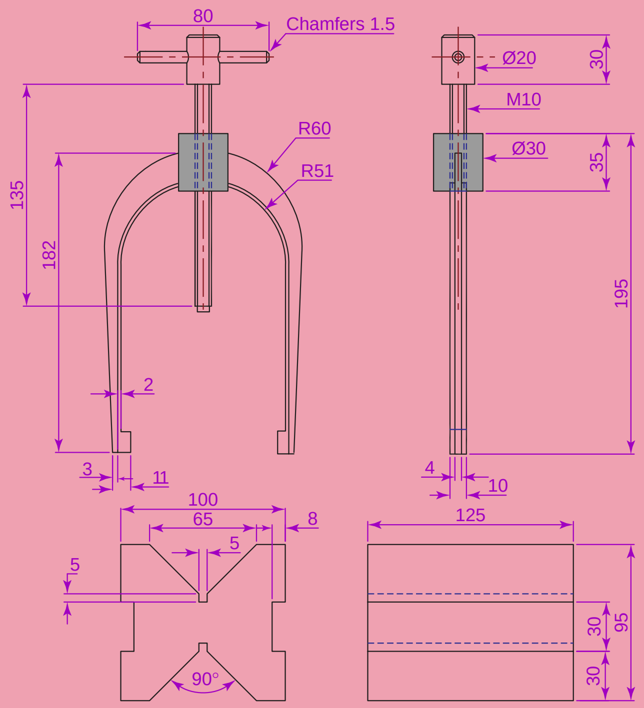

Fig. 19.19 Exercise 2 – orthographic projection

3. Construct a 3D model drawing to the details given in Fig. 19.21. Add suitable lighting and apply a material, then render as shown in Fig. 19.20.

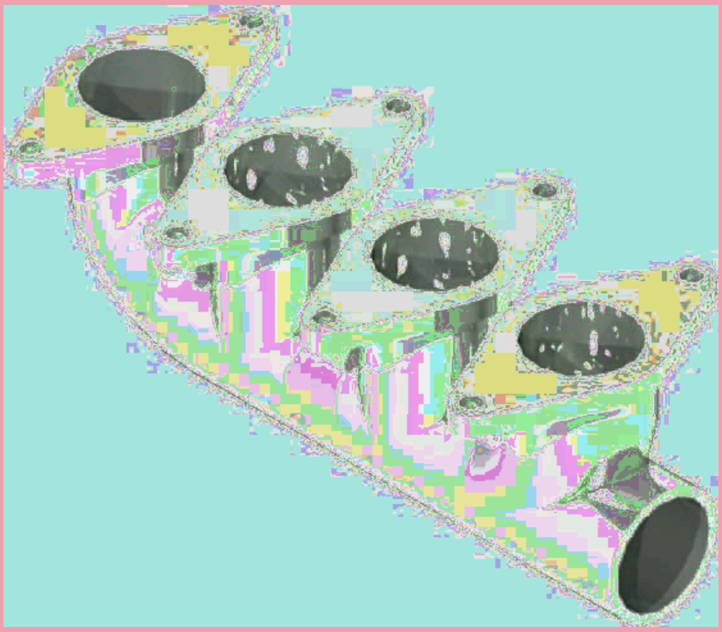

Fig. 19.20 Exercise 3 – **ViewCube/Isometric** view

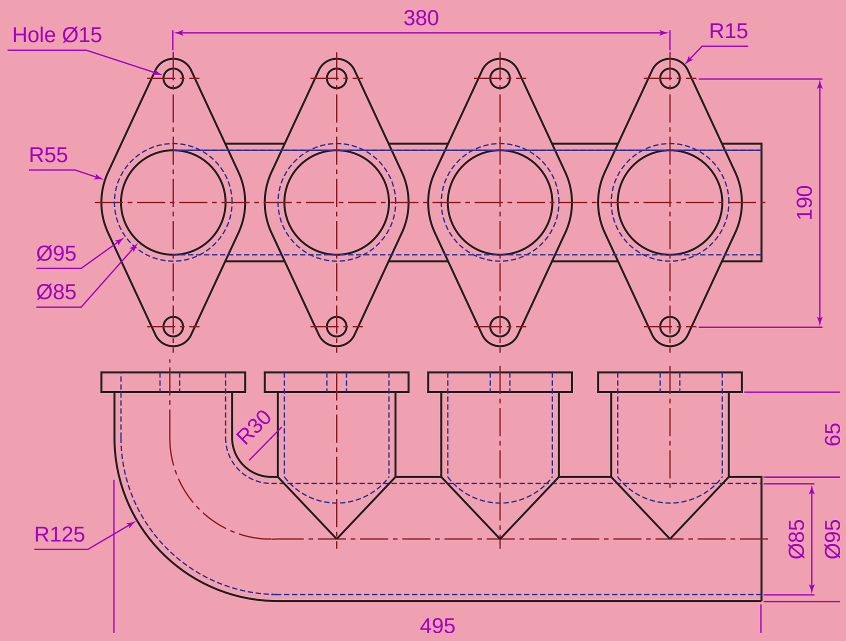

Fig. 19.21 Exercise 3

4. Construct an assembled 3D model drawing working to the details given in Fig. 19.22. When the 3D model drawing has been constructed disassemble the parts as shown in the given exploded isometric drawing (Fig. 19.23).

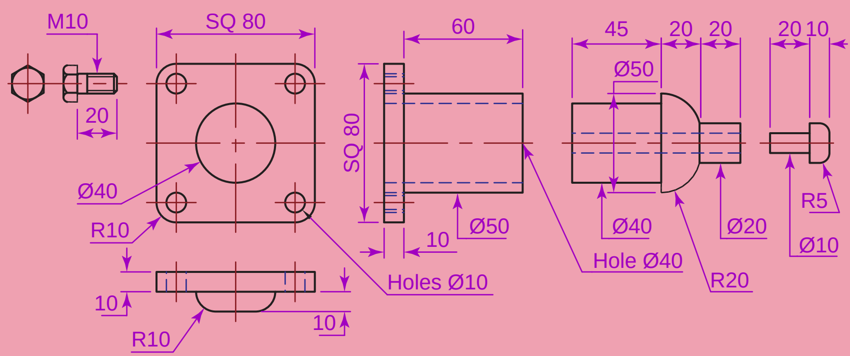

Fig. 19.22 Exercise 4 – details of shapes and sizes

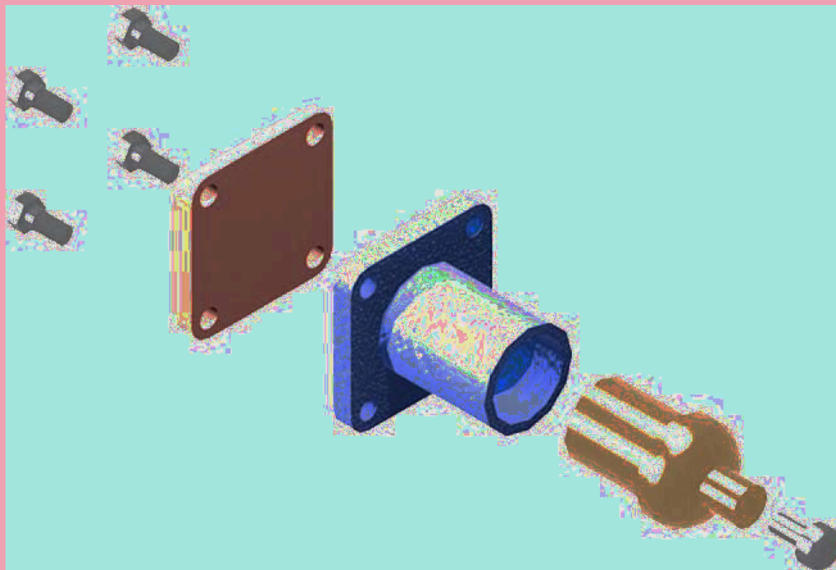

Fig. 19.23 Exercise 4 – an exploded rendered model

5. Working to the details shown in Fig. 19.24, construct an assembled 3D model, with the parts in their correct positions relative to each other. Then separate the parts as shown in the 3D rendered model drawing Fig. 19.25. When the 3D model is complete add suitable lighting and materials and render the result.

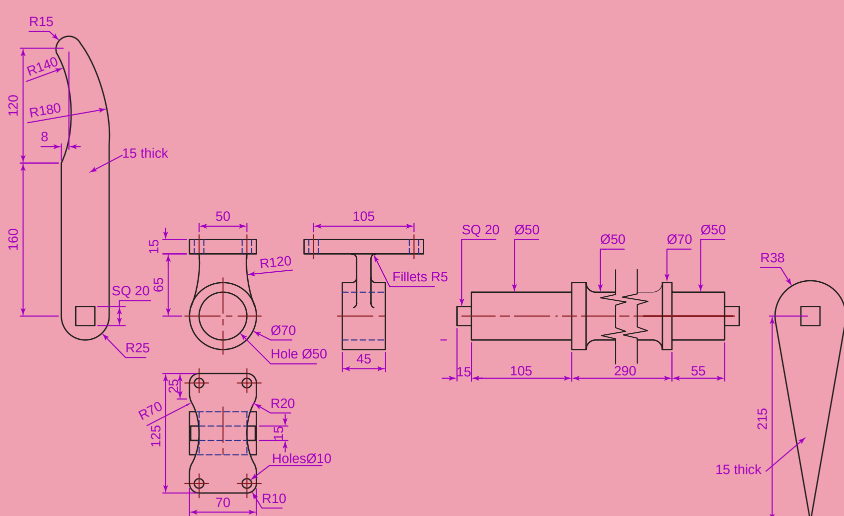

Fig. 19.24 Exercise 5 – details drawing

Fig. 19.25 Exercise 5 – exploded rendered view

6. Working to the details shown in Fig. 19.26 construct a 3D model of the parts of the wheel with its handle.

Two renderings of 3D models of the rotating handle are shown in Fig. 19.27, one with its parts assembled, the other with the parts in an exploded position relative to each other.

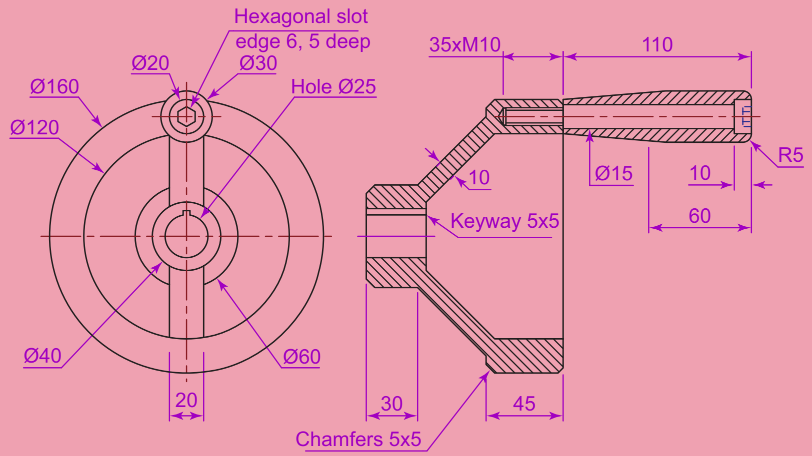

Fig. 19.26 Exercise 6 – details drawing

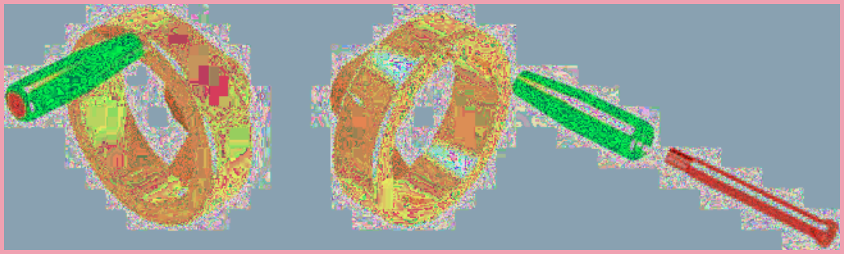

Fig. 19.27 Exercise 6 – renderings

Part 3

Internet tools and design

Chapter 20

Internet Tools and Help

AIMS OF THIS CHAPTER

The purpose of this chapter is to introduce the tools which are available in AutoCAD 2010 which make use of facilities available on the World Wide Web (www).

Emailing drawings

As with any other files which are composed of data, AutoCAD drawings can be sent by email as attachments. If a problem with the security of the drawings is involved, they can be encapsulated with a password as the drawings are saved prior to being attached in an email. To encrypt a drawing with a password, *click* **Tools** in the **Save Drawing As** dialog and from the pop-up list which appears *click* **Security Options…** (Fig. 20.1).

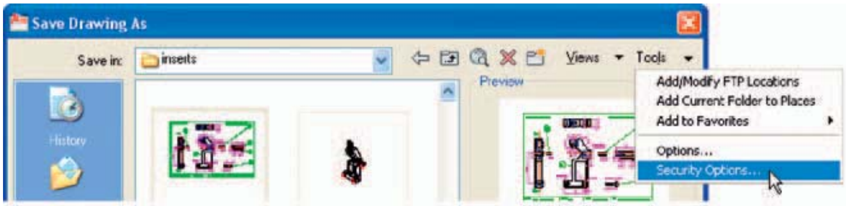

Fig. 20.1 Selecting **Security Options…** in the **Save Drawing As** dialog

Then in the **Security Options** dialog which appears (Fig. 20.2) *enter* a password in the **Password or phrase to open this drawing** field, followed by a *click* on the **OK** button. After *entering* a password *click* the **OK** button and *enter* the password in the **Confirm Password** dialog which appears.

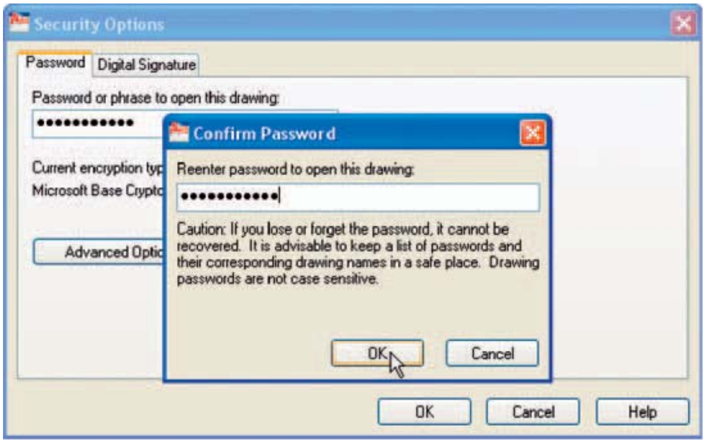

Fig. 20.2 *Entering* and confirming a password in the **Security Options** dialog

The drawing then cannot be opened until the password is *entered* in the **Password** dialog which appears when an attempt is made to open the drawing by the person receiving the email (Fig. 20.3).

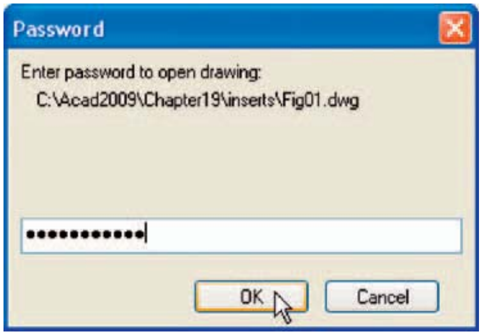

Fig. 20.3 The **Password** dialog appearing when a password-encrypted drawing is about to be opened

There are many reasons why drawings may need to be password-encapsulated in order to protect confidentiality of the contents of drawings.

Creating a web page (Fig. 20.5)

To create a web page which includes AutoCAD drawings first *left-click* **Publish to Web…** in the **File** drop-down menu (Fig. 20.4).

Fig. 20.4 The **Publish to Web** tool in the **File** drop-down menu

A series of **Publish to Web** dialogs appear, some of which are shown here in Figs. 20.5 to 20.7. After making entries in the dialogs which come on screen after each **Next** button is *clicked*, the resulting web page such as that shown in Fig. 20.7 will be seen. *Double-click* in any of the thumbnail views in this web page and another page appears showing the selected drawing in full.

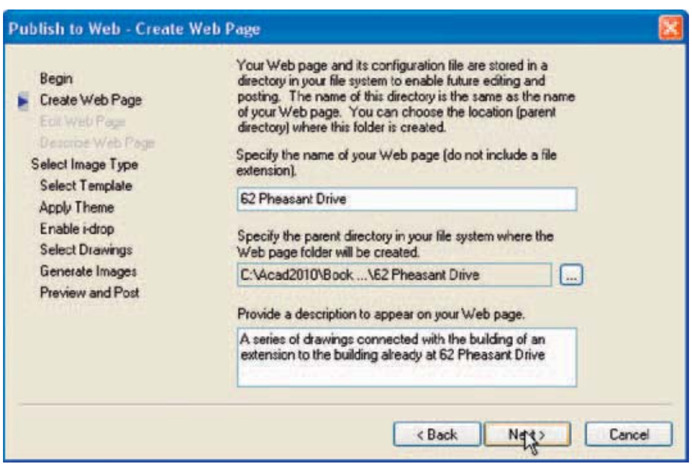

Fig. 20.5 The **Publish to Web – Create Web Page** dialog

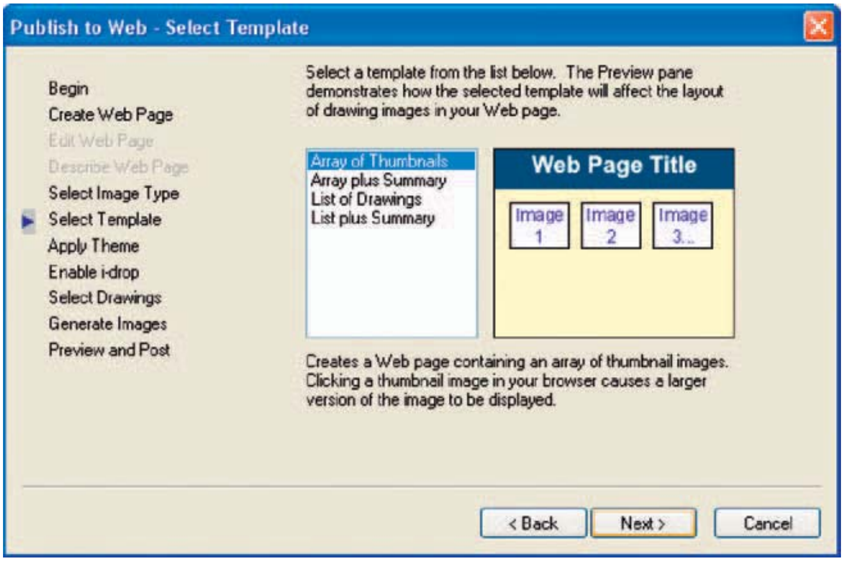

Fig. 20.6 The **Publish to Web – Select Template** dialog

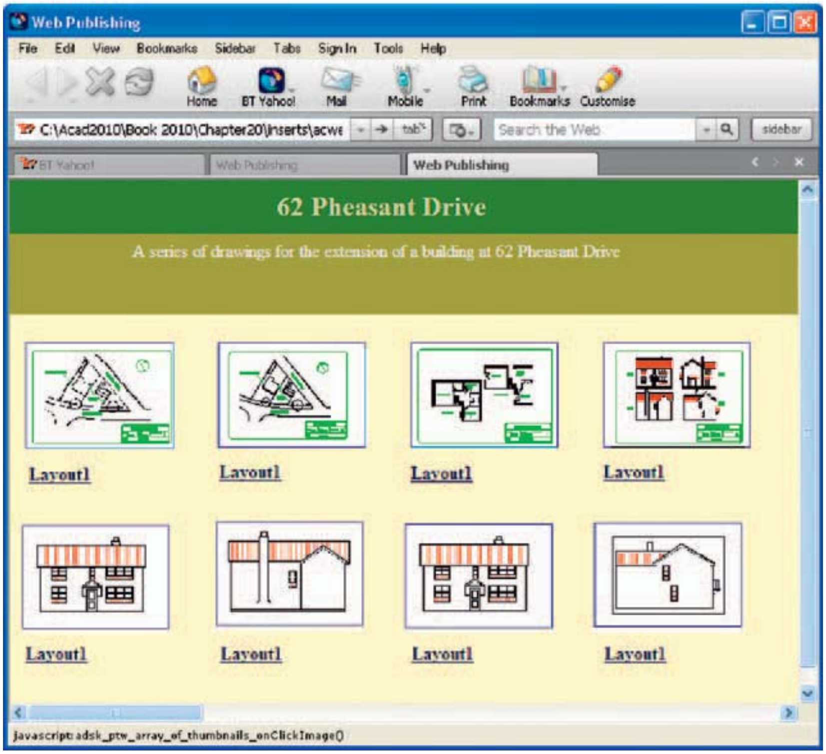

Fig. 20.7 The **Web Publishing – Windows Internet Explorer** page

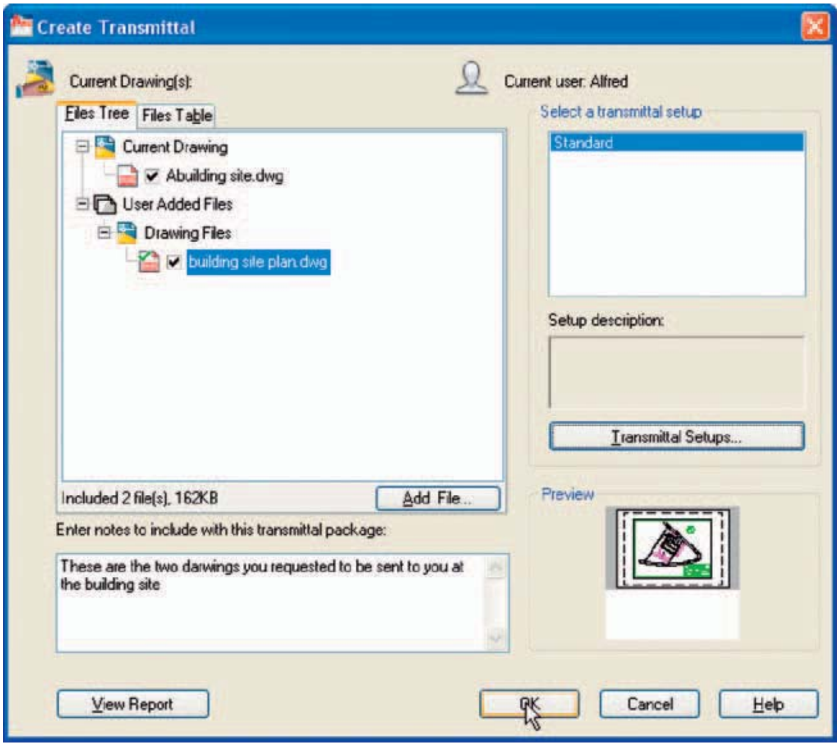

Fig. 20.8 The **Create Transmittal** dialog

The eTransmit tool

At the command line *enter* **etransmit**. The **Create Transmittal** dialog appears (Fig. 20.8). The transmittal shown in Fig. 20.8 is the drawing on screen at the time the transmittal was made plus a second drawing. Fill in the details as necessary. The transmittal is sent as a **zip** file. A **zip** file is easier and quicker to email than a drawing file. The AutoCAD drawing can be obtained by unzipping the **zip** file at the receiving end.

Note

There is no icon for **eTransmit** in the ribbon panels.

Help

Figure. 20.9 shows a method of getting help. In this example help on using the **Break** tool is required. *Enter* **Break** in the **Search** field, followed by

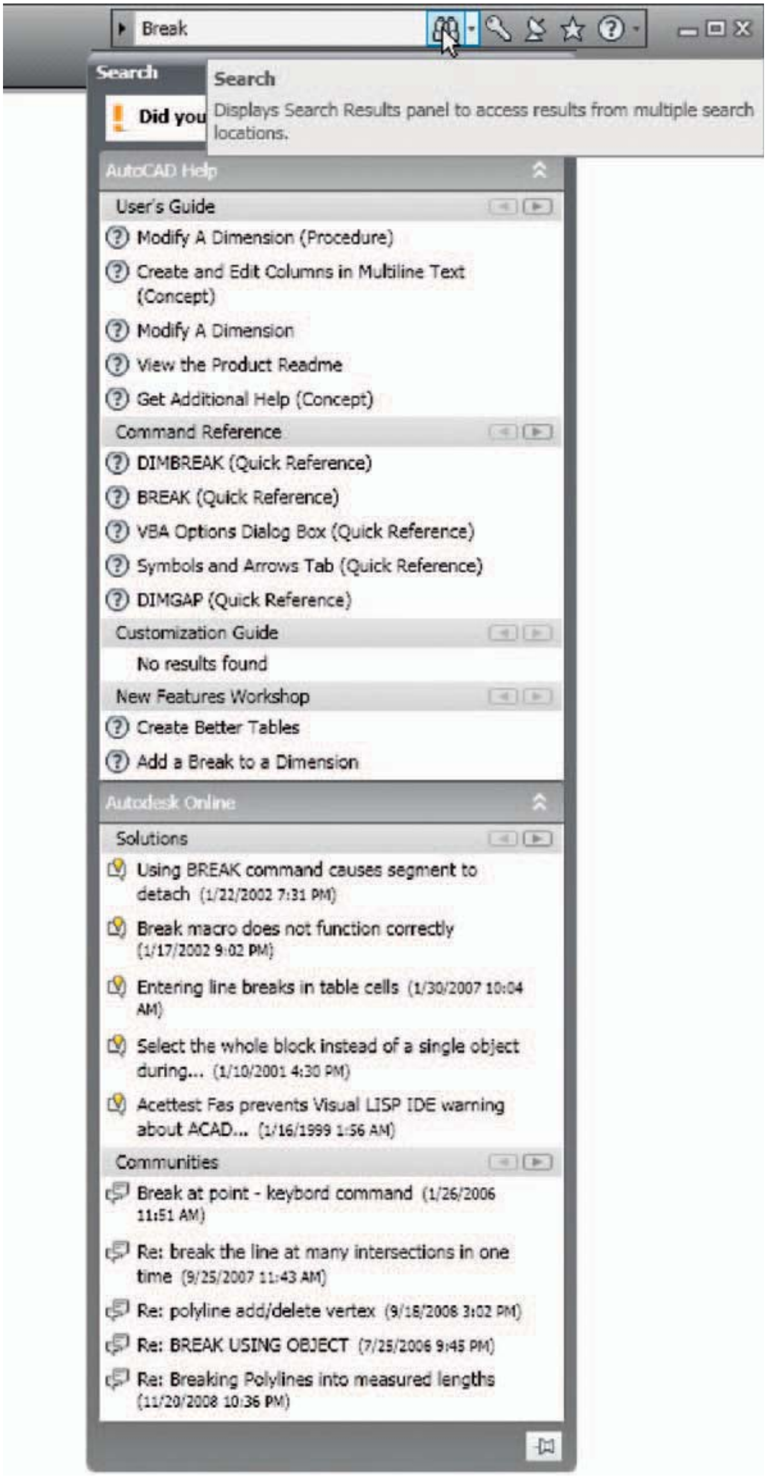

Fig. 20.9 Help for **Break**

a *click* on the **Search** button. A list appears from which the operator can select what he/she considers to be the most appropriate response.

The new features workshop

Click the down pointing arrow to the right of the **?** icon and select **New Features Workshop** from the menu which appears (Fig. 20.10). Fig. 20.11 shows one of the features from the **New Features** window describing how to **Create, Smooth and Refine a 3D Mesh**.

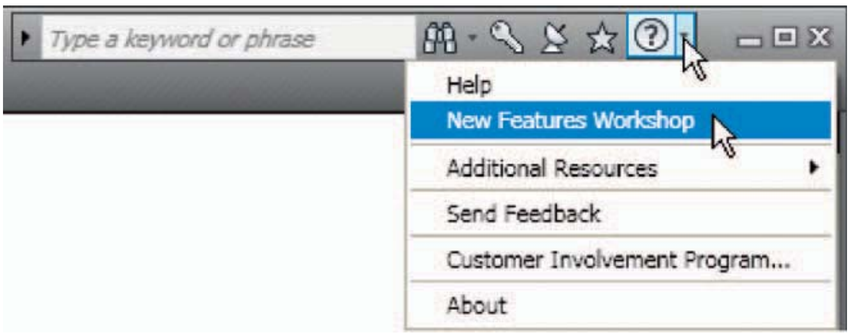

Fig. 20.10 Selecting **New Features Workshop**

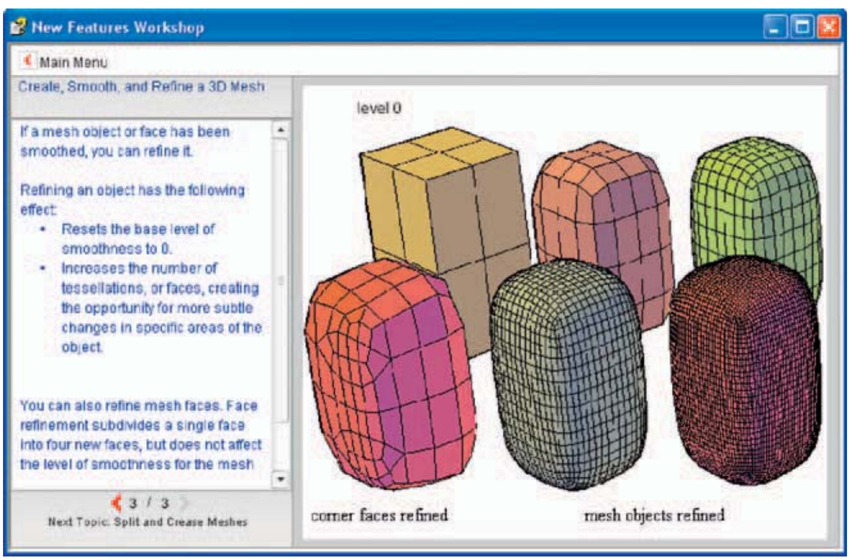

Fig. 20.11 The **New Features Workshop** showing **Create, Smooth and Refine a 3D Mesh**

Chapter 21

Design and AutoCAD 2010

AIMS OF THIS CHAPTER

The aims of this chapter are:

1. To describe reasons for using AutoCAD.
2. To describe methods of designing artefacts and the place of AutoCAD in the design process.
3. To list the system requirements for running AutoCAD 2010 software.
4. To list some of the enhancements in AutoCAD 2010.

10 reasons for using AutoCAD

1. A CAD software package such as AutoCAD 2010 can be used to produce any form of technical drawing.
2. Technical drawings can be produced much more speedily using AutoCAD than when working manually – probably as much as 10 times as quickly when used by skilled AutoCAD operators.
3. Drawing with AutoCAD is less tedious than drawing by hand – features such as hatching, lettering, adding notes etc. are easier, quicker and indeed more accurate to construct.
4. Drawings or parts of drawings can be moved, copied, scaled, rotated, mirrored and inserted into other drawings without having to redraw.
5. AutoCAD drawings can be saved to a file system without necessarily having to print the drawing. This can save the need for large paper drawing storage areas.
6. The same drawing or part of a drawing need never be drawn twice, because it can be copied or inserted into other drawings with ease. A basic rule when working with AutoCAD is: ***Never draw the same feature twice***.
7. New details can be added to drawings or be changed within drawings without having to mechanically erase the old detail.
8. Dimensions can be added to drawings with accuracy, reducing the possibility of making errors.
9. Drawings can be plotted or printed to any scale without having to redraw.
10. Drawings can be exchanged between computers and/or emailed around the world without having to physically send the drawing.

The place of AutoCAD 2010 in designing

The contents of this book are only designed to help those who have a limited (or no) knowledge and skills of the construction of technical drawings using AutoCAD 2010. However, it needs to be recognised that the impact of modern computing on the methods of designing in industry has been immense. Such features as analysis of stresses, shear forces, bending forces and the like can be carried out more quickly and accurately using computing methods. The storage of data connected with a design and the ability to recover the data speedily are carried out much more easily using computing methods than prior to the introduction of computing.

AutoCAD 2010 can play an important part in the design process because technical drawings of all types are necessary for achieving well-designed artefacts, whether it be an engineering component, a machine, a building, an electronics circuit or any other design project.

In particular, two-dimensional drawings (2D drawings) which can be constructed in AutoCAD 2010 are still of great value in modern industry. AutoCAD 2010 can also be used to produce excellent and accurate three-dimensional (3D) models, which can be rendered to produce photographic-like images of a suggested design. Although not dealt with in this book, data from 3D models constructed in AutoCAD 2010 can be taken for use in computer aided machining (CAM).

At all stages in the design process, either (or both) 2D or 3D drawings play an important part in aiding those engaged in designing to assist in assessing the results of their work at various stages. It is in the design process that drawings constructed in AutoCAD 2010 play an important part.

In the simplified design process chart shown in Fig. 21.1 an asterisk (*) has been shown against those features where the use of AutoCAD 2010 can be regarded as being of value.

A design chart (Fig. 21.1)

The simplified design chart Fig. 21.1 shows the following features:

Design brief: A design brief is a necessary feature of the design process. It can be in the form of a statement, but it is usually much more. A design

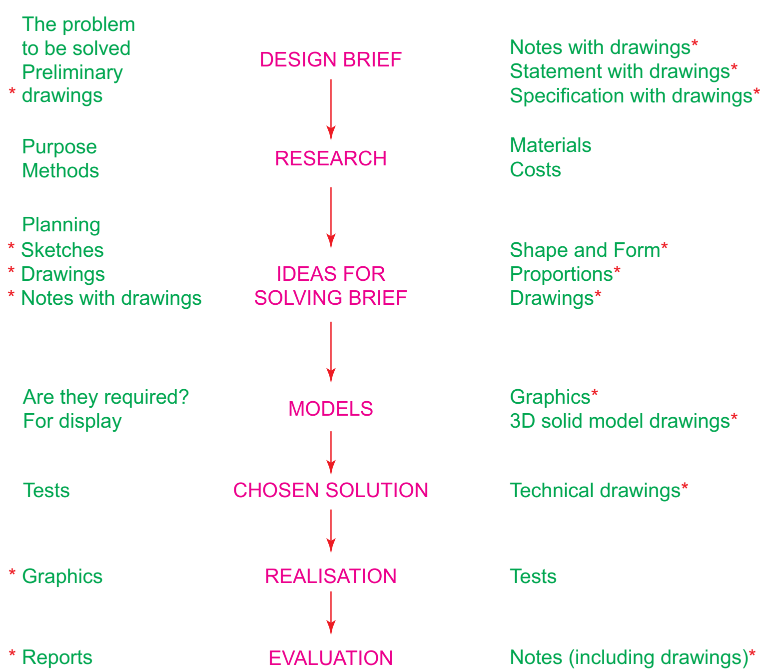

Fig. 21.1 A simplified design chart

brief can be a written report which not only includes a statement made of the problem which the design is assumed to be solving, but includes preliminary notes and drawings describing difficulties which may be encountered in solving the design. It may include charts, drawings, costings etc. to emphasise some of the needs in solving the problem for which the design is being made.

Research: The need to research the various problems which may arise when designing is often much more demanding than the chart (Fig. 21.1) shows. For example, the materials being used may require extensive research as to costing, stress analysis, electrical conductivity, difficulties in machining or in constructional techniques and other such features.

Ideas for solving the brief: This is where technical, other drawings and sketches play an important part in designing. It is only after research that designers can ensure the brief will be fulfilled.

Models: These may be constructed models in materials representing the actual materials which have been chosen for the design, but in addition 3D solid model drawings such as those which can be constructed in AutoCAD 2010 can be of value. Some models may also be made in the materials from which the final design is to be made so as to allow testing of the materials in the design situation.

Chosen solution: This is where the use of drawings constructed in AutoCAD 2010 is of great value. 2D and 3D drawings come into their own here. It is from such drawings that the final design will be manufactured.

Realisation: The design is made. There may be a need to manufacture a number of the designs in order to enable evaluation of the design to be fully assessed.

Evaluation: The manufactured design is tested in situations in which it is liable to be placed in use. Evaluation will include reports and notes which could include drawings with suggestions for amendments to the working drawings from which the design was realised.

Enhancements in AutoCAD 2010

AutoCAD 2010 contains major enhancements over previous releases, whether working in either a **2D** or a **3D** workspace. Please note that not all the enhancements in AutoCAD 2010 are described in this introductory book. Among the more important enhancements are the following:

1. When first loaded, an **Initial Setup** dialog offers choice of use.
2. The **Ribbon** has been amended and brought up to date.

3. New AutoCAD 2010 drawing file format.
4. Considerable updating of 3D modelling.
5. 3D printing enhanced.
6. Some dialogs have been amended.
7. Among others, the following features have been enhanced:
   Application menu – top left-hand corner of AutoCAD 2010 window
   Quick Access Bar
   Dimensioning
   Spell checking
   Pedit
   Splineedit
   Purge
   Sheet sets
   Hatching methods
8. **External References** more flexible.
9. New **VROTATEASSOC** variable allows views to be rotated.
10. PDF systems enhanced.
11. Parametric drawing introduced allowing geometric and dimensional functions to be correct when a feature in a drawing is modified.
12. New command **MEASUREGEOM** allows distance, radius, angle, area and volume to be measured.
13. New **Help** features in an **InfoCenter** (top right-hand corner of AutoCAD 2010 window).
14. Some new set variables.

System requirements for running AutoCAD 2010

Note: there are two editions of AutoCAD 2010 – 32 bit and 64 bit editions.

Operating system: Windows XP Professional, Windows XP Professional (x64 Edition), Windows XP Home Edition, Windows 2000 or Windows Vista 32 bit, Windows Vista 64 bit.

Microsoft Internet Explorer 7.0.

Processor: Pentium III 800 Mhz.

Ram: At least 128 MB.

Monitor screen: 1024 × 768 VGA with True Colour as a minimum.

Hard disk: A minimum of 300 MB.

Graphics card: An AutoCAD-certified graphics card. Details can be found on the web page **AutoCAD Certified Hardware XML Database**.

Part 4

Appendices

Appendix A

List of tools

Introduction

AutoCAD 2010 allows the use of over 300 tools. Some operators prefer using the word "commands", although command as an alternative to tool is not in common use today. Most of these tools are described in this list. Many of the tools described here have not been used in this book, because this book is an introductory text designed to initiate readers into the basic methods of using AutoCAD 2010. It is hoped the list will encourage readers to experiment with those tools not described in the book. The abbreviations for tools which can be abbreviated are included in brackets after the tool name. Tool names can be *entered* in upper or lower case.

A list of 2D tools is followed by a listing of 3D tools. Internet tools are described at the end of this listing. Not all of the tools available in AutoCAD 2010 are shown here.

2D tools

About – Brings the **About AutoCAD** bitmap on screen
Appload – Brings the **Load/Unload Applications** dialog to screen
Adcenter (dc) – Brings the **DesignCenter** palette on screen
Align (al) – Aligns objects between chosen points
Arc (a) – Creates an arc
Area – States in square units the area selected from a number of points
Array (ar) – Creates **Rectangular** or **Polar** arrays in 2D
Ase – Brings the **dbConnect Manager** on screen
Attdef – Brings the **Attribute Definition** dialog on screen
Attedit – Allows editing of attributes from the Command line
Audit – Checks and fixes any errors in a drawing
Autopublish – Creates a **DWF** file for the drawing on screen
Bhatch (h) – Brings the **Boundary Hatch** dialog on screen
Block – Brings the **Block Definition** dialog on screen
Bmake (b) – Brings the **Block Definition** dialog on screen
Bmpout – Brings the **Create Raster File** dialog on screen
Boundary (bo) – Brings the **Boundary Creation** dialog on screen
Break (br) – Breaks an object into parts
Cal – Calculates mathematical expressions
Chamfer (cha) – Creates a chamfer between two entities
Chprop (ch) – Brings the **Properties** window on screen
Circle (c) – Creates a circle
Copytolayer – Copies objects from one layer to another

Copy (co) – Creates a single or multiple copies of selected entities
Copyclip (Ctrl + C) – Copies a drawing or part of a drawing for inserting into a document from another application
Copylink – Forms a link between an AutoCAD drawing and its appearance in another application such as a word-processing package
Customize – Brings the **Customize** dialog to screen, allowing the customisation of toolbars, palettes etc.
Dashboard – Has the same action as **Ribbon**
Dashboardclose – Closes the **Ribbon**
Ddattdef (at) – Brings the **Attribute Definition** dialog to screen
Ddatte (ate) – Edits individual attribute values
Ddcolor (col) – Brings the **Select Color** dialog on screen
Ddedit (ed) – The **Text Formatting** dialog box appears on selecting text
Ddim (d) – Brings the **Dimension Style Manager** dialog box on screen
Ddinsert (i) – Brings the **Insert** dialog on screen
Ddmodify – Brings the **Properties** window on screen
Ddosnap (os) – Brings the **Drafting Settings** dialog on screen
Ddptype – Brings the **Point Style** dialog on screen
Ddrmodes (rm) – Brings the **Drafting Settings** dialog on screen
Ddunits (un) – Brings the **Drawing Units** dialog on screen
Ddview (v) – Brings the **View Manager** on screen
Del – Allows a file to be deleted
Dgnexport – Creates a **MicroStation V8 dgn** file from the drawing on screen
Dgnimport – Allows a **MicroStation V8 dgn** file to be imported as an AutoCAD dwg file
Dim – Starts a session of dimensioning
Dimension tools – The **Dimension** toolbar contains the following tools – **Linear**, **Aligned**, **Arc Length**, **Ordinate**, **Radius**, **Jogged**, **Diameter**, **Angular**, **Quick Dimension**, **Baseline**, **Continue**, **Quick Leader**, **Tolerance**, **Center Mark**, **Dimension Edit**, **Dimension Edit Text**, **Update** and **Dimension Style**
Dim1 – Allows the addition of a single dimension to a drawing
Dist (di) – Measures the distance between two points in coordinate units
Distantlight – Creates a distant light
Divide (div) – Divides an entity into equal parts
Donut (do) – Creates a donut
Dsviewer – Brings the **Aerial View** window on screen
Dtext (dt) – Creates dynamic text. Text appears in drawing area as it is entered
Dxbin – Brings the **Select DXB File** dialog on screen
Dxfin – Brings the **Select File** dialog on screen
Dxfout – Brings the **Save Drawing As** dialog on screen

Ellipse (el) – Creates an ellipse
Erase (e) – Erases selected entities from a drawing
Exit – Ends a drawing session and closes AutoCAD 2010
Explode (x) – Explodes a block or group into its various entities
Explorer – Brings **Windows Explorer** on screen
Export (exp) – Brings the **Export Data** dialog on screen
Extend (ex) – To extend an entity to another
Fillet (f) – Creates a fillet between two entities
Filter – Brings the **Object Selection Filters** dialog on screen
Gradient – Brings the **Hatch and Gradient** dialog on screen
Group (g) – Brings the **Object Grouping** dialog on screen
Hatch – Allows hatching by the *entry* responses to prompts
Hatchedit (he) – Allows editing of associative hatching
Help – Brings the **AutoCAD 2010 Help: User Documentation** dialog on screen
Hide (hi) – Hides parts behind 3D meshes in 3D models
Id – Identifies a point on screen in coordinate units
Imageadjust (iad) – Allows adjustment of images
Imageattach (iat) – Brings the **Select Image File** dialog on screen
Imageclip – Allows clipping of images
Import – Brings the **Import File** dialog on screen
Insert (i) – Brings the **Insert** dialog on screen
Insertobj – Brings the **Insert Object** dialog on screen
Isoplane (Ctrl + E) – Sets the isoplane when constructing an isometric drawing
Join (j) – Joins lines which are in line with each other or arcs which are from the same centre point
Laycur – Changes layer of selected objects to current layer
Layer (la) – Brings the **Layer Properties Manager** dialog on screen
Layout – Allows editing of layouts
Lengthen (len) – Lengthens an entity on screen
Limits – Sets the drawing limits in coordinate units
Line (l) – Creates a line
Linetype (lt) – Brings the **Linetype Manager** dialog on screen
List (li) – Lists in a text window details of any entity or group of entities selected
Load – Brings the **Select Shape File** dialog on screen
Ltscale (lts) – Allows the linetype scale to be adjusted
Measure (me) – Allows measured intervals to be placed along entities
Menu – Brings the **Select Customization File** dialog on screen
Menuload – Brings the **Load/Unload Customizations** dialog on screen
Mirror (mi) – Creates an identical mirror image of selected entities
Mledit – Brings the **Multiline Edit Tools** dialog on screen

Mline (ml) – Creates mlines
Mlstyle – Brings the **Multiline Styles** dialog on screen
Move (m) – Allows selected entities to be moved
Mslide – Brings the **Create Slide File** dialog on screen
Mspace (ms) – When in PSpace changes to MSpace
Mtext (mt or t) – Brings the **Multiline Text Editor** on screen
Mview (mv) – To make settings of viewports in Paper Space
Mvsetup – Allows drawing specifications to be set up
New (Ctrl + N) – Brings the **Select template** dialog on screen
Notepad – For editing files from **Windows Notepad**
Offset (o) – Offsets selected entity by a stated distance
Oops – Cancels the effect of using **Erase**
Open – Brings the **Select File** dialog on screen
Options – Brings the **Options** dialog to screen
Ortho – Allows ortho to be set ON/OFF
Osnap (os) – Brings the **Drafting Settings** dialog to screen
Pagesetup – Brings either the **Page Setup Manager** on screen
Pan (p) – Drags a drawing in any direction
Pbrush – Brings Windows **Paint** on screen
Pedit (pe) – Allows editing of polylines. One of the options is **Multiple**, allowing continuous editing of polylines without closing the command
Pline (pl) – Creates a polyline
Plot (Ctrl + P) – Brings the **Plot** dialog to screen
Point (po) – Allows a point to be placed on screen
Polygon (pol) – Creates a polygon
Polyline (pl) – Creates a polyline
Preferences (pr) – Brings the **Options** dialog on screen
Preview (pre) – Brings the print/plot preview box on screen
Properties – Brings the **Properties** palette on screen
Psfill – Allows polylines to be filled with patterns
Psout – Brings the **Create Postscript File** dialog on screen
Purge (pu) – Purges unwanted data from a drawing before saving to file
Qsave – Saves the drawing file to its current name in AutoCAD 2010
Quickcalc (qc) – Brings the **QUICKCALC** palette to screen
Quit – Ends a drawing session and closes down AutoCAD 2010
Ray – A construction line from a point
Recover – Brings the **Select File** dialog on screen to allow recovery of selected drawings as necessary
Recoverall – Repairs damaged drawing
Rectang (rec) – Creates a pline rectangle
Redefine – If an AutoCAD command name has been turned off by **Undefine**, **Redefine** turns the command name back on
Redo – Cancels the last **Undo**

Redraw (r) – Redraws the contents of the AutoCAD 2010 drawing area
Redrawall (ra) – Redraws the whole of a drawing
Regen (re) – Regenerates the contents of the AutoCAD 2010 drawing area
Regenall (rea) – Regenerates the whole of a drawing
Region (reg) – Creates a region from an area within a boundary
Rename (ren) – Brings the **Rename** dialog on screen
Revcloud – Forms a cloud-like outline around objects in a drawing to which attention needs to be drawn
Ribbon – Brings the ribbon on screen
Ribbonclose – Closes the ribbon
Save (Ctrl + S) – Brings the **Save Drawing As** dialog box on screen
Saveas – Brings the **Save Drawing As** dialog box on screen
Saveimg – Brings the **Render Output File** dialog on screen
Scale (sc) – Allows selected entities to be scaled in size – smaller or larger
Script (scr) – Brings the **Select Script File** dialog on screen
Setvar (set) – Can be used to bring a list of the settings of set variables into an AutoCAD Text window
Shape – Inserts an already loaded shape into a drawing
Shell – Allows MS-DOS commands to be entered
Sketch – Allows freehand sketching
Solid (so) – Creates a filled outline in triangular parts
Spell (sp) – Brings the **Check Spelling** dialog on screen
Spline (spl) – Creates a spline curve through selected points
Splinedit (spe) – Allows the editing of a spline curve
Status – Shows the status (particularly memory use) in a Text window
Stretch (s) – Allows selected entities to be stretched
Style (st) – Brings the **Text Styles** dialog on screen
Tablet (ta) – Allows a tablet to be used with a pointing device
Tbconfig – Brings the **Customize User Interface** dialog on screen to allow configuration of a toolbar
Text –Allows text from the Command line to be entered into a drawing
Thickness (th) – Sets the thickness for the Elevation command
Tilemode – Allows settings to enable Paper Space
Tolerance – Brings the **Geometric Tolerance** dialog on screen
Toolbar (to) – Brings the **Customize User Interface** dialog on screen
Trim (tr) – Allows entities to be trimmed up to other entities
Type – Types the contents of a named file to screen
UCS – Allows selection of **UCS** (User Coordinate System) facilities
Undefine – Suppresses an AutoCAD command name
Undo (u) (Ctrl + Z) – Undoes the last action of a tool
View – Brings the **View** dialog on screen
Vplayer – Controls the visibility of layers in Paper Space
Vports – Brings the **Viewports** dialog on screen

Vslide – Brings the **Select Slide File** dialog on screen
Wblock (w) – Brings the **Create Drawing File** dialog on screen
Wmfin – Brings the **Import WMF** dialog on screen
Wipeout – Forms a polygonal outline within which all crossed parts of objects are erased
Wmfopts – Brings the **WMF in Options** dialog on screen
Wmfout – Brings the **Create WMF File** dialog on screen
Xattach (xa) – Brings the **Select Reference File** dialog on screen
Xline – Creates a construction line
Xref (xr) – Brings the **Xref Manager** dialog on screen
Zoom (z) – Brings the zoom tool into action

3D tools

3darray – Creates an array of 3D models in 3D space
3dface (3f) – Creates a 3- or 4-sided 3D mesh behind which other features can be hidden
3dmesh – Creates a 3D mesh in 3D space
3dcorbit – Allows methods of manipulating 3D models on screen
3ddistance – Allows the controlling of the distance of 3D models from the operator
3dfly – Allows walkthroughs in any 3D plane
3dforbit – Controls the viewing of 3D models without constraint
3dmove – Shows a 3D move gizmo. Moves 3D objects
3dorbit (3do) – Allows a continuous movement and other methods of manipulation of 3D models on screen
3dorbitctr – Allows further and a variety of other methods of manipulation of 3D models on screen
3dpan – Allows the panning of 3D models vertically and horizontally on screen
3drotate – Displays a 3D rotate gizmo. Rotates 3D objects
3dscale – Shows a 3D scale gizmo. Scales 3D objects
3dsin – Brings the **3D Studio File Import** dialog on screen
3dsout – Brings the **3D Studio Output File** dialog on screen
3ddwf – Brings up the **Export 3D DWF** dialog on screen
3dwalk – Starts walk mode in 3D
anipath – Opens the **Motion Path Animation** dialog
Align – Allows selected entities to be aligned to selected points in 3D space
Ameconvert – Converts AME solid models (from Release 12) into AutoCAD 2000 solid models
Box – Creates a 3D solid box

Cone – Creates a 3D model of a cone
convertoldlights – Converts lighting from previous releases to AutoCAD 2010 lighting
convertoldmaterials – Converts materials from previous releases to AutoCAD 2010 materials
convtosolid – Converts plines and circles with thickness to 3D solids
convtosurface – Converts objects to surfaces
Cylinder – Creates a 3D cylinder
Dducs (uc) – Brings the **UCS** dialog on screen
Edgesurf – Creates a 3D mesh surface from four adjoining edges
Extrude (ext) – Extrudes a closed polyline
Flatshot – Brings the **Flatshot** dialog to screen
Freepoint – Point light created without settings
Freespot – Spot light created without settings
Helix – Constructs a helix
Interfere – Creates an interference solid from a selection of several solids
Intersect (in) – Creates an intersection solid from a group of solids
Light – Enables different forms of lighting to be placed in a scene
Lightlist – Opens the **Lights in Model** palette
Loft – Activates the **Loft** command
Materials – Opens the **Materials** palette
Matlib – Outdated instruction
Mesh – Can be used to set tessellations for a 3D primitive
Meshrefine – Refines the meshing of a 3D object
Meshsmooth – Increases the smoothness of 3D objects
Meshsmooth – Smoothes outlines of 3D objects
Mirror3d – Mirrors 3D models in 3D space in selected directions
Mview (mv) – When in PSpace brings in MSpace objects
Pface – Allows the construction of a 3D mesh through a number of selected vertices
Plan – Allows a drawing in 3D space to be seen in plan (UCS World)
Planesurf – Creates a planar surface
Pointlight – Allows a point light to be created
Pspace (ps) – Changes MSpace to PSpace
Pyramid – Creates a pyramid
-render – Can be used to make rendering settings from the command line. Note the hyphen (**-**) must precede **render**
Renderpresets – Opens the **Render Presets Manager** dialog
Renderwin – Opens the **Render** window
Revolve (rev) – Forms a solid of revolution from outlines
Revsurf – Creates a solid of revolution from a pline
Rmat – Brings the **Materials** palette on screen
Rpref (rpr) – Opens the **Advanced Render Settings** palette

Section (sec) – Creates a section plane in a 3D model
Shade (sha) – Shades a selected 3D model
Slice (sl) – Allows a 3D model to be cut into several parts
Solprof – Creates a profile from a 3D solid model drawing
Sphere – Creates a 3D solid model sphere
Spotlight – Creates a spotlight
Stlout – Saves a 3D model drawing in ASCII or binary format
Sunproperties – Opens the **Sun Properties** palette
Sweep – Creates a 3D model from a 2D outline along a path
Tabsurf – Creates a 3D solid from an outline and a direction vector
Torus (tor) – Allows a 3D torus to be created
Ucs – Allows settings of the UCS plane
Union (uni) – Unites 3D solids into a single solid
View – Creates view settings for 3D models
Visualstyles – Opens the **Visual Styles Manager** palette
Vpoint – Allows viewing positions to be set from *x,y,z* entries
Vports – Brings the **Viewports** dialog on screen
Wedge (we) – Creates a 3D solid in the shape of a wedge
Xedges – Creates a 3D wireframe for a 3D solid

Internet tools

Etransmit – Brings the **Create Transmittal** dialog to screen
Publish – Brings the **Publish** dialog to screen

Appendix B

Some set variables

Introduction

AutoCAD 2010 is controlled by a large number of variables (over 460 in number), the settings of many of which are determined when making entries in dialogs. Others have to be set at the command line. Some are read-only variables which depend upon the configuration of AutoCAD 2010 when it was originally loaded into a computer (default values). Only a limited number of the variables are shown here.

A list follows of those set variables which are of interest in that they often require setting by *entering* figures or letters at the command line. To set a variable, enter its name at the command line and respond to the prompts which arise.

To see all set variables, *enter* **set** (or **setvar**) at the command line:

```
Command:enter set right-click
SETVAR Enter variable name or ?:enter ?
Enter variable name to list <*>:right-click
```

And a Text window opens showing a first window with a list of the first of the variables. To continue with the list press the **Return** key when prompted and at each press of the **Return** key another window opens.

To see the settings for each set variable *enter* the name of the variable at the command line, followed by pressing the **F1** key, which brings up the **Help** screen, *click* the search tab, followed by *entering* set variables in the **Ask** field. From the list then displayed the various settings of all set variables can be read.

Some of the set variables

ANGDIR – Sets angle direction. **0** counterclockwise; **1** clockwise
APERTURE – Sets size of pick box in pixels
AUTODWFPUBLISH – Sets **Autopublish** on or off
BLIPMODE – Set to **1** marker blips show; set to **0** no blips
COMMANDLINE – Opens the command line palette
COMMANDLINEHIDE – Closes the command line palette
COPYMODE – Sets whether **Copy** repeats

Note

DIM variables – There are over 70 variables for setting dimensioning, but most are in any case set in the **Dimension Styles** dialog or as dimensioning proceeds. However, one series of the **Dim** variables may be of interest:

DMBLOCK – Sets a name for the block drawn for an operator's own arrowheads. These are drawn in unit sizes and saved as required

DIMBLK1 – Operator's arrowhead for first end of line

DIMBLK2 – Operator's arrowhead for other end of line

DRAGMODE – Set to **0** no dragging; set to **1** dragging on; set to **2** automatic dragging
DRAG1 – Sets regeneration drag sampling. Initial value is 10
DRAG2 – Sets fast dragging regeneration rate. Initial value is 25
FILEDIA – Set to **0** disables **Open** and **Save As** dialogs; set to **1** enables these dialogs
FILLMODE – Set to **0** hatched areas are filled with hatching; set to **0** hatched areas are not filled; set to **0** and plines are not filled
GRIPS – Set to **1** and grips show; set to **0** and grips do not show
LIGHTINGUNITS – Set to **1** (international) or **2** (USA) for photometric lighting to function
MBUTTONPAN – Set to **0** no *right-click* menu with the Intellimouse; set to **1** Intellimouse *right-click* menu on
MIRRTEXT – Set to **0** text direction is retained; set to **1** text is mirrored
NAVVCUBE – Sets the **ViewCube** on/off
NAVVCUBELOCATION – Controls the position of the **ViewCube** between top-right (**0**) and bottom-left (**3**)
NAVVCUBEOPACITY – Controls the opacity of the **ViewCube** from **0** (hidden) to **100** (dark)
NAVVCUBESIZE – Controls the size of the **ViewCube** between **0** (small to **2** (large)
PELLIPSE – Set to **0** creates true ellipses; set to **1** polyline ellipses
PERSPECTIVE – Set to **0** places the drawing area into parallel projection; set to **1** places the drawing area into perspective projection
PICKBOX – Sets selection pick box height in pixels
PICKDRAG – Set to **0** selection windows picked by two corners; set to **1** selection windows are dragged from corner to corner
RASTERPREVIEW – Set to **0** raster preview images not created with drawing; set to **1** preview image created
SHORTCUTMENU – For controlling how *right-click* menus show: **0** all disabled; **1** default menus only; **2** edit mode menus; **4** command mode menus; **8** command mode menus when options are currently available. Adding the figures enables more than one option

SURFTAB1 – Sets mesh density in the M direction for surfaces generated by the **Surfaces** tools

SURFTAB2 – Sets mesh density in the N direction for surfaces generated by the **Surfaces** tools

TEXTFILL – Set to **0** True Type text shows as outlines only; set to **1** True Type text is filled

TIILEMODE – Set to **0** Paper Space enabled; set to **1** tiled viewports in Model Space

TOOLTIPS – Set to **0** no tooltips; set to **1** tooltips enabled

TPSTATE – Set to **0** and the Tool Palettes window is inactive; set to **1** and the Tool Palettes window is active

TRIMMODE – Set to **0** edges not trimmed when **Chamfer** and **Fillet** are used; set to **1** edges are trimmed

UCSFOLLOW – Set to **0** new UCS settings do not take effect; set to **1** UCS settings follow requested settings

UCSICON – Set **OFF** UCS icon does not show; set to **ON** it shows

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Page numbers followed by *f* and *n* indicate figures and notes, respectively

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