DeskArtes

Industrial Design System

Tutorial

Second Edition

David Cheshire and Charles Woodward: "DeskArtes Tutorial: A Practical Guide to Computer-Aided Industrial Design".

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Trade Marks

Credits

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INTRODUCTION

The System

DeskArtes is a Computer Aided Industrial Design (CAID) system. It covers all the stages of design from first sketches to final models. It connects you to Desk Top Publishing (DTP), Computer Aided Drafting (CAD), Engineering and Manufacturing (CAE/CAM), and Rapid Prototyping (RP) systems.

Using DeskArtes you may easily create different forms for your designs. Different design alternatives can be experimented with and compared on the computer screen until the optimum solution is found. You may freely experiment with shape, colors, materials, and textures. Produce preview renders of your designs as you work, tuning them up to photographic quality final presentation renderings, with features like mirror reflection, transparency, and textured surfaces. On completion, your design information can be electronically transferred to other systems and output devices via one of many international standards. DeskArtes is easy to learn, yet powerful and efficient to use.

About this Tutorial

This Tutorial is designed for you to quickly become acquainted with the DeskArtes industrial design system. In fact, it goes through practically *all* the functionality with DeskArtes. Spend a couple of days with the Tutorial now, and you'll get to know the most efficient ways to create your own designs.

Before you begin

Before you start using this Tutorial, you should have DeskArtes installed on your workstation, you should have the workstation switched on, you should have logged in, and you should have the Motif windowing environment running. If you have trouble with any of these, please consult the installation instructions in the DeskArtes Technical Manual, or call your DeskArtes or workstation dealer.

Command Reference

A full explanation of every command is included in the DeskArtes Reference Manual. You may wish to refer to it from time to time if you meet with a particularly interesting subject, or if you run into any trouble.

Notation

Pay attention to the text in the margin: it contains information of importance to you as you progress.

New terminology in the text is introduced with ***bold italic*** typeface. Other important words and phrases are emphasized with *plain italic*.

The names of menus, commands and buttons, as well as other computer terminology, are printed in `This Typeface`.

Command shortcuts are expressed in brackets, *e.g.*, `[b]`.

Editing functions are written with bold typeface, *e.g.*, **b**.

This is a note.

This is a technical tip.

This shows where to find further instructions.

We finished something!

Parts and Lessons

The Tutorial is divided into four major Parts, called Basics, Modeling Principles, Visualization, and Further Modeling. The Chapters are further divided into Lessons, each with their particular subjects to teach.

The Basics Part consists of four Lessons. They teach you the general user interface and interaction principles, while you design and render a simple example model. It will give you a feel on how DeskArtes is operated, and build up your confidence before moving on to more challenging designs.

⌚ 2 – 4 hours.

The Modeling Principles Part consists of six Lessons. The first Lesson is still concerned with quite basic functionality, such as editing and transforming curves. The next four Lessons go into more the powerful modeling techniques available in DeskArtes, building, trimming and blending of surfaces, using command sequences, etc. These exercises allow you to create quite a demanding, pleasing model. The final Lesson in this Part teaches you to produce dimensioned drawings of the model, and how to transport it to other systems.

⌚ 6 – 10 hours.

The Visualization Part has five Lessons that cover all aspects of visualizing the model you've just created. It includes composing the scene, assigning material properties and textures, setting of light points, different modes of fast shading, using DeskArtes's painting program, and finally, producing photographic quality images with ray tracing. As you proceed, you'll also learn about various ways of file management with DeskArtes.

⌚ 4 – 6 hours.

After these three Tutorial parts you will be capable of producing many of your own designs and may want to take time out to practice and consolidate what you have learned. When you feel confident with the fundamental design methods, you may progress to the Further Modeling Part. Its four Lessons give you a chance to complete further exercises, and teach you which techniques are best used for different kinds of work.

⌚ Take your time!

Demo files

As you progress, you may want to review the original models used to illustrate this Tutorial: they are supplied with DeskArtes in the directory `DA_tutorial`.

Some additional models, and images, are provided in the directory `DA_DEMO`. To view these files, you must basically do as follows (details are explained later in this Tutorial):

To read a demo file

1. Display the file window by holding don the SHIFT-key, and clicking the *middle* mouse button with the cursor in the graphics window.

2. Select the `DA_tutorial` (or `DA_DEMO`) directory by pointing and clicking with the *left* mouse button in the left hand field of the file window.

3. You may scroll in the middle field to see all the file names. Double click (two clicks in fast succession) on the file you want to read (`geom_` for a model file, or `expic_` for an image).

4. To get rid of an image, just press “q” on the keyboard, with the cursor in the image window.

   To get rid of a model, click on the “root” title bar of the object, and press “k” on the keyboard (shortcut for deleting an object).

Technical Notes

DeskArtes has been designed to be as tolerant as possible against any kinds of errors. However, something may always go wrong. To avoid the unnecessary errors, you are requested to keep in mind the following ground rules while working through this Tutorial:

- Some command may be interrupted by pressing the `ESC` key during computation. You may also at any time break a command's execution with the `CANCEL` button provided in the dialog boxes.

  Otherwise, *most commands cannot be interrupted.* In such case, *wait for the command must be completed*, even if the command is not doing what you intended to.

  After the command is completed, you may *cancel* it by using `UNDO` in the settings window (at the right), or with one of the edit mode cancel functions.

- *You may not execute several commands at the same time.* Trying to start a new command in the middle of the previous one is usually prevented by the system, but it could lead to an error if attempted.

In the worst case, erroneous actions may actually *crash* the program. However, even if this should happen nothing is lost! No matter what caused the problem, even a power failure, you may always *continue* right from the latest modeling situation by following these simple steps:

- start DeskArtes as described at the beginning of Lesson 1,
- select your model directory, as described at the beginning of Lesson 5,
- select the `UNDO` command from the settings window.

! If your ***workstation*** crashed, like dropping from the 13th floor, we hope you made a ***backup*** copy of your files.

Demo version

If you haven't actually purchased DeskArtes yet, you may be running a ***demo version*** of it. This will be highlighted by the words "Demo Version" in the title bar of the DeskArtes user interface window.

The demo version enables you to try out all of the functionality, but it puts certain limits to the visualization accuracy, and after a certain ***model size limit*** it won't allow you to output any files. In particular, the UNDO command won't work after the size limit has been exceeded.

This Tutorial has been designed so that you may carry out the Lessons 1–7 within memory limits of the demo version. The remaining Lessons, however, you will have to do without UNDO.

PART I: BASICS

The following four Lessons give the first introduction to using DESKARTES. You will design and visualize a shampoo bottle, consisting of a bottle and a cap. This is a very simple shape and the intention is to give you a quick overview of the general procedures required to design models. Later in the Tutorial you will create more complex models using basically the same procedures as described here.

You will learn how to start and finish a modeling session, create your model directory, create curves, make simple surfaces by rotation and, finally, save your work. You will also be introduced to controlling the way your model looks on the screen and rendering the object with fast shading. Pay particular attention to the hierarchy of objects described here as this is fundamental to all modeling work in DESKARTES.

Illustrations are provided to help clarify the design process, but you might wish to do something a bit different adding your own design flair. You may do so, but the first time you work through the Tutorial it is recommended that nothing too radical is attempted. Later, when you fully understand the procedures, you can return to the Tutorial and let your imagination run wild.

Lesson 1 : Getting Started

In this Lesson you will learn the basic techniques you will use every time you start modeling. You might get the feeling that you have to do a lot without anything interesting happening. However, be patient: once you familiarize yourself with these basic routines, you will be able to concentrate on the actual modeling.

You will learn how to

- *use the mouse*
- *start DeskArtes*
- *make a model directory*
- *work with pop-up windows and menus*
- *work with pull-down menus*
- *work with dialog boxes*
- *create the objects you need for your model*

Meet the mouse

DeskArtes is ***mouse*** controlled. The mouse is the small device attached to your workstation by a wire, sitting on a pad usually to the right of your keyboard. When you move the mouse, a small object moves on the screen. It is called the ***cursor***.

Rest your hand on the mouse with it's 'tail', the wire away from your arm. When you move the mouse forward away from your body the cursor should move up the screen, when you drag the mouse towards you the cursor should move down the screen. Left and right movements of the mouse will be similarly imitated by the cursor.

In the beginning, you might find it a bit difficult to get the cursor to go where you want. Don't worry: it doesn't take long for it to become a natural movement. Also, note that if you run out of space on the mouse pad, simply lift and move the mouse to a better position: the cursor only moves when the mouse is on the pad.

The position of the cursor is very important: it often determines what happens when you do something, such as pressing one of the mouse buttons, or a key on the keyboard. Usually, you do things by *pointing* with the cursor, and *pressing* or *clicking* one of the three mouse buttons.

Some actions, such as popping up windows, may require *holding the SHIFT- or the CTRL-key down* when clicking the mouse button.

✍ You may change some mouse-key combinations to your liking from the `SYSTEM` menu.

The shape of the cursor varies according to the situation, giving you visual feedback. Much of the time it looks like an arrow. At other times it might look like a cross or a watch.

Starting DeskArtes

The command that starts DeskArtes is "`DA`". Move the mouse so that the cursor (that looks like an x) is within a ***command shell window***. A window is a rectangular object on the screen of your workstation, consisting of a frame and something inside.

✍ Type DA in UPPERCASE LETTERS, hold the `Shift` key down while typing.

The command shell window displays a ***prompt***, for example:

```
deskartes%_
```

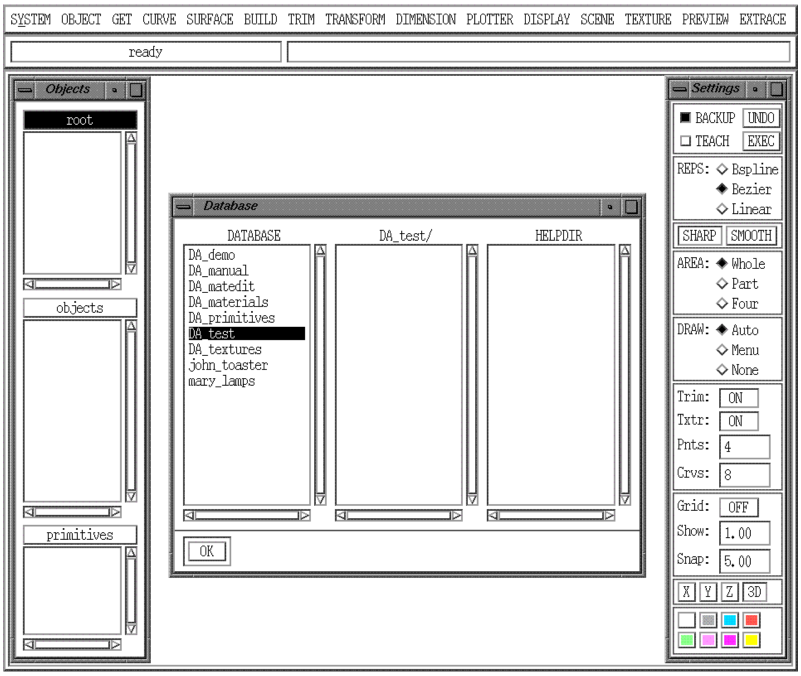
The appearance of the prompt may vary on you system.

To start DeskArtes:

1. *Hold* the `Shift` button down, type `DA` while holding, and hit the `Return` (↵) key.

2. Wait a while.

✌ ***You have DeskArtes running on your workstation.***



A number of windows should show up. You now have DeskArtes running on your workstation.

? *Nothing showed on the screen when I typed* `DA`.

You didn't have the cursor within the command shell window. Move the mouse so that the cursor is in the window, and try again.

? *DeskArtes didn't start when I typed* `DA` *and hit the Return (↵) key*.

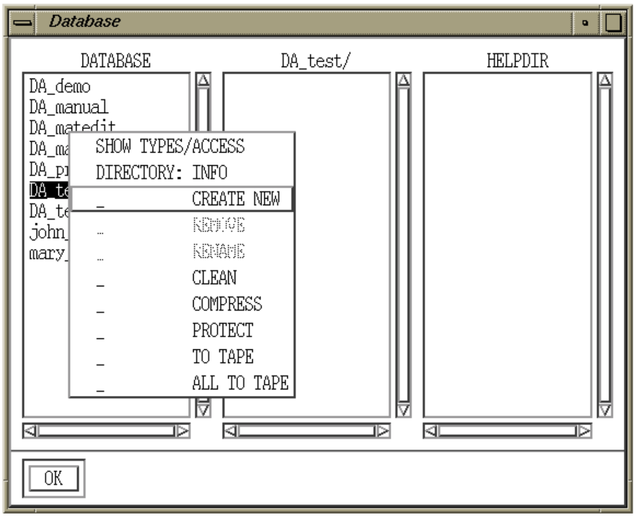
If you didn't make a typing error, you have a problem with the installation. Refer to the installation instructions in the DeskArtes Technical Manual, or ask your software dealer for help.

Making a model directory

The first thing you need to do when you start working with DeskArtes for the first time is to create a ***model directory***. A model directory is like a folder where you store all your models. By storing different people's models in different directories we keep them in order.

You will handle directories and files with the commands within the DeskArtes ***file window***. The file window appears and disappears again if you *hold down the SHIFT key*, and click the *middle* mouse button in the main graphics window. When DeskArtes is started, the file window is automatically displayed.

The file window is divided into three vertical fields containing lists of information.



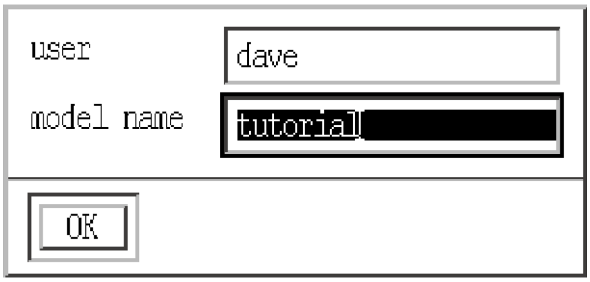
To create your own model directory:

1. Move the mouse so that the cursor is over the left-hand field of the file window. *Press and hold* the *middle* mouse button. A list of commands ("***menu***") pops up.

2. Still holding the mouse button, find the line that reads `DIRECTORY: CREATE NEW`. *Move* the cursor on to it so that it is highlighted. *Release* the mouse button.

From now on, whenever you are told to select something from a pop-up menu, do as here: move the cursor to the required location, press and hold the middle mouse button, drag the cursor to the desired item, and release the mouse button.

A ***dialog box*** pops up above the file window. DESKARTES pops up a dialog box whenever it needs you to give some additional information.



When asked to *type* something into a part of a dialog box, *click* to select that part with the cursor, then type.

To move to the next field in a dialog box, you could also press the `tab` key on the keyboard.

1. The part of the dialog box that says

   `user:`

   is highlighted. Move the cursor into the dialog box, and type your name (as “dave” above). Use the `Backspace` (←) key if you make a typing error.

2. Click at the second line, which says

   `model name:`

   Type

   `tutorial`

3. Click on the `OK` button at the bottom left corner of the dialog box when you have finished, or press the return key to the same effect.

Now that you have created a model directory for the bottle, you should hide the file window.

4. Click on the `OK` button in the lower left corner of the file window.

You are now ready to start modeling.

✌ ***You have created a model directory.***

Initializing the model

Object hierarchy

Within DeskArtes, the things you design consist of ***surfaces***, which are in turn defined with ***curves***.

Curves and surfaces that belong together are stored in so-called ***elements***. In other words, an element usually contains a surface with all the information that defines it.

Finally, the top or ***root level*** contains all the elements within a model.

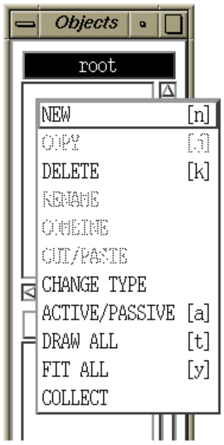
For instance, the shampoo bottle you are about to create will consist of two elements, the bottle and the cap. Each element holds the corresponding surfaces and the curves that define the surfaces. This hierarchy is displayed in the ***object window*** on the left of the screen.

Creating an element

To be able to design something, you must first create an element in which to store your design. You will always start creating a new model by making an element for it.

To create a new element:

1. Move the cursor into the tall window at the left side of the screen (the object window).



2. Select the NEW command from the object window pop up menu. (Press and hold middle mouse button, locate command, move mouse to it, release button. Remember?)

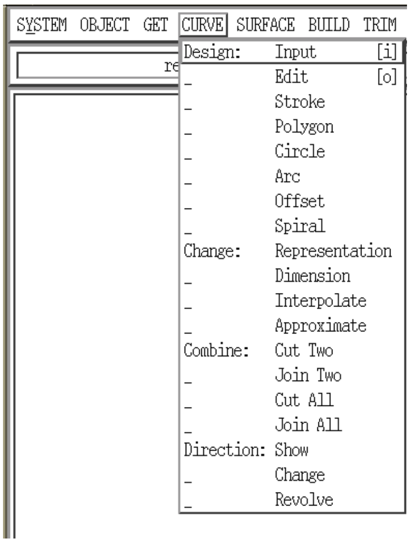
3. The system suggests a name "`part1`" for the element. Instead of accepting it, type `bottle` into the dialog box and click `OK`. Make sure that the cursor is within the window before you start typing.

✌ ***You have created an element for the bottle.***

Look at the object window, on the left side of the screen. It has three sub-windows. The top sub-window is titled `root`. Inside the sub-window, you see the text `bottle`, which is highlighted in black. This is the element you just created. At this stage of course it is nothing more than a name ready to store one part of your design.

Menu commands

Before moving on, let us have a look at the ***menu bar*** across the top of the screen. The menu bar has several names which group together commands with similar functions or that operate on similar objects. When the name of a menu is clicked a list of all of the options in that menu is displayed.



The command you just used to create a new element can also be found in the menu bar. We'll in fact use it in just a while, but let's first just practice digging up a menu.

To view the menu contents:

1. Locate the `OBJECT` menu. It is situated within the menu bar at the top of the screen. Place the cursor so that it is on the text that reads `OBJECT`.

2. *Press and hold* the *left* mouse button. The menu pops up.

3. This time, don't select anything from the menu. Keep holding the mouse button and move the mouse so that it is away from the menu. Release the mouse button, and the menu disappears.

Note on command names

From now on, a command from a window's *pop-up menu* is written as “Window⇒ COMMAND”, ***e.g.***, `Objectﬁ NEW [n]`.

Commands which belong to the menu bar (*pull-down menus*) are written as "MENU⇒ Command", ***e.g.***, `OBJECT⇒ New [n]`.

The “object” commands may be chosen either from the pop-up menu, or the pull-down menu, just as you prefer. There is no risk of confusion, by the way. All the pop-up menu commands are written in capital letters, and those in the pull-down menus in lower case.

Shortcuts

Note also the ***keyboard shortcuts***. which are assigned to the most often used commands, such as `[n]` for `OBJECT⇒ New`. The available shortcuts are shown within brackets [ ] after the menu items.

You know where and how to find commands.

You can execute a menu command simply by hitting the shortcut letter on the keyboard when the cursor is over the main graphics window. Once you learn the shortcuts, this is much faster than going to the menus with the mouse.

Curve sets

Now let's get back to what we were doing. You have created an element for the bottle. Next you will start designing some curves in it.

However, curves are not stored directly under elements. You must create a ***curve set*** to hold your curves. This is because curves can be used to control different things in DESKARTES.

Basically, there are two main kinds of curve sets: ***projection sets*** and ***section sets***. The type of curve set determines the way DESKARTES uses the curves to make surfaces. Projections define the surface’s side view, while section curves give the surface its cross-sectional shapes.

For the bottle you will create a projection set, defining the surface’s shape from the ***x-direction*** of the three-dimensional space.

To create an x projection set:

1. Select the command `OBJECT`⇒ `New [n]` from the main menu bar: dig up the menu as it was explained above, move the mouse to the first menu item, and release the mouse button.

2. Now a dialog box pops up, asking what type of an object you want to create. Click at the line that says

   `projection`

   and click at `OK`.

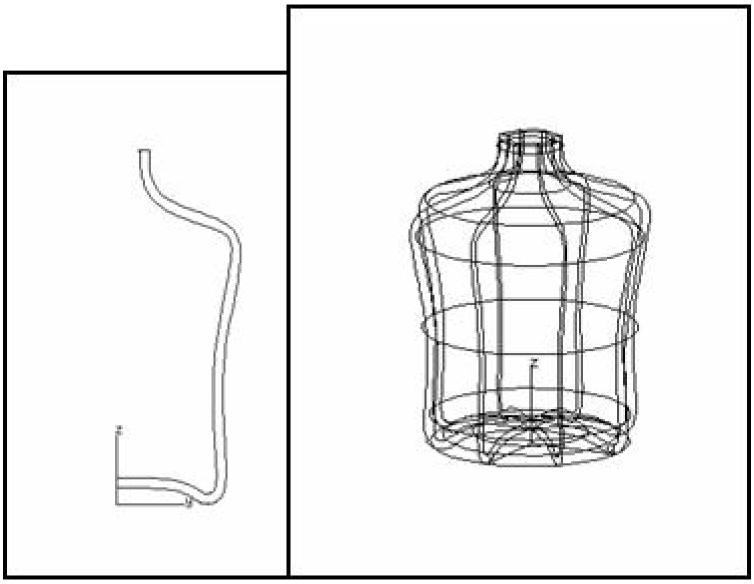
3. Another dialog box pops up, asking which projection direction you want. You want to create an x projection set, so click at `x` and then at `OK`.

Now you have an x projection set for your curves. In the middle sub-window of the object window (entitled `bottle`, the name of your element), you see the text `Projections/X`. This is the set you created. Currently it is just an empty object ready to store a curve.

✌ ***Now you are ready to actually start designing!***

Lesson 2 : The Bottle

In the next few pages, you will design a bottle based on its ***side view***, like this:



The curve only shows half of the bottle because you will finally rotate the curve 360 degrees around the vertical, z axis to make a circular bottle.

Inputting the curve

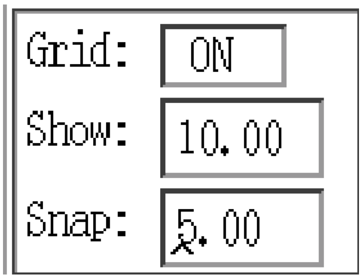
For designing the curve we will use a reference ***grid*** to help locate the points.

Using the grid

The grid helps you to gauge the size of an object, and allows you to place the curve points accurately at fixed spacing. The grid commands are located in the vertical window on the right of your screen entitled the ***Settings***. This window contains many regularly used functions.

To use the grid :

1. Click at the `Grid: OFF` button in the settings window on the right hand side of the screen.



The `OFF` text changes to `ON`, and the grid is displayed.

2. The density of the visible grid lines may be controlled with the `Show` parameter below `Grid`.

3. The coordinates of any point placed on the screen will be rounded to the nearest multiple of the `Snap` parameter. The `Show` parameter value is normally a multiple of `Snap`.

You may change either one or both of these values by typing a value into the number field. However, if you change the `Show` value, the change will be shown on screen only after your next displaying command. So don't change it now—before continuing with the next section make sure the `Grid` is `ON` with a `Show` of 10 and a `Snap` of 5.

Input mode

To start designing the curve, you must get into the correct ***mode*** for entering the curve points. DeskArtes works in two different modes: ***command mode*** is where you have been so far. There you handle *objects* (or pictures) using the ordinary menu commands.

The modes for working with individual *points* (curve points, light points, pixels, etc.) are called ***edit modes***. There you will use what we call as ***functions***, while the ordinary commands are not available.

We will next enter one of the edit modes, the ***curve input mode***. To start the curve input mode, you must choose the appropriate command from the `CURVE` menu.

To input a curve:

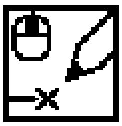
1. Check to see that the x projection set you created is still highlighted in the object window. If not, click on it.

2. Select the menu command `CURVE`⇒ `Design: Input [i]`.

Now you are all set to draw the curve. Notice that some small pictures, or ***icons*** appear. This happens with all edit modes. The icons represent the editing functions, and vary for the different edit modes, depending on which functions are relevant for the type of editing.

DeskArtes represents curves by using a ***control polygon***. A control polygon is a series of connected line segments. The curve generally follows the shape of the control polygon. When you input a curve, you place the corners of its control polygon, *i.e.*, ***control points***.

This means that at first when you add points they will be joined with straight lines. Don't worry, when you've finished adding points DeskArtes will smooth these out to form a curve.

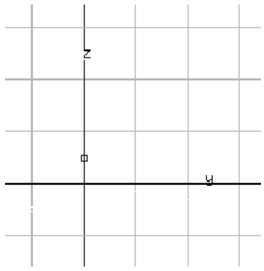


Creating a point

Place the first point:

1. Find the icon for adding a point (as the image above). Click on it.

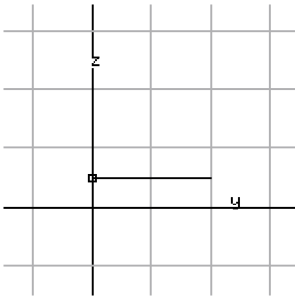
2. Move the cursor on top of the vertical axis and click the *middle* mouse button. The point drops there.



Notice that the top left corner of the icon shows a picture of the mouse with the middle button highlighted. This means that you don't need to click at the icon every time you want to add a point — simply press the middle mouse button directly where you wish to place the point.

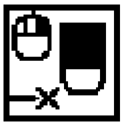
Similarly, all other icons have a ***function key*** at their top left corner. For most of the icons, this is a letter, and for others, it is a mouse button. To perform the function, simply hit the key in question.

Now, place the second point to the left of the first one. Try using the middle mouse button directly instead of going to the icons. Press and hold the middle mouse button to create the point, move the cursor to where you want the point to be (right to the first point, as shown below), and release the mouse button.



If you made an error in placing the point, you may backtrack with the following function:

Removing the last point



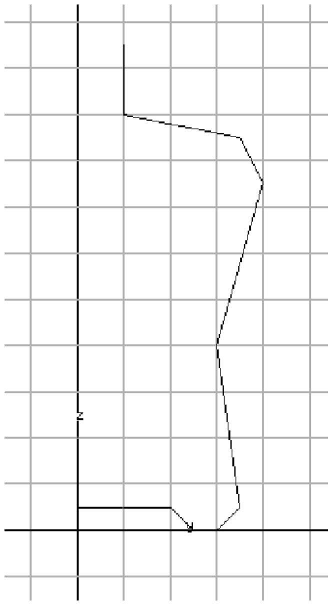
To remove the last point:

- Click on the eraser icon,
- or click the *right* mouse button.

Try it and see the last point vanish.

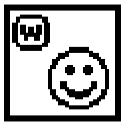
Completing the curve

Now, place the rest of the points the same way you placed the first two.



To complete the curve:

- Move the mouse and use the middle mouse button to place the rest of the points. By counting the grid squares try to copy the shape of the curve in the above diagram as closely as possible.



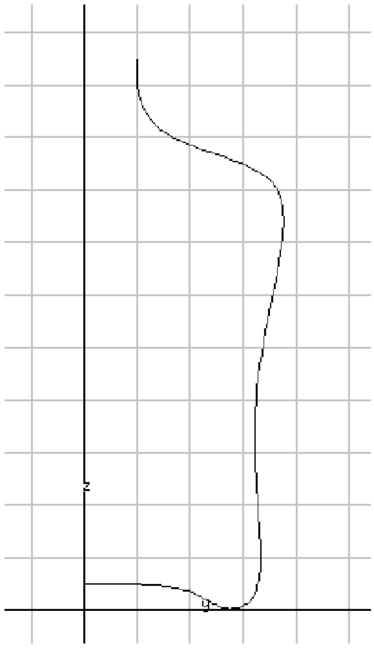
Getting out of input mode

To get out of input mode:

You have drawn a curve.

- Click on the Smile icon, or press **`w`** on the keyboard.

The icons vanish, and the polygon changes to a smooth curve.



Turning off the grid

We have finished with the grid so we can turn it off now.

To turn off the grid

- Click at the `Grid: ON` button in the settings window.

The `OFF` text changes to `ON`, and the grid is no longer displayed.

Fitting the curve on screen

The curve you drew might not appear as large on the screen as you would like. You can ***fit*** it nicely in the middle of the screen at a suitable size.

To fit the object in middle of the screen:

- Select the `DISPLAY⇒ Object: Fit [f]` command from the menu bar.

Deleting the curve

If you completely mess up your curve and feel you would like to start again, ***delete*** it and input another one.

You will find out in the next Lesson that you will be able to further edit the curve, too, if it is not to your liking. But for now if you don't like the curve, delete it and start again. Here is how:

To delete the curve:

- Select the `DELETE` command from the object window pop-up menu or `OBJECT⇒ Delete [k]` from the pull-down menu if you prefer.

If you wish to input a new curve, start over again with `CURVE⇒ Design: Input [i]`. Otherwise just continue reading.

The UNDO command

If you decide that you would like to ***undo*** what you just did (such as deleting an object as described above), click on the `UNDO` button in the settings window (*i.e.*, `Settings`⇒ `UNDO`). This is vital, if for example, you delete the wrong object by mistake.

Try deleting your curve and undoing that.

Creating a surface by rotation

You should now have a curve that looks like one half of the bottle. Now you will ***rotate*** it to create the actual bottle. Having come this far, it is very easy to actually do the rotation.

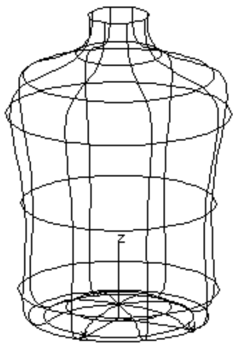
To make a rotational object:

1. Select the command `SURFACE`⇒ `Design: Rotate` from the menu window.

2. A dialog box with some options appears. Accept the default parameters, that is, just click `OK`.

This rotates the selected curve around the z axis to produce a surface: the bottle appears.

You have created a three-dimensional object!



The target object

Take a new look at the object window. You will see the text

`Surf/Bs/rotat`

highlighted in the middle sub-window.

This is the ***object hierarchy*** at work. The top window (root) contains all the elements. One element (in this case only one, `bottle`) may be selected. The middle window has the name of the selected element for a title, and shows all the surfaces and curve sets that the element contains. The line `Surf/Bs/rotat` is selected. The lowest window shows the individual curves that make up the object, in this case, the surface's "control curves".

Most DeskArtes commands require something to work on. This object is known as the ***target object***. Any object specific command, *e.g.*, `OBJECT`⇒ `Delete [k]` would apply just to the target object, and nothing else.

We are next going to do a modeling operation to the surface's projection curve, so we need to make it the target first. This is easy to do through the object window.

To make a curve the target object:

Here you only have one element: it is already selected.

1. If it is not already selected, select the element containing the curve by clicking at it. Its contents appear in the middle sub-window.

2. Click on the curve set containing the curve. In this case, it is the item labeled `Projections/X`. This always appears in the middle sub-window.

You now know what "target object" means.

3. Click on the curve you want to make the target. In this case, it is the only item within the curve set, *i.e.*, the line labeled `1. curve/Bs` in the lower sub-window.

Creating the inner surface

The curve you have drawn represents the outer surface of the bottle. The surface has no thickness at all. A real bottle is should of course have thickness, and to represent this we will design the inside of the bottle, too.

There are several ways of achieving this. The simplest is to extend the curve you have already drawn so that it represents the inside as well. When doing this you need to ensure that the inside is a constant distance from the outside. This can easily be achieved using an ***offset curve*** as follows:

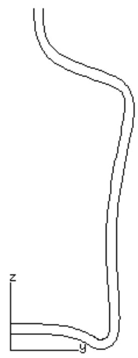
Creating an offset curve

1. Issue the command `CURVE⇒ Design: Offset`.

2. A dialog box pops up which requests the offset distance. Type `3` and click `OK`.

3. A second curve appears and a line is added to the bottom field of the object window (labeled `2. curve/Bs`).

4. It is possible (if you drew the curve in the reverse order, starting from the top) that the offset curve appeared outside the bottle instead of inside. If this happened select `UNDO` from the settings window and repeat steps 1 to 3, but this time type -3 as the offset distance.



☞ See for CURVE⇒ Design Offset in the Reference Manual.

If the offset curve doesn't look quite accurate, don't worry – DESKARTES has ways to make it better.

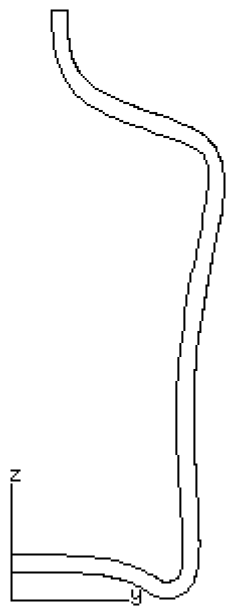
The offset curve is not connected to the original, thus leaving a gap at the top of the neck of the bottle. To fill in this gap we need to ***join*** the two curves.

To join two curves

1. Issue the command CURVE⇒ Combine: Join Two.

2. Click the mouse near the top of the curves, once for each curve, to indicate the ends to be joined. Answer NO to the close curve question.

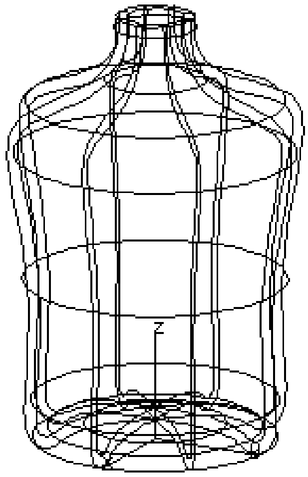
❢ The curve should remain open in the bottom!



The curves are joined to form one single curve which defines both the outside and inside of the bottle.

The surface hasn't changed yet, only the curve has. To make the surface have the inside as well, you must rotate the curve again with `SURFACE⇒ Design: Rotate`.

✌ ***You've just learned to update a surface.***



Lesson 3 : The Cap

Let's introduce a second element to show how to work with *multiple surfaces*. The second element will be a cap on top of the bottle.

To design the cap, you will learn how to edit curves. We will also introduce the concept of ***(cross-)sections*** which will allow you to produce surfaces which are not just circular.

Creating a second element

Since the cap for the bottle is going to be created as a separate surface we will first of all need to create a new element. Do you remember how we created the `bottle` element? Give the command `OBJECT⇒ New [n]`. Select `element` from the next dialog box and type `cap` into the final dialog box that appears. Click `OK`.

Do you remember the next step in creating an element? You must create a curve set to hold your curves. Once again you will create a projection set, defining the surface's shape from the x-direction. Give `[n]` again. Click at the parameter line that says `projection` and click at `OK`. Another dialog box pops up. You want to create an x projection set, so click at `x projection` and then at `OK`.

Inputting another curve

✌ ***Now you are ready to design the cap!***

✍ The command `DISPLAY⇒ All Fit [y]` is very useful. It fits all similar objects on the screen.

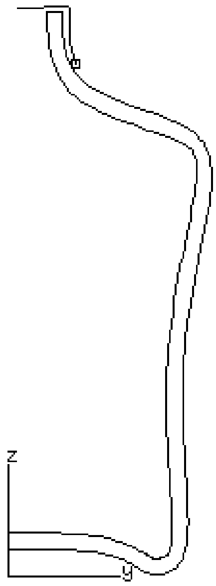
When drawing multiple but related surfaces you should draw the defining curves for each surface in the correct relative positions. In this case you need to ensure the cap sits on top of the bottle. Since this is an important concept DeskArtes provides tools to assist you.

Select the command `DISPLAY⇒ All: Fit [y]`. Since you have an x projection selected, DeskArtes will fit all x projections on the screen. You will see the bottle projection on the screen, while the cap projection still remains selected. We can now input a new curve to define the cap in the correct position on top of the bottle.

This time let's input the curve without the grid – check that `Settings⇒ Grid` is turned to `OFF`.

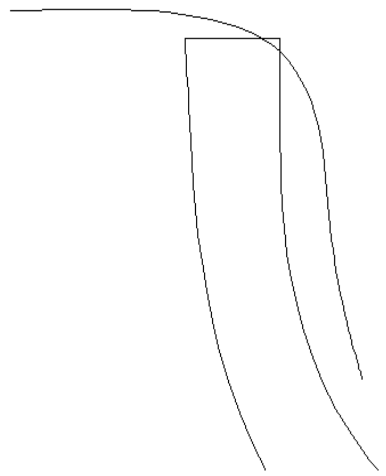
Remember how to input a new curve? Give command `CURVE⇒ Design: Input [i]` function. Position four new points with the middle mouse button, as shown below.

☞ You may look a couple of pages ahead to see the actual points.



Exit from input mode using the Smile icon. The curve changes into a smooth one.

Fit the curve to the middle of the screen using command `DISPLAY⇒ Object: Fit [f]`. Then give command `DISPLAY⇒ All: Draw [t]` to see the bottle projection in the same size.



The curve doesn't look what we want! But don't worry – next you'll get a chance to change it. No matter how carefully you are at inputting a curve you will always want to subsequently modify it’s shape. The best approach to creating a curve is to use the input mode to enter just the very basic shape, and then edit the curve to add the fine detail.

Editing a curve

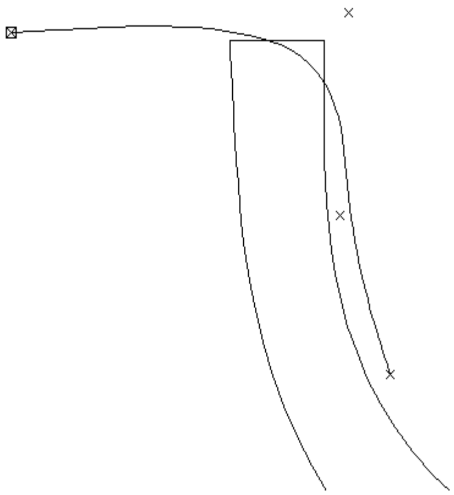
Curves are edited in an edit mode, similar to the input mode used to create them. However, you can do a lot more in curve editing mode than in curve input mode. Among other things, you can add points anywhere in the curve, move existing points freely, relative to other points or using numeric input, and produce sharp or smooth corners.

To help you give the curve the shape you want, some of the most important techniques are described below. Go through the techniques as described, but feel free to experiment with them as much as you like.

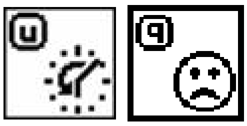
To get into curve edit mode:

• Select the command `CURVE⇒ Change: Edit [o].`

Some icons appear, the control points show up on the curve, and you are ready to go.



To begin with, you will only see a few icons at the top of the icon window. These represent the ***general functions***, related to getting back to command mode, canceling an operation, and selecting more specific functions.



Canceling

Sometimes you might want to ***undo*** something you did while editing. Don't do this now, as you haven't done anything yet, but at any time during editing you can undo the last change made:

To be able to use the undo function, you must not be doing something else. If you change your mind while performing a function, finish it, and then undo it.

To undo the previous operation:

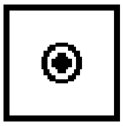
- Click on the icon that looks like a clock running backwards, or press **`u`**.

If you make more than just a single error, you might like to go back to what the curve looked like before you started the editing session. In such case, click at the `Sorry` icon, or press **`q`** on the keyboard. This exits from curve edit mode *without saving the changes made.* Don't do this now, just keep it in mind.

To undo all changes at once:

- Click on the Sorry icon, or press **`q`**.

Use this function if you feel you have completely messed up your curve, then try editing again.



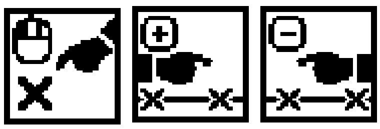
Local functions

Now you are ready actually to start editing.

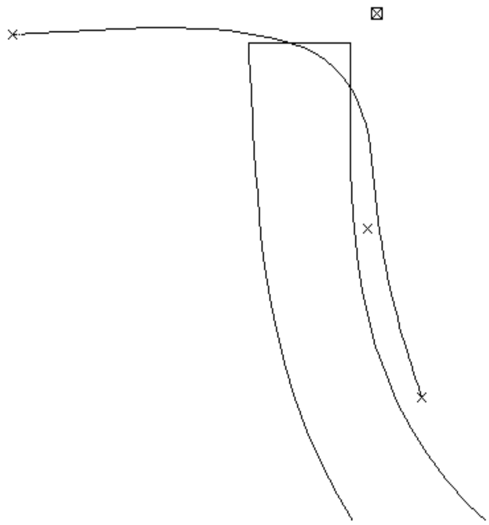
Local functions affect individual points. Such functions include things like moving, adding and deleting points, and producing or removing round corners at selected locations on the curve. You will mostly work with local functions.

To see the local functions:

- Click on the “local” icon.



Selecting a point



Before you can do anything to a point, you must ***select*** it.

To select a point:

- Click at the point with the *left* mouse button, or

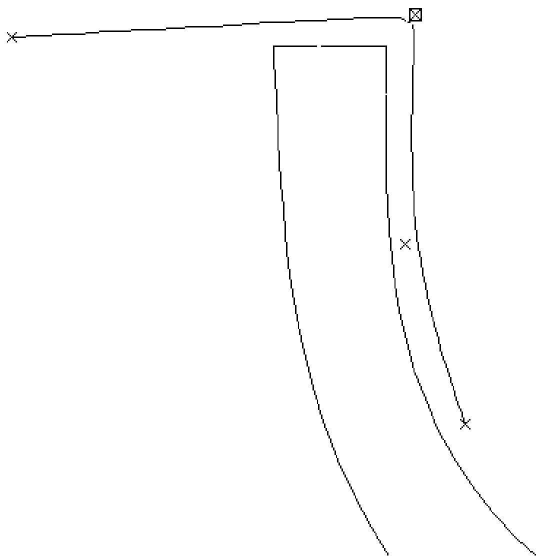
- You may move to the next or previous points on the curve by pressing + or **-** on the keyboard, or by clicking at the respective icons.

The currently selected, ***active point*** is highlighted with a box drawn around it.

Look at the lines above the graphics window: they are called the ***message lines***. One of the lines displays the exact ***coordinates*** of the active point.

❢ When you first start editing a curve the first point in the curve is selected for you.

Making a corner



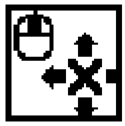
You would now like to pull the curve towards the ***corner point*** of the cap. Here's how:

To make a corner on your curve:

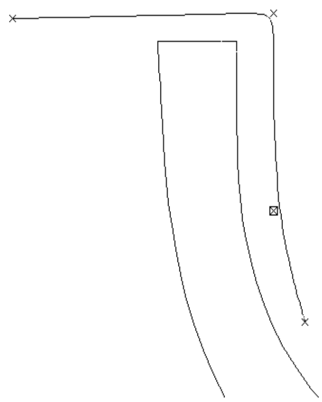
1. Select the point where you want the corner.
2. Click **c** on the keyboard, or click at the “c” icon.

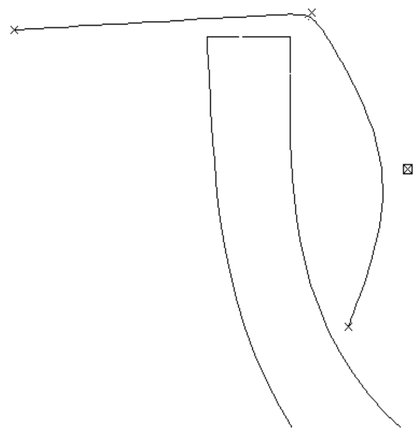
This adds a point on top of the selected one, creating a corner. Such a ***double point*** makes a *soft* corner near the point. If you perform **c** again, the point becomes ***triple*** and it makes a *sharp* corner through the point.

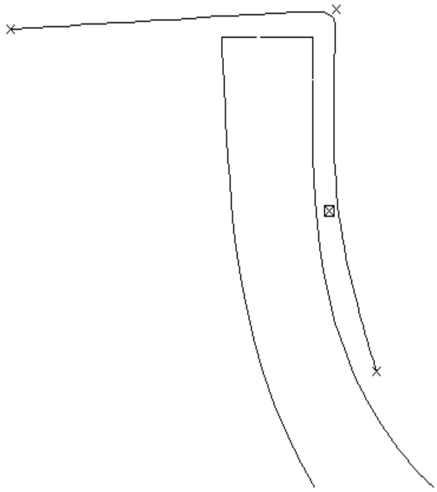
Don't perform **c** on a triple point – it would just complicate things.



Moving a point







The most usual way to modify the curve is by moving the control points. Try it to make the cap follow closer the bottle neck's shape.

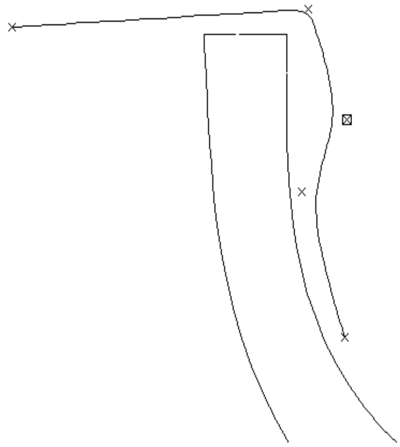
To move a point:

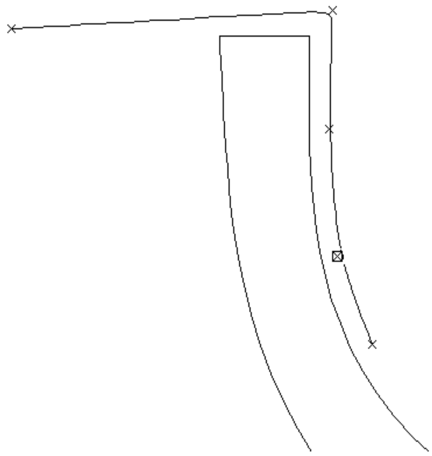
1. Select the point with the *left* mouse button.

2. Press and hold the *middle* mouse button to pick up the point.

3. Move the point freely by moving the cursor. Notice how the shape of the curve is shown as you move the point.

4. Drop it in place by releasing the middle mouse button.





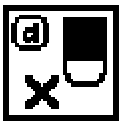
You probably found it difficult to create exactly the shape you wanted just by moving the points. To gain more interaction freedom, you may ***add*** new control points to the curve.

To add points to your curve:

1. Select a point next to where you wish to add the new one.

2. Click at the pencil icon or press **`i`** on the keyboard.

3. Click at the place you want to insert the point with the left mouse button. Move the point as desired, and click again to end the function.



Deleting a point

You may also ***delete*** points from the curve.

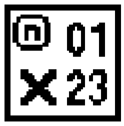
To delete a point:

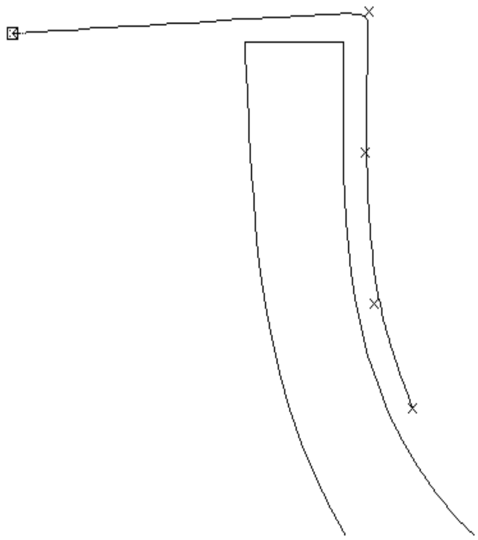
1. Select it.

2. Press **`d`** on your keyboard or click at the eraser icon.

The selected point vanishes. You may use the undo function **`u`** to get it back.

Using the **`d`** option on a *multiple point* reduces the number of points by one each time. So to completely remove a triple point you would need to use **`d`** three times.





The curve's left end should be located on the vertical axis – otherwise the rotated surface will end up with a hole at the top!

A way to place the end point exactly to the axis is to define its location numerically:

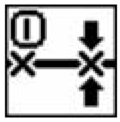
There's an easier way for this: use the **m** function, and click again at the active point!

To define a point numerically

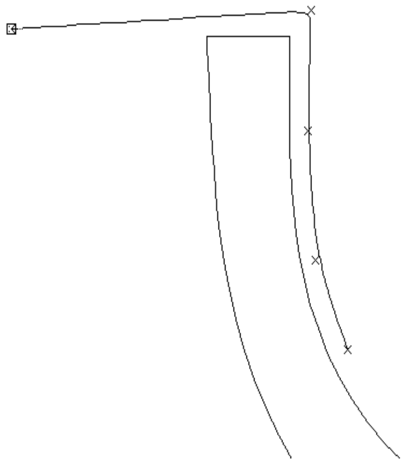
1. Select the curve's left end point.

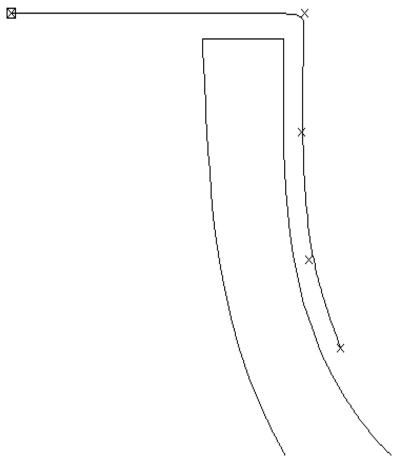
2. Use the **n** function.

3. Give the horizontal `(hor)` coordinate the value zero (0.0), and click `OK`.



Aligning a point with another





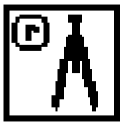
The curve should be flat at the top for the surface to be so. Use the following function:

To line up two points

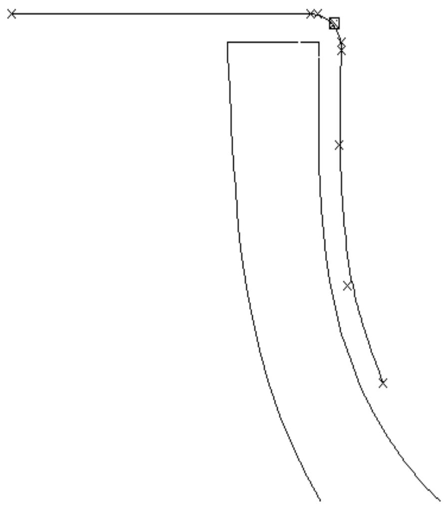
1. Select the curve's left end point.

2. Use the `l` function.

3. Click on the double point next to the selected one. This is to show which is the *target point* you want aligned with the selected one.



Adding a rounding



Finally let's replace the smooth corner with a numerically defined ***rounding***.

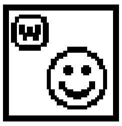
To add a rounding at a point:

1. Select the point for the rounding.

2. Press **`r`** on your keyboard or click at the radius icon.

3. A dialog box appears, asking the size of the radius, and how many points you want to use for the rounding. Answer 1.0 for the radius and accept 5 for the points.

The curve changes into circular corner, a so called ***fillet***, near the selected point.



Exiting curve edit mode

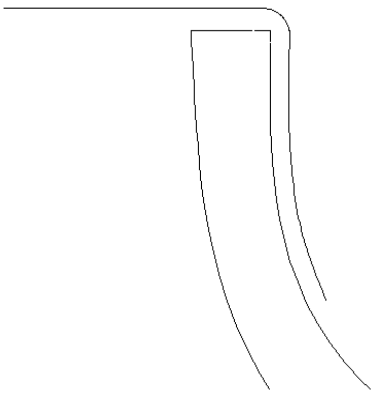
Save the changes you've made.

To exit curve edit mode:

You have learned to edit a curve.

• Press **`w`** on your keyboard, or click at the Smile icon.

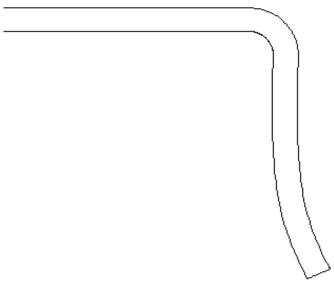
The control points and icons disappear, and you are back in the normal command mode.



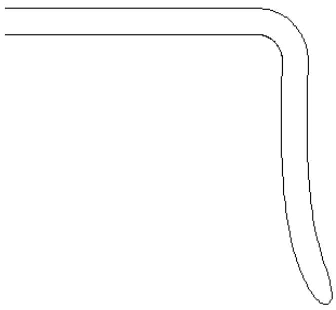
Another offset

Offset this curve to form the outer surface, using command CURVE⇒ Design: Offset and a distance of 1.0. If the curve offsets inwards then UNDO and repeat using -1.0.

Join the two curves to form one, using CURVE⇒ Combine: Join Two.



Notice that as the curves were joined, the end points became triple (sharp). Call CURVE⇒ Change: Edit [o] and make the triple points smoother using the **d** function.



Another surface

Now make a second rotational surface.

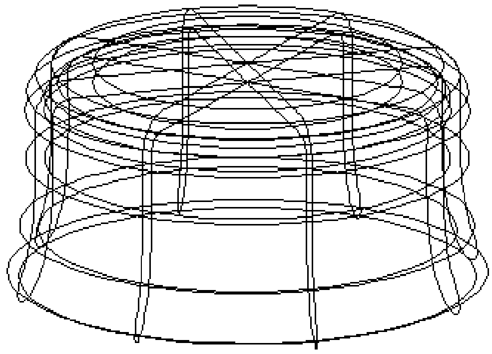
To make a rotational object:

1. Select the command `SURFACE⇒ Design: Rotate` from the menu window.

2. Accept the options for `vertical` rotation axis and `NO` for center at fix point.

The cap appears.

✌ ***You have made another three-dimensional object!***



Displaying multiple surfaces

Display the cap with the bottle surface using the command `DISPLAY⇒ All: Draw [t]`.

Give DISPLAY⇒ All: Fit [y], to ***fit*** both surfaces on the screen.

To find out which surface you have selected, ***blink*** it using the command DISPLAY⇒ Object: Blink [l].

Try also changing the surface's ***display color***. Click on one of the color buttons at the bottom of the settings window (at right), and see what happens.

Free-form rotational surface

What if you want something other than a circular cap? With DeskArtes it’s easy! If you don’t give any more information DeskArtes will assume you require a circular section. But you can define a new curve set containing a curve which defines the shape of the ***cross-section*** you want. Let’s do it.

To create a section set:

1. Select the command OBJECT⇒ New [n].

2. A dialog box pops up, asking what type of object you want to create. Click at the line that says

   cross-section

   and click at OK.

The cap element now has two curve sets: Projections/X and Cross-sects. To actually define the shape of the section you need to draw a curve in the Cross-sects curve set. Rather than using the input mode to create a free form curve let's define a regular eight sided polygon, an octagon.

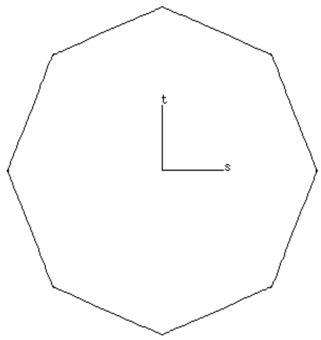
To create a polygon:

1. Check to see that the section set you created is still highlighted in the object window. If not, click at it to make it the target.

2. Select the menu command CURVE⇒ Design: Polygon.

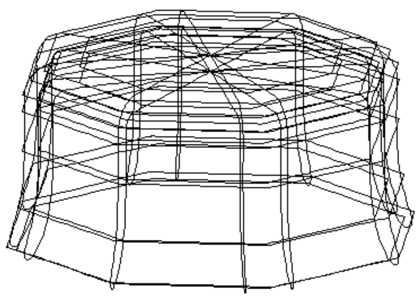
3. A dialog box appears. Answer the number of points question by typing 8. It does not matter what value you input for the radius of the polygon.

An octagon appears on the screen. To see it alone, without the surface, give the commands `DISPLAY⇒ All: Erase [e]` and `Object: Fit [f]`.



If you now re-make the surface (`SURFACE⇒ Design: Rotate`) DeskArtes will use the octagon as the cross-section shape instead of the default circle.

✌ ***You have made a free-form three-dimensional object!***



Can you see why the diameter of the polygon was not important? It is the x projection which defines the ***size*** of the cap by the distance of any point from the vertical axis. The section simply defines the ***shape***.

Lesson 4 : Viewing and Shading

You have reached the final Lesson of the Basics Part of the Tutorial.

You will learn how to

- *select objects from different elements*
- *select objects by graphical picking*
- *pan and zoom the objects*
- *view the model from different directions*
- *fast shade the model*
- *save your work*
- *quit DeskArtes.*

Selecting objects

Now that we have defined a couple of different surfaces, it would be useful to learn how to select different components of the model for target object.

Selecting from object window

Assume you are not happy with the shape of the bottle, and you would like to edit its projection curve.

To select a curve from another element:

1. Click at the `bottle` element in the topmost field of the object window.

2. Click at `Projections/X` in the middle field.

3. Click at the curve object (`1. curve/Bs`) in the lowest field.

Not too difficult.

Selecting by graphical picking

But let's try an even more convenient way, ***graphical picking.*** Assume you wish to get back to the cap's projection curve.

To pick a curve from another element:

1. You should have the bottle's projection curve selected. If not, select it through the object window, as explained above.

2. Display all the x-projection curves with `DISPLAY`⇒ `All: Fit [y]`.

2. Give command `SELECT`⇒ `Object: Pick [g]`.

3. You are now able to select any object shown on the screen by pointing at it with the mouse. *Point* at the cap's projection curve and click the *left* mouse button.

The curve gets selected. You'll see it darkened in the object window.

Displaying objects

We have already seen how to display objects, one at a time, or several at once. Let's expand a bit on this.

Display preferences

Select the command `DISPLAY`⇒ `Preferences`. These parameter options control how ***accurately*** objects are displayed.

Try a new value for the ***wirefr accuracy*** parameter, say, one (1). Accept the dialog box with `OK`. Note how the surface is displayed - the curves are shown less smooth.

Select the command `DISPLAY⇒ Preferences` again. Set the wireframe accuracy value back to the default four (4), and give a value six (6) to the ***wirefr max curves*** field. When you next display the surfaces, only six curves are drawn in the surface's cross- and lengthwise directions.

The other parameters with the command `DISPLAY⇒ Preferences` affect the way how objects are ***shaded***. We will return to those a bit later.

Auto display mode

As you select objects, they are automatically displayed. If the selected object is of a different type than the previous one, the previous screen contents disappear and the new object is fitted on the screen.

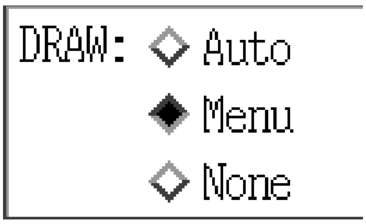
However, if you select an element nothing is immediately displayed. The system doesn't know what type of the element's contents to display – should it be projections, surfaces or what?

There is a special option to automatically display all the surfaces within an element. For this, use double-selection: select the element another time. Erase the screen `[e]`, and try it!

Menu display mode

Sometimes you might want to *prevent* the automatic displaying and erasing effect. To achieve this, change to ***menu display mode*** so that objects will be displayed only when commands are issued by the operator (you).

Some DESKARTES users prefer to work in this mode all the time, to have full control of the display events to themselves.



Click at the button `DRAW: Menu` in the settings window (at the right) and practice with the `DISPLAY` menu commands. Notice that selecting objects won't change the display.

No displaying

The third DRAW button `None` means that the system *won't display anything*, even if told so. This feature is sometimes useful to speed up the execution of the commands if displaying is not required, but otherwise it is rarely used.

✌ ***You now know all about selecting and displaying objects!***

After you have finished experimenting, click at the settings window button `DRAW: Auto` to get the system into the default displaying state.

Eye point and viewing window

You might want to look at the items you create from a different ***angle***. You might also want to ***zoom*** in to look at a detail of the surface, or zoom out to see a larger part of the picture.

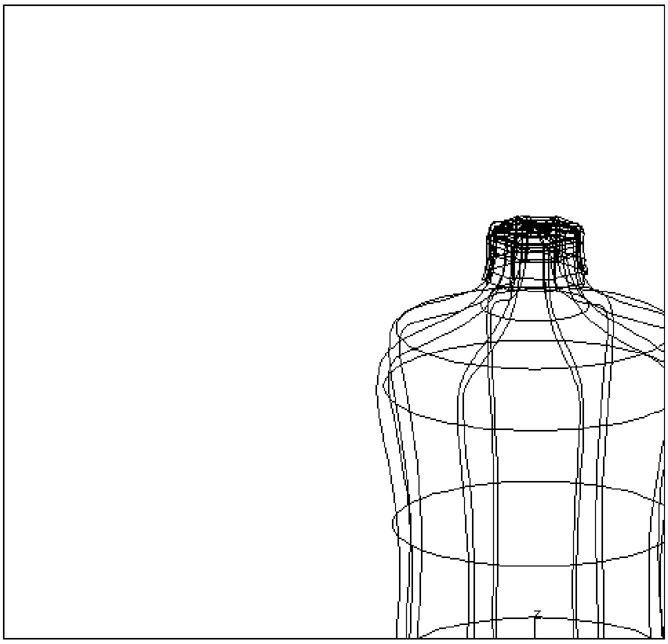
DeskArtes determines the size and position of your models on the computer screen with two things: the ***eye point*** and the ***viewing window***. The following viewing operations affect only the display of the object, not the actual size of the geometry.

At this stage, the eye point is always “infinitely far”: there is no perspective. The eye point defines the viewing direction, and the window describes the where to look at and how large the “zoom” is.

Before you continue, have a surface selected as target and give the command `DISPLAY`⇒ `All: Fit [y]` to view both the surfaces.

Panning

You can change the viewing window by ***panning***. This means that you change the part of the scene that the camera looks at.



To pan:

1. Select the command `DISPLAY`⇒ `View: Pan [x]`.

> ✍ Use the keyboard shortcut `[x]`.

2. Press (and hold) the left mouse button to show a point within the graphics window.

3. Move the mouse, and a line appears. It shows where the selected point will move.

   Release the mouse button where you want the first chosen point to move. The objects move on the screen.

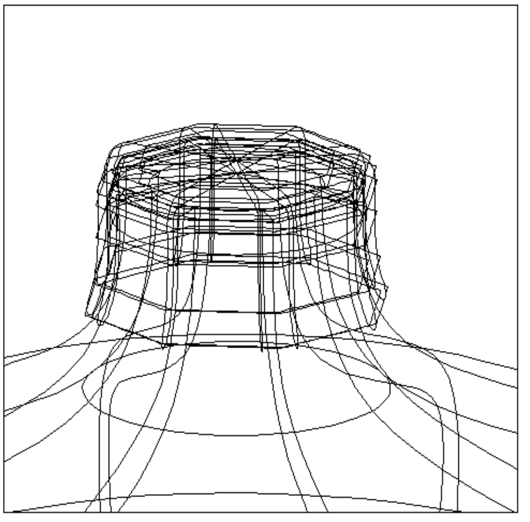
4. On machines where the *shaded mode* (see below) is supported, the middle mouse button allows for *continuously changing* the view. Move the mouse, and the objects follow.

> ✍ On other machines the middle button works just like left.

Experiment a while with panning.

Zooming

Another way of changing the viewing window is by ***zooming***. This makes the objects on the screen look smaller or larger.



With the zoom command, the different mouse buttons change the view in different ways.

To zoom:

1. Select the command `DISPLAY⇒ View: Zoom [z].`

2. Take a look at the message lines above the graphics window? With zooming, there should read: "draw window (LEFT)/zoom closer (MID)/zoom away (RIGHT)/pan (key)". This describes the way the mouse buttons change the view.

3. Press the *left* mouse button at the center point of the desired window and hold the button down.

   Still holding the mouse button, move the cursor upwards: a box appears. It changes size according to the location of the cursor.

   When the box encompasses everything you want to see, release the mouse button.

4. Press `[z]` (shortcut for zooming).

5. Click the *right* mouse button: you zoom out. The objects become smaller.

6. Press `[z]` again.

7. Click the *middle* mouse button. The behavior of this button depends on your hardware.

   On machines where the *shaded mode* (see below) is supported, the middle mouse button allows for *continuously changing* the view. Move the mouse up and down to make the objects smaller or bigger.

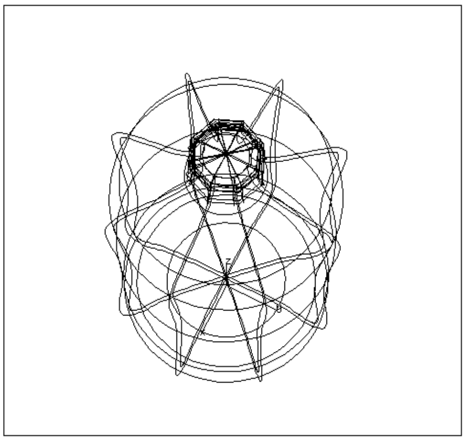
✍ On other machines the objects become twice the bigger in one step.

8. Finally, there's an “extra” option with the zoom command: if you click at *any key on the keyboard* after issuing the command, you will be able to pan instead of zooming.

Experiment a while with the different zooming options.

Changing the eye point

Panning and zooming did not change the viewing direction. Now let's try how to do that.



To move the camera:

1. Display all surfaces `[y]`.

2. Select the command `DISPLAY`⇒ `View: Eye Point [v]`.

   A box appears around the bottle.

3. Point at the box and press the left mouse button.

4. Move the mouse sideways. You will see the box rotate horizontally.

5. Move the mouse up and down. The box rotates vertically.

6. Release the mouse button, when you are happy with the view.

7. Repeat the steps 2 – 6 as many times as you like.

8. When you are happy with your new eye point, press the **`w`** key on the keyboard. The new eye point is now selected for all 3D display operations.

✌ ***You have learned to pan, zoom, and change the eye point.***

Shaded mode

Depending on your workstation hardware, you have the option to view the model any time as a ***shaded image***. There are various ways available to accomplish this. The easiest way is using the `Mode: Shaded` button in the Settings Window.

☞ ***On some workstations:***

.. The `Mode: Shaded` *button may not be available. Yet, some other shading modes will be there. Please see the instructions in the following sections for details.*

✍ Displaying shaded images is obviously slower than wire frames ...

You may use any viewing or modeling commands in the shaded mode. However, it is usually recommendable to stick to the wire frame mode during complex modeling work, just to make it faster.

Try panning, zooming, and changing the eye point in shaded mode now. Experiment also with the other `DISPLAY` menu shading commands, for example to *move the light point* around the model:

Viewing the shaded image:

1. Display the bottle and cap surfaces `[y]`. Click at the `Mode: Shaded` button. Wait a while, and you'll see your design shaded!

2. Try the `DISPLAY` menu commands `View: Pan`, `Zoom` and `Eye Point`. They work in shaded mode just like with wire frames!

3. Select the cap surface by graphical picking `[g]`. Try changing its ***display color*** from the Settings Window color buttons.

4. Try the command `DISPLAY⇒ View: Move Light`. Its interaction is equal to `Move Eye Point`, but now the ***light point*** moves around the model.

5. You may also try out the other DISPLAY menu commands, or other commands as you wish. Remember, though, that if you apply ***clipping planes***, please set them off before continuing with the exercises.

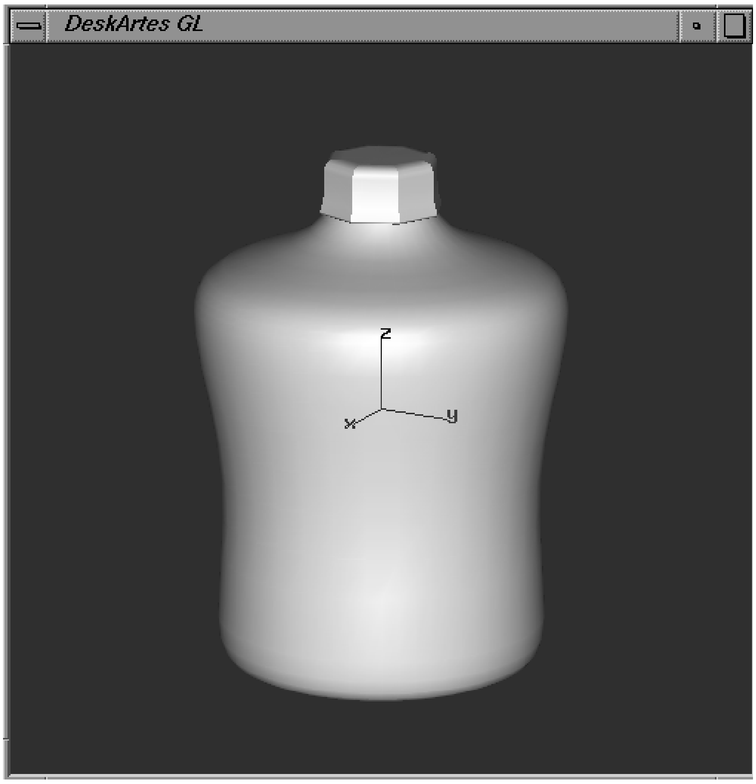
6. Once you are ready with experimenting, you may exit the shaded mode by clicking at the `Mode: Wirefr` button.

✌ ***Change back to shaded mode any time!***

Perspective Shading

The shaded mode above always displays the model in *orthogonal view*, without applying perspective. In other words, you may think of the eye point as located infinitely far from the model, with a tight focus. For most applications, this is quite sufficient, as the final presentation images will typically be computed using ray tracing.

However, depending on your workstation hardware, you have the option to shade and rotate the bottle also in *perspective view* using the ***GL Window*** functionality.



☞ ***On workstations without GL support:***

.. You will not have the GL functionality available. Use the `RENDER⇒ PreView` *commands instead of* `RENDER⇒ GL Window`.

To shade the bottle in GL Window:

1. Display the bottle and cap surfaces `[y]`.

2. Select the command `RENDER⇒ GL Window: Shaded View`.

3. The GL Window appears, attached with the cursor. Place it somewhere in the upper left hand corner of the screen.

4. Wait a short while, as the bottle appears shaded in the GL Window.

5. You may enlarge the GL Window to cover the whole screen. Click at the larger rectangle at the GL Window's upper right hand corner.

6. A menu of the ***GL Window commands*** appears as you press the *right* mouse button within the GL Window.

   Some menu items have a ***sub-menu***. The sub-menu commands may be selected as you move the cursor to the right end of the chosen menu item.

   Always ***end the GL Window command*** by clicking the *right mouse button* again.

7. Try the command `Move Camera`. Move the mouse, and the object rotates—just as with command `DISPLAY⇒ View: Edit Eye [v]`!

On entry level machines, the ***rotation speed*** won't really be real time. Select the command `Move Mode⇒ Box` to make the rotations more fluent.

Remember this also when rendering very large models.

8. Try `Move Camera` again. Now hold the *middle* mouse button down, and move the mouse up and down to change the ***perspective*** of the image.

9. If you get lost, by zooming too close for instance, you may always ***recover*** with the command `Lost in Space!`

10. Try the other commands, such as `Move Light` and `Auto Rotation ⇒ Infinite Rotation`. Move the mouse to change the light position, or to see different rotation speeds and directions. You may try the other functions, as well (see the Reference Manual for details).

11. End the real-time shading with the GL Window command `Done`. The GL Window disappears from the screen.

You now know how to shade your models!

Notice another difference between the shaded mode and the GL Window: the former takes the objects' shading colors from the Settings Window, whereas the GL Window assumes the material palette definitions. The material palette will be introduced in just a while, in the next section.

Shading is fun, but it is much more than that. Shading is a very useful *surface analysis* tool. You can use it to check that the shape of the surfaces you have created are exactly what you required.

Yet, this is the lowest level of visualization available within DeskArtes. Much more realistic pictures of your design can be generated using the *camera view shading*, with interactively defined colors, materials and light points. Ultimately, you would use the *ExTrace system* to render the bottle of true glass, textured with painted graphics, reflecting the natural surroundings defined around it.

Trying out ExTrace

So let's give a go for it! See what you can do with ***ray tracing***. You'll also get a hang on ***material editing***.

All details and many more options for what happens next will be explained thoroughly in the Visualization Part of this Tutorial. So just relax, and follow the step-by step instructions now.

To use the material palette:

1. Give the command `SCENE`⇒ `Edit: Materials`.

   A large window (the material palette) shows up.

2. Click at the name "glass" under the MATERIALS title, and `LOAD` it in the palette.

3. Click at the button `SHOW` under the TESTIMAGE window. You'll see how the chosen material looks like on sphere and a checker table (floor).

4. Select the bottle surface (or element) using the object window selections.

   Then click at the `ASSIGN` button in the middle of the material palette window to assign the selected material to the bottle.

5. Click at the box labeled "floor" in the long horizontal field in the middle.

6. Click with the *left* mouse button on any color you see in the upper left corner.

7. Select the "glass" material. Click `SHOW` again to see in the test image how the checker squares under the ball have new colors.

8. Repeat steps 5-7 to change the second floor color ("floor2"), and the "background" color, as well.

8. Exit the material palette with `OK` at bottom left.

Now you have the bottle assigned with the proper material, glass. The cap is still of the default material. You've also specified how the surroundings will look like. By default, you only have one light point defined, but let it be so.

What remains is to create the picture.

✌ ***You've worked with materials and colors!***

To ray trace:

1. Display [y] the cap and the bottle. View [v] them from the direction you want to have ray traced.

2. Select command EXTRACE⇒ Start/Update. Accept the parameter queries as they are with OK.

3. A rectangle shows up on the screen. It represents the size of the ExTrace window.

   Position the window in the upper left corner of the screen. Click the left mouse button to drop the window to its place.

4. Wait a few seconds, and the ray tracing starts. First you'll see just a rough picture, but it is quickly refined to finer detail.

5. The floor is missing! Move the cursor into the ExTrace window, and interrupt the computation by clicking the Stop button.

6. Give command EXTRACE⇒ Insert: Floor. In the following dialog boxes, tell that you wish to have a default sized floor of stripes/squares, consisting checkerboard pattern, with 16 (times 16) squares in it.

7. ExTrace waits if you wish to give it more specifications of the scene. As you don't, give command EXTRACE⇒ Start/Update to see the picture anew.

8. Have a coffee break, you've deserved it!

   ... If the image isn't ready when you come back, you apparently take long coffee breaks. In such case, please interrupt the computation as described above (Stop button).

9. For further image interaction, return to the material palette for further interaction with command SCENE⇒ Edit Materials. Change some colors or material properties, as desired.

Now notice the `EXTRACE` button in the lower right corner of the palette window! Clicking at it, all the material changes are immediately transported to ExTrace, and rendering of the new image is started.

10. Play a while with this interaction feature. Remember to click at `Stop` in the ExTrace window before transporting new materials.

    Once ready with experimenting, please exit the material palette.

11. To exit from ExTrace, give command `EXTRACE`⇒ `Done`. Accept the parameter option so as not to start the background process. Later you'll learn how to compute the picture in the desired size, accuracy, and other options.

✌ ***You've ray traced the picture!***

Saving your work

Before you end the modeling session, you must ***save your work***. The first thing you did at the start of the Tutorial was to create a model directory for yourself. Now you will save your model in it.

To save your work:

1. Click at the *middle* mouse button in the graphics window (or use command `SYSTEM⇒ Show Files`). The file window pops up.

2. Display the pop-up menu in the middle sub-window using the *middle* mouse button. Note that the commands are different from the ones in the left sub-window pop-up menu. Select the `FILE: WRITE` command.

3. DeskArtes asks you for the type of file you want to write. Accept the option `model (geom_)` and click at `OK`.

4. Now, DeskArtes prompts you for a name for your model. Type `shampoo` and click at `OK`.

DeskArtes gives model files the prefix `geom_`.

Your model was now written in a file named `geom_shampoo`. You can see the name in the middle field of the file window.

You have saved your work.

Ending a modeling session

Now you have completed a modeling session and you may wish to exit DeskArtes.

It is not good practice to exit DeskArtes without first saving your work if you want to keep it.

To exit DeskArtes:

1. Select the command `SYSTEM⇒ Quit [q]`.

2. DeskArtes asks if you really want to quit. Click at `YES` to accept.

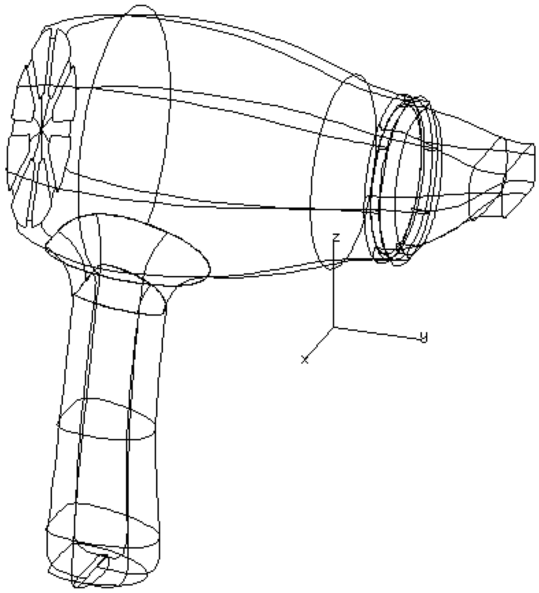
Congratulations! You have completed the Basics Part of the Tutorial, ready to move on to more interesting work.

You know the Basics now!

Even if you still feel uncertain of your skills, don't worry. The next Tutorial Part begins with interaction quite similar to what was introduced here, providing you a further chance to practice with the DeskArtes basics.

PART II: MODELING PRINCIPLES

The following six Lessons give the step-by-step description of the operations you need to perform to design a moderately complex model, namely, a hairdryer.



The example demonstrates most of the modeling features of DeskArtes. You might wish to repeat some of the operations within a Lesson. This will allow you to express your own design characteristics. Please feel free to do so. However, we recommend that you first follow the Tutorial descriptions quite closely before you begin to experiment.

Lesson 5 : The Hairdryer Body

In this Lesson, you will review the simple curve and surface creation techniques introduced in the first Tutorial Part, and learn some new techniques to modify curves. You will design the main body of a hairdryer. This will form the start of a continuing modeling exercise that will be used for the rest of the DESKARTES Tutorial.

By now, you should be familiar with the basic DESKARTES interaction techniques, and should be able to concentrate on the actual modeling instead of using the menus and buttons.

Resuming work

Start DESKARTES.

To start DESKARTES, type "DA" in the command window.

Last time, you created a model directory for your shampoo bottle, as well as a model file. Instead of creating a new model directory now, you will use the one you have already created.

In the left sub-window of the file window, you see a list of the existing DESKARTES ***directories***.

Scrolling

It is possible that there are more directories than fit in the window. This means that you will have to ***scroll*** through the sub-window. Scrolling means moving text or a picture within a window.

If all the directories fit into the sub-window, the scroll bar is entirely filled by an embossed rectangle, and you can't scroll. In that case, skip this bit. Return here if you need to scroll later.

There are several ways you can scroll the sub-window.

The ***scroll bar*** is situated to the right of the sub-window. It looks like a thin, tall rectangle with arrows at either end and a smaller, embossed rectangle within the thin one.

To scroll:

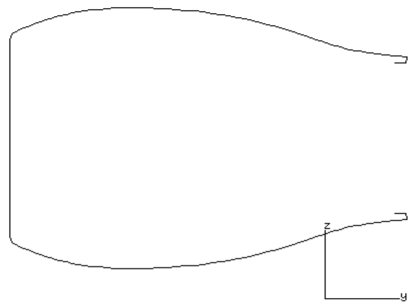
- Click with *left* mouse button at the lower arrow to move the text within the window up one line. A new line is displayed at the bottom.
- Click at the upper arrow to move the text back down. The top line shows again.
- Press the *left* mouse button on the lower arrow to move the text rapidly up, until you reach the bottom of the list.
- Drag the small embossed rectangle within the scroll bar up or down.

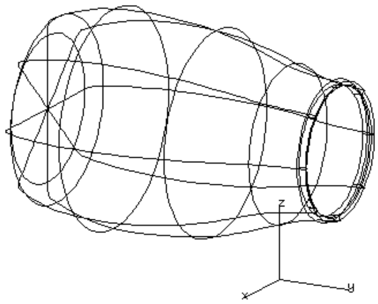
Since we want to create a new model in the same directory that we used before we need to select the directory. Do this by clicking on the name in the left hand list that you created in Lesson 1 (`name_tutorial`). When you have done this you should see the name of the shampoo bottle model file (`geom_shampoo`) appear in the middle window. The work we do now will be stored in the same directory as the shampoo bottle.

As you have selected your working directory, hide the file window with the `OK` button and begin work.

Creating the hairdryer

You will create the body of the hairdryer by rotation, like this:





Begin like with the bottle in the beginning of the Tutorial.

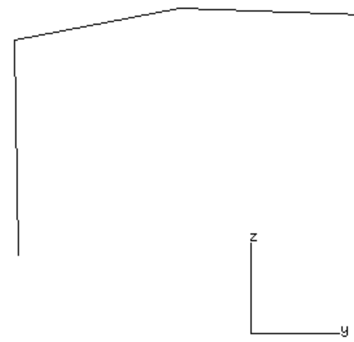
To initialize the body element:

1. Create `[n]` an element named `body`.

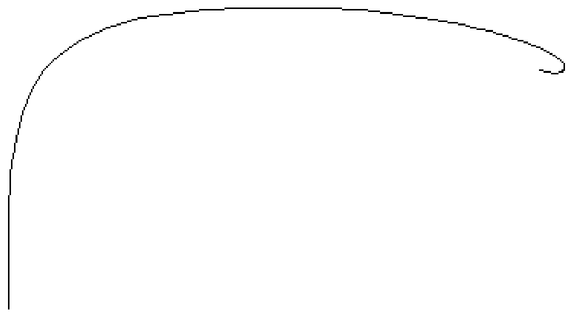
2. Create an x projection set. However, instead of giving `[n]` again, this time try a specialized command: `SELECT`⇒ `Object: Projection [p]`. You'll get the projection directly, without having to select parameters.

The command `[p]` directly creates a projection set!

3. Use `CURVE`⇒ `Design: Input [i]` to enter the outer curve, similar to that below.



4. When ready, exit the input mode (**w**). The curve turns into a smooth one.



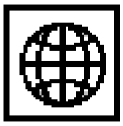
Editing a curve

Next you will edit the curve. You'll be introduced to a couple of new editing functions on the way.

Start the edit mode, and take a look at the global functions.

❢ CURVE⇒ Change: Edit [o].

Global functions

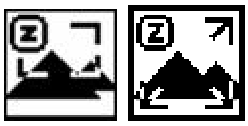


Global functions affect the curve as a whole or several points at once, or control the way the curve is displayed on the screen.

To see the global icons:

- Click at the “globe” icon.

At this point, you will use a couple of global functions that alter the way the curve is displayed on the screen.



Zooming and panning

Note that the menu commands, like `DISPLAY⇒ View: Zoom [z]`, are not available when you enter an edit mode. However, some of the display functions are included in the editing functions, as well. Zooming is one of them.

Experiment a while with this:

To zoom in edit mode:

1. Click at the “z” icon or press **z** on the keyboard.

2. You may zoom using the different mouse buttons, just as with command `DISPLAY⇒ View: Zoom [z]`.

☞ See Lesson 4.

There is no special function for panning, but remember you can do it with the zooming function:

To pan the image:

1. Click at the “z” icon or press **z** on the keyboard.

2. Click at *any key on the keyboard* (not a mouse button).

3. Press and hold a left mouse button down. Move the mouse, and release the mouse button at the new location where you wish to have the image move.

If you wish to get back to the exact window size you started from, you have the following function available:

To zoom to the initial size:

• Click at the “Z” icon or press **Z** on the keyboard.

Refreshing the screen

As you move the points during editing, the old parts may not always be properly erased, and you might have some extra dots remaining on the screen. That won't be the case just now, but here's how to get over it anyway:

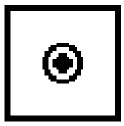
❢ You probably noticed this in the previous Lessons.

To refresh the screen:

1. Click at the “f” icon or press **f** on the keyboard.

✌ ***You now know the editing display functions.***

Now let's get to actual modeling. You may keep the global icons on the screen, or hide them by clicking the “globe” icon again, just as you like.



Local functions

Now use the local editing functions, as you've already learned with the cap model. Before you start, click on the “local” icon to see the functions.

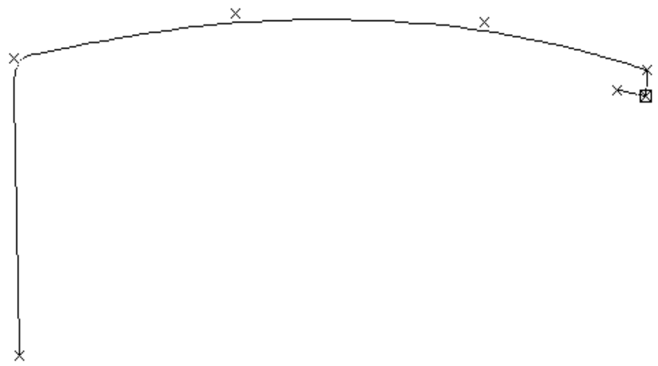
☞ Have a hand on Lesson 3 for details.

Remember always to select the active point first before executing the function.

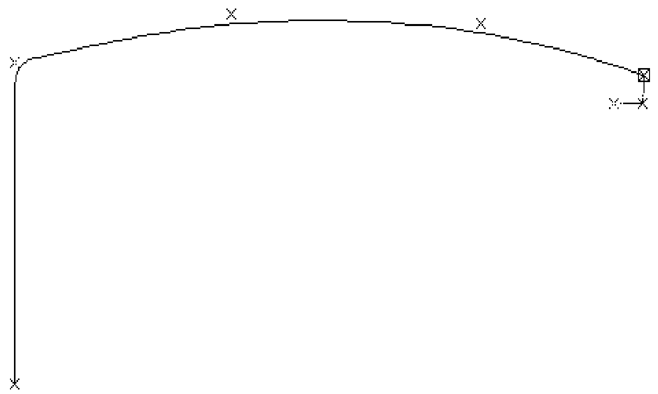
If (when) you make mistakes, you can always cancel with the **`u`** function.

Review on local editing

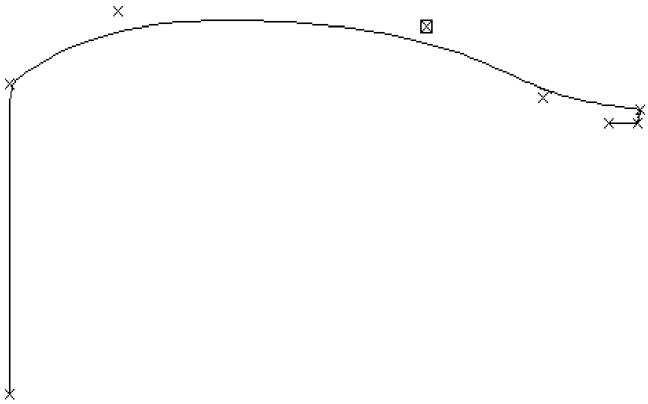
Create some corners to the curve using the **`c`** function.



Align the left and right hand end curve parts with **`l`** to form right angled corners.

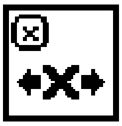


Move (*middle*), insert (**`i`**) and delete (**`d`**) the points just as you wish.



Some new functions

Axial moving

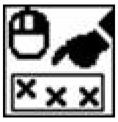


If you have already aligned a couple of points, but still wish to move them, there is a way to do it while keeping them aligned. Try this:

To move in axial directions:

- Use the function **x** to move the point. The movement becomes restricted to the direction in which you first move the mouse.

Moving multiple points

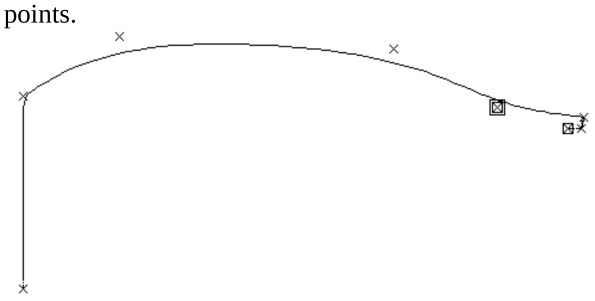


You may want to move a group of points. This is achieved by first making a ***multiple point selection***, then using the usual moving functions.

To move multiple points:

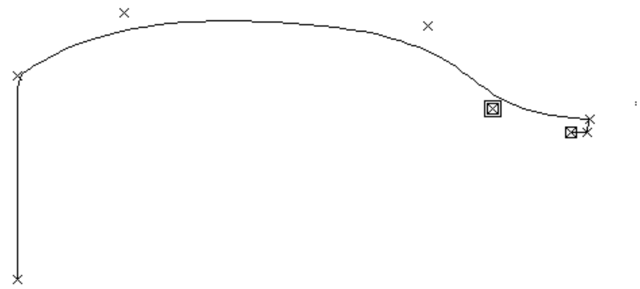
1. Click on the first point of the group to be moved with the *left* mouse button.

2. Click on the last point to be moved with the *right* mouse button. It is highlighted with a double box. This makes a multiple selection of all the points between the first and last points.



3. Press and hold the *middle* mouse button to pick up the points.

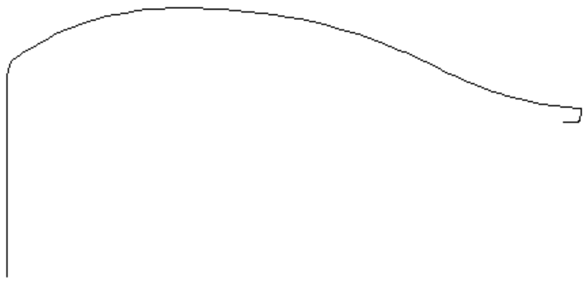
4. Move the points freely by moving the cursor. Drop them in place by releasing the middle mouse button.



5. Try multiple selection with the **x** function, too.

The functions **n**, **x** and **p** work on multiple selections, too.

Play with the editing functions as long as you like. You may take the liberty to make the shape your own, but don't get too wild! We'll use this model for the remaining of this Tutorial, and very different shapes than the below one might not work out for you.

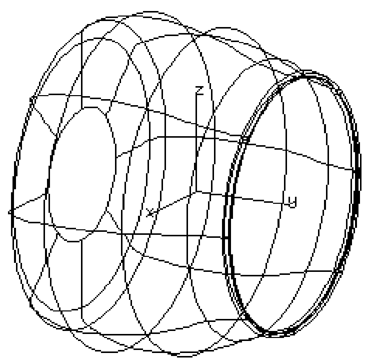


✌ ***You've learned many useful editing functions.***

Creating a rotational surface

Rotate the curve with `SURFACE⇒ Design: Rotate` like you did with the bottle. This time use the options for `horizontal` axis and Center at fix point `NO`.

❢ ***OOPS! You have created an incorrect hairdryer body.***



The fix point

✍ The fix point defines the origin of an object. It affects many commands.

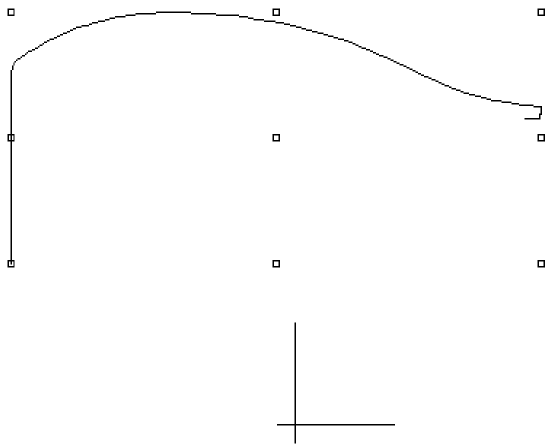
The result of the previous surface rotation is not what was intended! The body has a large hole through the middle. This is because the body was rotated about the central y axis. To avoid this we need to use a feature of DeskArtes called the ***fix point*** which determines where the origin for an object is.

The fix point is specified for *each object separately*. It can be moved around at any time to suit the situation. In this case, to get the correct result when we rotate the surface, the fix point which defines the axis of rotation should be located on the left hand end of the defined curve. Let's move it now.

To position the fix point:

1. Make the curve the target object. It is labeled as `1. curve/Bs` in the object window.

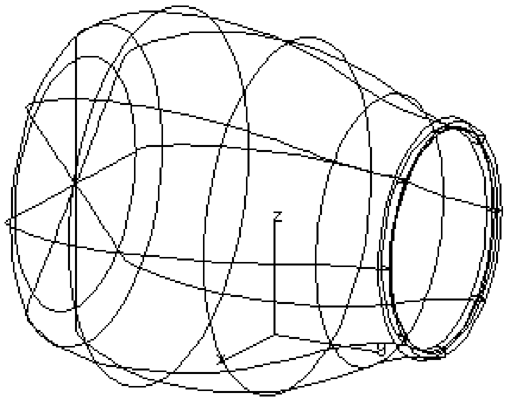
2. Select the `TRANSF`⇒ `Fix Point [0]` command.



3. Click with the *middle* mouse button on the box (handle) that appears on the bottom left of the curve. This places the fix point to the nearest handle.

Rotate the curve again with `SURFACE⇒ Design: Rotate` this time using the options for `horizontal` axis and center at fix point `YES`.

You can place the fix point freely with the *left* mouse button, or reset it to the origin with *right* .



That's better! You have created the correct hairdryer body.

Transforming curves

It would be useful to see the projection curves representing *__both__* sides of the body. The whole side view would not only show the shape better, but also helps us in creating the other parts of the hairdryer later on.

Mirroring an object

The other half can easily be created by taking a ***copy*** of the existing curve and ***mirroring*** it in the vertical direction.

To copy and mirror a curve:

1. Select the projection curve (`1. curve/Bs` in the object window).

Not the curve set! We want to copy a curve within a set, not have two curve sets.

2. Select `OBJECT`⇒ `Copy [j]`. This will duplicate the curve.

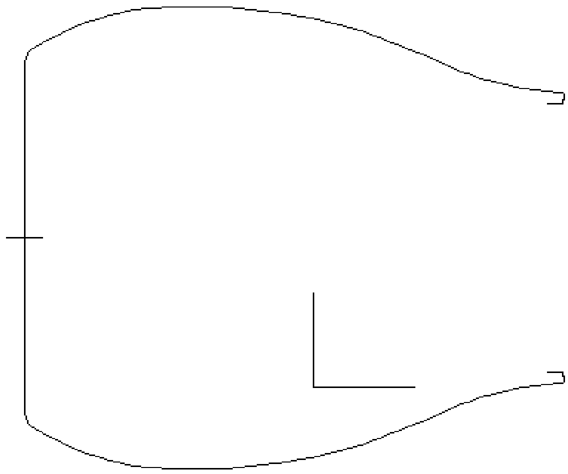
   There will now be two names in the bottom field of the object window called `1. curve/Bs` and `2. curve/Bs`. The second (copied) curve is selected.

3. Select `TRANSF`⇒ `Mirror [m]`.

4. Select the option to mirror `vertically`.

The fix point defines the origin for mirroring an object.

5. The curve is mirrored. Display the curves with `[y]`.



Moving and scaling

Now that you see the whole hairdryer body profile from the side, you might want to modify the curves. Let's see how to scale both curves:

To scale the curves:

1. Select the line `Projections/X` in the middle field of the object window.

2. Give command `TRANSF⇒ Fix Point Copy [9]`. This copies the last used fix point (the one you used for mirroring) to be the fix point of the target object (the whole projection set).

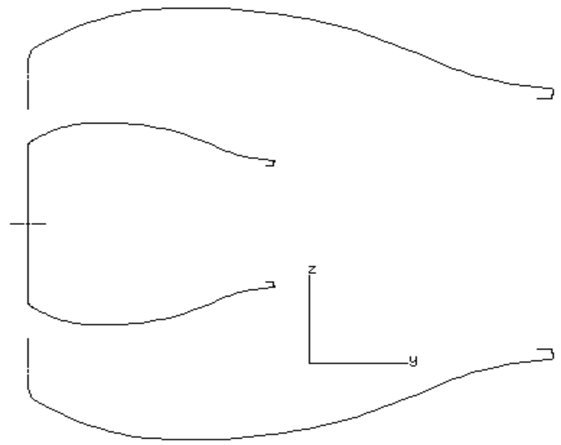
3. Select `TRANSF⇒ Scale [2]`.

4. Press and hold the *left* mouse button at the middle of the curves. Move the mouse, and the curve follows the cursor, scaling uniformly in both directions until you release the button.

   Notice that as the curve grows and shrinks it does so about the fix point, at the middle left.

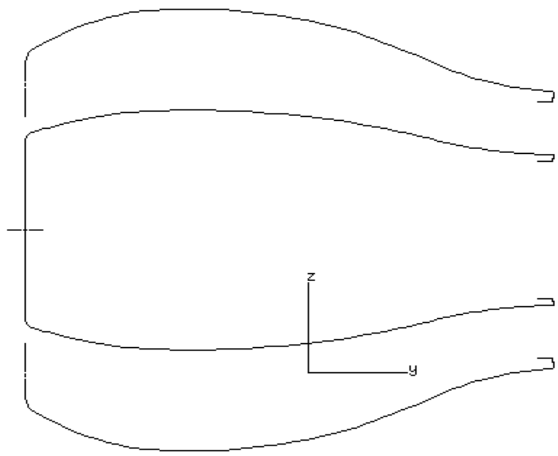
You will transform both curves within the set.

The fix point defines the center for scaling.



5. Repeat command `TRANSF⇒ Scale [2]`, but now press the *middle* mouse button and move the mouse upwards. The curve follows the cursor until you release the button, but this time is constrained to only scale vertically.

   When you use the middle mouse button, DeskArtes locks the curve to scale in the direction of your first mouse movement.



Try moving the curves, too:

To move a curve:

1. Have `Projections/X` selected in the object window.

2. Select `TRANSF⇒ Move [1]`.

3. Press and hold the *left* mouse button and move the mouse. The curve follows the cursor until you release the button.

   ❢ The fix point moves, too!

4. Give `TRANSF⇒ Move [1]` again. Press and hold the *middle* mouse button and move the mouse upwards. Since you are using the middle button the curve follows the cursor again but this time it is constrained to only move vertically. Release the mouse button to drop the curve.

   ❢ Just like scaling!

Numeric transformations

Another way to move or scale your curve is by numeric values. This is easily achieved. The description here is for scaling but the technique works the same for all transformation commands.

To scale a curve numerically:

1. Select the curves you want to transform.

2. Select the appropriate transform command, for example `TRANSF⇒ Scale [2]`.

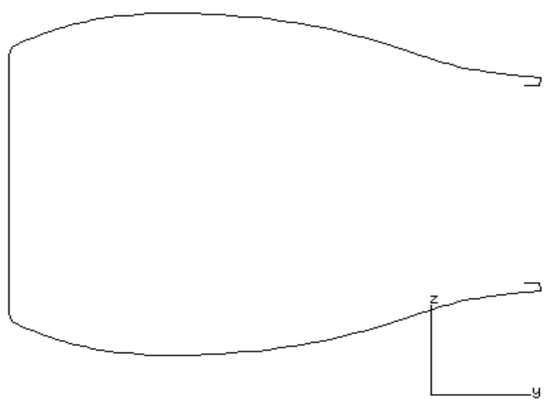
3. Press *any key on the keyboard* to indicate you want to enter a numeric transformation. A dialog box appears to allow you to enter numeric values for the transformation.

4. Enter the scaling values, *e.g.*, 1.0 and 2.0. Click on `OK` to exit the dialog box.

Try that, and use the UNDO function to return the curve to the original position after each attempt.

Before you continue, you should have the curve scaled to the desired shape, as below.

You have learned to transform curves!

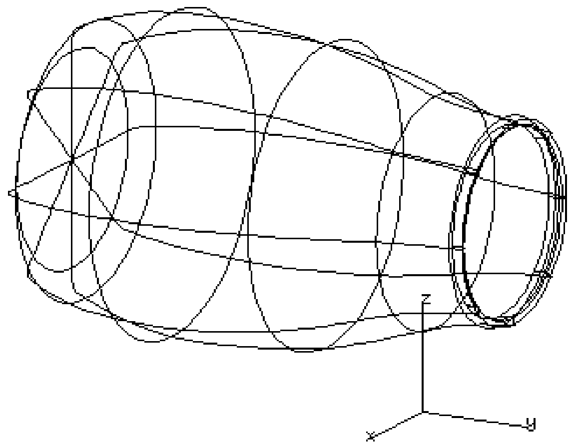


Updating the surface

✍ Actually, only the first curve in the projection set is accounted for the rotation, the second curve only acts as visual aid.

The previous transformations changed just the curves, not the surface. You will need to rotate the surface again so that it accurately reflects the shape of the curves.

Give command `SURFACE⇒ Design: Rotate`, with parameters `horizontal` axis and center at fixpoint `YES`.



Saving your work

Remember you learnt in the first Part of the Tutorial that before you end a modeling session, you must ***save your work***. This is an opportune time to save the work you have completed. Here is a reminder of how to do this.

To save your work:

1. Click at the middle button in the graphics window. The file window pops up.

2. Display the pop-up menu in the middle sub-window. Note that the commands are different from the ones in the left sub-window pop-up menu. Select the `FILE: WRITE` command.

3. DeskArtes asks you for the type of file you want to write. Select `model (geom_)` and click at `OK`.

4. Now, DeskArtes prompts you for a name for your model. Type `hairdryer` and click at `OK`.

   Your model is written in a file named `geom_hairdryer`. You can see the name in the middle field of the file window.

✌ ***You've designed the hairdryer body.***

Finally, end the modeling session with command `SYSTEM`⇒ `Quit [q]`. Do this in any case, even if you wish to continue modeling right away – we will practice resuming work in the next Lesson.

Lesson 6 : Getting a Handle on it!

The surfaces you have created so far are by DeskArtes standards very simple surfaces! You will now make a handle for the hairdryer using a technique capable of producing much more complex surfaces: building a surface. It is worthwhile concentrating hard on this Lesson.

Resuming work

You have previously created a model directory for your model, as well as a model file. Now, you will ***resume work*** on the hairdryer model.

Start DeskArtes the same way as before.

Reading a model file

Your model is stored in a model file, which is in your model directory. Therefore, you will want to ***open*** it.

To open a model file:

1. Display the file window, if it is not already displayed. Locate your model directory in the left sub-window and select it by clicking at it.

2. The middle sub-window shows the contents of your directory. Select your model file (`geom_hairdryer`).

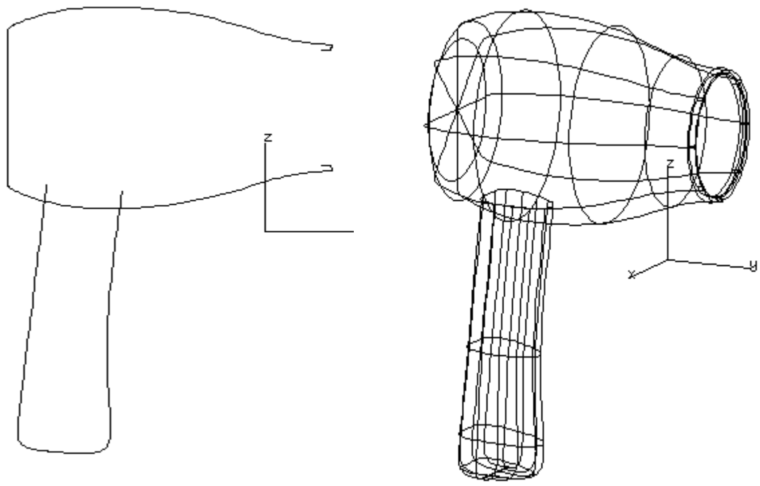
3. Select the command `FILE: READ` in the middle sub-window pop-up menu.

Now you have your model in DeskArtes again and may hide the file window with the `OK` button and begin work.

Projection curves for building

The surface building command creates a surface that follows the shape of the projection curves from the projection direction. In other words, the projection curves define the ***side view*** of the surface. You'll create the curves very much like the two curves you defined for the rotation, but now you will be able to edit the curves separately, as well.

✍ Input the projection curves in the right place. That way you won’t have to use the transformation commands.



Creating the projection curves

You will use two projection curves to define the handle. They define its left and right hand shapes from the chosen view (x direction).

Make a projection curve for the handle:

1. Make a new element and label it `handle` (use `OBJECT⇒ New` - remember?).

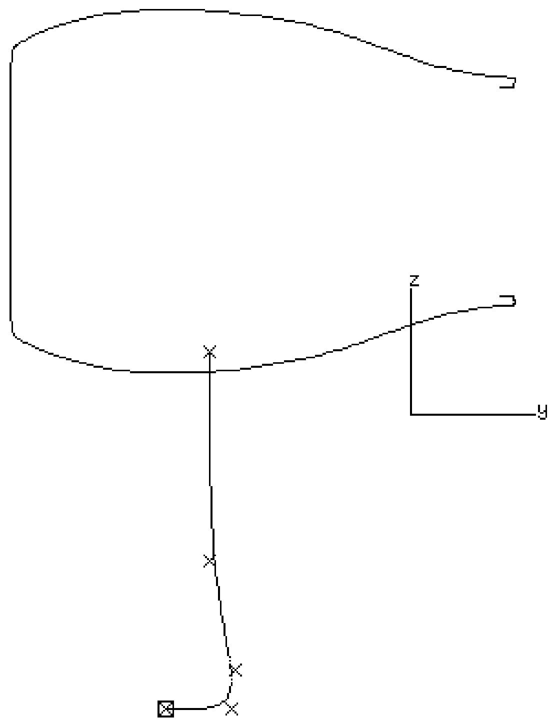
2. Make an x-projection set (`OBJECT⇒ New`).

3. Display the projection curves of the body. Remember this is achieved by the `DISPLAY⇒ All: Fit [y]` command.

4. Zoom `[z]`/*right* button and pan `[x]` to have more space for your drawing.

5. Input and edit the right hand curve of the handle as shown below.

❢ The end of the curve should protrude through the inside of the body.



For building a surface, two projection curves are normally required. An easy way to create the other curve is to *copy* the right hand curve we have already drawn, and *mirror* it to form the left hand side of the handle.

Remember the feature of DESKARTES called the *fix point* that we introduced in the previous Lesson. Here is another chance to use it. To get the correct result when we mirror the curve, the fix point should be located on the bottom end of the curve. Move it now.

To position the fix point:

1. Select the `TRANSF`⇒ `Fix Point: Set [0]` command.

2. Click with the *middle* mouse button on the handle on the bottom left of the curve.

Now we can copy and mirror the curve. Do you remember how?

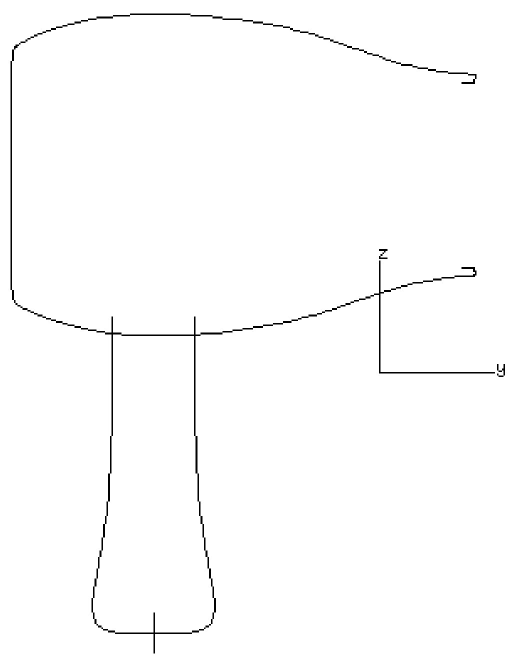
To copy and mirror a curve:

1. Select the curve you want to copy.

2. Select `OBJECT`⇒ `Copy [j]` command.

3. Select `TRANSF`⇒ `Mirror [m]`.

4. Select the option to mirror `horizontally`.



Editing the projection curves

Now we have the two sides of the handle. But the shape doesn't look too “handy”! Let's edit the back of the handle to make it flatter.

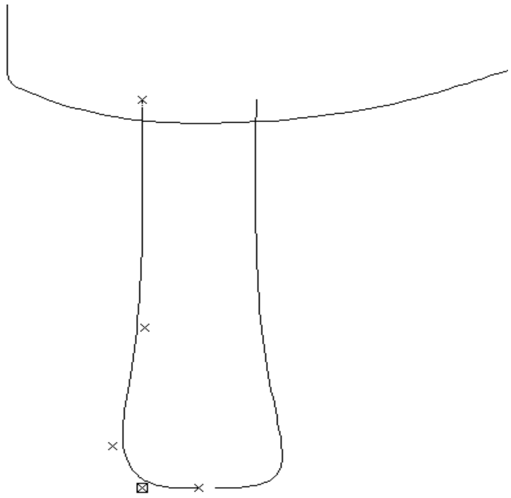
Before editing, let us note that there are some rules to be obeyed when building a surface. One of these rules is that the *two projection curves must share an equal number of control points*. If we alter the shape of one of the projection curves and add or remove points to achieve the change, we would have to add/remove similar points from *both* projection curves.

This time let's make the change simpler by just moving some points, not adding or deleting any. Give command `CURVE⇒ Make Edit [o]` and use the following functions.

First level the bottom left point with the topmost one, so that we can define a linear curve part between them.

To level two points:

1. Select the point at the bottom left.
2. Use the **`l`** function.
3. Click on the topmost point for reference.



Next ask all the points between to fall on the connecting line.

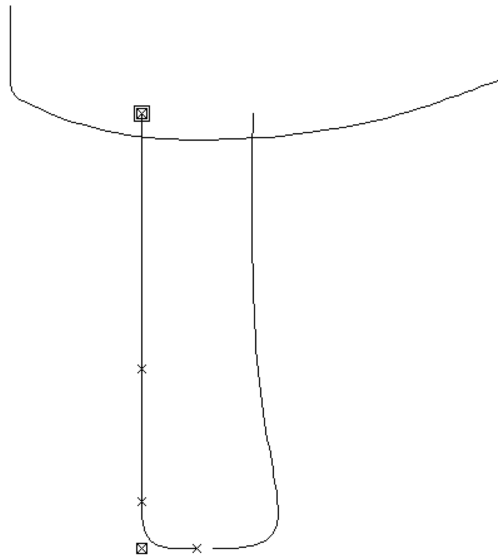
To align the points between:

1. Select the point at the bottom left, by clicking the *left* mouse button.

2. Make a multiple point selection by clicking at the topmost point with the *right* mouse button.

2. Use the **p** function.

3. In the dialog box that appears, tell the points to be projected `orthogonal` to the line.



Easy, isn't it! Use other point moving functions, too, if you wish. Exit the curve edit mode with **w** when ready.

Rotating the curves

To finish work on the projection curves let's rotate both curves so that the handle no longer meets the body square on.

To transform the handle:

1. Select the projection set (line `Projections/X` in the middle field of the object window). Now both curves will move since the curve set is selected.

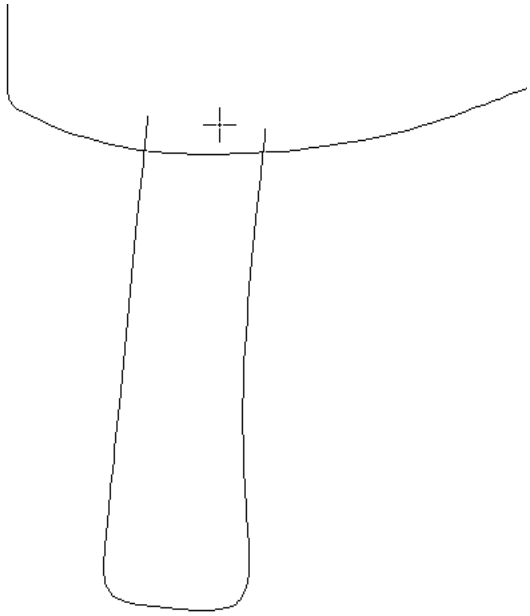
2. Set the fix point to the top middle of the curves.

3. Select `TRANSF`⇒ `Rotate [3]`.

4. Press the *right* hand mouse button down and move the mouse to rotate.

✍ Positive values rotate anti-clockwise. Negative values rotate clockwise.

   Pay attention to the message lines: they tell the *rotation degree*. As you pressed the *right* mouse button, the rotation is restricted to whole degree increments.



5. Scale `[2]` the curves, if you like, and move `[1]` the handle projection curves to the correct position. Make sure both curves pass well inside the hairdryer body, as above.

✌ ***You've designed the handle's projection.***

A section curve

The surface building command also needs to know what the ***cross-section*** of the surface looks like. Surface cross-sections are described by ***section curves***, contained within a section set.

Remember we used a section curve for the bottle cap in Lesson 3 for the surface rotate command. In that case sections were optional, for building surfaces they are always required. At this stage, you will use only one section curve for the handle. Here is a reminder of the procedure for creating a section curve.

Creating a section set

Create a section set:

- Perform `OBJECT⇒ New [n]` and select `cross-section` from the dialog box.

Or

- Use the faster alternative, `SELECT⇒ Object: Cross Section [c]`!

Making the section curve

Create a circle as the basis for the section curve.

To create a circle:

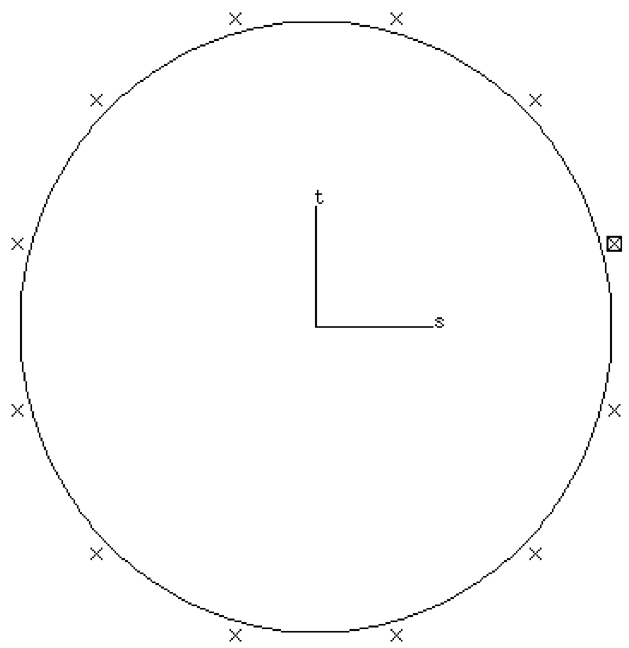
1. Select the command `CURVE⇒ Design: Circle`.

2. Type `10` for the radius of the circle, and `12` for the number of points to use. Accept the centerpoint as origin and click `OK`.

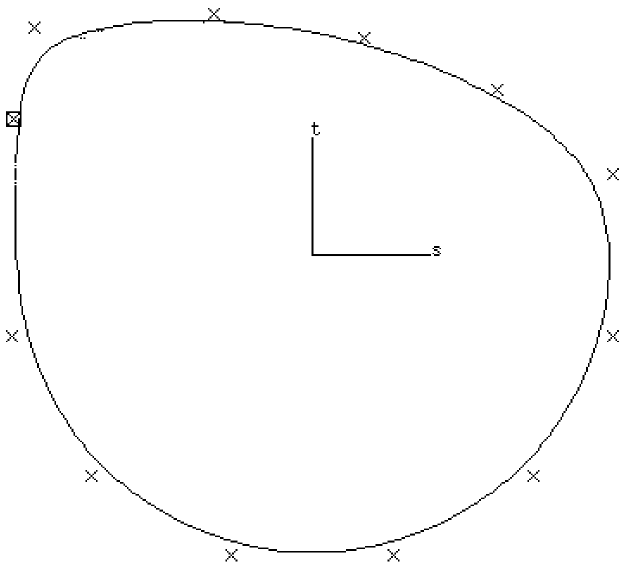
The circle appears around the origin of the coordinate system.

Editing the section curve

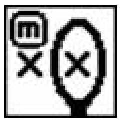
You won't want a circular cross-section for your handle. Fit `[f]` the circle to the middle of the screen, and enter the curve editing mode `[o]`.



You will want to ensure that the section is ***symmetrical*** about the horizontal center line - there are some useful functions in curve editing to help you to achieve this. Therefore, first edit just the upper half of the curve into the desired shape.



Now look at the local editing functions.



Mirroring a point

The **m** function mirrors a point relative to another point. Use it now.

To mirror a point with another:

1. Select one of the points on the bottom of the curve.

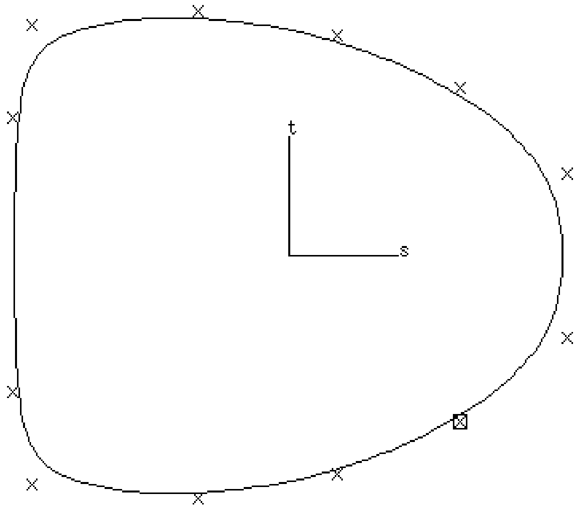
2. Select the mirror function **m**.

The **m** function would mirror horizontally, if appropriate.

If you select a point, press **m**, and select *the same point that is already selected,* it moves to the nearest *axis*.

3. Click near the opposite point on the top of the curve. The first, **selected point** moves directly opposite the second point.

4. Repeat steps 1-3 for all the points you wish to mirror.

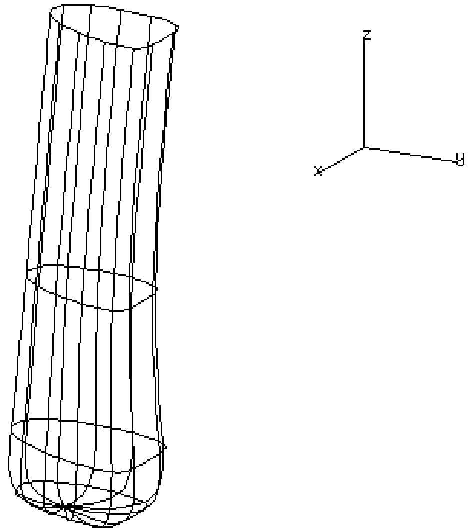


You've designed the handle's cross-section.

Move and mirror the points until you come up with a shape you'll accept. When ready with the changes, exit the edit mode with **w**.

Building the handle

As you have finished the projection curves and the section curve, you will want to build the surface. Easy! Just select the command `BUILD⇒ Create: Surface [b]` and the handle appears.



❢ ***OOPS! The section points in the wrong direction.***

The handle appears. But – depending on the direction you drew the projection curve – the section may the wrong way around, as above. The narrow part should point ahead, not back! Read through the following even if you didn't have this problem, to know how to overcome it in the future.

... or if the surface didn't appear at all, see the Problems section below.

Build parameters

You could get over the problem by rotating the section curve by 180 degrees. But often you would want to keep the section curve in the orientation you defined it. Therefore, you may tell DeskArtes to rotate the curve only *when building*, while the actual curve stays in its place.

The command `BUILD⇒ Set: Build Parameters` controls various ways *how* the surface is built. Section orientation on the surface is one of them. The build parameters can be defined separately for each element.

Section orientation

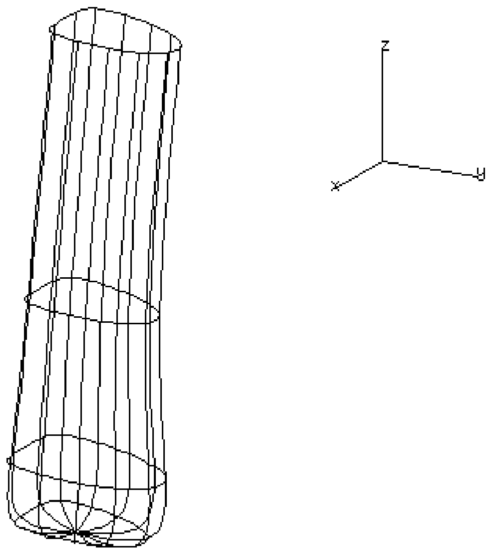
To change the section rotation:

1. Give command `BUILD⇒ Set: Build Parameters`.

2. Tell DeskArtes to use `section rotation` of 180 degrees when building the surface.

This is better!

Build the surface again with `BUILD⇒ Create Surface [b]`.



? Problems

If you did not get the handle computed properly, the most probable cause is that you have broken one of the rules for building. Read through the following check list.

Remember each projection curve must have the same number of points? Click on each of the projection curves in turn at the bottom object window field, or select the by graphic picking `SELECT⇒ Object: Pick [g]`. The number of points is then shown in the message line at the top of the screen. If they are different, edit the curves and add/delete points until they are equal.

Or perhaps the building command did something, but the resulting surface looks funny? Check to see if you really have *two* projection curves defined. Or did you accidentally give a wrong surface creation command?

To build a surface you must have a section curve. On the other hand, there may not be more than two projection curves. Perhaps you have accidentally created the section curve in the projection set? If so, try the following.

To move a curve into another curve set:

1. Select the section curve in the projection set.

2. Give command `OBJECT⇒ Cut`. The curve is deleted from the object list, but it remains still in the system's memory.

3. Select (or create) the section set.

4. Give command `OBJECT⇒ Paste`. The section curve is pasted from the system memory to the chosen curve set.

Finally, if you don't have a section curve defined at all, you may have accidentally deleted it. Try defining it again.

Orthogonal views

To check that the handle surface is really the desired shape, try the ***eye point control buttons*** in the settings window.

The x, y, z, and 3D views:

1. Select the handle surface.

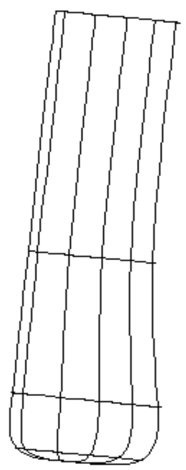
2. Click at the button labeled `X` at the bottom of the settings window. The eye point moves to the x axis.

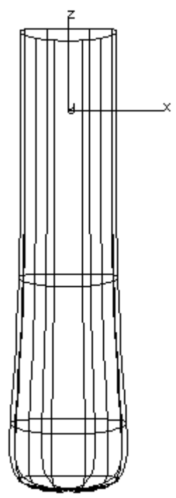
3. Try the other two axial views from the buttons: `Y` and `Z`.

4. When you are done with experimenting, click at the `3D` button.

Section scaling in one direction

As you look at the surface from different directions you will see that the handle indeed bulges out at the bottom, reflecting the shape of the x projection curves. However, as the handle bulges when seen from the x direction, it by default also bulges at the base when seen from the y direction.





In other words, at all points, the cross-section of the handle is the same *shape* as the section curve you drew. It has been *scaled* up in both directions so that it will fit between the two projection curves.

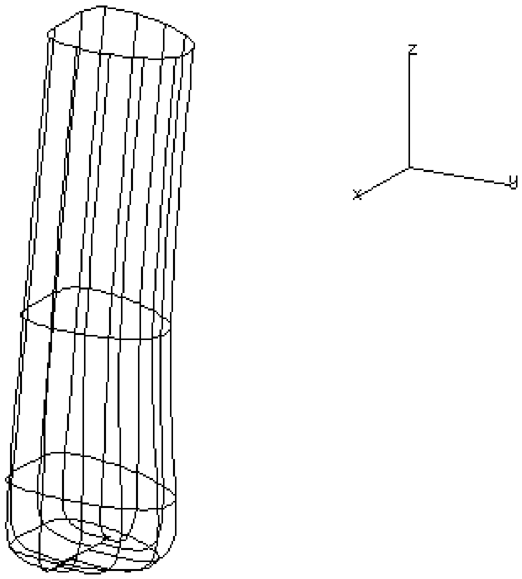
This could be just what you wanted, but there is one option of the build command that you might like to investigate here. Change one of the controls for building.

To build the surface with constant width:

1. Select the command `BUILD⇒ Set: Build Parameters`.

2. Select `section scaling in one direction` from the dialog box that pops up. Click `OK`.

3. Build `[b]` the surface again.



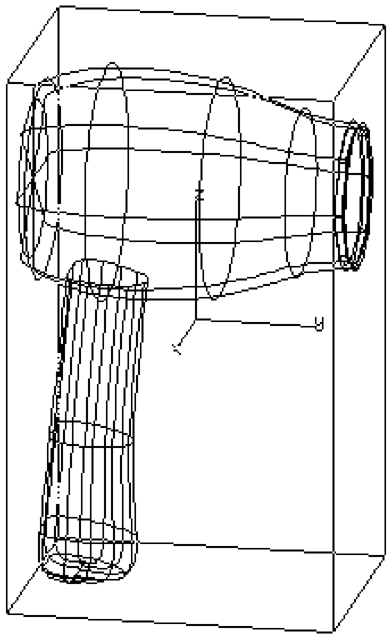
The handle appears. Can you see the difference? It is particularly evident if you look at the surface from the y direction. The sides of the handle when viewed from this direction are vertical. No bulge!

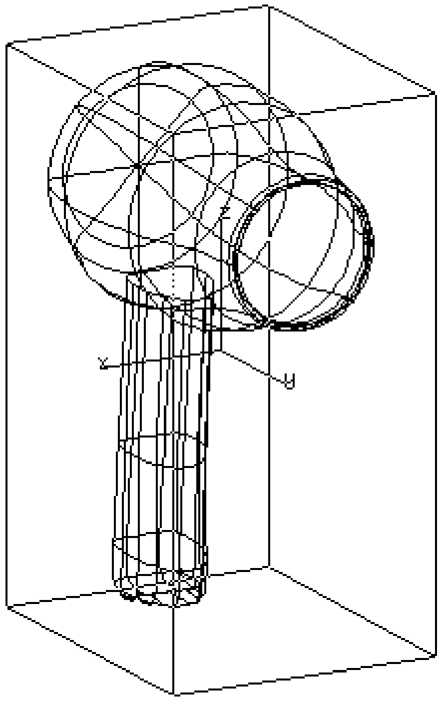
The width of the handle is now exactly the same as the width of the original section curve all the way up. If you consider the handle to be too narrow or too wide for your taste, scale the section curve accordingly and rebuild the surface.

In fact, the bottom could be a bit smoother. But don't worry, you'll learn just in a while, with the *secondary projections*, how to control such delicate things.

Revert to the `3D` view and draw the handle with the base surface `[y]`. You might also want to view the model from different directions with `DISPLAY⇒ View Eye Point [v]`. See Lesson 4 if you don't remember how.

The handle is ready.





Saving the work

We will save the work in file, just in case we need to come back to this point.

Save your work:

1. Show the file window.
2. Perform `FILE: WRITE`.
3. DeskArtes asks you for the type of file you want to write. Accept `model (geom_)`.
4. DeskArtes prompts you with a name for your model. Accept the previous file name `hairdryer` and click `OK`.

Overwriting a file means the old contents are wiped out.

5. DeskArtes points out that a file named `geom_hairdryer` already exists, and asks if you want to ***overwrite*** it. Click `YES` and `OK`.

Lesson 7 : Joining the handle

This Lesson teaches you how to cut (intersect) and blend separate surfaces to form a combined model. In the future, when you make your own designs, this is the way to do it: not to build the whole model of one surface, but to combine easier shapes with each other.

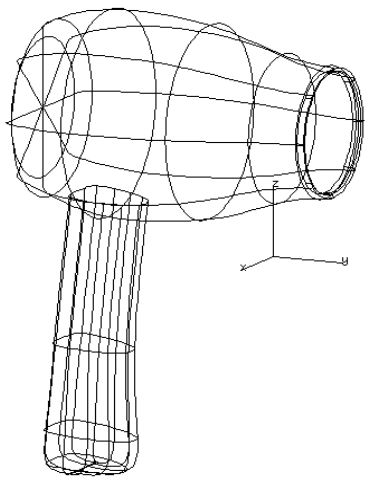
Trimming the two surfaces

You will now connect the handle to the body surface so that the two objects appear as one. To produce a sharp join, you will ***trim*** them. Trimming removes unwanted parts of a surface so that they are effectively cut away. In this case, the part of the handle that protrudes through the inside of the body will be removed and a hole will be cut into the body.

To trim the handle to the body:

1. Select the surface in the `handle` element as the target object.

2. Display the handle and the body using `DISPLAY`⇒ `All: Fit [y]`.



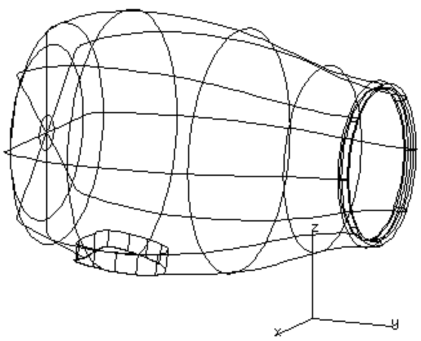
4. DeskArtes asks for the other surface which is to be trimmed to the target (`handle`) surface. The easy way to do this is by pointing with the cursor at the `body` surface on the screen and clicking. Make sure you position your cursor where it is clear that you are pointing to the `body`.

6. DeskArtes displays the intersection line, that is the line where the handle and body surfaces cross over. This should be a continuous loop around the handle.

   If the line is broken it means your handle does not completely intersect the body — see the Problems section towards the end of this Lesson for advice.

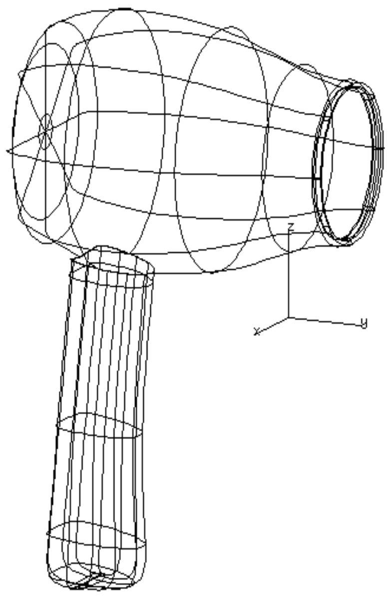
7. DeskArtes displays the two surfaces again with part of the surfaces removed by the trim line.

`This` surface means the target object, the handle. `Other` surface means the body.



You are asked if which parts of the surfaces you want to keep. If the wrong part of either surface is displayed you must *invert* it. In the example, `this` (the handle) surface had to be inverted.

☝ ***You have connected two surfaces.***



Expand on explanations above?

Trimming two surfaces is just one way of connecting two surfaces. It is probably not the most appropriate solution for this case. A better way of connecting the surfaces would be to add a smooth blend. Here's how.

Before you continue, UNDO the previous operation from the settings window. This should remove the trims if you have not done any other operations. If it doesn't, load in the file from the file window again. (We saved it just before we added the trims for this reason.)

Blending the two surfaces

To produce a nicely rounded join between the body and the handle, you will ***blend*** them. Blending two surfaces is an operation that both:

- produces a ***blend surface*** that joins the surfaces smoothly.

- ***trims*** the surfaces so that unwanted parts are cut away.

You will connect the handle to the body with a ***rolling ball blend***. The shape of the blend surface is created by rolling a ball of a given ***radius*** around the two blended surfaces.

The *direction* of the blend will be determined relative to the surface ***normals***. Normals are shown by arrows on the surfaces, determining what the system considers to be the “inside” and “outside” of a surface.

Rolling ball blend

Make sure you used UNDO to get rid of the previous intersection. You are then ready to make the blend.

To blend the handle to the body:

1. Select the surface in the `handle` element as the target object.

2. Display the handle and the body`[y]`. Zoom `[z]` into the area to be blended.

3. Select `TRIM`⇒ `Blend: Rolling Ball`.

4. DESKARTES asks for the other surface to be blended. Click at the body surface on the screen.

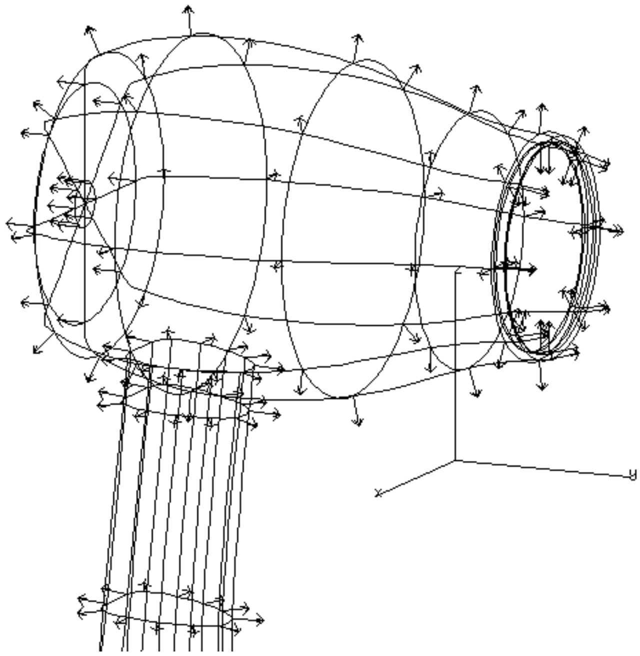
5. DESKARTES displays the intersection line, that is the line where the handle and body surfaces cross over. This should be a continuous loop around the handle.

   If the line is broken it means your handle does not completely intersect the body—see the Problems section below.

6. DESKARTES proposes a ball radius. Type `3`.

   DESKARTES also draws little arrows all over the surfaces. These indicate the normal direction.

To get the blend on the right side of the surface, you must tell the system whether the ball should roll on the `normal` direction of the surface, or on the `opposite` side.



In the above figure the normals point in the “natural“ directions, what you would normally consider as the outsides of the surfaces. You would then tell the system to roll the ball on the `normal` directions on both surfaces.

But if, for example, the normals of the handle would point in to the model, you would tell the ball to roll on the `opposite` side of `this` (the handle) surface.

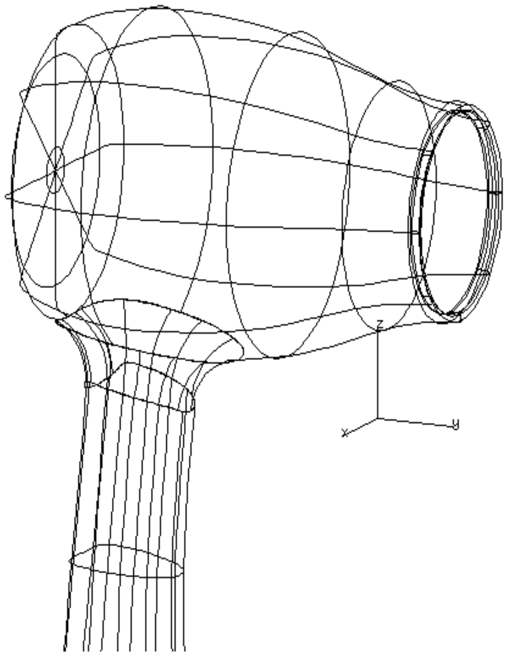
9. DeskArtes creates the blend, displays it, and asks if you would like to accept it. The radius we have chosen is very small so reject the blend by answering `NO`.

   Do the same if you accidentally created the blend on the wrong sides of the surfaces.

10. You are asked if you want to continue with a new blend. Answer `YES`.

11. Answer the questions again this time specifying 10 as the radius and accept the blend when it is created.

✌ ***You have blended two surfaces.***



? Problems

If you did not get the cut or the blend computed properly, the most probable reason is that the handle did not completely intersect the body.

This could be because the handle is too wide for the body. If this is the case, `UNDO` the blend, rebuild the handle after first vertically scaling down the section curve, and try the blend again.

You could also “push” the handle surface more into the body: `UNDO` the blend, edit or transform the handle projection curves, build the surface and try blending again.

If you’re not happy with the blend for some other reason, for instance, you have accepted a too small radius, again `UNDO` the blending and try with different parameters.

Reshaping the blend

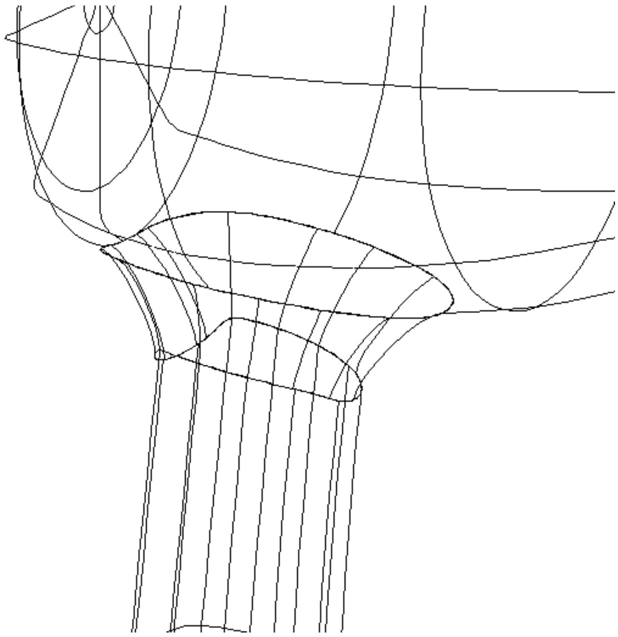
By default, the rolling ball blend surfaces have a circular arc shape. However, after the blend is computed it is possible to change the blend to have an elliptical or a slanted shape. For instance, to create a flatter blend surface (a ***chamfer***), you may do the following:

To reshape the blend surface:

1. Select the blend surface `Surf/Bz/blend` in the handle element. Fit it `[f]` and show with the other surfaces `[t]`.

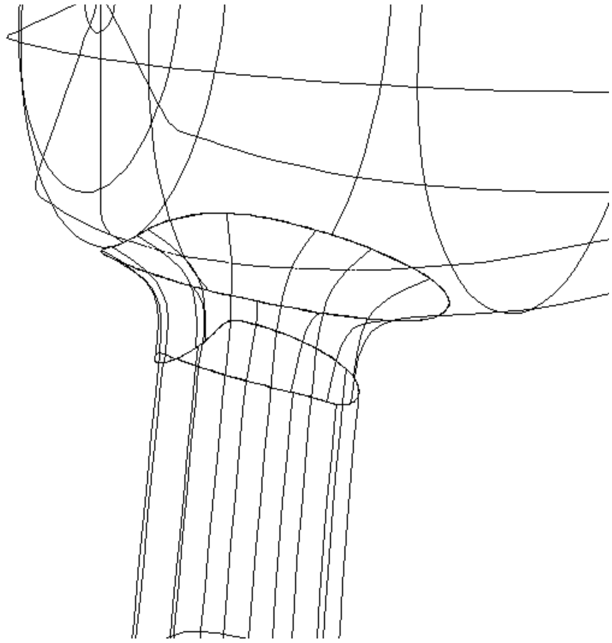
2. Select the command `TRIM`⇒ `Blend: Reshape`.

3. The system asks two *curvature values* as parameters. Answer 0.5 to both, and see the blend change to more slanted shape. Notice the blend is still tangent continuous with the other surfaces.



✌ ***You created a chamfer.***

4. Repeat steps 2 - 3 with curvature values 1.5.



5. If you wish to get the blend back to its original ball shape, repeat steps 2 - 3 with curvature values 1.0.

Recomputing blends

You might still want to modify the blend size, if you consider it too small or large for the model. This means you have to compute the blend again. Let us make a note on that.

You can't use `UNDO` to get rid of the old blend, as you have already used some other commands after you created the blend. You can of course delete the blend surface, but how about the cuts – they should be removed, as well.

Fortunately, the surfaces are not permanently cut! The cuts (trim curves) are stored separately from the actual surface. This method has the advantage that if the trims are later thrown away the original surface reappears!

See the object window. Within the handle element there is an item labeled “`->Trim/body`”. It contains the cuts (trim curves) of the handle surface, as we combined it with the body.

How to interact with trim curves is more closely explained later, in Lesson 16. But if you now wish to recompute the blend, you may simply delete `[k]` the “`Trim`” object of the handle. The system is able to automatically delete the corresponding trimming on the body surface! After deleting the trim curves, you are ready to blend again.

Variable radius blending

Instead of the rolling ball, you might want to try out the variable radius blend now! Please refer to the Reference Manual for detail instructions of the command `TRIM⇒ Blend: Variable Radius`. As a small hint, to precisely locate the different radii it is easiest if you view the model from the side (`X` direction).

Shading

Whichever way you did it, you should now have the body and handle surface joined nicely together. Shade the model with `Mode: Shaded` (or `RENDER⇒ GL Window: Shaded View`) to view the shapes. Remember how this is done? If not, please refer back to Lesson 4 for instructions.

Ending the Lesson

To end this Lesson, you'll save the work again.

Instead of using the file window let's try a faster way. Writing of files is so frequently done that it is provided with a shortcut in the command menus.

Save your work using a shortcut:

✍ [w] is the shortcut for SELECT⇒ File: Write. It does exactly the same thing as FILE: WRITE, but easier.

1. Click [w] on the keyboard.
2. Accept the parameter option model (geom_).
3. Accept the model name hairdryer and click OK.
4. DeskArtes points out that a file named geom_hairdryer already exists, and asks if you want to overwrite it. Click Yes and OK.

Congratulations! You have now finished Lesson 7. You may now exit DeskArtes like you did before, or go directly on to the next Lesson, where you will learn more about creating surface models.

Lesson 8 : The Nozzle

In this Lesson, you will add an outlet nozzle to your hairdryer. This fits on the end of the hairdryer and is specially shaped to concentrate the flow of air. The shape of such a nozzle is very free-form.

Free-form shapes are often very difficult to achieve on a computer modeling system, but DeskArtes provides facilities to make such a shape relatively simple to create. You will learn a lot more on the building method.

You will remember we used the surface build command for the construction of the handle. We built it by defining a pair of projection curves which described the outline or silhouette of the surface from a projection direction. The cross-section of the handle was defined by a single section curve. DeskArtes then generated the shape by stepping the section curve along the projection curves and at each stage scaling the section curve till it just fitted between the projection curves.

The only control we placed on the surface at that stage was to decide whether to scale the section curve in one or two directions. Here we will show you how to extend the use of the build command to have several cross-sections of different shapes in a single surface and control the shape of the surface when viewed from another projection direction using secondary projection curves.

Resuming work

If you exited DeskArtes at the end of the previous Lesson, please resume work on the hairdryer model now. Refer to the previous Lessons if you don't remember how.

Building another surface

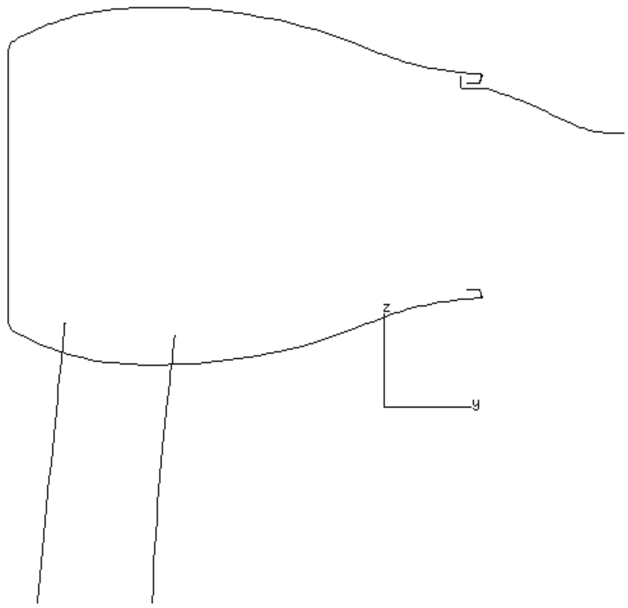
We'll start building the nozzle using two projection curves from the x view, and a single section curve. The procedure is very much the same we already used with the handle.

Building the nozzle from one view:

1. Make a new element [n] and label it nozzle.

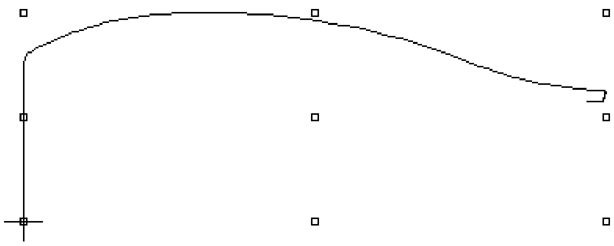
2. Make an x-projection set [p], and show the others [y]. Zoom [z] as required.

3. Input and edit the upper curve of the nozzle as shown below.



4. To help positioning the lower curve of the nozzle symmetrically with the base, copy the fix point from the base as follows.

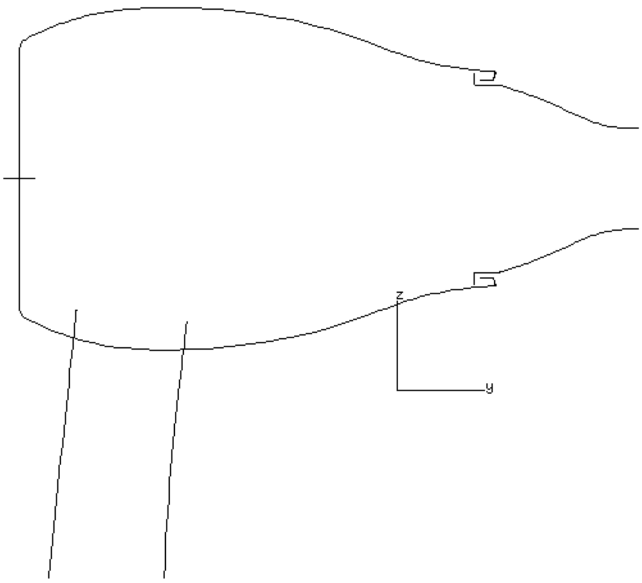
   Pick [g] one of the base projection curves. Give command TRANSF⇒ Fix Point Set [0]. Click the *middle* mouse button on a handle at the center line of the base.



Then select [g] the nozzle projection curve again, and give command Fix Point Copy [9].

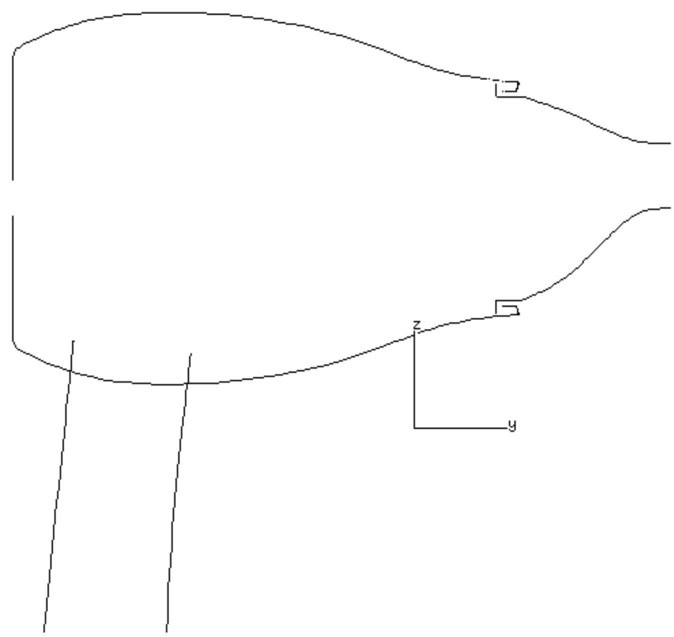
5. Create the lower curve applying the methods you have learned in the previous Lessons: copy the first curve [j] and mirror the curve vertically[m].

❢ Do you now see why you copied the fix point?



6. Edit `[o]` the curves. This time, select the projection set before starting to edit. As you see, you will then be able to edit both the projection curves at once!

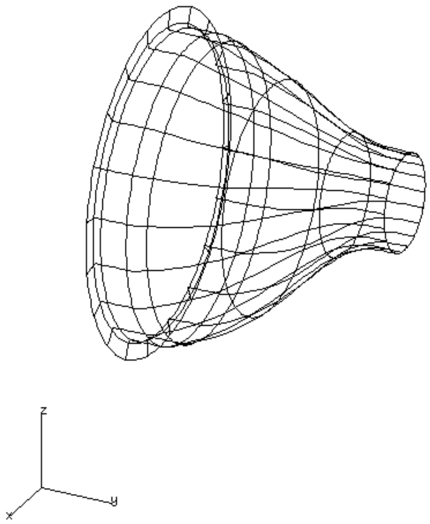
   During editing, remember the projection curves must have an equal numbers of points. If you add or delete a point from one curve, you must do the same to the other curve, too.



7. Make `[c]` a cross-section set.

8. Create a circle with 16 points. The radius doesn't matter.

9. Build `[b]` the surface.



Finally display the surface with the others (`[t]`, `[y]`).

The techniques briefly described above should be very routine to you now. If they aren't you will need to refer back in the Tutorial to refresh your memory.

Varying section curves

You should now have a nozzle surface, though it may not yet be a very acceptable shape. Patience! It will get better.

We could improve the look of the surface by making the outlet end a smooth rectangular shape. Of course, the end that attaches to the hairdryer must remain circular to fit with the body. We need a surface which changes cross-section! This is something new.

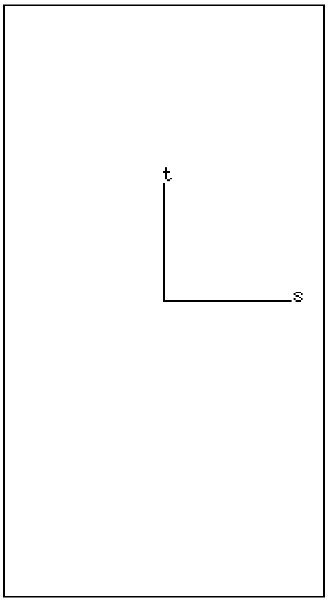
The first stage in achieving this is to design the second section curve.

To make a rounded rectangle:

1. Click on the section set (Cross-sects) of the nozzle.

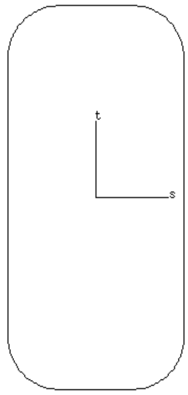
2. Create a polygon (CURVE⇒ Design: Polygon) using the default parameter values four (4) points and radius of 50.

3. Scale [2] the section by half in the horizontal direction to achieve the shape below.



4. Enter curve edit mode [o]. Execute the global function **R**, which replaces all sharp corners with circular rounding. Accept the radius parameter value 10.

   Exit curve editing with **w**, and your curve should now look like this:



Matching the section curves

Now you have two section curves defined. However, we should check they are suitable for building.

Number of points

Remember that for building, the projection curves must have an equal number of points. The same goes for the section curves:

- *All section curves must have an equal number of control points.*

Your curves are defined with a different number of points. See it yourself:

To check the number of points:

1. Display the section curves `[y]`.

2. Select the rectangular curve `[g]`. Look at the message lines. You'll notice the curve has twenty points (`20 pts`).

❢ Use the shortcuts!

3. Select the circle curve `[g]`. The message lines tell that the curve has only sixteen points (`16 pts`).

To make the curves have an equal number of points, you may select the circle curve, delete it, and define a new circle with twenty (20) points.

Curve directions and start points

The second thing we must keep in mind is that:

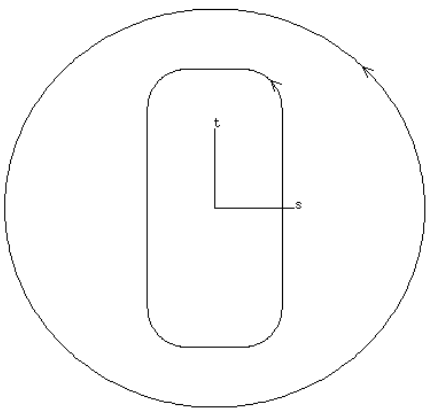
- *All section curves must start at the same angle and go in the same direction.*

If this rule is violated the surface will end up twisted.

To check the curve start points and directions:

1. Display the section curves with `DISPLAY`⇒ `All: Fit [y]`.

2. Select command `CURVE`⇒ `Direction: Show`. It shows arrows at the curve start points, indicating the directions of the curve.



In this case everything is correct - both curves start symmetrically at the upper right, and they go in the same direction (counter clockwise). But if required, you could locate a new start point for each curve with command `CURVE⇒ Direction: Revolve`, and change the directions with command `CURVE⇒ Direction: Change`.

As you have checked everything you need to, select `CURVE⇒ Direction: Show` again to switch the arrows off.

Attaching the sections to projections

Before building, you need to tell the system where to apply the sections on the surface.

Section curves are attached to projection curves at ***knot points***. Knot points are points that lie on the curves near control points. There are always as many knot points as there are control points.

Displaying section numbers

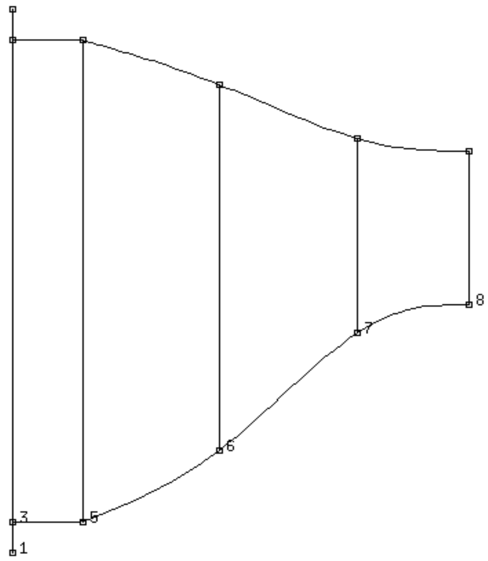
The projection curve knot points are numbered from one. You may attach a section curve between any pair of knot points on the projection curves. You do this by assigning the knot point number to a section curve as its ***section number***.

To display the possible section positions:

- Select `BUILD⇒ Show: Section Positions [h].`

You see the knot points appear on the projection curves, numbered and attached with line segments. The lines represent the section curves scaled between the knot points.

✍ If the numbers overlap so that you can't see them properly, zoom in and repeat.



Assigning section numbers

In this case, you want to fix the form of the nozzle in two places: at either end of the surface. At the left it will be circular, and rectangular at the right, as described by the two already defined section curves..

To assign the section numbers:

1. Look at the section positions displayed on the screen. Note the numbers of the left and the right of the nozzle section reduction.

2. Select the circular section curve.

3. Select the command `BUILD⇒ Set: Section Parameters [u]`. You are asked for a section number. Type the number that defines where you want to start the circular part of the nozzle. In the above picture it could be five (5), so that all sections before that would be circular.

   Accept the weight as it is (1.0), and click `OK`.

4. Select the rectangular section curve.

5. Select the command BUILD⇒ Set: Section Parameters [u]. Type the number that defines where the rectangular shape should belong.

   In the above illustration eight (8) would be a good choice. The shape will thus smoothly change from the circular shape to the rectangular one at the end.

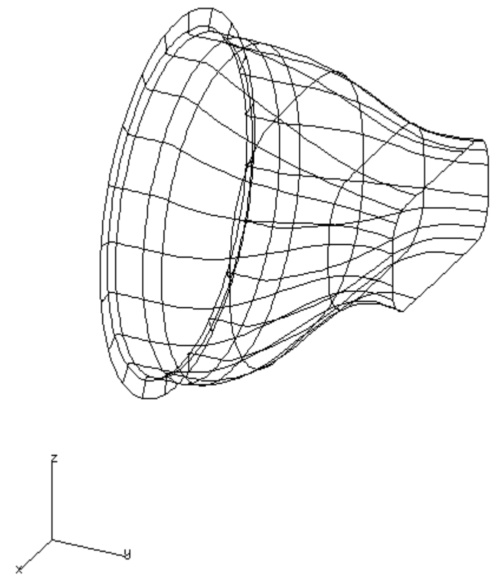
Now, take a look in your section set. You see items like curve/Bs/5 in the lowest field of the object window. The numbers at the end show the curves' section numbers as you just assigned them.

How the shape changes may be controlled with the section weights.

Building the surface

Now that you have the projections and section curves you want, and their numbers assigned, all you need to do is build [b] the surface again.

You can build surfaces with varying cross-sections!



Secondary projections

When you look at the nozzle from above (the direction of the z axis), you will probably notice that it has a somewhat “lumpy” shape. To change the shape, you will need something called a ***secondary projection.***

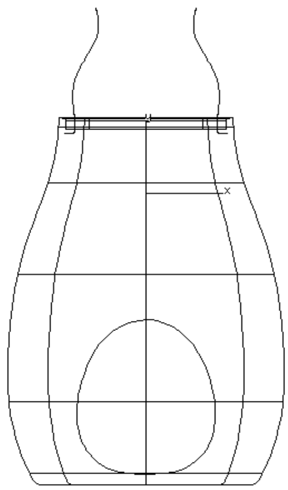
Your current projection curves describe the nozzle as it appears from the direction of the x axis. A secondary projection is a curve set that describe the surface from another axis direction. You need to make a secondary projection that describes the shape from above, in other words, a z projection.

To make a secondary projection:

- Select the command `BUILD⇒ Create: Secondary Projection`. Select `z` for the projection direction and `2 curves` from the dialog box.

The z projection curves are created. They show how the surface presently looks from the top.

To see the projection together with the base surface, place the eye to `Z` axis using the settings window buttons (at bottom right), then select and draw `[d]` the body element.



Constraints on secondary projections

The first projection curves you created (the x-projections, called ***primary projections***) place some *constraints* on the secondary projection. For example, an object cannot be longer when you look at it from above than when you look at it from the side.

The constraints on secondary projection curves are:

- All projection curves must have the *same number of knot points (control points).* Adding a point to one projection curve means that you must add one to all of the others.

- The corresponding knot points of the projection curves must lie at the *same level*. This is because section curves lie on a plane, and you cannot attach the curve to all of the projection curves if their knot points do not lie on the same plane.

- Because of the above constraint, DeskArtes will only allow you to move secondary projection control points in the primary projection direction. For instance, if you have an x projection and make a z projection, you can only move the points of the z projection curves in the direction of the x axis.

Editing a secondary projection

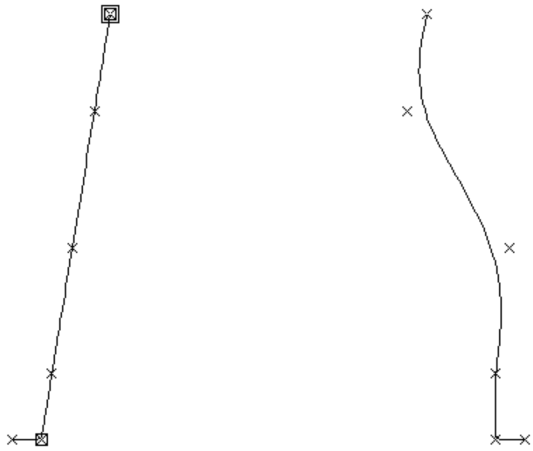
We will straighten out the nozzle's top shape, to make it look like a truncated cone, by editing the secondary projections.

To edit a secondary projection:

1. Select and edit the secondary projection curves `[o]`.

2. Do the following with the left side curve:

   Select the point at the base of the curve with the left mouse button. Make a multiple selection by selecting the top point with the right button. Then use the **`p`** function to move the points of the curve to a line.

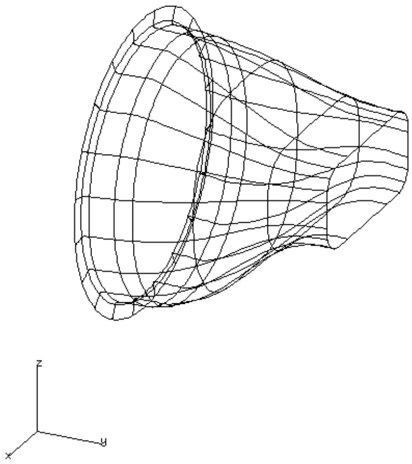


3. Repeat step 2 for the right hand curve.

4. Try also moving the points with the middle mouse button. Notice the system automatically restricts the movements to the allowed projection direction.

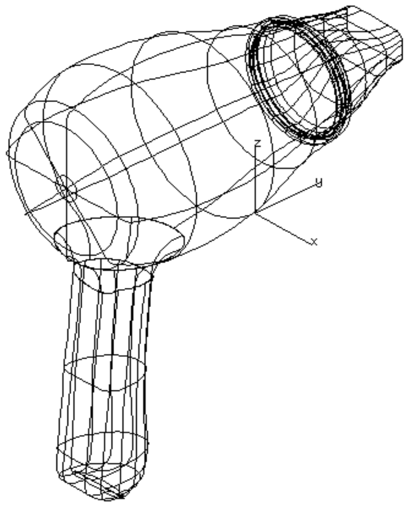
5. Exit the edit mode with **`w`**.

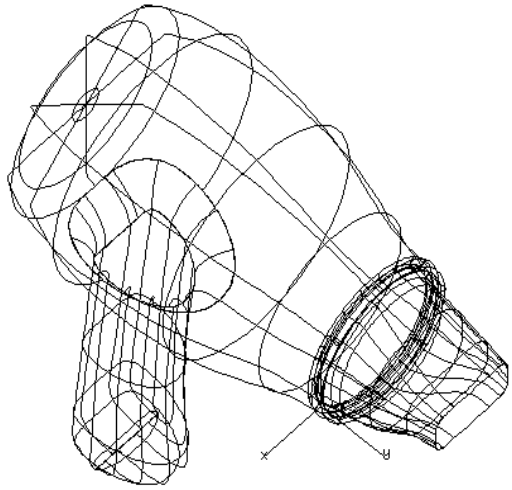
Rebuild the surface (`BUILD`⇒ `Make: Surface`) and you now have a nicely shaped nozzle!



☝ ***You can use secondary projections.***

Display `[f]` and view `[v]` the surfaces from different directions. You might also try shading again.





If you feel like you would like to edit the secondary projection further, feel free to do so. Just remember the rules described above.

? Problems

If the system *refuses* to build the surface, it normally gives an explanation of what is wrong with the model. The most typical reason is that you have a different number of points on the projection or the section curves. See the section “Constraints on secondary projections” above, and the “Problems” section at the end of Lesson 6.

If the surface is created, but just *doesn't look right*, there may be something wrong with the directions of the curves. Use the command `CURVE⇒ Direction: Show` to check the directions, as explained in section “ Curve directions and start points” above.

Finally, if you make an illegal secondary projection by moving the control points in wrong directions (DeskArtes tries hard to stop you doing this), the surface will built but it won't look exactly like the secondary projections.

You can always ***update*** the secondary projection to make it the same shape as the surface. This is done by giving the command `BUILD⇒ Create: Secondary Projection` again. Use it whenever you feel unsure of the secondary projection shape.

Ending the Lesson

When you are happy with the hairdryer, save it in the model file named `hairdryer`. Then continue with the next Lesson ..

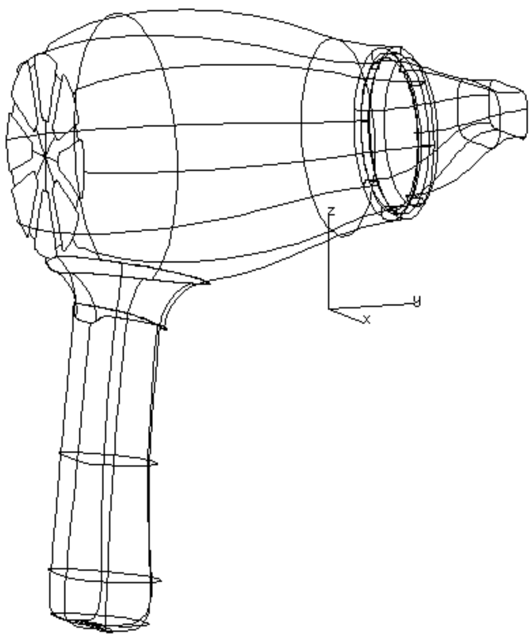
.. or, you might like to learn more about visualization right now. This Tutorial is designed to meet your needs! Go ahead and jump directly to Visualization if you wish, but in that case make sure to return here later on ..

Lesson 9 : The Airways

In this Lesson, you will add some air inlets to your hairdryer. These are holes in the body of the hairdryer to let the air in. In the process, you'll learn many new things which we haven't discussed yet.

The outline of the hole will be designed on the back of the body using a curve different of what we have used so far, the Bézier curve. The curve will then be swept through the body to form a new kind of surface, an extrusion.

The extruded surface will be replicated, transformed and rotated in 3D to define eight holes in total. This is done using an automatic command sequence feature of DeskArtes. Finally, the holes are cut into the body with a multiple intersection command.



Bézier curves

So far, you only have used ***B-spline*** curves to design your models. They are not the only kind of curve that DeskArtes can work with. For some applications, another kind of curve, called the ***Bézier*** curve, is better. The most important differences between them are:

B-spline curves	***Bézier curves***
Control points do not necessarily lie on curves.	Control (knot) points lie on the curves.
Curve flows from control point to control point.	Each knot point has two handles that control the tangent directions.
Corners are produced by double or triple control points.	Corners are produced with handles.
Naturally smooth, but sometimes difficult to control exactly.	Possible to control exactly, but tend to produce “lumps” if you use too many points.
You have to use at least 5 points for circle roundings.	A single curve segment can represent circle roundings.
Can be used for projections and section curves.	Can be used for section curves but not for surface build projections.
Can always be converted to Bézier form without distortion.	Cannot always be converted to B-spline form without distortion.
Surfaces are converted to Bézier form for visualizing.	Bézier surfaces do not need to be converted for visualizing.

Let us emphasize one item in the above table: *projection curves for building must be defined as B-splines.*

It is possible to carry out all your designs with B-splines, but Bézier curves are better in some applications. In particular, Bézier curves are more efficient and accurate in representing curves which consist of straight lines and circle arcs.

Extruded surfaces are a particularly good application for the Bézier curves, so let's try them now.

Setting the grid

If you didn't continue directly from the previous Lesson, read in the `hairdryer` model before you start.

Make `[n]` a new element called `cutter`, and a `y projection` set in it.

Set the viewing direction to `Y` and display the `body` element `[f]`. Zoom `[z]` to the area where you want to have the holes.

Turn on the grid from the settings window.

If the grid looks too coarse or dense, set the `GRID: Show` value to smaller or larger. After entering the new value you must give `[e]` and `[d]` to see the new grid.

If you changed the `GRID: Show` value, you should change the `Snap` value, too. It defines the increments of the values the inputted points may have, and should typically be one fifth or half of the `Show` value.

Erase `[e]` the base from the display so that it won't disturb your playing with the Bézier curves – we'll transform the curve to the right position later.

Creating a Bézier curve

You need to tell DeskArtes what ***curve representation*** you now want to use.

To change to sharp Bézier mode:

1. Click at `REPS: Bézier` from the settings window.

   This means that all curves which are now input are represented in Bézier form.

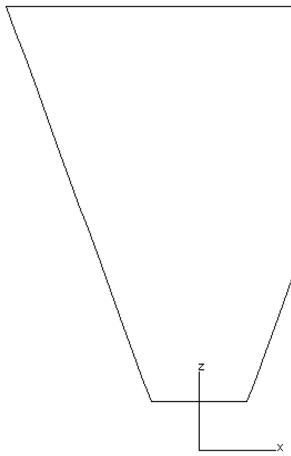
2. Click on the `SHARP` button in the settings window.

This means that all curves which are now input are to be sharp, just like the shape of the inputted polygon.

The SHARP button works for B-splines, too.

You are now ready to go. Input `[i]` a curve. Make it like the one below.

Note that the curve is a bit different of what we have done earlier: it is *closed*, *i.e.,* the first and last points meet. So, after you have entered the first four points, just place the last point to the same location as the first one, and exit with **w**.



Editing a Bézier curve

Now edit the curve to the shape of the hole.

To construct a Bézier curve:

1. Go into edit mode `[o]`. Click on the local and global icons to see the functions.

   The icons look a bit different than normal B-spline editing. Most functions, like the ones used below, behave the same for B-splines and Bézier, but some others are unique.

You'll also see that the control points look different from the B-splines. Don't worry about them now, you'll get a chance to play with them in just a while.

2. Use the local function **s** to create an arc between the top points.

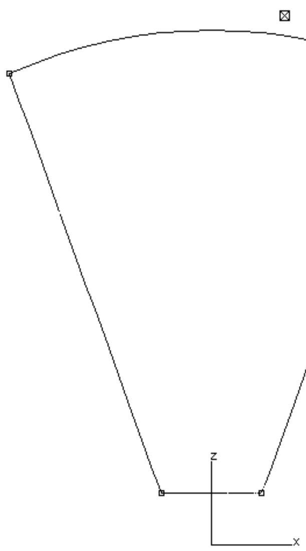
Press the "s" icon or **s** on the keyboard. DeskArtes asks you to show the start point of the arc. Click on the top left corner of the curve.

DeskArtes asks you for the end point of the arc. Click on the top right corner.

Next you are asked to show on which side of the points the center of the arc should be. Click somewhere inside the curve.

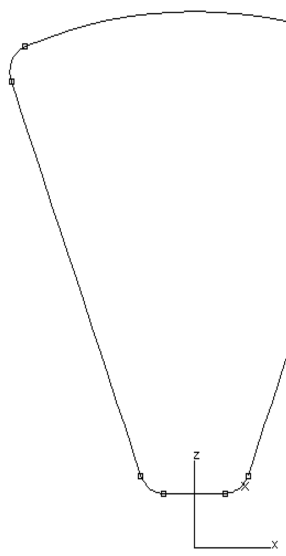
✍ This works for B-splines, too!

Finally DeskArtes asks for the radius of the arc. Give a value about ten times the height of the curve (refer to the grid for it).



3. Give the global rounding function **R**, and enter a radius of about tenth of the curve height.

Undo with **u** if required.



4. Exit with **w**

The curve now consists of straight lines and circle arcs only. This is exactly the right application for Bézier curves.

Or **q** if you want to start over.

However, you might want to use the Bézier curves for some other purposes, as well. Play a while with the editing functions. Don't care if the curve shape gets funny, as we are going to cancel these changes anyhow.

Editing a Bézier curve:

1. Enter into the edit mode again `[o]`.

2. There are *handle points* (crosses) associated to each *knot point* (dot) on the curve. Only the handles associated to the active knot are displayed.

   You can select a knot point or a handle with the left mouse button. The points can be moved with the middle mouse button, just as with B-splines.

Experiment with moving the points.

3. Change the curve into a smooth one, using the global **A** function.

4. Play with the knots and handles again.

   Note that when you move a handle the knot point location is preserved, but the opposite handle moves.

5. Execute function **p** on a handle. Now when you move the handle it keeps on the tangent line towards the next handle, which stays in place.

6. Select a handle point and use the **c** function. You'll then be able to move the point independently, to create a corner to the curve.

7. Input a now knot with **i**, placing the point location with the mouse. Notice the curve shape does not change as you add a point.

   Try also deleting points with **d**.

8. Use the global function **K** to see all the handles at the same time. Move the points to see how it works.

   To get rid of the control polygon, give **K** again.

9. Try the mirroring function **m**. Notice that if you mirror a knot point, it's handles are mirrored, too.

10. Play with the functions as long as you like. If you end up with a curve shape you like, accept it by all means, but otherwise exit with the “Sorry” **q** icon.

You now know what Bézier curves are.

You should now have the hole shape ready. Click on the setting window buttons `REPS: Bspline` and `SMOOTH` to get back to the normal design mode.

Extruding the surface

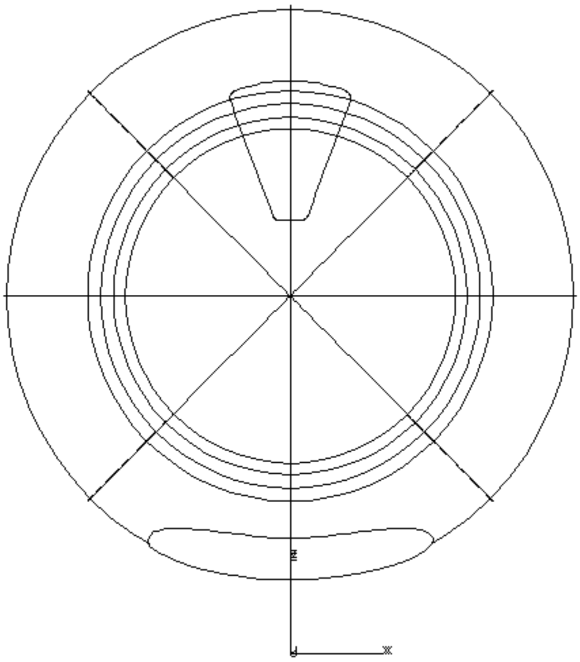
If you didn't have the base surface shown as template when designing the Bézier curve, you need to transform the curve to the correct position.

Transform the curve to the base surface:

1. Select the `body` surface and display it from the `Y` direction (use the Y button in settings window).

2. Select the cutter curve you have just drawn. If the curve does not fit in the screen with the body surface, zoom away (`[z]`/*right* button) until you see them both.

4. Scale the cutter curve (`[2]`/*left* button) and move it vertically (`[1]`/*middle* button) so that it lies above the center of the body.



We now have the outline of the hole we want to cut into the body. The tool surface will be created by ***extruding*** the curve along the direction of the y axis (since we drew a y projection).

To make the cutter by extrusion:

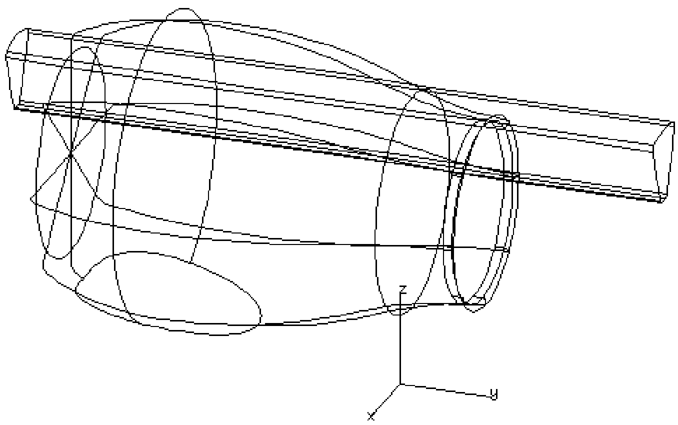
1. Select the cutter curve.

2. Select the command `SURFACE⇒ Design: Extrude`.

3. Click on `OK` in the dialog box.

✌ ***You've extruded a surface.***

A surface is created. You'll see it properly if you move back to 3D viewing (click the `3D` button in the settings window).



Transforming surfaces

The extruded surface extends through the whole of the body surface, which is too wide for our purpose. It could cut out parts from the front of the base surface.

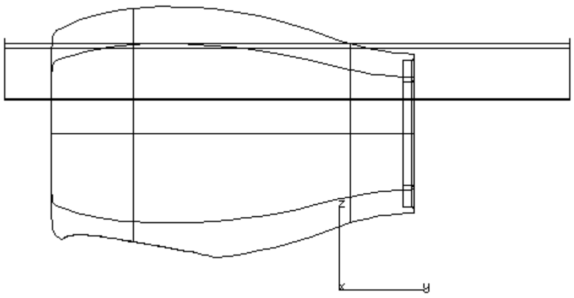
We could have specified the suitable surface extents in the dialog box when extruding the surfaces. But let's try transformations on 3D objects instead!

If you view a surface from an axis view, the transformation commands work exactly as in the case of 2D curves. So here's what to do:

☞ Transformations in 3D view will be explained in Lesson 11.

Scaling the surface in one direction:

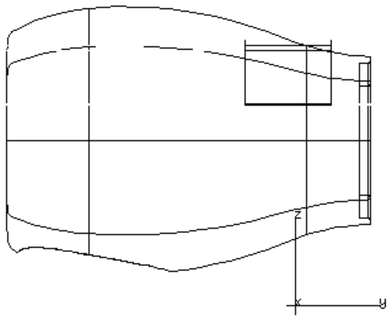
1. Set the eye point to `X` view, and display all the surfaces `[t]`.



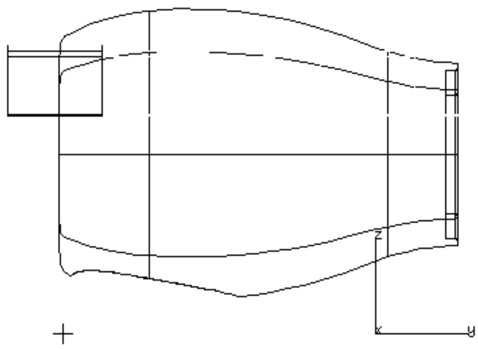
2. Give the scaling transformation command `[2]`.

3. Press the *middle* mouse button and move the mouse horizontally. The surface is scaled relative to the z axis, as the fix point is still at the origin.

❢ If you make a mistake here, use UNDO, or extrude the surface again.

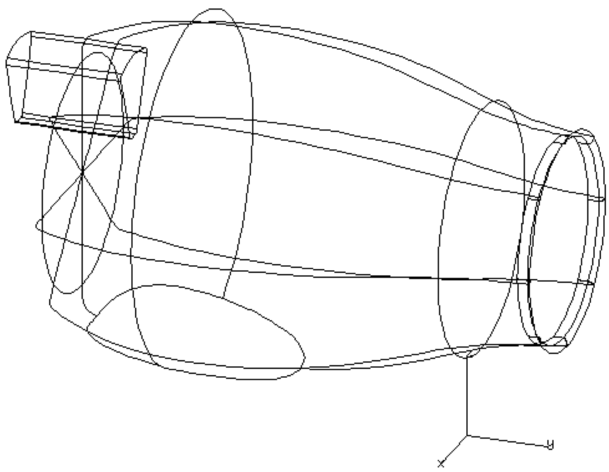


4. Move the surface horizontally to the end of the base surface ([1]/*middle* button).



5. When ready with the transformations, set the viewing direction back to 3D.

You have transformed a surface!



Teaching a command sequence

Now you should have the cutter positioned correctly to cut a hole in the back of the body surface. However, we would like *eight* holes. Easy you might think! I can copy the surface I have just created and then rotate it round the center of the body about the Y axis by 45 degrees, repeating this operation seven times. Yes that's correct. But DeskArtes can make it even easier for you!

Whenever you need to repeat the same operation many times you may teach DeskArtes a ***command sequence*** (or, a ***lesson***) and then replay it a number of times.

Before you start teaching DeskArtes the lesson, it's a good idea to take a few moments to review the series of commands that you need to complete the intended operation. You wouldn't want to teach DeskArtes to make mistakes would you!

In this case we just need to make a copy of the selected element, and rotate it numerically by 45 degrees about the center of the hairdryer body. But first we need to set the fix point for the rotation:

Setting the 3D fix point:

1. Select the `body` surface.

2. Give `TRANSF`⇒ `Fix Point: Set [0]`. Click the *middle* mouse button. This sets the fix point to the center of the body surface, as shown with a 3D cross there.

3. Select the cutter surface. Copy the previously shown fix point to the cutter surface with `TRANSF`⇒ `Fix Point: Copy [9]`.

You are now ready to teach the lesson

Defining a command sequence:

1. Select the cutter surface.

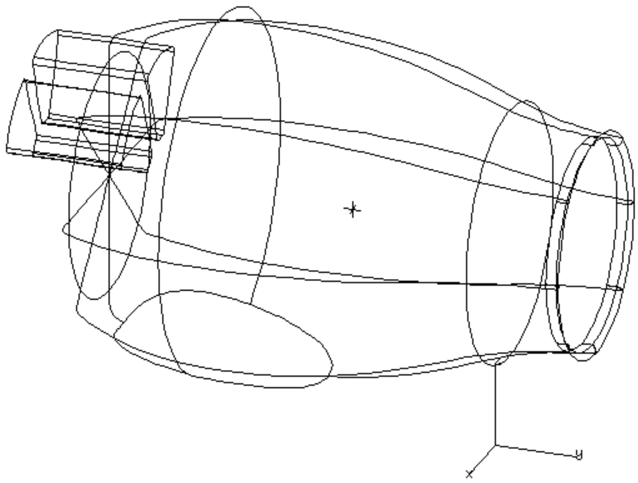
2. Click TEACH in the settings window. A dialog box appears asking you for a name for the command sequence. Type in the name "`rot45`". Click on `OK`.

3. Select the command `OBJECT`⇒ `Copy [j]`.

4. Select the command `TRANSF`⇒ `Rotate [3]`.

5. Press *any key on the keyboard* and type 45 into the dialog box that appears. Select rotation about `y` axis. Then click `OK`.

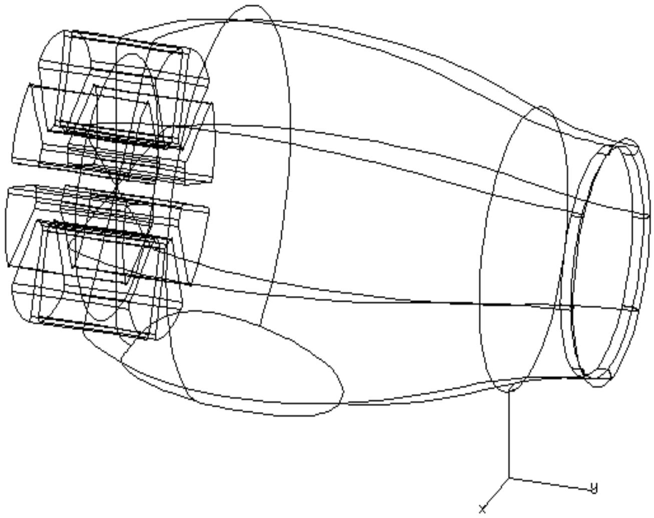
6. That's all there is to it! Click `TEACH` again to end the lesson.



To replay the command sequence, simply click `EXEC` in the settings window and type six (6) for the number of repetitions (two of the eight tools are already created). Click on `OK`, sit back, and watch DeskArtes do all of the work.

At the end your model should look like the picture below.

✌ ***You have executed a command sequence!***



Cutting out the holes

So we now have eight cutters in the correct position to make eight holes. All that remains is to make the cuts. This is an example on how to intersect more than two, *i.e.*, multiple surfaces at a time.

To make a multiple intersection:

> ✍ This would work even if the surfaces would already be trimmed, forming a complete model!

1. Erase the screen `[e]`.

2. Select the cutter **element** (not surface!) and fit `[f]` it on the screen.

3. Select the body **surface** (not element!) and draw `[d]` it.

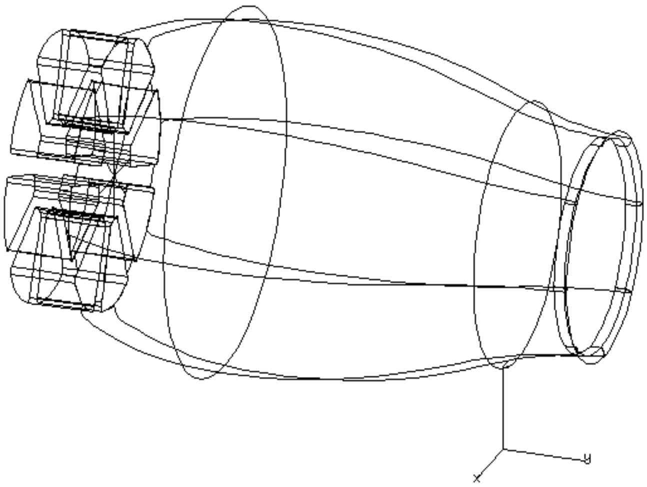
4. Select `TRIM⇒ Intersect: Multiple`. DeskArtes displays the normals on the body surface and asks which side of the cutter surfaces to keep. Since these don't form part of the model, just accept the default.

Hope you had the right surfaces displayed and selected

You have cut multiple surfaces!

5. DeskArtes intersects all of the displayed surfaces with the current target surface.

   When the cuts are done, a dialog box appears. If the wrong parts of the body were cut away, *i.e.*, only the holes remain, tell the system to invert the body surface. Otherwise just click `OK`.



Passive and Active Elements

The holes have now been cut in the body. If you display them with `[y]` you will see all the surfaces on the screen including the cutters.

The cutter surfaces don't really form part of the model. They shouldn’t really be shown here - they were simply used as tools to make the holes. At this point we could simply delete the cutter element, and they would not be displayed. But if we needed to make the holes again we would have to remake all of the cutters - not a very satisfactory solution. DeskArtes provides a better method.

All elements in DeskArtes are either active or passive. ***Active*** objects are considered as currently interesting. If an element is ***Passive*** it is not displayed on the screen unless the operator explicitly requests it.

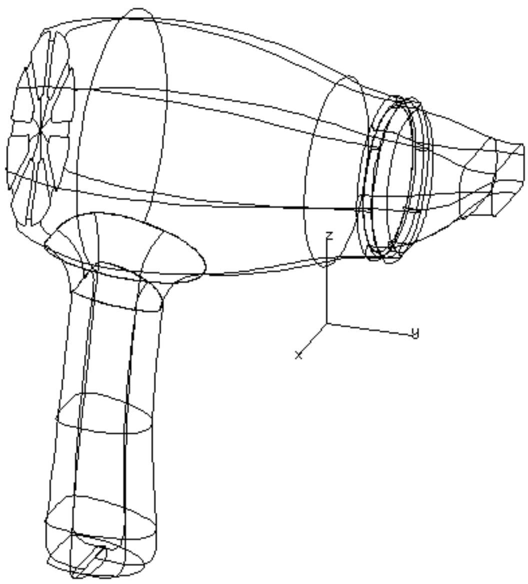
To make an element passive:

1. Select the object to be made passive.

2. Select the command `OBJECT⇒ Active/Passive [a]`. The object name is prefixed by a minus sign (–) in the object window to show that it is passive.

If you perform this operation now on the cutter object, then select another element and issue `DISPLAY⇒ Fit: All [y]`, you will see all other surfaces on the screen but not the cutters.

The hairdryer is ready!



Ending the Lesson

When you are happy with the hairdryer, save `[w]` it in the model file named `hairdryer`. You are then ready to continue with the next Lesson.

Lesson 10 : Making Use of It!

In this Lesson, you will prepare your model for communicating the design on to other members of your organization or to customers.

Traditionally the information would be passed on by means of a ***2D drawing***, probably showing one or more orthographic projections with key dimensions shown. DeskArtes supports not only this method, but also more advanced methods of exchanging ***3D geometric data*** by electronic means.

The information which is currently stored in the DeskArtes's own personal format can be written into many international ***data exchange formats*** supported by DeskArtes. Having converted the model into such common format it can be used by different computer manufacturing systems to create a physical model of your design.

Creating a line drawing

The model of the hairdryer is now complete, at least for the purposes of this exercise. So now it's time to produce a dimensioned line drawing of the model. We will look at two ways of achieving this. But first of all we need to load the hairdryer model again.

Start DeskArtes the same way as before. Select your model file (`geom_hairdryer`) and give the `FILE: READ` command. Hide the file window and begin work.

Making a drawing of the projections

You should by now be very familiar with the much used command `DISPLAY`⇒ `Fit All [y]`. We have used it many times already to fit all of the objects of a *similar type* on the screen at once. For example if you click on any surface and click on `[y]` you will see all of your model on the screen. The exceptions to this are the surfaces contained in any object which has been made *passive*, which in this case includes the `cutter` surfaces.

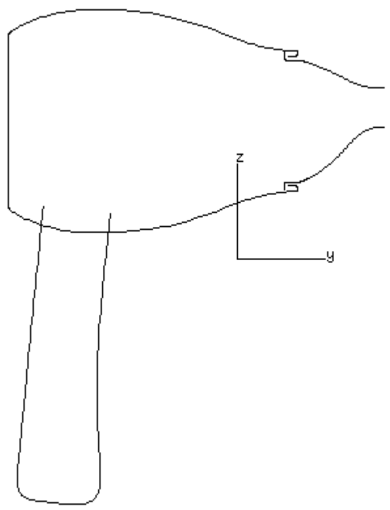
You may consider this command to be useful in producing a drawing since if you issue the command with an x projection is selected you will see all of the x projections on the screen. Almost a drawing in itself! There is another command in DESKARTES which has a similar, but a more powerful effect. It is the `SELECT⇒ Collect: Actives` command.

To collect objects together:

1. Click on the type of object you want to collect, in this case an x projection.

2. Issue the `SELECT⇒ Collect: Actives` command.

Notice the top sub-window in the object window. A new element has appeared, it is called `ALL`. This contains a ***copy of the objects*** of the same type you selected. Since we selected x projections these can form the start of drawing, though some work is still needed.



The next step is to tidy up the drawing by removing the unwanted parts of the curves, for instance the handle fitting inside the body. Remember it doesn't matter what we do to these curves, since they are *copies* of the original curves. The original curves which define the surfaces are still stored in their original elements.

To cut curves with each other:

1. Click on the x projection set in the `ALL` element.

2. Issue the `CURVE⇒ Combine: Cut All` command.

This command ***cuts*** every curve in the set into separate pieces, ending where the curves cross each other. Notice how they are displayed with different colors.

So now the portions of the handle curves which protrude inside the body are isolated. To remove these portions it is a simple task of ***deleting*** them from the model.

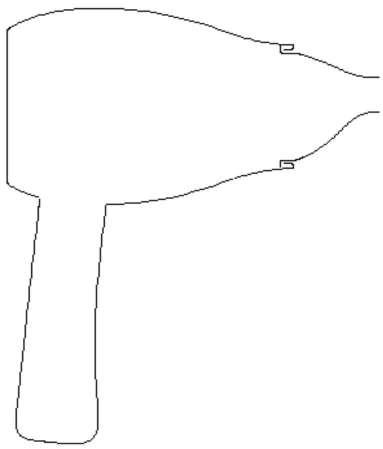
To remove unwanted portions of curves:

1. Issue the command `SELECT⇒ Object: Pick [g].`

2. Point on the screen with the cursor on a curve segment which you wish to delete.

3. DeskArtes finds the picked object and selects it. Issue the command `OBJECT⇒ Delete [k]` to remove the object.

4. Repeat steps 3 to 5 to delete all of the curves not required for your drawing.



To complete the drawing operation, ***join*** all the curves to form as few separate curves as possible. This is effectively the opposite of the cut command introduced earlier.

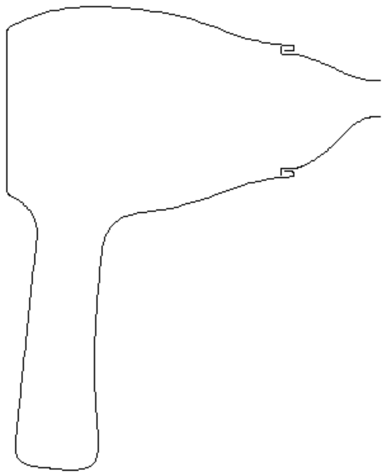
To join curves together:

1. Select the curve set.

2. Issue the command `CURVE⇒ Combine: Join All`.

Finally, you could now go and edit the curves to *add the blend shapes*. Display the surfaces from the `X` direction, select the body/handle curve in the ALL element, and edit it to follow the blend surface shape, as below.

✍ The curves are changed from B-splines to Bézier when cut.



Making a drawing by slicing

An alternative, and more automated method to produce a drawing, is to compute the ***plane intersection curves*** through an object. The `TRIM⇒ Intersect Slice` command is available for this.

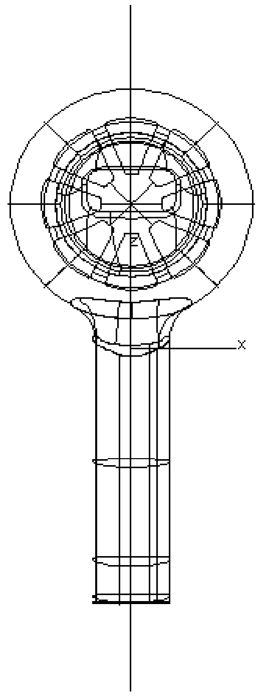
The command is really just a special case of the `TRIM⇒ Intersect: Multiple`, but it is not intended to trim back parts of surfaces. Instead, it generates the 3D intersection curves of the cut. This, among other applications, allows you to use them as the basis of a drawing. An example will explain this.

To generate a slice:

1. Display `[y]` all the surfaces you want to slice. Change the eye point to `Y` direction.

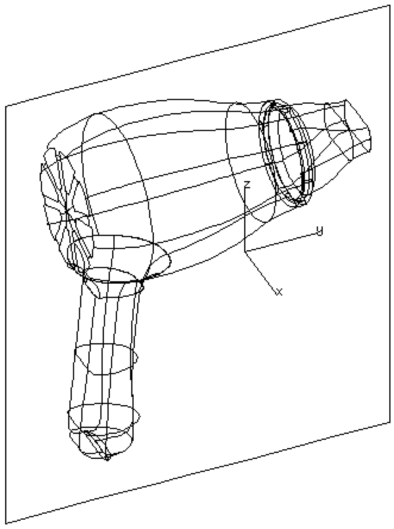
2. Generate a plane in the middle through the object, as follows.

   Set the grid on. Make a new element called `slice`, and a y projection set into it. Input a curve which extends from above the top to below the bottom of the hairdryer.



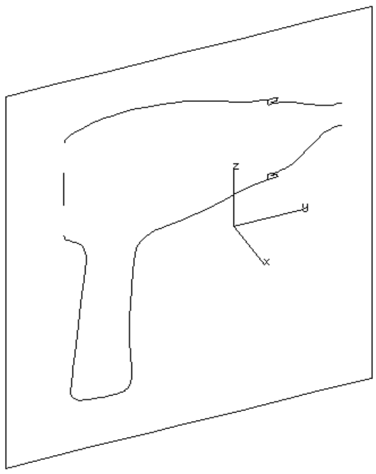
3. Extrude the curve to make a plane: give `SURFACE⇒ Design: Extrude`, accepting its default parameters.

4. Change back to `3D` view and fit `[y]` the surfaces on display.



5. Issue the command `TRIM⇒ Intersect: Slice`, and accept the joining accuracy parameter. The command intersects all the surfaces on display with the target object (the plane).

   Select the sliced curves, called `Curves/3D` in the object window. Erase `[e]` and display `[d]` to see the slice.



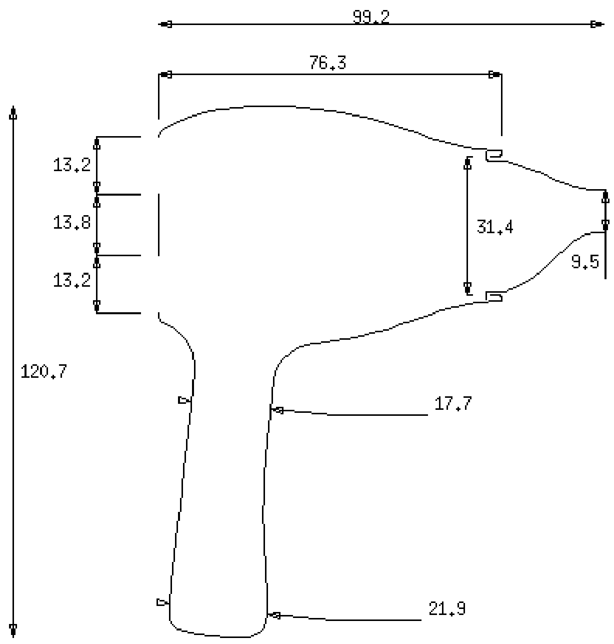
6. Change the resulting 3D curves into a 2D Drawing using the command `CURVE⇒ Change: Dimension`. Tell `x` to be the direction to project the curves into plane.

7. If you want to fill the holes of the airways to make the curves whole, you could use command `CURVE⇒ Join: Two`. If you don't remember how, take a look back to Lesson 2.

These two methods of creating a drawing are presented as alternatives. You will no doubt favor one of the other, depending on the application. Keep in mind the two methods as they both have a role to play.

Dimensioning a curve

You should now have a complete line drawing of the hairdryer. All that remains is to add some ***dimension lines*** to indicate the intended properties of your model.



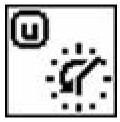
To start curve dimension mode:

1. Select the curve set you want to dimension, *e.g.*, the `Drawing` object in the `slice` element.

2. Issue the command `DIMENS`⇒ `Curve: Dimension`.

The two curve sets are not exactly identical.

You will see a new set of icons which describe the functions available in curve dimension mode. Experiment with them, and try to create a drawing like the one below. Only the interaction guidelines are provided in the following, for further details, consult the DeskArtes Reference Manual.



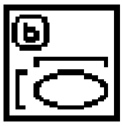
Canceling an operation

Sometimes you might want to undo something you did while dimensioning. Don't do this now, as you haven't done anything yet, but note that while adding dimensions as explained below, you can at any time undo the last change made:

Remember – to undo, you must not be in the middle of performing a function.

To undo the previous operation:

- Click on the icon that looks like a clock running backwards, or click **`u`**.



Bounding box dimensions

This icon allows you to quickly add the dimensions describing the overall size (***extents***) of the curves in both the horizontal and vertical directions.

To add bounding box dimensions:

1. Click at the bounding box icon **`b`**.

2. A line appears stretching vertically across the full extent of the curves.

3. Click and hold the mouse button near the line. Move the mouse and the line follows allowing you to position your dimension line in the most suitable place.

4. Release the button to place the dimension line.

5. You may now place the dimension value at will. Press and hold the *left* mouse button, move the number, and release the button when ready.

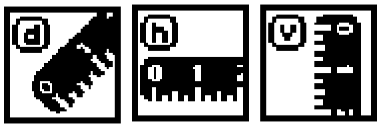
6. A line appears stretching horizontally across the full extent of the curves. Repeat steps 3-4 to place the line. Instead of repeating 5, however, click at the *right* mouse button after the line is in place: the value drops to its default location.

Steps 5 and 6 above present the general interaction rule with dimensioning:

- To *place* the dimension value, click at the *left* mouse button.

- To accept the *default* value location, click at *right*.

Distance dimensions



These icons allow you to quickly measure ***distances*** between any two points on a curve. There are three similar tools which add angular, horizontal or vertical distance dimensions between two points. Try the first one now.

To add a distance dimension:

1. Click at a distance icon **d**.

2. You now need to indicate two points which DeskArtes will dimension between. For the first point, press *and hold* the left mouse button at one side of the curve which you want to dimension.

Still holding the mouse button down, move the mouse, and a line appears. Move the line so that it *intersects* the curve at the point you want to dimension.

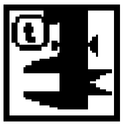
3. Repeat step 2 for the other end point of the dimension line.

4. Place the dimension line as with the **`b`** function above.

There is a special effect to the above interaction:

- To pick an *end point* of a curve, just *start* your intersecting line near it, but *don't intersect anything.*

Try this technique, too.



Thickness dimension

This function works effectively like **`d`**, but draws the dimension lines outside to the curves:

To add a thickness dimension:

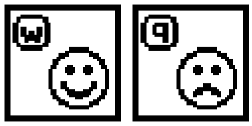
1. Click at a distance icon **`t`**.

2. Press *and hold* the left mouse button at one side of the curve which you want to dimension.

   Move the mouse, and a line appears. Move the line so that it intersects the curve *through both the two points* you want to dimension.

3. Place the dimension line as above.

Exiting curve dimension mode



So that's for starters. Before going on to the next section, add some dimensions to your curve until you feel familiar with the interaction.

The radius function **r** won't work for this model, as it's completely free-form.

You have learned to dimension a curve.

To store the curve dimensions:

- Press **w** on your keyboard, or click at the Smile icon.

This way the changes you made will be saved. The dimension lines and values appear as another `Drawing` in the object window. It is made separate from the actual curves so that it could be ***plotted*** separately, using different line width, pen color, and so.

If you would like to abandon the dimensioning lines you've made, click at the `Sorry` icon, or press **q** on the keyboard. This exits from curve dimension mode without saving the dimensions added, though they still remain on the display for checking.

Transferring information electronically

In your brief experience of working with DeskArtes you have seen it is an efficient tool for generating *computer based design ideas.* As such it has the potential to allow a designer to experiment with many more design ideas and/or provide a much quicker turn around of new design proposals. This translates into *shorter lead times* of new products allowing a company to maximize market leadership.

The potential is actually much greater if a product is going to be brought to market using *computer based manufacturing techniques.* For example, if your product requires plastic injection moulds these complex shapes can be produced using Computer Numerically Controlled (CNC) machines. To control these machines for complex shapes a computer based model is required.

But wait a minute! We have just created a computer based three dimensional model in DeskArtes! Do you see the potential? Rather than giving your manufacturer a drawing you can give the manufacturer your DeskArtes model and they can use that, right away!

Not quite. There are thousands of computer aided design software's available and they all use their own ***format*** for storing the information which defines the model. They all speak different "languages". Just like spoken language, a ***translator*** is needed.

In actual fact there are several "translators" available, but only a few of them count. The three significant ones are called ***IGES***, ***VDA-FS*** and ***DXF***.

DeskArtes supports all of the major translators!

So to pass information from DeskArtes to another system, all that is required is to:

1. Find out which translators your manufacturer's CAD system understands. It is almost certain that it knows one of the above mentioned formats.

2. Agree which format you will use to transfer data.

3. Convert your DeskArtes model to the agreed format (see below).

4. Pass the information to your manufacturer via means of floppy, tape, CD disk or electronic mail.

5. Upon receipt of the information, your manufacturer can convert the information into the native language of their CAD system.

Step 3 above is equal to all formats. It's just as simple as writing a DeskArtes model file!

To write a data transfer file:

1 Select the target object you wish to transfer, *e.g.*, a collected `ALL` element of the surfaces.

2. Before transporting to IGES or VDA-FS, it is recommendable to *optimize the model* using the command

FORMAT⇒ Change: Split Trims. This throws away those surface parts that are completely trimmed away, and splits all closed surfaces into open ones.

You may also at this point verify the model's correctness using the command FORMAT⇒ Check: Everything, which reports errors like duplicate surfaces or erroneous trim curves.

3. Call up the file window in the normal manner. Select the command FILE: WRITE from the middle field pop-up menu, just as if your were going to save a model file.

4. Choose the data transfer option, and the desired data transfer format.

5. Enter a name for the file in the final dialog box. Depending on the chosen format, there may be some additional parameters to specify. Usually you may just accept the default values. Please consult the DESKARTES Reference Manual for further information.

✌ ***You have learned about data transfer.***

On completion you will see a new name appear in the middle field of the file window. It will be the name you typed, with the format identifier ".igs", ".vda" or ".dxf" appended. This is the data transfer file you should now pass on.

PART III: VISUALIZATION

The Visualization Part consists of five Lessons, all of which work on the models you have already produced with the Tutorial. If you prefer, the *standard models* which were used to illustrate this Tutorial can be found in the directory `DA_tutorial`. They are called `geom_shampoo` and `geom_hairdryer`.

The five Lessons introduce different levels of visualization. You'll also learn how to perform various file management operations on the way.

In the first Lesson you will compose the layout for the objects to be visualized in the remaining Lessons. You will learn more about 3D transformations.

The second Lesson will show you how to apply different properties to a model to determine how it will appear. These consist of the object's material, including colors, and texture images mapped on the surfaces. You'll shade the model, with some advanced techniques to control the picture contents.

The third Lesson introduces the concept of scene elements. They are controlled with the DeskArtes scene editor. It will allow you to position the camera and light sources, define their view angles, colors, intensities, and see the changes shaded in real time.

In the fourth Lesson, the picture thus composed will be rendered to the highest quality by ray-tracing. You'll also learn many ways how to interact and add scene elements with ExTrace.

The final Lesson teaches you to use DeskArtes's painting program to create your own graphic designs. You'll design a simple texture, which finally will be mapped onto the complete hairdryer model.

Lesson 11 : Composing the Scene

In this Lesson you will learn how to combine models from different files, and how to transform the models in the 3D space. In the process, you will form a scene which will be visualized in the next Lessons.

Combining models from two files

You will now ***combine*** two models from different files, to form a complete scene. The models you use are the ones you have already created, the shampoo bottle and the hairdryer. To combine these, it is easiest to make a “scene model” by collecting the surfaces from the two models in your active model space.

To collect the surfaces of the hairdryer:

1. Start DeskArtes as usual.

2. From the file window, select the `geom_hairdryer` file and perform `FILE: READ`.

3. Select any surface, and issue the command `SELECT⇒ Collect: Actives`. This copies all your active surfaces into a new element called “`ALL`”.

The ALL element is passive, by default, as it contains just copies of the actual surfaces.

4. Select each of the other elements in turn (*i.e.*, `body`, `nozzle` etc.) and delete them using the command `OBJECT⇒ Delete [k]`.

5. Rename the `ALL` element: select it, perform `OBJECT⇒ Rename`, and type `hairdryer`.

6. Make the `hairdryer` element active with `OBJECT⇒ Active/Passive [a]`.

You now have an element called `hairdryer` which contains only the surfaces, no curves. Next, read in the shampoo bottle:

To read in the shampoo bottle:

1. From the file window, select the `geom_shampoo` file and perform `FILE: READ`.

2. The system asks, whether the old model should be replaced or not. Answer `NO` since we want to combine the two models. Then hide the file window by clicking on `OK`.

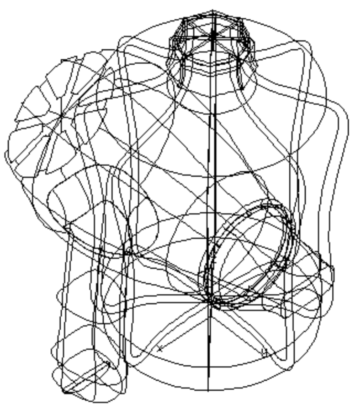
3. Remove the projection and section curve sets from the `bottle` and `cap` elements (`OBJECT`⇒ `Delete [k]`).

You should end up with three surface elements called `hairdryer`, `bottle` and `cap`. Additionally, you have two extra elements called `SCENE` and `MAT`. These contain the scene descriptions of the ExTrace picture you created of the bottle in Lesson 4. Leave the elements there for further use.

You have combined models to make a display file.

Transforming the models

When you now display the elements with `DISPLAY`⇒ `All: Fit [y]`, your hairdryer and the bottle appear in the graphics window. However, you have a minor problem: the bottle and cap occupy much the same space as the hairdryer.



You want to move the hairdryer out of the way. Here you'll learn how to ***transform surfaces in a 3D view***, and using ***multiple viewports***.

Graphical moving

Move the hairdryer away from the bottle with the mouse.

To move the hairdryer in 3D:

1. View the model from a 3D view. Zoom out to have more space for moving, using `[z]` and *right* mouse button.

2. Select the `hairdryer` element in the top field of the object window.

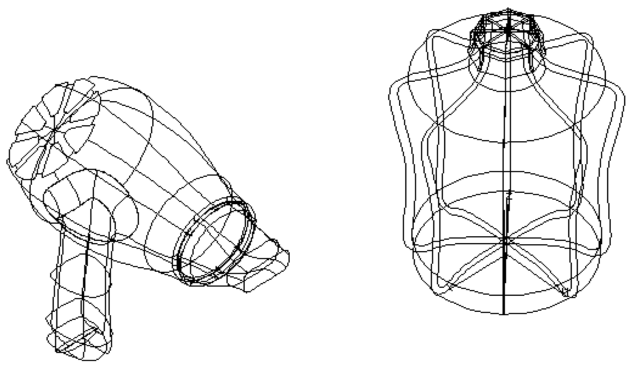
3. Select `TRANSF`⇒ `Move [1]`.

✍ Look at the message lines for instructions.

4. A box appears around the hairdryer to show the hairdryer location in real time. Press and hold the *left* mouse button. Move the mouse, and the hairdryer (box around it) moves in the x direction.

   Release the mouse button when you are finished with moving.

5. Repeat steps 3 - 4, and move the hairdryer in the y direction: use the *middle* mouse button to do this.



To move the hairdryer in an axis view:

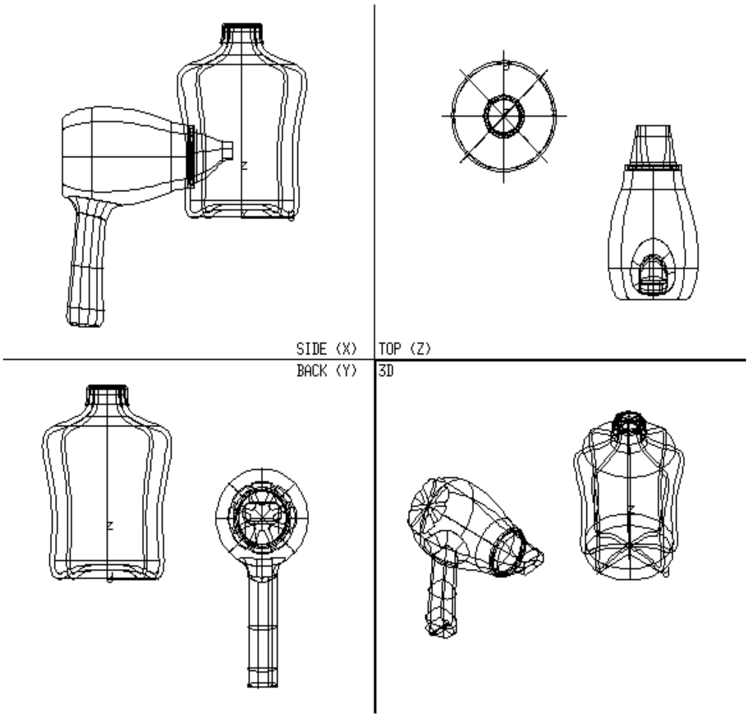
1. View the model from the Z axis view (click on `Z` in the settings window). Fit the objects on screen with `[y]`.

2. Move the hairdryer using the mouse. It now moves just like 2D objects.

Four views

So far we have used the just one view in the whole of the graphics window to display the models. But there's an alternative to this.

If you click at the `Area: four` button in the settings window (do it now!), DeskArtes shows the objects in the three orthographic views *and* the 3D view, all at once. You may fit the surfaces in all display quarters with `[y]`, and zoom in each quarter separately using `[z]`.



This ***four views mode*** is particularly useful for performing transformation on 3D objects, as it helps to see where the objects really are located. During transformations, all the four views are updated when the object is moved.

Mouse buttons in different views

The transformations are slightly different if performed in an orthographic view, or in the 3D view. With four views, the behavior depends on *which view* the mouse button is clicked at. Let us summarize the basic rules:

- If the cursor is in a ***3D view*** for a transformation command, then movement with the mouse buttons is locked to one of the three axes.

  Left mouse button moves in X, *middle* moves in Y and *right* moves in Z.

  Rotation behaves similarly, rotating around X, Y or Z axis depending on which mouse button is pressed.

  Scaling is done uniformly in all directions, regardless of the mouse buttons.

- In an ***orthographic view***, the *left* hand mouse button allows free movement.

  The *middle* button locks the transformation to either vertical or horizontal depending on the first movement of the mouse (like 2D transformations).

  The *right* mouse button works like the left, but it restricts movement to grid or other set increment.

- All transformations, regardless of the view, can be performed ***numerically*** if you click on any *key* on the keyboard instead of a mouse button.

Let's try these alternatives. You should have the `AREA: four` button pushed down and the hairdryer model selected when performing the following exercises.

Scaling and rotation

The hairdryer is probably the wrong size compared to the bottle. You might want to scale it. The scene may also look a bit strange, as the hairdryer is standing vertically. You will rotate the hairdryer to make the scene look nicer.

As with 2D transformations, it is best to set the fix point to the middle of the object before the transformations.

To scale and rotate the hairdryer:

1. Select the command `TRANSF`⇒ `Fix Point [0]`.

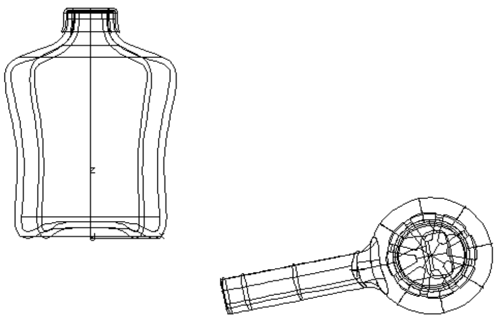
   Press the *middle* mouse button in the 3D viewport. This sets the fix point to the middle of the hairdryer.

2. Select the command `TRANSF`⇒ `Scale [2]`.

   Press any mouse button in the 3D viewport and scale the hairdryer to a suitable size.

3. Select the command `TRANSF`⇒ `Rotate [3]`.

   Press the any mouse button in the Y viewport and rotate the hairdryer with the mouse till the hairdryer is lying flat.



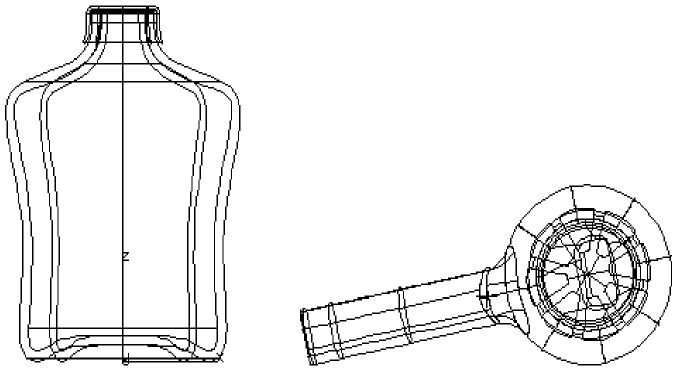
Moving to the same level

You probably have the hairdryer and the bottle at different heights: one of the objects apparently “floats” in mid air.

To move the items to the same height:

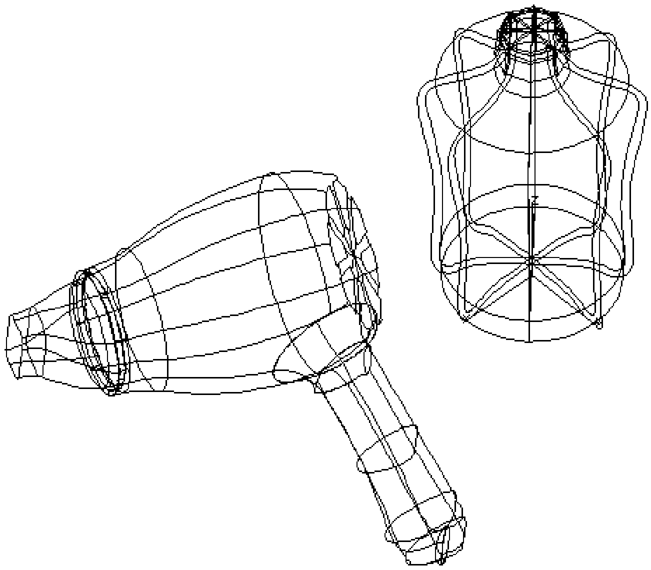
1. Select the command `TRANSF⇒ Move [1]`.

2. Press the left mouse button in the Y viewport and move the hairdryer to the same height as the bottle.



Try again until you have the objects in the right place and the right size. Try also rotating `[3]` around the z axis both in the 3D view (use *right* mouse button), and the Z view (with any mouse button). You should end up with something like this:

You can transform 3D models.



Ending the Lesson

Exit the four displays mode by clicking `Settings`⇒ `AREA: whole`.

Save `[w]` your work into a model file name named `collection`, so you can continue to use it for visualizing in the next Lessons.

Lesson 12 : Materials and Textures

The models you have so far created have been defined by their shape. But shape is not the only thing that determines how an object looks. Both the ***material*** an object is made from and its ***texturing*** affect the final appearance. The material defines the surface structure, or its “shininess”, while a texture is a pattern, a painting, a label, or a relief which appears “on top” of the material.

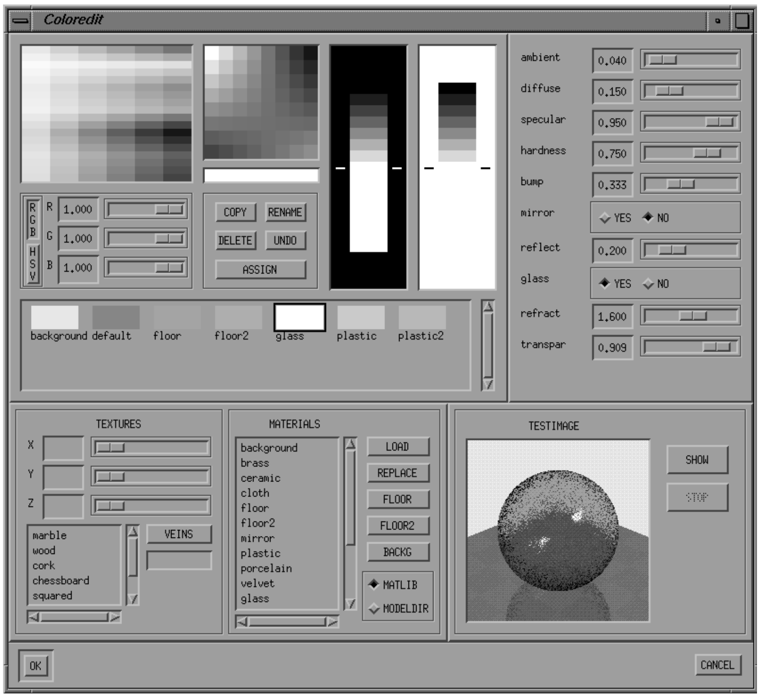
The way the object is lit is of course important, too, but let's not rush ahead of things! Before you can play with the lighting conditions, you must always define the materials to your objects.

Have the `collection` model loaded in DeskArtes to perform the following exercises. If required, such an already composed scene may also be found as the file `geom_collection` in the `DA_tutorial` directory.

The material palette

Materials are defined and edited through a single menu command, `SCENE`⇒ `Edit Materials` . Give it now.

A large window, the ***material palette***, appears. It contains all the functions to define materials and may at first appear quite complicated – it isn’t! To prove it let's work through a ***material editing session***. The hairdryer will be made of a plastic material and will be a light pastel green in color.



Default material

In fact your model always has a material. If nothing else has been defined, the ***default material*** is used.

You have already seen the default material in the various shaded pictures you've created. It is shown in the material palette's list of ***currently defined materials***, at middle left, in a box labeled “default”. The default material is a grayish nondescript material. Very boring! So let’s define something a little more exiting.

Library materials

First because we have already decided the material will be plastic let’s look in the ***material library*** to see if the there is a predefined material we could use. The material library is accessed through the middle bottom window headed MATERIALS.

To load a material from the library:

☞ How to scroll was explained in Lesson 5.

1. Scroll through the list of materials until you find a suitable name. Try the one called “plastic”.

2. Click on the material name to highlight it.

3. Press the button LOAD.

Notice that when a material is loaded all of the controls alter to reflect the properties of that material. Now let's see what the “plastic” material looks like.

Test object

In the bottom right of the material editor you will see the ***test object window***. Press the button labeled SHOW and watch what happens. A picture of a test ball is rendered. The ball has the properties of the current material **-** “plastic”. Use the test object to show your material changes whenever required.

Do you like the plastic material? If you don’t it doesn’t matter, your not stuck with it! Let's change it's color first.

Colors

Color on the computer screen is produced by combining three different colors—red, green, and blue—in varying combinations. For a DESKARTES material you can define your own colors in the same way, by numerically specifying the red, green and blue components. But DESKARTES also allows you to *interactively select and mix* colors on the screen in much the same way as an artist mixes paint.

To select a color:

1. Select a color with the *left* mouse button from the basic color field, at top left.

2. Zoom the color by clicking the *middle* mouse button. This displays a more accurate color chart around the selected color.

3. You may select any of the zoomed colors with the left mouse button.

3. Click the middle mouse button again to return to the basic color chart.

The ***color mixing field***, at center top, allows you to create your own colors.

There are over 16 million colors available!

To mix a color:

1. Click on any color within the color palette window to select it.

2. Click the *right* mouse button on a *corner* of the color mixing field. The selected color drops there, and the shades inside the color mixing field change correspondingly.

3. Repeat steps 1 and 2 for the other three corners.

4. Select and zoom the colors within the color mixing field, using the left and middle mouse buttons.

It's often a good idea to put black and/or white in some corners.

Play around with the colors until you feel happy with the controls. Try to mix a pastel green color, or something else if you prefer. Render the test ball again to see the changes you have made.

Material properties

A material consists not only of color, but also of ***light emittance properties*** such as shininess, mirroring, etc. You can see the material properties of "plastic" by looking at the sliders at the top right. More importantly, you can change these to make your own variation on the material.

The meanings of the different sliders are explained below. Try moving them, and render the material on the test object after each change to see what effect they all have. It's worth spending some time at this stage to get a good feel of the way these properties interact as they are crucial to the creation of realistic images.

Don't mind if your material starts to look funny as you experiment – you'll get a chance to cancel your changes later.

Ambient

Ambient light describes a constant brightness for the whole surface. You can think of it as *"day light"* which comes from all directions, independently of the user-defined light points.

Try what happens with the extreme values 0.0 (no ambient) and 1.0 (lots of ambient).

Usually, give a material some ambient light: otherwise light points result in completely black shadows. However, *avoid using it with glass and mirror materials* - they easily become overlit if you add the ambient component.

Diffuse

The ***diffuse reflectivity*** value describes the general reflectivity of the surface, *i.e.*, the overall effect of light points. A low value means a dark object, a high value, a light one.

Diffuse reflectivity does not affect highlights. They are controlled separately, with the following two sliders.

Specular

The ***specular reflectivity*** factor describes the polish of a surface, *i.e.*, *brightness of highlights.* The greater the value, the brighter the highlights and the shinier the surface appears.

Hardness

Hardness describes the *highlight sharpness* (size) on the surface. For soft materials, use values near to zero, and for hard materials larger values.

With very large hardness values (close to one), the highlights may become so small they don't show on the test ball at all. They will show on a larger picture resolution, though.

Bump

The ***bump*** parameter makes the material behave irregular, not perfectly smooth. This is a very useful effect in many occasions, as real world rarely behaves so regularly! Try different values between zero and one.

Mirroring and reflectivity

The material can be made ***mirroring*** or not by clicking at the corresponding `YES` and `NO` buttons.

The ***reflection factor*** describes how much the object mirrors other objects. Value 1.0 describes a perfect mirror, while smaller values make the material reflect the environment only dimly.

Remember to *use a low ambient value* with mirroring materials.

Glass

Make the material appear as ***glass*** by clicking the `glass: YES` button.

Mirroring does not have much impact on glass, so you should usually set it off. If you have mirroring on, however, use a *low reflection value* – an object cannot simultaneously show through and be a perfect mirror.

Refraction and transparency

The glass behavior is controlled by two properties: a factor that controls ***refractivity* -** how the light is *bent* as it passes through the object, and another that controls ***transparency* -** *how much* the object shows through.

Glass normally has a refraction factor between 1.2 and 1.4. Values below one are rarely needed, unless the object is made of a material thinner than air.

If the glass is highly transparent, and mirroring at the same time, remember to *use a low value on mirror refractivity.* Otherwise the object gains too much light!

Canceling material changes

Obviously if you have moved the sliders a lot the material won't look very much like plastic anymore. In this case, you may click the `UNDO` button in the middle. It cancels all the changes you made to the material, including color selection, since the time you last selected a material for editing.

If you have for some reason selected another material during the editing session, and wish to go back further than to the last selection, you could reload the "plastic" from the material library. Since you have already loaded "plastic" before, use the `REPLACE` button this time instead of `LOAD`.

✌ ***You now know how to define materials.***

If you have edited several materials, and wish to cancel all the changes to them, you may exit the material palette by clicking at the CANCEL button at the bottom right. However, this works only if you haven't already assigned materials to the objects – see below.

Applying a texture

The bottom left corner field of the material editor allows you to try a ***solid texture*** over the surface. This isn't really appropriate here but let's get radical for a while - how about a plastic marble hairdryer!

To apply a marble texture:

1. Click on the name “marble” in the TEXTURES list.

   Render the test image to see the texture.

2. Change the X, Y or Z sliders.

   Render the test image to see the change.

3. Click on the VEINS button. Then point at the “default” material box in the current material's window.

   Render the test image, and see how the marble veins change to the default material's color.

4. Don’t like a marble hairdryer? Select “marble” from the texture list again to inactivate it.

Actually, DESKARTES treats textures separately from the materials. A texture is not considered to be a material property, but rather a picture painted on the object. Textures like marble can be *shown* with the material palette, to check how they appear, but *not assigned* to objects.

☞ If you wish to apply a texture on the surface, use the TEXTURE menu.

Assigning materials to objects

You should now have defined the plastic material for the hairdryer. But how does the system know it belongs to the hairdryer, and not the bottle for instance? You need to ***assign*** the material to the surface.

Notice the object window is still visible on the screen. You may use it to select objects during material editing.

Select the hairdryer element. Then click on the wide ASSIGN button in the middle. This transports the currently selected material to the object selected from the object window.

Now repeat the material editing process to define a chrome steel nozzle. Make the nozzle of same material as the rest of the hairdryer, but different color: Select “plastic” from the active material's list (not the library!) and COPY it. Give name “plastic2” to the copied material. Edit its color, but keep the properties.

To assign the “plastic2” material, you will need to select the nozzle *surface* in the hairdryer element. It's the last surface you designed, and the only one which is not trimmed, so it appears as the last surface in the hairdryer element's list. Select it and ASSIGN.

We already assigned the “glass” material to the bottle in Lesson 4, but you could now make it more interesting with a bump factor of, say, 0.2, and less transparent using a factor of about 0.9.

You know how to assign different materials.

The material name “glass” is already assigned to the bottle. You don't have to assign it again, but it won't make any harm if you do.

The cap is still made of “default” material. Edit it any way you like, and assign to the cap when ready.

Transporting to ExTrace

Remember the ExTrace button we used in Lesson 4? If you had ExTrace running on the screen now, you could use this button to immediately see all the material changes ray traced in their natural environment.

Keep this in mind for your future modeling work, it's an extremely useful feature!

Exiting the material editor

When you have set and assigned all the materials, please close the material editor. Click OK at the bottom left.

Texturing

Now the materials are all set, let's define a textured label on the bottle. You’ll place a picture of the DeskArtes logo on to the bottle by ***texture mapping***.

Textures are defined as ***texture areas*** on the surfaces. A texture area may cover the whole surface or just a part of it. It also holds the information on which image to apply for the texturing, and how.

Reading a library image

Before you start with texturing, go and see how the logo looks like. The following explains how to ***view a file*** under DeskArtes's texture library, the directory `DA_textures`, without leaving from your current model directory:

To see a library texture:

1. Pop up the file window.

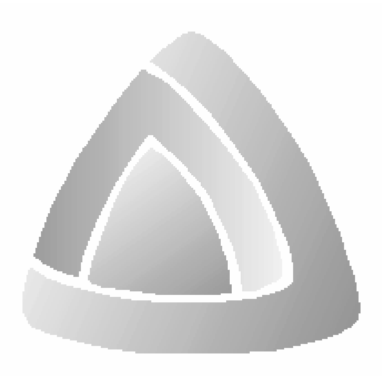
2. Move the cursor to the *right hand field* of the file window. Press the *middle* mouse button to get the menu appear.

3. Give the command `HELP DIR: SELECT`.

4. Click at the `DA_textures` directory in the left hand field. Its contents then appear in the help directory field.

5. Select the file `tex_DAlogo.pic.Z` from the right hand field and give command `HELP FILE: READ`.

6. Move the cursor to the image and click “q” on the keyboard when you've seen it.



Now to place the logo on the bottle. In this case, the texture consists of an image on a part of the surface, but the following procedure would similarly apply to many other texturing applications, as well.

To define a texture:

1. Select and display `[f]` the bottle surface.

2. Give the command `TEXTURE`⇒ `Area: Create New`.

3. Tell the system to apply `color image` texturing.

☞ Note the other options!

4. A list of available textures appears. Select the texture library "`DA_textures`" field, and from there the “DAlogo” image (use scrolling as necessary). Click at `OK` to confirm the selection of the texture.

5. Next define the texture's `material` as “default”, which happens to be a suitable glossy material for a paper label.

✍ To define the texture of the surface's own material, you could just leave the `material` field empty.

Using the `replication` parameters you could produce multiple copies of the texture, like flowers on a wallpaper. But don't use them now.

`Blurring` smoothes out the texture, so that it's individual pixels won't show so sharply. Use it if you like.

`Adaptive mapping` minimizes the distortion of the texture as it spreads on the surface. It should normally be applied, so click `YES` on it.

Leave `transparent background` to `NO`. This way only the logo will be shown on the surface with it's own background color.

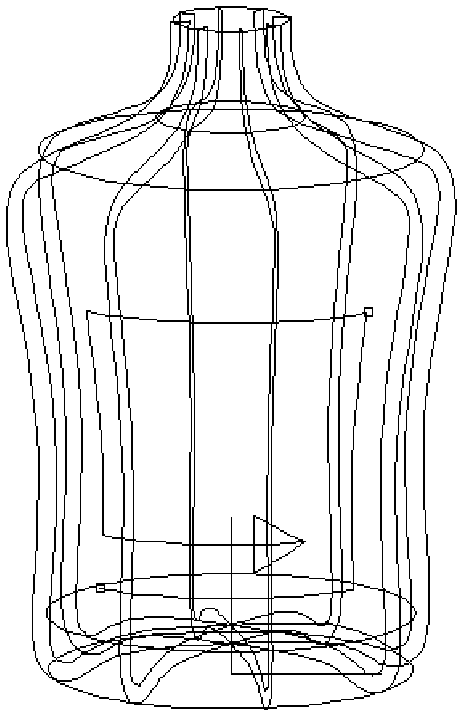
✍ Otherwise the empty parts in the texture will show through.

Finally click `OK` to accept the chosen parameters.

6. In the next dialog box select the parameter option `corners`.

7. Click at the lower left and upper right corners of the desired rectangular area on the surface, where you wish the image to appear.

A rectangle with an arrow inside appears on the surface. The arrow in the box should go from left to right across the bottom of the box as below:



You might want to complain that the sides of the texture area aren't straight. But don't worry, we could manage that by *projecting* the rectangular label on the surface, as it will be done later in Lesson 15.

If you made a mistake in placing the texture's corners, you may change it to new position and size using the command `TEXTURE⇒ Area: Placement`. To check the other parameters, texture name etc., use the command `TEXTURE⇒ Area: Parameters`.

✌ ***You now know how to define a texture on a surface.***

Camera View shading

You would probably like to render the objects with their new materials and textures.

The shading method which we have used so far, is the lowest level of shading available within DeskArtes. It only uses one light point, it simplifies the material definitions, it does not display textures, or make any attempt to render mirroring effects.

There is a higher level of shading called the ***camera view mode***. Among other things, it shows the materials more accurately than the default shaded mode, and displays textures, too.

You should be aware, however, that shading does not treat the models accurately, instead, it approximates them with small facets. It also makes simplifications when showing the textures, and it is not able to render true reflections or glass material at all.

All of these things could be accurately rendered with ray tracing, as you'll learn a bit learn later. But first let's see what camera view shading can do for you.

Starting Camera View Shading

Start shading now, as follows.

Starting Camera View Shading:

1. Display `[y]` the objects you wish to render. View `[v]` and zoom `[z]` the model as you want it to appear in GL Window.

2. Give command `SCENE⇒ Match: Camera to Eye`, and specify 30 degrees as the `view angle`. This places the objects in GL Window initially to your current viewing direction and size.

3. Give the command `RENDER⇒ GL Window: Camera View`.

The GL Window menus and interaction work just the same as you've learned with the default shaded mode, you may rotate the image, etc.

Texture control

Unfortunately, the GL Window is not able to render textures accurately. It either *mixes* the texture colors with the object's material color, or shows the texture in its own colors, but *non-shaded*. Try these options now:

Texturing with GL Window:

- To mix the texture colors with the material color, give the GL Window menu command `Texture Control`⇒ `Colors: Mix with Materials`.
- To show the textures in their actual colors, but non-shaded, select `Texture Control`⇒ `Plain Colors`.

The image below was actually rendered with *software PreView*, which is better able to render the textures (but still not nearly as good as ExTrace).

Defining a background image

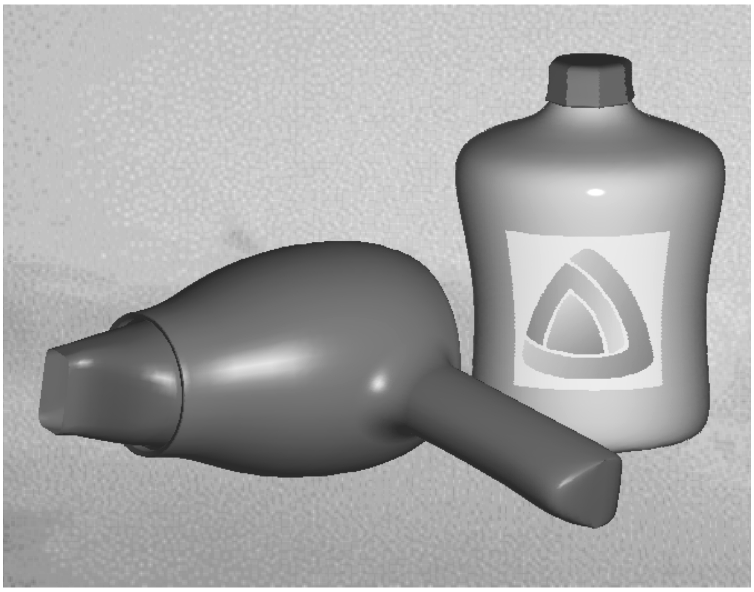
Try adding an image to show in the shaded image's background.

To define a background image:

1. Give command `SCENE`⇒ `Define: Backg Type`.
2. Tell the system to paste a `texture` in the background.
3. As above, select the background texture from the texture selection window, e.g., the one named as "`sky`".

☞ Note the other options!

To see the image, give command `RENDER`⇒ `GL Window: Camera View` again. It shades the scene, complete with the background.



Shading accuracy

You may notice as you rotate the objects around in the window, at times some of the curved sides of the model look polygonal, not smooth. The high lights should also be sharper than they appear. These defects are due to ***faceting***.

In shading, the surfaces are broken down into a series of flat triangular surfaces, facets. This enables the speed of real time rotation to be achieved at the loss of some realism. If the faceting effect is too pronounced you can improve it at the cost of real time speed - the choice is yours.

To improve shading accuracy:

1. Select the command `Preferences` in the `RENDER menu`.

2. Change the `shading accuracy` setting to `fine`.

3. Start `RENDER`⇒ `GL Window: Camera View again`.

You should see a reduction in the amount of faceting but will probably find the rotation speed slightly slower.

Exiting GL Window efficiently

Exit GL Window now. To do it most efficiently, *don't* give the `Done` command from the GL Window menu. Instead, ***iconize*** the GL Window for later use:

To iconize the GL Window:

1. Click at the small rectangle at the upper right corner of the GL Window. The window changes into a small picture, a window icon.

2. Press and hold the *middle* mouse button at the GL Window icon, and move it to somewhere where it doesn't disturb your work.

This way, you'll save time when you next time call for GL Window – the surfaces needn't be triangulated (faceted) again, as they already reside in the GL Window memory.

Next time when you need the GL Window again, just click on it's icon to open it, then give the desired `RENDER⇒ GL Window` command.

Saving the file

Save this model into a file, so you can continue to use it in the next Lesson.

To save the model:

- Select FILE: WRITE in the file window, select model (geom_), and accept collection.

Lesson 13 : Lights! Camera ! Action!

In this Lesson you will learn how to set up the camera and position various kinds of light sources using the scene editor. The exercise continues on the `collection` model.

If you had any trouble in the last Lesson, you could also start this one with a model already furnished with some example materials and textures, the file `geom_materials` in the `DA_tutorial` directory.

The scene components

Creating a computer generated picture is easy - creating a *realistic* computer generated picture can take much more care. It helps if you have some flair for composing a picture as the operations you need to perform relate directly to photography. In fact DeskArtes takes the analogy a little further by allowing you to position an electronic camera and lights around your model in the scene editor. Before we do this let's just define what is meant by the terms camera and lights.

Camera

A ***camera*** in DeskArtes is the object which determines what you see in the shaded picture. This is generally different from the ***eye point*** which we have used for viewing the objects as wire frames during modeling work.

This may seem an unnecessary complication, but just consider. When you are creating the model you judge it with your own eyes, just like manual design! When the design is finally ready, you would to take several photos of it from different angles to show it off to its best - you need to position the camera for each picture, along with the associated lighting positions. In other words you need to define several ***scenes***.

So a camera defines what you see in a picture. To do this a camera has a ***position*** or location, a ***viewing direction*** and a ***viewing angle***. As you will soon see you can control the position of the camera interactively on the screen. The viewing direction is controlled by a target to which the camera points, it defines the center of the picture. Just like the camera position you can control the position of the target interactively in DeskArtes. Finally the viewing angle determines the extent or limits of the picture, often known as the field of view, and guess what, you can control it interactively in DeskArtes.

Remember though if you position the camera very close to the object with a wide viewing angle you will see the same extent of your model if you position the camera further away with a narrower view angle. The difference between the two pictures is the ***perspective***. The close up camera position will generate a much stronger perspective effect than the distant camera and may make your picture appear distorted.

To summarize a camera has a position, a target point and view angle.

Lights

There are two types of lights supported by DeskArtes. ***General lights*** emit an equal amount of light in all directions. ***Spotlights*** emit a cone of light in a specific direction. Outside of this cone the light has no effect.

DeskArtes allows you to position your lights (as many as you like) around the model. For spot lights you can also position the target point just like the camera. Finally, lights can be assigned a ***color and an intensity***, which may be different with each light.

The scene editor

Let's set up a scene. Load in the `geom_materials` file we created in the previous Lesson and run the ***light editor***.

To start the light editor:

1. Display the surfaces using `DISPLAY`⇒ `All: Fit [y]`. This defines what will be shown in the scene editor.

2. Issue the `SCENE⇒ Edit: Lights` command.

3. A dialog box appears asking if you want to move the camera to the current eye point (remember the difference?). Answer `NO`, as you just matched it in the previous Lesson.

You will see the camera pointing to the model right from the eye direction, and one light point in its current location. The camera and the light are drawn with a vertical “plumb” line which drops down on to the model's "floor", to help you visualize their position.

You'll also see a new set of icons which describe the functions available in scene editing mode. You are ready to set the scene for a picture.

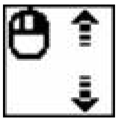
Selection

This icon allows you to *select a scene item* – the camera or a light point – to manipulate it in some way.

To select an item:

- Point at the item on the screen and click the *left* mouse button.

The currently selected item is drawn in white. At this stage select the camera ready to reposition it.



Moving

These functions allow you to *move the selected item* on the screen. They constrain the movement either vertically or horizontally.

Try the following operations to move both the camera and the light to new positions.

To move an item:

1. Select the item you want to move.

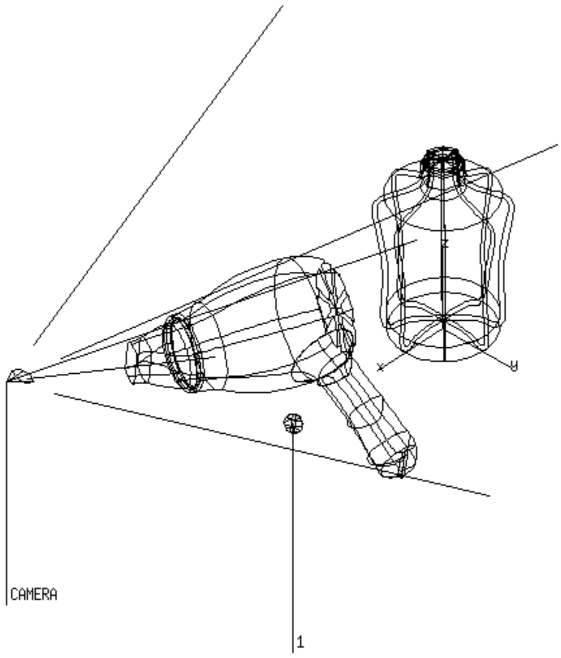
2. To move horizontally **-** Click near the currently selected item with the *middle* mouse button and hold the button.

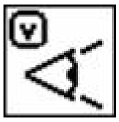
   To move vertically **-** Click near the currently selected item with the *left* mouse button and hold the button.

3. Move the mouse and the item follows.

4. Release the button when the object is positioned to your satisfaction.

Before you continue, make sure the camera and the light are positioned to the same side of the scene. Otherwise the light will fall on the back of the model, and the camera side will appear dark.





Viewing the picture

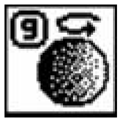
This function *displays the model as wire frames*, showing you exactly what the camera sees of the scene.

After checking the camera view, you may click any mouse button to return to the normal viewing mode.

If the item you have selected would be a spot light, the **v** function would show what the light field contains of the scene. This is a very useful tool!

Shading the picture

This function *shows the scene shaded*, using software PreView. The function is intended in particular to those users who don't have the following GL Window functions available.



GL Window shading

The **g** function calls for the GL Window to render your scene changes in real time. As you move or otherwise manipulate the scene items, the changes are immediately updated in the GL Window. Keep the GL Window on screen during the following scene editing session.

Click on the GL Window icon if you have it there, then give **g**.

Real-time GL Window changes

The GL Window is normally updated only after each of your changes is complete, that is, as you release the mouse button after moving. However, if you give the **G** function – after having started **g**

– all changes will be rendered immediately as they happen, *during the mouse movement.*

Be warned: using the **G** option will be quite jerky if you are not using a reasonably powerful workstation. To turn off the continuous updating mode, click on **G** again.

Zooming and panning

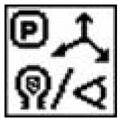
Remember how to pan – click on the keyboard after **z**.

As you may have the GL or the ExTrace Window covering a large portion of the screen, or for some other reasons, you might like to *zoom and pan* the image to see the scene items. For this, use the **z** function just like in all the other edit modes.

Adding another light

You currently have only one light in the scene but you can add more if you like. Click at the add light icon or press **n**.

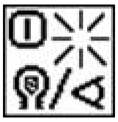
A second light appears on the scene. Move it to another position.



Setting the positions

This function is available to *numerically* set the camera or light positions, view angles and target. It is particularly useful in architectural and other applications where you wish to have exact control on these. Try it to check how the camera is currently defined.

Spots and colored lights



You should now have two lights in the scene. They are currently both general lights. You can alter the properties, to make one a *colored spot light*, for example.

Select a light point, and select the **l** function. Make the light a `spot light`. Give the light a bluish color, using rgb values red: 0.5, green: 0.5 and blue: 1.0, for instance.

Colored lights make things often a lot more interesting.

Note that the light is drawn differently to indicate it is a spotlight. It now has a target point, just like a camera, which can be selected and moved to control the light direction. The angle of the spotlight can also be altered by using the view angle function. See the next two functions!

Altering the view angle

This function allows you to change the *field of view* of the camera so that you will see more or less in the picture. It can also be used to alter the *angle of a spotlight,* if you have one selected.

Try the following first with the camera.

To alter the camera view angle:

1. Select the camera.
2. Click at the view angle icon or press **`a`**.
3. Press and hold the left mouse button.
4. Move the mouse up or down to increase and decrease the camera view angle
5. Release and mouse button to set the view angle.

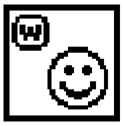
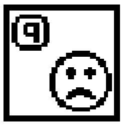
Try the same function with the spot light, as well. Check the spot view using the **v** function.

Altering the camera target

This function *moves the target point of the camera or a spot light.* The movement happens just as moving the actual items: middle mouse button moves the target horizontally, and right button vertically. Try it with the camera.

Deleting a light

This function *deletes the selected light.* Use it if you don't like the spot light effect, for instance.

Exiting scene edit mode

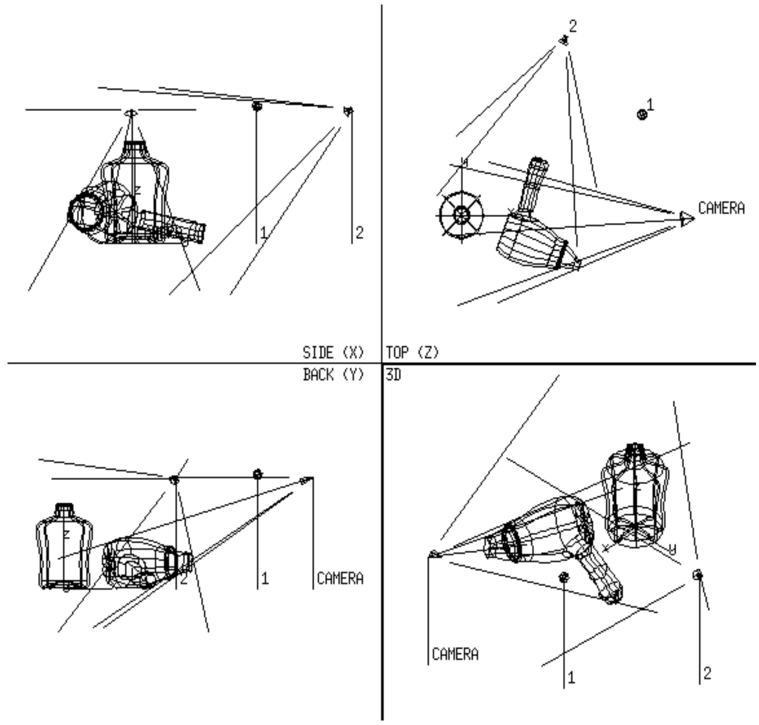
You have learned to set up a scene.

Use the functions until you create a scene that you are happy with. Don't mind if the picture doesn't really match your artistic standards – remember it's just your first experiment, and we'll keep adding detail in it later on.

Exit from the scene editing with **w**. This way the changes you made to the scene will be saved. To discard your changes, you could use the **q** function and start over again.

Scene editing in four views

Before you continue, see also how scene editing feels like in *four views*, if you have the settings window button `AREA: four` selected. You'll probably find out this is the way you want to do your scene editing in the future!



Ending the Lesson

Now you now most of the various scene editing possibilities. To end the Lesson, save your work again into the model file called `collection`.

Lesson 14 : Time to press the shutter!

Shading generally gives you just a simplification of the image. It is fast, but it cannot render true reflections or glass, among other things. The technique used to calculate the final picture is known as ***ray tracing***. It is a very intensive operation but one that produces extremely effective results. The ray trace module of DeskArtes is called ExTrace.

Continuing with our analogy to photography, you are now in the position to press the shutter release to take a picture. With a real camera this would take only 1/60th of a second or so. With a computer generated picture the wait is going to be a little bit longer. This should not be surprising to you since the computer has not actually got a physical model to work with. It only has a virtual, electronic model. But you won't have to wait all that time to check your picture is what you wanted – DeskArtes makes even ray tracing a very interactive procedure!

Continue with your `collection` model, or if you're not confident with your own scene settings read in file `geom_scene` from the `DA_tutorial` directory.

Starting ExTrace

You'll first render the image just as it is defined now. Later you will continue adding detail until you are perfectly happy with it.

To start ray tracing:

1. Start ExTrace with the command
   `EXTRACE`⇒ `Start/Update`.

2. A dialog box appears. Make the size for the image 600 by 600 pixels.

   You want to ray trace everything currently shown on the screen, and use the camera position you just defined with scene editing, so accept the other parameter options as they are.

3. The ExTrace window will start to show a picture of the scene you have just defined. At first the picture will be quite crude - made up of large blocks.

   The image gradually refines and the blocks (*macro pixels*) become smaller. This way you can quickly see the picture at required detail to ensure that everything is all right.

4. Click `Stop` in the ExTrace window to interrupt when you have seen enough. You are then able to continue with any changes you want to make in the picture.

Defining the floor

To make the scene more realistic, add a `marble` floor underneath the models.

To define an ExTrace floor:

1. Give command `EXTRACE`⇒ `Insert: Floor`.

2. Select `marble` from the dialog box.

3. Enter `densities` of 5.0 in the next dialog box.

   These define how small or large the marble pattern is. The larger the density values, the denser the veins.

4. The marble will consist of the materials and colors you have previously defined with the material palette – change them now if you like.

ExTrace automatically starts to compute the new image.

Interrupt with `Stop` after a while when you see the picture clear enough.

✍ Some other commands need `EXTRACE`fi `Start/Update` to show the changes.

Zooming and panning with ExTrace

Try a couple of ***graphical interaction*** options with ExTrace.

You might want to see part of your image in more detail, so make the picture "tighter":

To zoom into the ExTrace image:

1. Give the command `EXTRACE⇒ Locate: Zoom`.
2. In the ExTrace window, press *and hold* the left mouse at the middle of the picture area you wish to get zoomed.
3. Move the mouse and release the button. The picture begins to update automatically.
4. To zoom out in the ExTrace image, repeat step 1 and *click* the *right* mouse button.

Try also panning the image:

To pan the ExTrace image:

1. Give the command `EXTRACE⇒ Locate: Pan`.
2. Press *and hold* the left mouse button at a point which you wish to move.
3. Move the mouse to the place where you want the point to move and release the button. The picture begins to update automatically.

✍ In the same way, you could also zoom and pan the background texture, c.f., commands `EXTRACE⇒ Backg: ...`

Scene editing with ExTrace

Now change the ExTrace picture using the scene editor, and see the changes updated in the ExTrace window as they are done!

Scene editing with the ExTrace image:

1. `Stop` the rendering operation in the ExTrace window.
2. Give the command `SCENE⇒ Edit: Lights`.

3. You are asked if to `match the camera with eye`. Answer `NO` if you want to continue from your zoomed ExTrace view, or `YES` if you wish to return to the original wire frame view.

4. *Iconize* the ExTrace window, to remove it temporarily from screen.

5. Move, add or delete the light points, and move the camera as you wish. If you don’t remember how, refer back to scene editing.

6. Select the **e** function to see the changes with ExTrace. The iconized ExTrace window pops up and starts to render. Click on `Stop` when you’ve seen enough.

   Even though ExTrace is slower than shading, it gives much better quality, and many users prefer to use ExTrace all the time to monitor their scene editing work.

7. Repeat 5&6 as often as you like.

8. Leave scene editing by pressing **w** (or **q** if you got lost).

You've done interactive ray tracing!

ExTrace from eye view

Scene editing is useful especially to define the lighting conditions, but the view direction is often most easy to define using the wire frame eye point and windowing commands. Here's how:

To compute the ExTrace image from eye view:

1. Use any of the `DISPLAY` menu commands, *e.g.*, `[v]` and `[z]`, to show as wire frames what you want to be ray traced.

2. Give command `SCENE`⇒ `Match: Camera to Eye`. This places the camera to the same view of the model as what is currently shown on screen as wire frames.

   Additionally you need to define the view angle, as you are moving from orthogonal viewing to perspective. Specify it as you like.

3. Update the ExTrace image with `EXTRACE⇒ Start/Update` to see the current view.

Batch processing the image

Finally, when you have finished experimenting and are happy with the picture, compute it as a ***background (batch) process***. Give command `EXTRACE⇒ Render: Batch Process`. Accept the parameters as they are.

This will start to render a high quality image in the background, while you can continue your work. When launching the process, you could also have told DeskArtes to start the computation only after so-and-so many hours, so that it wouldn't occupy the computer resources at the time you are working.

✍ Don't start several batch processes at the same hour - they would slow down each other.

You can continue making any changes to your image, and start them as other batch processes. Each batch process will produce an image just as it was defined when you launched it, even though the actual processing would start later on.

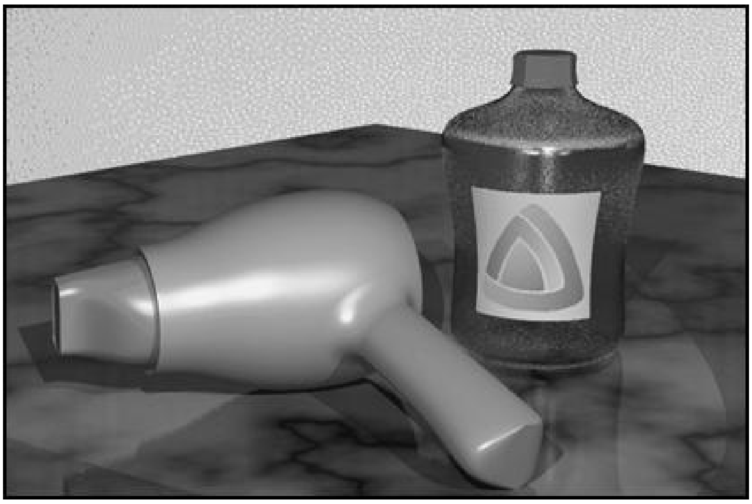
Continue working with ExTrace as long as you like. Finally, when you are ready, give command EXTRACE⇒ Done.

Reading the picture file

When the background process is started, a file called `expic_myscene.1.rgb` appears in your model directory. You may load it onto the screen to see how far the computation has reached.

Load the file by selecting it and give command `FILE: READ` in the file window. To remove an image from the screen, move the cursor in the picture window and press “q” on the keyboard.

When the background computation has finished, two files called `expic_myscene.1.rgb.Z` and `expic_myscene.1.pic.Z` appear in your model directory. The first one (`rgb.Z`) is the ready image in full 24-bit colors, and the second one (`pic.Z`) is the image reduced to 8-bits. According to your monitor's color resolution, load one of them on screen to see the ready picture.



✌ ***You now know how to batch process ExTrace images.***

By the way, when you see the image in full resolution you will probably notice that the “sky” background looks more like “snow”. The background texture is too small for the ExTrace image, so its details get expanded – the clouds turn into snow flakes. To get a better sky effect, you should apply a larger texture image.

Saving the work

Congratulations! You now know all the essentials about materials, textures, cameras, light points, and ray tracing, and how to work with them together.

The model is now complete, for the sakes of this Tutorial at least. The next Lesson will continue from another scene. Remember, however, to store your scene definitions into a model file, as always when you've done something worth keeping!

Lesson 15 : Painting on the Model

In the final Visualization Lesson, you will learn how to create your own textures using a simple ***painting*** program. You will design your own texture image and map it on the *complete* hairdryer model, not just on a single surface as previously.

You have rotated the hairdryer in your `collection` model in some, heaven knows what manner, so for the good of this exercise it's best we start fresh again. Read in the `geom_hairdryer` model. Answer YES if asked if you want to replace the old model.

You won't have your nice material definitions for the hairdryer present anymore, but never mind. (You could have written the “MAT” element from the collection to an ***object file***, and read it back to the hairdryer, if required.)

External graphics

Last time we used texturing, in Lesson 12, we mapped an already existing image – the DeskArtes logo – to the bottle surface. This is the most typical way of applying graphic designs with DeskArtes created models: you obtain them just from “somewhere”, they may be provided to you on a floppy, produced in some painting program, scanned from a photo, or whatever.

☞ How to treat various formats and devices is explained in the Technical Manual.

Any images from other systems and devices may be applied as DeskArtes textures, as soon they are *loaded in your model directory* in DeskArtes's data base. The images must be presented in either *TIFF, RGB or the Sun Raster File (PIC) formats*. The file window command FILE: CONVERT provides the most general alternatives to *convert images* from one format to another.

Using TextPaint

But you don’t have to use pre-defined images, instead, you can design an image of your own. Try ***TextPaint***, DESKARTES’s ***painting program***.

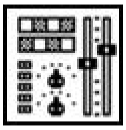
To start TextPaint:

1. Give the command `TEXTURE⇒ Image: Paint`.

2. The program asks you if you wish to *include* the current image into the drawing, use it as a *template*, or erase the screen before you start painting. Choose the last option.

After a short while, the painting ***toolbox*** icons appear. There are four toolboxes and a color chart. Click on the toolbox icons to see the tools. You can hide them by clicking at the toolbox icon again: when working, it saves space to show only the tools you need at the current time.

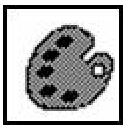
Try some of the tools, just to get the hang of them. At this stage it doesn't matter what or where you drew.



The controls' palette

The way *how* the different tools work depend on a number of adjustable factors, such as pen and spray sizes, the zooming factor, the active drawing color, and font type and size. They may be set with the sliders and buttons in the ***controls' palette***.

For the moment just accept the factors as they are.



Color chart

TextPaint has 256 colors available at a time. The available colors are shown in the ***color chart***. You can select your drawing color by clicking it in the color chart with the *left* mouse button.

Selecting with *middle* mouse button from the color chart has a different meaning. It *opens the color*, and pops up the ***color palette*** where you can select any new color to replace the old one. Try it and see!

You can also choose a ***color from the image*** itself. Point at the image, and select the color from there with the *middle* mouse button.

You may use these color selection functions *any time* during the following painting session.

General tools

The ***general toolbox*** contains the most commonly used tools for making graphics. Open it now.

The tools are operated very much like the other DeskArtes's controls you have already used. They don't have shortcuts, though, as painting is most naturally done using the icons directly.

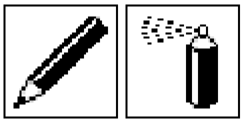
Using TextPaint functions:

1. To see brief explanations of the functions in the message lines, you may click on the icon with the *middle* mouse button.

2. To start a function, click on the icon with the *left* mouse button.

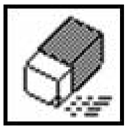
3. Use the function you've selected. You may change the color, adjust the pen size, etc., while executing the function.

4. To end the function, click the *right* mouse button, or just select a new function.



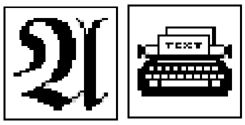
Pen and spray

Practice a while with the above functions (*pen draw and spray*). Try also changing the pen size and color from the controls' palette as you work.



The eraser

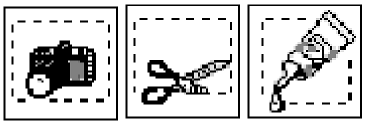
The eraser function works like pen, obeying the pen size, too, but it *wipes out* things you've painted.



Fonts and text

Font selection and typing text may be done with the above functions. *Change the font* from the window which pops up with the letter icon, then *type text* into the picture using the typewriter icon.

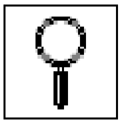
Notice the text appears in the selected drawing color. You may change the color, even in the middle of typing.



Copy, cut and paste

The camera icon (*copy*) copies the area you select onto an invisible *"clipboard"*. The glue icon (*paste*) pastes whatever is on the clipboard into the selected area. In other words, you could make a copy of an area with these two functions.

The scissors icon (*cut*) works just like copy, except that it erases the selected area, "cutting it out" into the clipboard, from which it can be pasted back in.

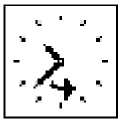
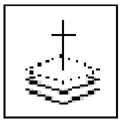


Zooming

This function allows you to zoom into a part of the picture, and *edit it pixel by pixel.* The changes are seen in the zoom window and in the actual picture, too.

Color selection from image, with the middle mouse button, is extremely useful with zoomed images. Try it to match the values of some neighboring pixels.

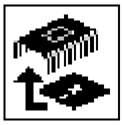
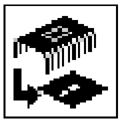
Notice also that you can enlarge the zoom window on the fly by grabbing it from the lower right corner.

Canceling

If you make a mistake and wish to cancel something you just did, press the cancel icon (the backwards running clock)

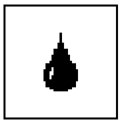
... or to start drawing the whole image again from scratch, use the “graveyard” icon.

Read and write

The *read* function (“from disk to chip”) allows you to load in an already existing image. The image may be an ExTrace picture, a texture image, or whatever. You may use any of the available functions to change it, *retouch* the image by zooming, adding text into it, and so on.

The *write* function stores your TextPaint image (back) into file. Don't use it just now, unless you've created something absolutely worth keeping.

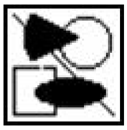


Drop fill

Finally notice the *drop fill* function. With it you may fill closed areas of the picture with the selected color or pattern.

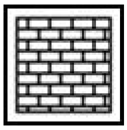
Drop fill not only fills the area, but it widens it by the factor of the pen size, too (just like “real” ink!).

Use drop fill to color the insides of the primitive elements, in the following.



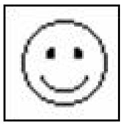
The primitive tools

The primitive tools are used to create *standard primitives*: elements made of straight lines or arcs, such as rectangles, polygons, and ovals. Try them.



Stipples and tiles

These tools make it possible to select, create and edit different kinds of patterns to be used when painting with the other tools. Let's leave them for later practice, however.



Exiting TextPaint

Finally, exit TextPaint by clicking at the Smile icon. The system notes you haven't saved your art work and asks if you want to exit anyhow. Answer `YES`, you'll get a chance to create a more useful painting in just a while.

You've learned to use TextPaint!

Bounding plane texturing

When you have finished experimenting it is time to produce a real pattern which flows over the handle of the hairdryer across the blend onto the body.

Since the texture stretches across several surfaces a special technique is required. We won't apply the texture separately with the different parts of the hairdryer – it would be impossible to make it flow from one surface to another that way. Instead it will be defined on another ***bounding surface***, in this case a *plane*, from which it will be *projected* onto all the hairdryer surfaces. This ensures that the texture matches up perfectly across the boundaries of each surface.

Painting on a template

To create the texture, you'll paint the picture right to the correct position on the hairdryer.

Collect the hairdryer surfaces in one "ALL" element, using `SELECT⇒ Collect: Actives`. Set the viewing direction to the side of the mode with `Settings⇒ X` and display `[f]` the collected model.

Then start TextPaint again (command `TEXTURE⇒ Image: Paint`). As a parameter, specify you wish to use the screen contents as ***template*** for your graphics – you'll paint on top of the hairdryer!

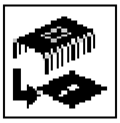
Using the TextPaint functions explained above, create a simple picture such as the ugly one shown below.

Or better, draw a flower!

When you are working, it may happen that you erase parts of the template and wish to ***refresh*** it. This may be done with one of the TextPaint menu commands: use the command `PICTURE⇒ Refresh Object` from the menu bar.

When you are ready, store the image into a file:

To store a part of the picture:

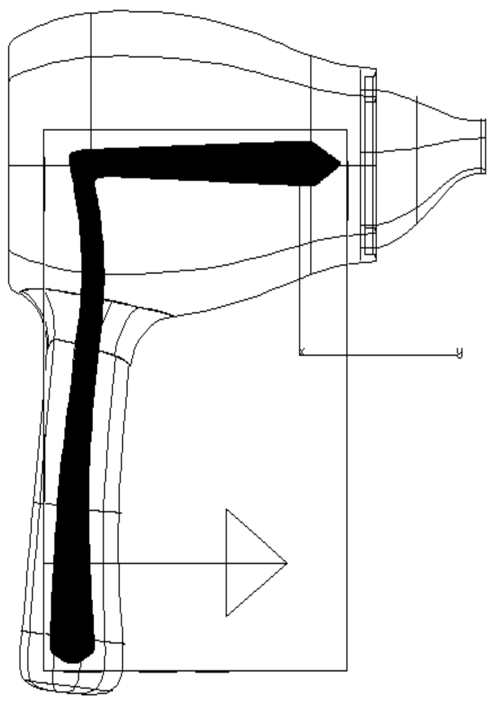


1. Click on the "write file" icon

2. A dialog box appears, asking for an image name. Type `mydesign`.

3. The dialog box also asks whether the whole screen should be stored, or just a part of it. Choose the option called `free select`.

4. Choose the desired area using the cross-hair which appears, first clicking at the lower left corner, then at upper right.



Creating the bounding plane

Now map the texture to the hairdryer.

To define a bounding plane texture:

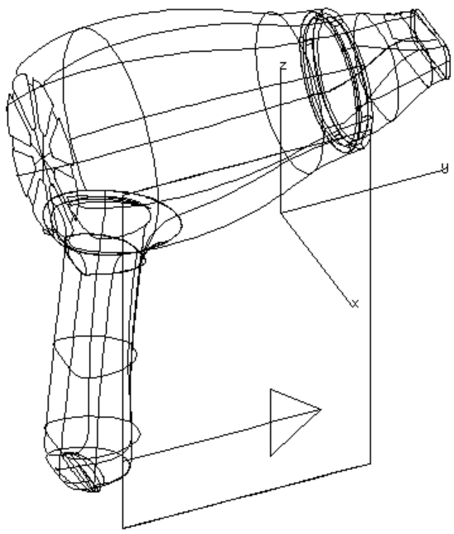
1. Give the command TEXTURE⇒ Bounding: Plane.

2. The systems memorizes that you just designed, and stored a texture image. It asks if that texture should be applied on the bounding plane. Answer YES.

3. In the next dialog box, you must give a name to the bounding plane, so that the actual surfaces may find it. Use any name, for example “plane”.

   You must also tell what kind of texturing, and which image to apply. This happens quite like in our earlier example with the logo: select color image texturing, then the rest of the parameters as they are, but now click YES on transparent background - *you only want the painted parts to show!*

The texture is there. Change the eye point back to 3D to see the plane. This is just a very special case of using bounding objects for texturing, but a very effective one, too.



Do you now see how you could have applied this method with the label on the bottle, to make it square? More generally, you could design the bounding object to *any shape* you require, *e.g.*, curved to follow the hairdryer more closely, and project textures from it to other surfaces in various ways.

☞ See Reference Manual for further uses of bounding objects.

Ray tracing the model

To see the results of your efforts, start ExTrace and render an image of your finished masterpiece. Let's also once more play with the ExTrace background colors, to make the picture a bit more interesting.

✌ ***You know how to use bounding planes.***

Eye view

To get right to the point, don't go to scene editing or other fancies this time. Just define a suitable view using `[v]` and `[z]`, then start ExTrace with `EXTRACE⇒ Start/Update` using the parameter option `match camera with eye`.

Sliding background

Interrupt the ExTrace computation with `Stop`.

Give command `SCENE⇒ Define: Backg Type`, and select the option `sliding color` from the dialog box. Render the scene (`EXTRACE⇒ Start/Update`), and see how the background color changes from light at bottom to dark at the top.

Background colors

Interrupt the ExTrace computation, and try command `EXTRACE⇒ Backg: Pick Colors`. Then click in the ExTrace window at the horizontal level where you wish to define a new color. A portion of the material palette, the ***color palette***, shows up. Select any color you like, and ExTrace starts to render.

Click at `Stop`. Give command `EXTRACE⇒ Backg: Pick Colors` again and select another color. Place it to another level in the ExTrace window and wait to see what you've accomplished!

Congratulations! You have completed the Visualization Part of the Tutorial. You should now know DESKARTES well enough to start designing on your own.

If you skipped Lessons 9-10 earlier on, do them now!

Play with the system to create real designs, modeling and rendering them with the techniques you've learned. You should still have most of the Tutorial exercises fresh in mind, so you'll easily find example instructions when you need them. Glance through the Contents section to review what you've been through!

Proceed to the final Tutorial Part after you have practised a while with the standard techniques, and want to learn more ..

PART IV: FURTHER MODELING

This Tutorial builds on the Modeling Principles Part of the Tutorial. It is anticipated that before progressing to this somewhat advanced stage students have completed and fully understood all aspects of the previous Tutorial Parts and will most probably have spent some time consolidating the skills they have learned by working on their own designs.

The style of this Part is intended to be much brisker with little explanation of the basic techniques already covered elsewhere. If you find yourself having difficulty with the following, obviously you should refer back to the earlier Tutorial.

Several topics are covered by means of four Lessons. All Lessons continue to use the basic modeling exercise of the hairdryer and bottle. You could of course use your own models for this if you have kept them. If not, the original models used to illustrate this Tutorial are to be found in the `DA_tutorial` directory of the DeskArtes data base.

Lesson 16 : Working with Trim Curves

In this Lesson, you will continue to work on the hairdryer model concentrating on the area of the blend between the handle and the body.

Rolling ball blends - review

You should now have DeskArtes running with the `geom_hairdryer` file loaded. Firstly review the hierarchy of the model. It is made of four elements, body, handle, nozzle and cutter (which has been made inactive). The element body contains a rotational surface. The handle contains a built surface and the blend surface. Both the rotational surface in body and the built surface in the handle own trim curves.

Do you remember how you made the blend originally? The command used was `TRIM⇒ Blend: Rolling Ball`. This required you to have the first surface selected and then to pick off the screen the other surface to be blended. You may also remember that the normal directions of the surface influenced exactly which of four possible blends was produced. In this case we had to ensure that the blend was created outwards from the body and the handle.

Upon completion of the blend we also showed how the blend could be re-shaped. Using the `TRIM⇒ Blend: Reshape` command two numbers could be specified in the range 0-1 which controlled the influence of each surface on the blend. Using these we could vary the normally circular blend, even to the point of creating a chamfer.

Applying variable radius blends, instead of just the constant radius with the Rolling Ball, was left as an independent exercise. (If you didn't try it yet, please do so now.)

Deleting a rolling ball blend

How would you now delete a blend? Easy, you think: I simply make it the target object in the object window and issue the `OBJECT⇒ Delete [k]` command. Try it and see!

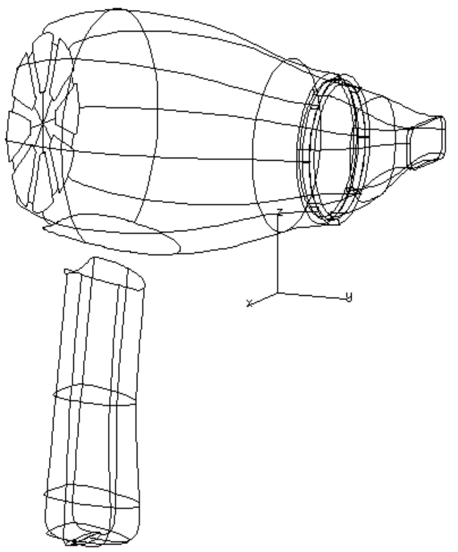
The rolling ball blend surface is in the `handle` element. It is called `Surf/Bz/blend`.

To delete a blend surface:

1. Select the surface to be deleted.

2. Issue the command `OBJECT`⇒ `Delete [k]`.

3. Select a surface to show all remaining surfaces on the screen.



Not quite what you expected? Part of the handle is still missing and there is still a hole in the body! Why? Stop and think and you can work out the reason. What cuts out parts of surfaces? Trim curves!

Look at the body surface in the object window. This surface doesn't own one set of trim curves. It actually owns three. Why? The names of the three trim sets give you a clue.

1. One is called ..`TRIM/multiple`. It is the result of the multiple intersection operations with the cutter element. It holds all of the curves to trim the eight holes for the airways.

2. Another is called ..`TRIM/handle`. It is the result of the blend operation with the handle. The curves it contains effectively cut a hole in the body for the handle.

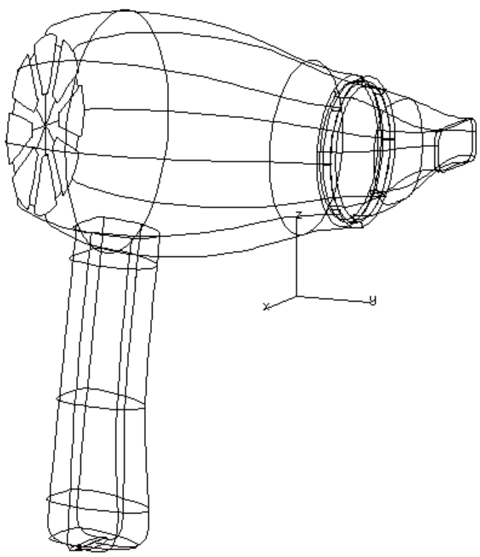
DeskArtes is clever enough to keep a ***historical record*** of the trim operations that have been performed on a surface. DeskArtes combines all of these historical records into one ***actual trim curve set***. This is the first trim curve set after the surface, called `–>TRIM/merged`.

That's it then – you want to keep the airways, so you need to delete only the set of trim curves associated with the handle (...`TRIM/handle).`

To delete a trim set:

1. Click on the trim set to be deleted. In this case the one called ...`TRIM/handle` in the `body` element.

2. Delete `[k]` the trim set. The system asks if the trim curves from the other involved surface (handle) should updated, too. Answer YES.

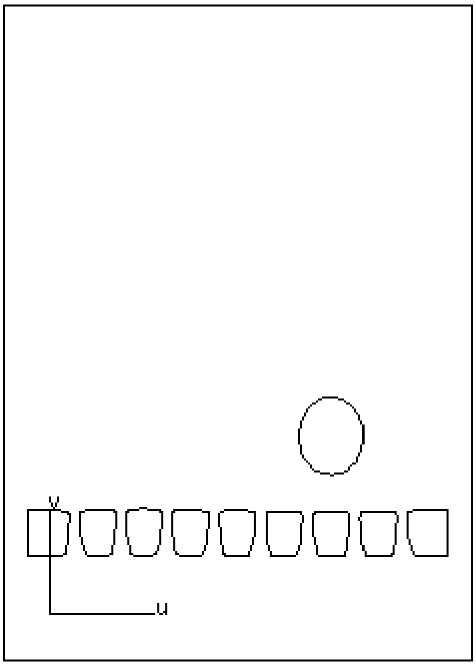


The trim curves between the body and the handle are removed, and you could now blend the surfaces again.

Trim curves for the technically minded

Some readers of this Tutorial may be interested in what trim curves are and how they work. Others may be very happy to just use them in their models - you can quite happily skip this bit now if you wish.

Start fresh with the original `geom_hairdryer` model again. Click on the trim curve set immediately below the surface in body element `DISPLAY⇒ Object: Fit [f]`. You will see something like the picture below.



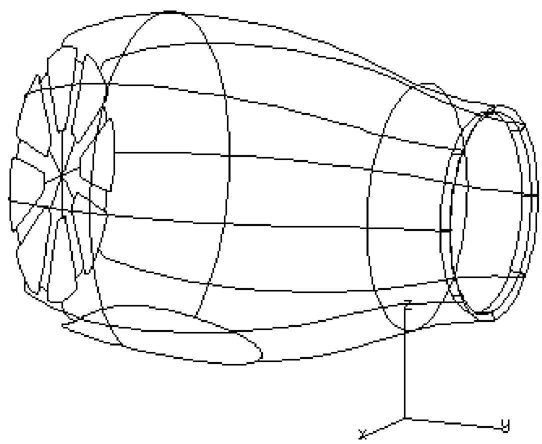
What you are seeing is the ***parameter plane*** of the surface. The easiest way to think of this is to image the surface to which the trim curves belong flattened out to form a rectangle. The perimeter of this rectangle is formed by the first curve in the trim curve set.

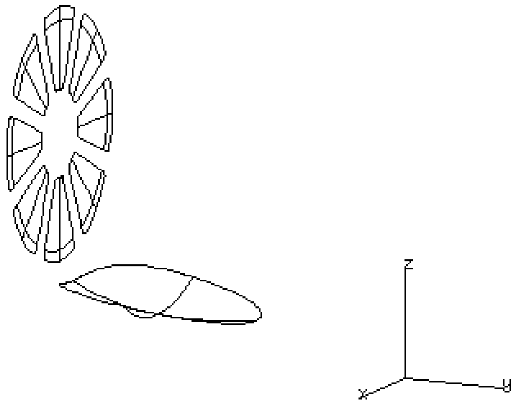
If you look in the bottom field of the object window you will see 9 or 10 polygons. The remaining polygons form the holes for the airways. They are not the same shape as the cut out holes since the surface has been distorted in the flattening process to form a rectangle.

But how does DESKARTES decide whether it is a hole in the surface or actually part of the surface? Imagine the rectangle as a *field* and the polygons as fences which guard *lakes*. The lakes may further have *islands* in them. There could even be more lakes in these islands, and so on.

If a man were standing somewhere in the field and were to walk across this field he might have to climb over the fences. If he were to count the number of fences he had climbed over he could determine whether or not his feet were wet! If the number of fences climbed is *even* then he was originally standing in a lake – *i.e.*, that surface part was cut out. Try it on the diagram above - don't forget the "fence" right around the outside of the "field".

Note that DESKARTES only considers *closed* poly<u>gons</u> in this process - *open* poly<u>lines</u> are ignored (the water from the lake would run out!). You may have come across the command `TRIM⇒ Change: Invert Cut Part` which swaps the part of a surface trimmed away. Try it on the body surface now, noting the change that occurs in the trim curve set:





How is this achieved? In the analogy of the man walking across the field this command effectively makes the field into a lake and the lakes into islands. To make this happen DeskArtes adds another fence around the field. Try counting across the diagram above again remembering the outside rectangle is a *double fence* (*i.e.*, it counts as two).

Recall the “fences and islands” if you ever need to work in detail with the trim curves, and wish to know which trim curves cut something out. And always remember that open trim curves (poly<u>lines</u>) don't cut anything out!

☞ ***To learn more on blending:***

.. Read through the TRIM section in the Reference Manual

.. Try variable radius, and free-form blending, too!

✌ ***You now know all about trim curves.***

Lesson 17 : Building Methods

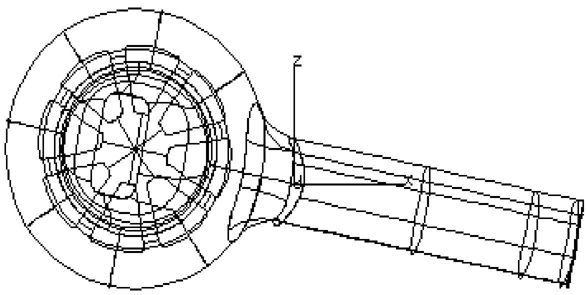
Once again you will work on the hairdryer model. You should now have DeskArtes running with the `geom_hairdryer` file loaded.

Building with single projections

We are going to add a wire to the hairdryer and shape it so that it looks flexible.

☞ Review Lesson 11 for details.

To do this we first need the hairdryer to be lying flat - as if it were lying on a flat surface. Collect the surfaces with `SELECT⇒ Collect: Actives`, activate the `ALL` element `[a]`, and delete other elements. Rotate `[3]` the model around the Y axis until it is flat.



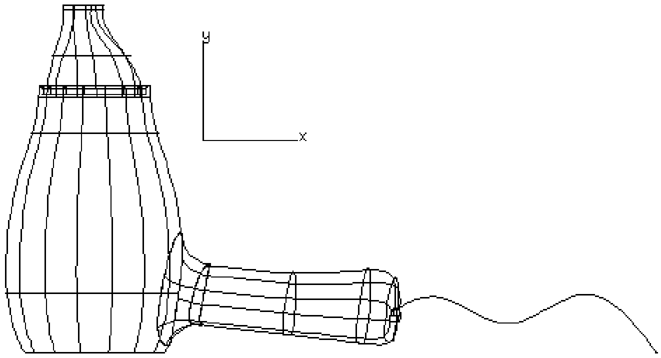
It is quite possible to create the wire as intended using the techniques you already have at your disposal using the build function. Here is how. First display the hairdryer from the `Z` direction.

To build the wire with a single projection curve:

1. Create `[n]` a new element called `wire`.

2. Create `[p]` a `z` projection set.

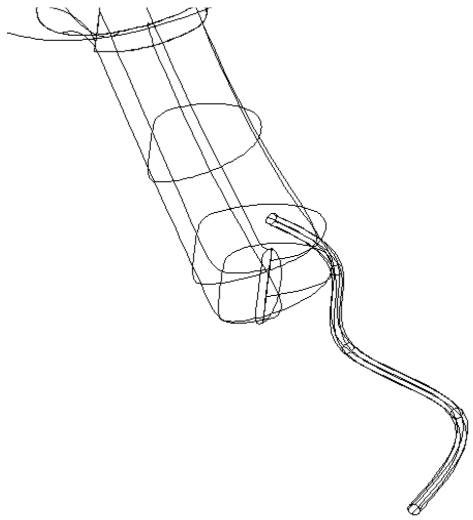
3. Input `[i]` a curve to describe the shape of the center line of the wire, as viewed from above.



4. Create a section set `[c]`.

5. Create a circle as a section curve, using `CURVE⇒ Design Circle`. The radius should be what you wish to have as the radius of the wire, say one (1). Use six (6) points for the circle, as it doesn't have to be that accurate.

6. Build `[b]` the wire, accepting the default parameter values.



Notice that this is slightly different from what you've done earlier in the Tutorial. You built the surface using just a ***single projection curve***, so the surface is formed by ***sweeping*** the section curve along the projection.

You now have a wire, but it is lying flat and may even be at the wrong height. So you need to make it better! View the model from the `Y` direction before you start:

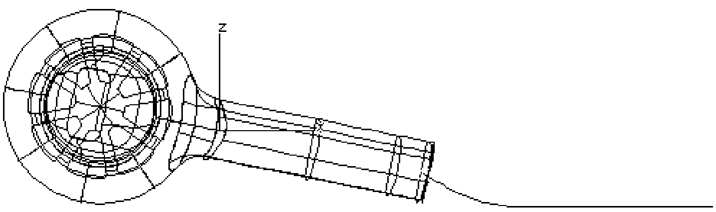
To build the wire with secondary projection:

1. Create a *single* secondary projection curve from Y, using command `BUILD⇒ Create: Projection` and the corresponding parameters.

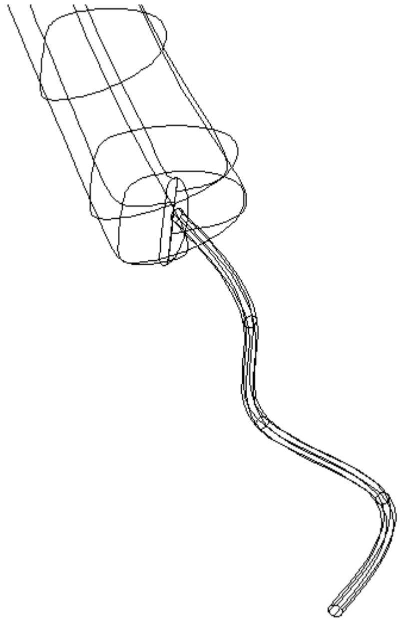
Remember the rules for secondary projections.

2. Move this curve to the correct level, so that its end meets the handle. Use command `TRANSF⇒ Object: Move [1]`, and the *middle* mouse button to move in vertical direction only.

3. Edit `[o]` the curve so that the wire looks as you want.



4. Build `[b]` the surface, and change back to 3D view.



The techniques described above should be quite familiar to you. The new thing is the ability to use a single projection curve. You can have single projection curves which describe the shape of the center line of the surface, not the silhouette. In this case the size of the section curve *is* important as it determines the size of the surface. You can mix single/double primary and secondary projection sets. You could even use varying sections with a single projections.

Building using 3D projections

You have successfully created the wire, but – to create even wilder 3D shapes – you might find the secondary projection editing too restrictive. This is an ideal opportunity to introduce something new: ***building on a 3D curve***.

Yes, it is possible to create a projection curve directly in 3D, and sweep a section along it to form a surface! Here's an example how:

To build with a 3D projection curve:

1. Delete the secondary (Y) projection set and the surface in the `wire` element. (Do *not* delete the Z projection, or the section set.)

2. Select the Z projection set as target.

3. Give command `CURVE⇒ Change: Dimension`. Accept the default parameter, which knows you have a `z` projection at hand.

4. Place the eye to `3D` view, and display `[y]` the curve with the model.

This has created a ***3D projection curve***. There would be other ways to create it, too - see the end of Lesson 19, for instance.

3D curves may be edited in a similar way to 2D projection curves. However, 3D curve editing is implemented for *Bézier curves only*. The added complication of the third dimension means also that some extra facilities are needed.

Try it! Edit the 3D curve to describe the center line of the wire.

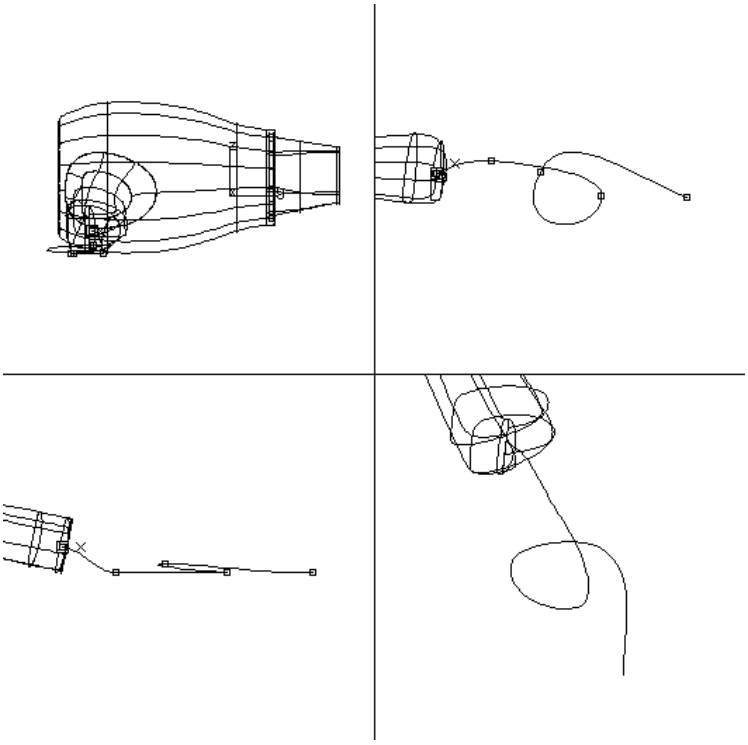
To edit a 3D curve:

1. Select the curve, and convert it to Bézier form. Use the command `CURVE⇒ Change: Representation` for this.

2. Start editing the curve with `[o]`, just as usual.

3. You'll see the wire appear in four different views. You may edit the curve in any view at a time, using the various Bézier editing functions.

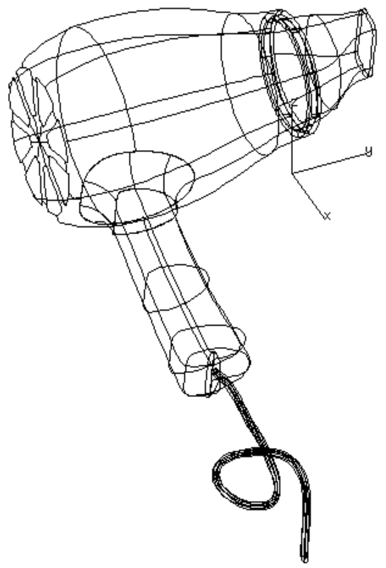
☞ See Lesson 7 for Bézier editing instructions.



4. Edit the wire into any shape you like, then exit with **`w`**.

To create the surface, give command `BUILD`⇒ `Create: Surface [b]`. As you are building with a 3D projection curve, the systems now asks you for an additional parameter: the ***orientation*** of the section curve around the projection curve. Accept the default parameter choice.

✍ If there are flat parts on the wire, you should apply function **D** for the projection curve.



So that's to give you a taste of it. Further, it would also be possible to build a surface by scaling a section between ***two 3D projections***, or even different sections if you like. But you may agree that the 2D projection curves are much nicer to interact with, and they should be used whenever possible.

✌ ***You've reached an expert level in building!***

☞ ***To learn more on 3D building:***

.. See 3D Curve Editing and Building in the Reference Manual

.. Try building with two 3D projections!

Lesson 18 : Design Alternatives

In this Lesson, you will continue to work on the hairdryer model concentrating on the shape of the handle. A new shape will be created as a design alternative and two different methods of creating the new shape will be tried and compared. Load in the original `geom_hairdryer` model for this Lesson.

The design scenario

The scenario for the following exercises is this:

> *The shape of the handle we originally created for this model was not satisfactory for our client. The following changes were suggested.*
>
> *(i) the handle should be connected at right angles to the body, and*
>
> *(ii) that indentations for fingers be added.*
>
> *You have been asked to compare this new design proposal with the original.*

So let's work through this new design and a couple of different ways of creating it. Before we start perhaps you could take a few minutes to think about how you, with the knowledge you already have of DeskArtes would go about creating such a shape.

A handle by building

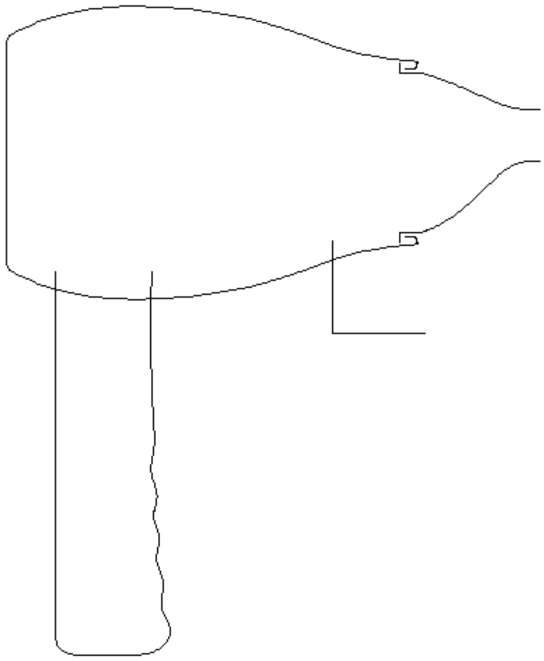
You may think you already know the techniques required to complete this design change. The obvious solution is to use exactly the same techniques as before to build the handle but to modify the shape of the front primary projection curve to add the finger grips. Try that now.

Working in the element `handle` rotate the x projection curve set so that connects at right angles to the body. Also add the finger grips to the front x projection, as shown below. You will need to add a couple of points for each finger grip.

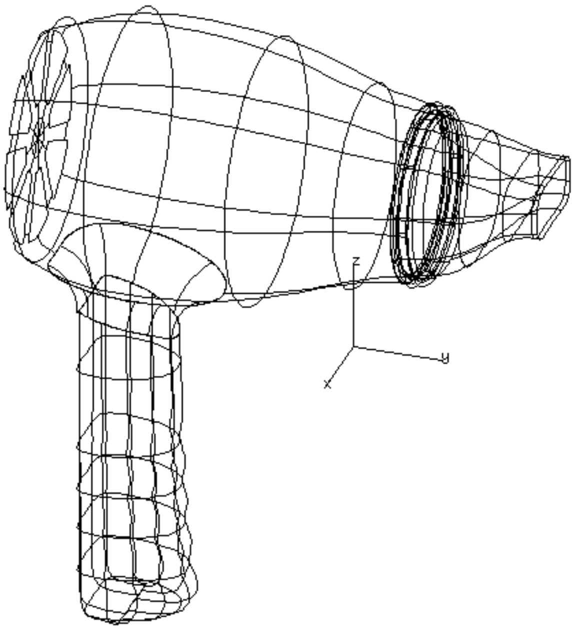
☞ See Lesson 6 for details.

Remember the rules for building surfaces? *The projection curves must all contain the same number of points.* So add points to the rear x projection curve to match the front, project them on line using multiple selection and **`p`**, and level them with the points at front using **`l`**.

The curves should end up looking something like the ones below.



Now build the surface. Check that you still have the `scale in one direction` option chosen in the `BUILD`⇒ `Set: Build Parameters` menu.



Everything looks fine doesn't it. But you've got a problem. Try generating a fine shaded picture of the handle using `RENDER⇒ GL Window: Shaded View`. If you look carefully you might see that the indentations for the pistol grips stretch along the sides of the handle, too. Why? Because as the finger grips make the cross-sections *squeeze* to fit between the projections. This causes the fluctuations on the sides.

So how are we going to get around this?

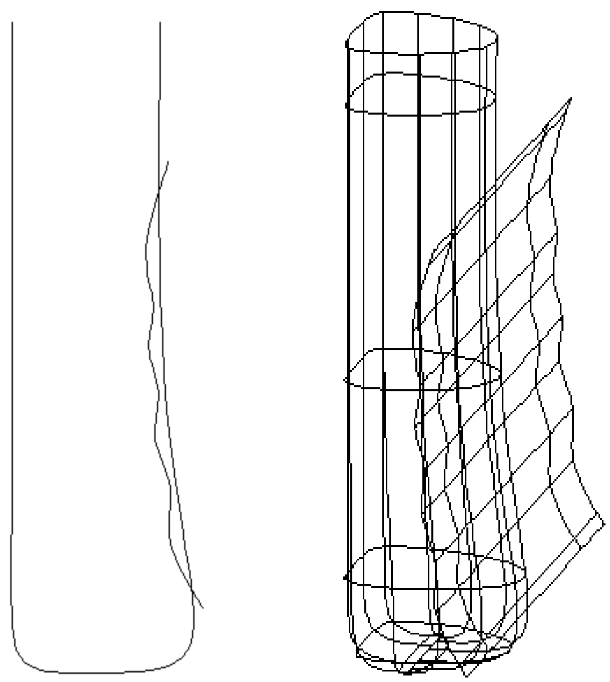
A handle by blending

Further control over the shape can be gained at the expense of a little more work. By breaking the surfaces down into smaller parts more control can be gained. A separate surface can be used to carve out the finger grips. That surface can be controlled in the normal way until the shape of it is satisfactory and then these surfaces can be either trimmed or joined using a rolling ball blend to the handle.

Write the previous design into a new file, in case you wish to show it to the customer. How about giving it an original file name like `geom_handle2`!

As a starting point for the new exercise, read in `geom_handle` and rotate the handle as previously.

Now create a new element called `finger` in which to create the finger grips. Create an x projection set and input the finger grip profile in relation to the handle as shown below. Then extrude the curve into a surface.



Of course, you could also have made the grip surface curved around the handle, by rotating the curve around a fix point somewhere behind the handle. You could have defined a section curve for the rotation, too. You could even have built the surface, using the grip curve as a section between two z projection curves, to make the grip any shape you desire. In any case, you get the point - there are alternative ways to do things!

Now to finish the job we will blend the surfaces together using a rolling ball. Remember how to do this:

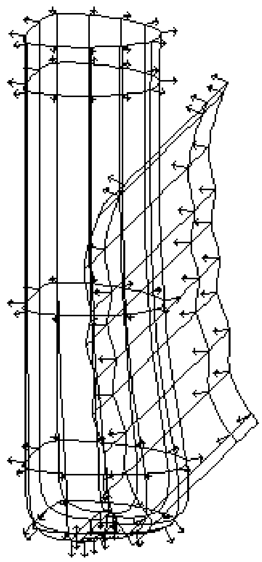
To blend the handle and a finger cut-out:

1. Select one the finger surface as the target object. Display it with the handle.

2. Select command `TRIM⇒ Blend: Rolling Ball`.

3. DeskArtes asks for the other surface which is to be blended to the target (`finger`) surface. Pick at the `handle` surface on the screen.

4. DeskArtes draws the normal directions.



5. DeskArtes displays the intersection line. This should be a continuous loop around the finger.

(If the line is broken it means your finger does not completely intersect the handle—you will need to move or scale it so that it does).

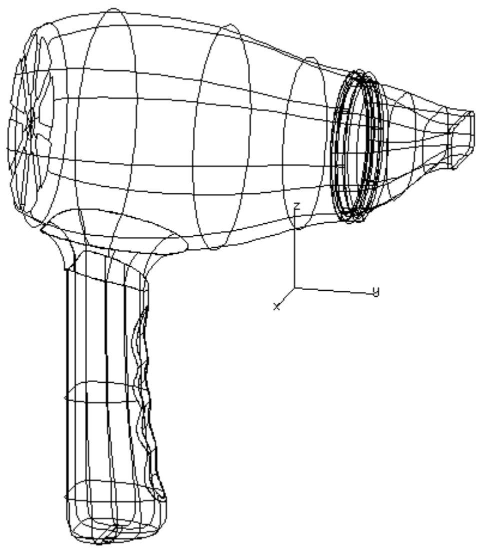
6. DeskArtes proposes a ball radius. Type `2`.

   The blend directions should be *inside* to the handle surface, and "*behind*" the tool surface. If the normals point to other directions than these, change the blend direction from the dialog box.

   In the above figure, you would choose `normal` for the finger (`this surface`) and `opposite` for the handle (`other surface`).

7. DeskArtes creates the blend, displays it, and asks if you would like to store it. If it looks all right, click `YES`, otherwise continue to change the blend radius and/or directions.

Finally furnish your design with new blends between the body and the handle, and compute images to show to your customer. Write the model into a new model file, call it `hairdryer3`.



The exercises you have just completed are to show how DeskArtes can be used in different ways to achieve similar ends. The first example created a quick representation of the handle which looked satisfactory but did not stand up to close inspection. Certainly in the early stages of a design exercise when large numbers of design alternatives are required this is a perfectly good, quick modeling technique.

When more detailed design work is required, including the potential for later manufacture, the inaccuracies of the first modeling exercise rule it out. However, since many of the design alternatives will already have been rejected the extra time involved in the later modeling exercise can be justified both in terms of the greater flexibility of design given and the more accurate model created.

✍ ***Remember always:***

.. There are more than one ways to create a model

.. some ways may be easier, others more accurate

✌ ***You've seen how to design similar models in different ways!***

Lesson 19 : Turning the Screw!

In this final Lesson, you will work on the shampoo bottle, creating a model of its contents (the shampoo!), calculating the content's volume and adding a helical screw thread to the model.

Read in the file `geom_shampoo`.

Calculate the volume

One of the design parameters for a bottle like this is the ***volume*** it holds. DeskArtes can calculate this for you. Before we can get an accurate answer we need to decide how full the bottle will be with liquid - where will the waterline be?

To define the water line:

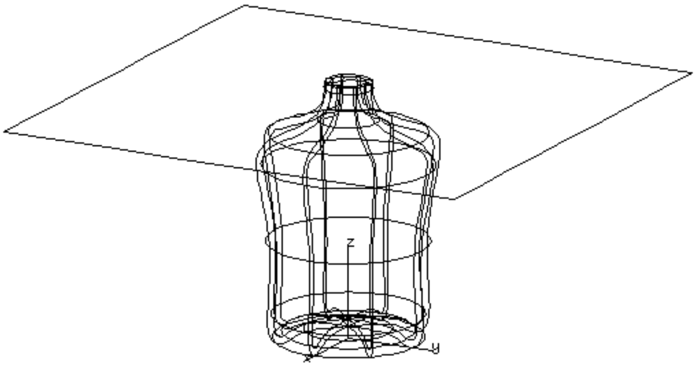
1. Select the `bottle` element as the target object.

2. Create a surface primitive `SURFACE`⇒ `Design: Primitive`. Choose the `plane/box` option and enter the following values into the dialog box -

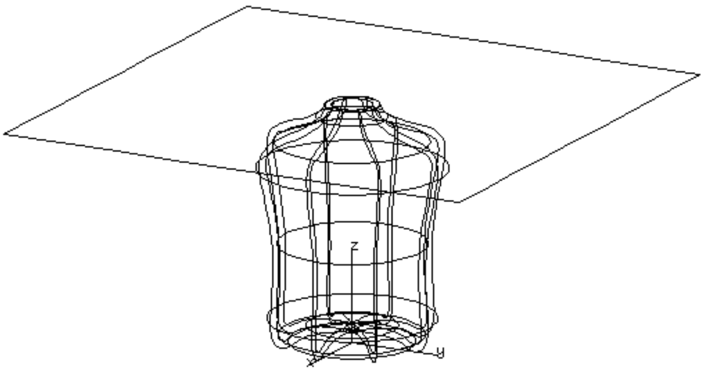
   xmin = -100, ymin = -100, zmin = 0
   xmax = 100, ymax = 100, zmax = 0

✍ Use the tab key to move from one parameter field to another!

3. Unless you made a typing error, a planar surface is created at Z=0. Move the plane in Z direction until it is at the correct height for the waterline - you decide.



4. TRIM⇒ `Intersect: Surface` the planar surface with the bottle to chop of the top of the bottle.

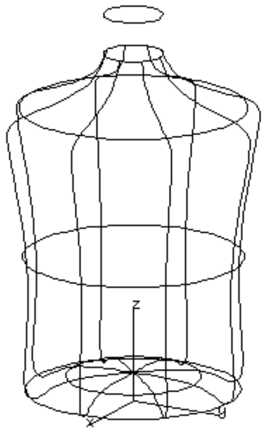


5. Remove the trim curves on the outer side of the bottle, as follows:

Display the plane surface alone `[f]`. Select the *trim set* of the plane surface. Pick `[g]` the outer trim curve by pointing at it *on the surface*. Delete `[k]` the trim curve. Select and display `[f]` the surface again. `TRIM⇒ Change: Invert Cut Part` if the wrong part of the surface remains.

6. Repeat step 5 for the bottle surface.

You should be left with the two surfaces which together form the outer surfaces of the fluid. In the below diagram, the top part (plane) has been lifted a bit to show it clearer (but don't *you* lift it!).



To compute the volume, the surfaces must share a consistent ***normal direction***, and be changed into a ***faceted model***.

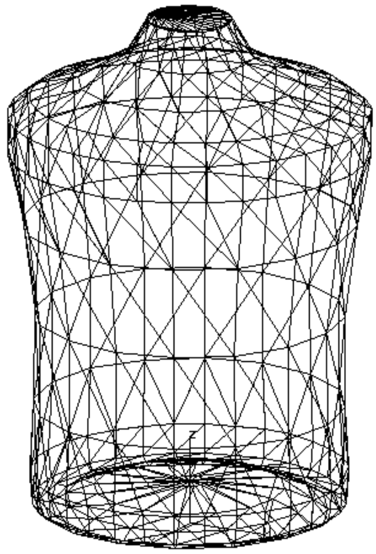
To calculate the volume:

1. Select the bottle element, and copy it to a new element called `volume`.

2. Perform `SURFACE⇒ Change: Faceted Model`. Accept the default tolerance, and max triangle size.

Set the `check directions` option to YES. This way all the facets will be oriented consistently, which is an absolutely necessary factor for obtaining a correct result for the volume computation.

The tighter the tolerance, the more accurate the volume!



3. Wait a while and the faceted model is displayed. Finally calculate the volume enclosed by the model with `DIMENS⇒ Faceted: Volume`.

The volume is reported in the message line in ***cubic units***. If you interpret the units as millimeters, the volume 240.000 cubic units would correspond to 240.000 cubic millimeters, *i.e.*, 24 centiliters.

Notice that for the volume to have a real meaning the model must enclose a *solid*, it must not have any holes or gaps. That's why we added the plane as the waterline – to exactly define the solid piece to measure.

Add a screw thread

To finish the bottle let's add a screw thread to the top. Before you start, read in the original `geom_shampoo` model again. Make the cap passive as you don't need to see it now.

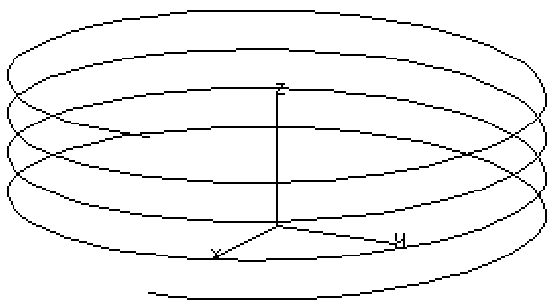
A simple screw thread can be formed by tracing a circular section curve along a helical path - sounds like a `Build` operation. We'll use a ***3D projection curve*** again. This time DeskArtes provides a command to create it automatically.

To create a thread:

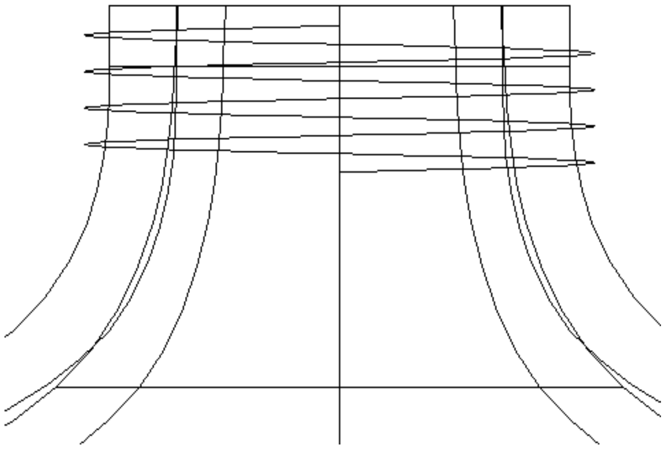
1. Create a new element called `thread`.

2. Create a `3D` projection set.

3. Create a helix with `CURVE`⇒ `Design: Spiral`. Answer the questions with 4 loops, height 1.5 and width 20.0.

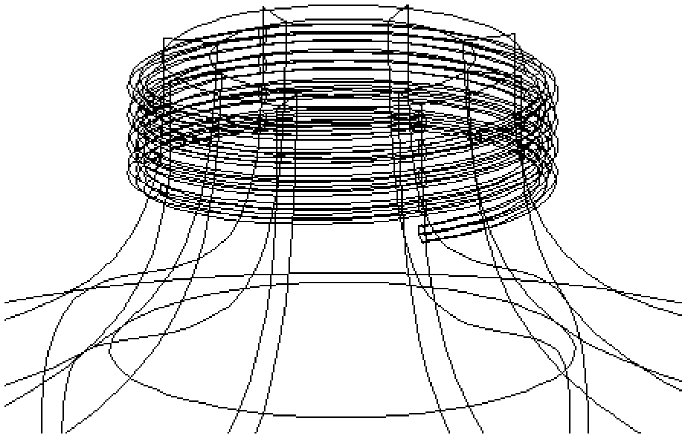


4. Move and scale the helix until it fits around the neck of the bottle.



5. Create a section set containing a circle of radius 0.5.

6. Build `[b]` the surface, accepting the default orientation parameter choice.



The thread surface should now fit snugly around the bottle. However, you may be unhappy with the end of the thread since it finishes abruptly - it should disappear into the bottle surface. This can be achieved by carefully editing both ends of the spiral curve, moving them in a little towards the center of the bottle and re-building the surface. Enter into the 3D edit mode using `[o]`, and work it out!

Build the thread again, and trim to the bottle.

To display the surfaces, finally try a new rendering option:

To draw a hidden-line image:

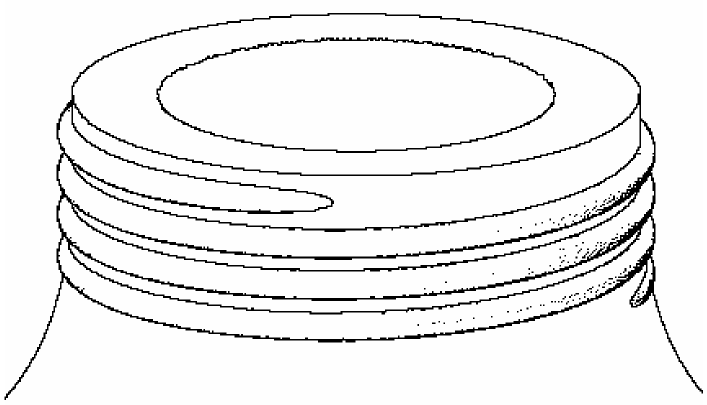
1. Display on screen what you want to render.

2. Give command `RENDER⇒ Preferences`.

   Set the `hidden lines` option to `silhouette`, and `accuracy` to `accurate`. Click `OK`.

3. Give command `RENDER⇒ Hidden Lines`.

Wait a while, and your model is displayed, hidden lines removed.



✌ ***You made it!***

Congratulations! You've come a long way and reached the End of the DeskArtes Tutorial.

You've seen applications of most of the DeskArtes commands. Many of the commands can be used in various ways for different modeling and visualization tasks, as you'll quickly learn when designing on your own. Remember – the only way to *really* learn DeskArtes is by *using* it!

☞ ***Before you close this Book:***

.. Have a glance through all the menus and buttons

. .Review the commands you've used

.. See if there are commands you haven't seen yet

.. Dig up the Reference Manual for further explanations
