

ObjectDesign

COLLABORATORS

	<i>TITLE :</i> ObjectDesign		
<i>ACTION</i>	<i>NAME</i>	<i>DATE</i>	<i>SIGNATURE</i>
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Chapter 1

ObjectDesign

1.1 ObjectDesign.guide

Documentation for Filled Vector Module for AmigaE 3.0+, object design

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Creating new objects

Modifying objects

Using objects

1.2 Creating Objects

Object Creation

Creating objects by hand is very difficult ... unfortunately, this is the iinly real way to create objects at the moment.

The utility can however be used to simplify the entry of data into the computer, and if you dont mind being limited to objects made of triangles, you can even use it to read in objects created with Imagine (not without more work mind you).

The following steps need to be taken whether designing objects with or without using ReadNFF, its just the final stages that can be simplified using it.

Starting

First, you need an idea. This can often be difficult, especially since you will want to create the object so it uses as few polygons as possible, yet still gets drawn correctly.

Working out the points

Once you have the idea though, it helps to draw it down on a piece of paper. You need to be able to identify and number all of the vertices or points in the object. The actual coordinates of these vertices will also need to be calculated - in 3d. Drawing several views of the object may help with this.

After this stage, you should have a list of coordinates, and you should also have identified each of the points by an index (start it at 0).

For example, a cube.

```

      4-----5
     /|      /|
    0-----1 |
    | |      | |
    | |      | |
    | 7---|-6
    | /      | /
    3-----2

```

```

+'ve Y
^
| ^+'ve Z
| /
o--> +'ve X

```

The numbers show the points we have assigned to each of the 8 corners of the cube.

Say, we want the cube to be 200*200*200 in size, we also would like to have centered about its centre of gravity (in the middle) so we place each point 100 from the origin.

This, our points table becomes:

```

-100,100,-100 0
100,100,-100 1
100,-100,-100 2
-100,-100,-100 3
-100,100,100 4
100,100,100 5
100,-100,100 6
-100,-100,100 7

```

Ok, so far so good, this is actually the easy part for most objects ...

Working out the polygons

This is where it starts to get tricky. Each "face" of an object (i.e. polygon) requires several pieces of information.

Firstly, it requires a set of line end-points which go up to make lines which form the polygon edges. This list of points must form a CLOSED shape. It can however form this shape in whatever way it likes, including crossing lines, and even several closed shapes. If multiple shapes are present, then they act as if each of them is complemented together (i.e. they will be transparent where they overlap). There is one restriction however for each polygon or face formed, all of the points of the face should be in the same "plane" otherwise it wont draw correctly.

So, going back to our cube example, the front face would consist of the following linking lines:

point 0 connected to 1, 1 to 2, 2 to 3 and 3 to 0.

This is 4 lines, so our polygon definition becomes:

```
[4, 0,1,1,2,2,3,3,0]:INT
```

The other polygons can be similarly defined.

Working out the order

One very important thing to note about how this vector module works is that individual polygons are NOT depth sorted! And yet, even very complex shapes like the 2 from the A1200 logo are drawn correctly. How can this be so?

This is where the 2 other pieces of information provided to the rendering engine are used. Firstly, the "crossn" members of the face OBJECT are used to describe which way a given polygon is facing (out or in), this allows the render engine to automatically forget about drawing the back sides of objects (known as backface removal). Secondly, the order in which the polygons are drawn (which is the same as the order they are defined in the creation function) becomes important.

This takes a bit of a mind-leap, but if you think about it carefully enough, you can see that only drawing faces of objects that are indeed facing you, and drawing them in the right order, you can get away without having to do any depth sorting for most objects you are likely to try to design.

Take a table as an example. If you wish to create a 3d table, with a solid, filled tabletop, and 4 square legs, you order the polygons like this:

```
draw the underside of the table
draw the 2 inside (the ones facing the centre of the table) faces of all
  legs
draw the 2 outside faces of all of the legs
draw the sides of the table
draw the tabletop
```

Since faces which are not "facing" the viewer are automatically culled, it can be seen that the above scheme can be used to draw the table accurately from EVERY conceivable external view.

And whats more, since no depth sorting step is required, computation time is reduced.

Some objects however cannot be drawn accurately all the time using this technique - either make sure you get it right for the cases where it is visible, break it into seperate objects, or simplify your object :)

In the case of this simple cube, the order is unimportant, since there are no overlapping polygons (when drawn).

Cross product indices

The cross product points (the "crossn" members mentioned above) are very necessary though. Its not too difficult to work out these either, provided you have a good spatial sense (unless you want to keep drawing rotated views of your object anyway!).

What you need to do for each face, is work out 3 points that are in the same plane as the face (usually 3 points of the face/polygon itself). Ideally, the 3 points should be as far apart as possible, and lines from the middle one to the other 2 should be close to 90 degrees (this is not necessary, but it provides for a more accurate result). These 3 points must then be ordered so that if you were to draw a line from point 0 to point 1, then point 1 to point 2, the lines would move around in a clockwise direction - this is if the object were rotated so that the given polygon was facing you.

So, for the cube, for front face, the 3 points could be:
0,1,2

They could also be 1,2,3 or 2,3,0 or 3,0,1 as well.

As an example, the back face would have to use 6,5,4 or and combination in the same direction. If we used 4,5,6 then it would mean that that back face was facing inwards instead of outwards, and the object wouldn't be drawn properly. Remember, the points need to traverse in a clockwise direction around the polygon.

Incidentally, theres nothing stopping you defining 2 faces with the same points, but one facing outwards, and one inwards, if you really needed two sided polygons.

Finally, choose which colour index you want for each of the polygons, taking into account the palette of the screen on which you willbe working.

You now basically have all the information required to generate a new vector object. The following sections describe how you do this by hand, or alternatively, how to use to help you.

Putting it together, all by hand

For the cube, we have:

```

front face:
[0,1,2, 1, [4, 0,1,1,2,2,3,3,0]:INT, 0]:face

^^^^ - The 3 cross product indices calculated above

^ - The colour of this polygon

^ - The number of edges in the polygon

^^^^^^^^^^^^^^^^ - The edge link table,
                  pairs of line endpoints

^ - padding

```

This can be done for all of the 6 faces of the cube to create the face array that needs to be fed into the newVectorObject() call.

With a bit more work, we get:

```

[0,1,2, 1, [4, 0,1,1,2,2,3,3,0]:INT, 0, -> front
6,5,4, 2, [4, 4,5,5,6,6,7,7,4]:INT, 0, -> back
2,1,5, 3, [4, 1,5,5,6,6,2,2,1]:INT, 0, -> right
4,0,3, 4, [4, 4,0,0,3,3,7,7,4]:INT, 0, -> left
1,0,4, 5, [4, 0,1,1,5,5,4,4,0]:INT, 0, -> top
7,3,2, 6, [4, 3,2,2,6,6,7,7,3]:INT, 0]:face -> bottom

```

And in this case, the ordering is unimportant.

Although above i usually defined the polygon using point indices which followed on from each other around the edges of the polygon, any ordering is allowed. For example, the front could also have been defined as:

```

[0,1,2, 1, [4, 3,2,0,1,0,3,1,2]:INT, 0, -> front

```

Since, the lines formed still create the same shape.

Combining everything so far, we can come up with the function call required to make our cube exist.

```

cube:=newVectorObject(0, -> basic type
8,      -> 8 points
6,      -> 6 faces
[-100,100,-100, -> 0  -> points array
100,100,-100, -> 1
100,-100,-100, -> 2
-100,-100,-100, -> 3
-100,100,100, -> 4
100,100,100, -> 5
100,-100,100, -> 6
-100,-100,100]:INT, -> 7  -> faces array below
[0,1,2, 1, [4, 0,1,1,2,2,3,3,0]:INT, 0, -> front
6,5,4, 2, [4, 4,5,5,6,6,7,7,4]:INT, 0, -> back
2,1,5, 3, [4, 1,5,5,6,6,2,2,1]:INT, 0, -> right
4,0,3, 4, [4, 4,0,0,3,3,7,7,4]:INT, 0, -> left
1,0,4, 5, [4, 0,1,1,5,5,4,4,0]:INT, 0, -> top

```

```
7,3,2, 6, [4, 3,2,2,6,6,7,7,3]:INT, 0]:face); -> bottom
```

And thats it! _phew_ Have a look at some of the examples, you can appreciate how difficult some of them were to make :)

Putting it together, using ReadNFF

Checkout the `section` for this.

1.3 readnff

ReadNFF information

This is a badly written, kludgy, and awkward to use utility that can however greatly simplify object creation.

There not many `that` need explaining.

It reads in a file in NFF format (neutral file format?) and converts it to sourcecode for the function call to create the object in AmigaE format.

Apart from designing objects using NFF by hand, there are utilities such as `tddd2nff` which can be used to convert Imagine objects to NFF, then NFF can be read by `ReadNFF` to create a function call. However, imagine doesn't know anything about polygon ordering, or correct cross product direction (since imagine uses triangles, `ReadNFF` is able to create the right cross product for you - but it will often be in reverse of what you want) doesn't work. So, it often requires a lot of hand-work to get the objects to work anyway ...

Going back to the cube example, we'll see how to use `ReadNFF` to do some of the work.

```

  4-----5
 /|      /|
0-----1 |
| |      | |
| |      | |
| 7---|-6
|/       |/
3-----2
```

For the `ReadNFF` file, what we need to do is to define all of the coordinates for each polygon. We can also try to order these points so that the polygons themselves are defined in clockwise order (to help the code create accurate cross product points), but this wont always work if the object has >3 points because of the point optimisation method used.

So, we come up with the following definition for our cube:

```
# a cube, in NFF format
# Comments start with #, and can be anywhere outside of
# polygon definitions
# A polygon definition is started with a p, followed by
# exactly one space, then a number which defines
# the number of points in that polygon
# There is 1 point per line, seperated with spaces
# with the x coordinate flush left (no leading
# spaces), with spaces (not tabs!) seperating
# each number
# front face
p 4
-100 100 -100
100 100 -100
100 -100 -100
-100 -100 -100
# back face
p 4
-100 -100 100
100 -100 100
100 100 100
-100 100 100
# right
p 4
100 100 -100
100 100 100
100 -100 100
100 -100 -100
# left
p 4
-100 100 -100
-100 -100 -100
-100 -100 100
-100 100 100
# top
p 4
-100 100 -100
-100 100 100
100 100 100
100 100 -100
# bottom
p 4
100 -100 -100
-100 -100 -100
-100 -100 100
100 -100 100
```

Ok, this can be fed into ReadNFF, and it comes up with:
(with a little editing)

```
obj:=newVectorObject(0,8,6,
    [-100,100,-100,
     100,100,-100,
     100,-100,-100,
```

```

-100,-100,-100,
-100,-100,100,
100,-100,100,
100,100,100,
-100,100,100]:INT,
[0,1,2,0,[4,0,1,1,2,2,3,3,0]:INT,0,
4,5,6,1,[4,4,5,5,6,6,7,7,4]:INT,0,
1,6,5,2,[4,1,6,6,5,5,2,2,1]:INT,0,
0,3,4,3,[4,0,3,3,4,4,7,7,0]:INT,0,
0,7,6,4,[4,0,7,7,6,6,1,1,0]:INT,0,
2,3,4,5,[4,2,3,3,4,4,5,5,2]:INT,0]:face

```

The editing involved:

```

deleting a spurious point at the end of the point array
(ok, so its buggy as hell!)
adding the []:face to the face array, and moving
it from the start of the output to the end
and thats about it ...

```

So, will this object work all on its own? I think so, since because the way the points were ordered in the file, they came out the same as the original. In this case, no more editing is required, luckily. All that needs to be modified is the colours, which isn't too difficult.

With more complex objects, you may have to manually enter in the cross product indices as well as the colours. It does save a bit of work though. shows an example of an object created in Imagine 2.0 (using create primitive/torus), which was then hand-edited to make it work (every second polygon needed its cross indices reversed).

Hopefully one day i'll sit down and design either a proper script language to make designing objects simpler, or a 3d editor ... (although, other commitments may affect this!).

1.4 ReadNFF command line options

ReadNFF options:

When you run it, it will open a window and the file, and as the file is read in, a wireframe version of the object will be displayed. The output of the program is simply dumped to the cli in which it was run. Once finished, it will automatically close the window.

NAME/A

Supply the filename of the NFF file to read. Not much error checking is done, so if this is in an invalid format, you're not going to get much more than a bloody mess out of it :)

SHIFT/N

Amount to shift values before they are output. This is only important with floating point input, or where some scaling is needed. Each number conforms to a shift up by 1. So, a shift value of 2 will mean the values are multiplied by 4 before being converted to integer format.

1.5 Modifying Objects

Modifying Objects

Currently there is really only one way to modify objects - the points in the object can be modified.

You can't even modify the colours of polygons and so on for copied objects (which would be handy ...) this should be fixed soon ...

Playing with Points

Using the application programmer has direct access to the coordinate table used by the object. This can be modified in any way you see fit, say by scaling the object and so on.

One thing that must be noted though, is that the points should continue to retain the same relationship to each other as when the object was defined - otherwise the face setup, backface removal and so on will not operate correctly.

This still allows a bit of scope for object morphing and things like that. (If i had the effort, i'd give you an example of morphing objects :)

For objects that have been copied using you can modify the points freely, as each copy of the object gets its own points. For cloned objects (the point lists are NOT copied, so in this case, you must be careful you don't accidentally change the wrong points!

When objects have been copied, this is where being able to modify them becomes useful. You can use the rotation and scaling functions in matrix operations to modify the copied object to create new versions.

1.6 Using Objects

Using Objects

It's all very well being able to create and bend objects and so

on, but how do you get them onto the screen usefully?

One-off objects, like a swirling Zed logo are easy enough. This uses a vector object list to allow the system itself to handle the nitty gritty of depth sorting and so on, and then uses the object's positions to position the letters within their own "space".

Using the functions, you could build up your own library of functions designed to position the objects (using their position specifiers), rotate them to the view you want, and then use the vector object list functions to do the depth sorting and rendering for you.

Finally, you could code everything yourself except for the object rendering function, and just use to do the hard work, at reasonable speed.