Object Editing - the oed Command

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The **oed** command in MGED is used to enter what is called "object edit mode" [1] - practically speaking, this mode allows transformations on combined objects (combinations of primitives created with **comb**, for example.) These transformations are not (by default) made to the coordinate information in the primitatives in question but are stored instead in a *transformation matrix*. This article provides a brief overview and explanation of the behavior of the **oed** command and its uses.

oed - Basic Syntax and Operations

The syntax of **oed** is fairly straightforward: [2]

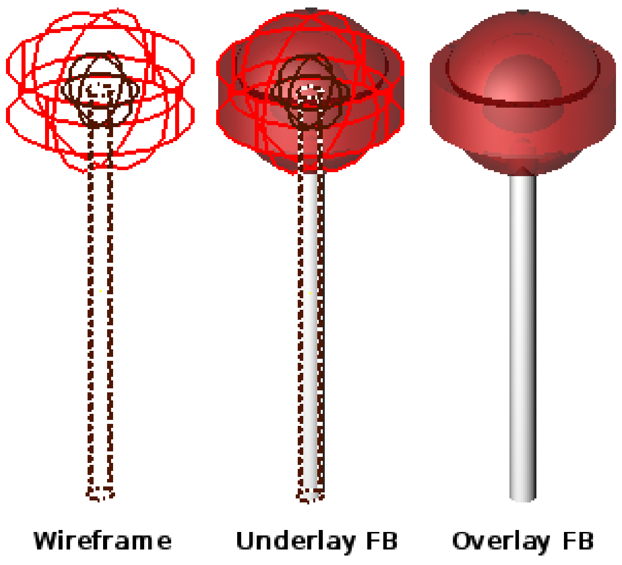
oed {*path_lhs*} {*path_rhs*}

oed serves primarily to make working with combinations and regions practical when there are large numbers of primitives involved. It is of course possible to move primitives one by one to desired locations, but the process is extremely tedious for any non-trivial combination of primitives and the result is inflexible - for example,if the modeler wished to return the primitives in a combination to their original position after moving them *as primitives* the process of moving them would need to be reversed one by one as well. Barring being able to do everything perfectly the first time, individual primitive placement is impractical.

The notion of *path* in this context refers to the tree of objects that traditionally makes up a CSG model. Primitives will be combined with other primitives to make groups of objects, and the "path" to any individual shape within the combinations is described by the series of nodes in the tree that identify the object of interest. For example, take a simple model of a lollipop:

[1]In some places in MGED this will be referred to as "matrix edit mode" - the terms both refer to the same concept.

[2]Note: *lhs* is an abbreviation for left hand side and rhs similary stands for right hand side, given the assumption that a path is displayed as an ascii stream with left to right text orientation (e.g. /toplevel/level-1/level-2/etc.)



If we examine the tree structure of this object, we see it resembles a filesystem - combinations and regions act a bit like "folders" which can hold other folders and files. [3]

```
mged> tree lollipop
lollipop/
        u outer-candy-shell.r/R
                u outer-candy-sphere.c/
                        u outer-candy-sphere.s
                        - core.s
                        - stick.s
                u outer-candy-cyl.c/
                        u outer-candy-cyl.s
                        - outer-candy-sphere.s
                        - core.s
                        - stick.s
        u stick.r/R
                u stick.s
        u core.r/R
                u core.s
                - stick.s
```

In the "filesystem" of a BRL-CAD object combinations can hold combinations, regions and primitives. Regions can hold combinations and primitives. [4] Primitives are always leaves on the tree - they do not "contain" anything. Combinations, regions, and primitives can have associated with them transformation data (sort of like metadata in a filesystem) that tells BRL-CAD how to manipulate the combination, region, or primitive in question. It is this data that will be acted upon when the **oed** command is used. So in the above example the full "path" of the outer-candy-sphere.c combination used in lollipop would be:

[3] When tree structures are displayed, a "/" suffix denotes a combination and a "/R" denotes a combination that is a region.

[4] Regions will accept other regions as constructive arguments if given, but this is not good practice - BRL-CAD assumes a region is composed of combinations and primitives which share a material type.

```
/lollipop/outer-candy-shell.r/outer-candy-sphere.c
```

Note that if we wish to operate on this combination it is not enough to specify /lollipop/outer-candy-shell.r for the lhs and outer-candy-sphere.c for the rhs - *combinations and regions do not themselves have default control points.* In other words, if you want to rotate a combination there must be a point around which that rotation occurs - a combination will have no default point assigned. This is the reason the rhs must always end with a primitive - even though the intent is not to edit the primitive, information necessary for most operations on the combination will use information (such as default keypoint settings) that the primitive *does* have. So,

```
oed /lollipop/outer-candy-shell.r outer-candy-sphere.c
```

is not enough. Either

```
oed /lollipop/outer-candy-shell.r
    outer-candy-sphere.c/outer-candy-sphere.s
```

or

```
oed /lollipop/outer-candy-shell.r outer-candy-sphere.c/core.s
```

or

```
oed /lollipop/outer-candy-shell.r outer-candy-sphere.c/stick.s
```

is needed to have **oed** actually enter edit mode on lollipop's outer-candy-sphere.c. Because they are primitives in the outer-candy-sphere.c combination, outer-candy-sphere.s, core.s and stick.s are all legal - there will be illustrations later of the consequences of different primitive choices.

To demonstrate basic **oed** behavior an example is in order. [5] [6]

In an empty MGED session, create a new geometry database called *oed_examples.g*. Enable the model coordinate axes display by entering the MGED command **rset ax model_draw 1**. Create two primitives: [7]

```
in sphere.s sph 0 0 0 4
```

```
in cube.s arb8 5 5 0 8 5 0 8 5 3 5 5 3 5 8 0 8 8 0 8 8 3 5 8 3
```

There should now be a sphere and a cube visible on the screen. Next create a combination of these two primitives:

```
comb object1.c u sphere.s u cube.s
```

After this command both the primitives and the combination are \ present in the display, which will result in overlaps. Use the **B** command to reduce the display to just the combination. [8]

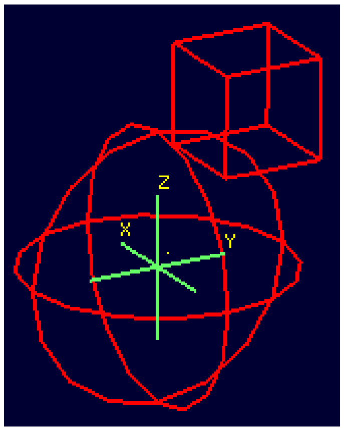
```
B object1.c
```

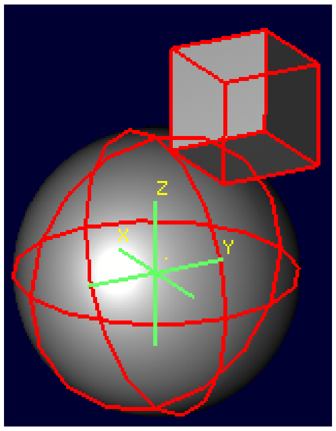
[5]Bear in mind that these examples will be using very basic primitives for the sake of simplicity and it is not guaranteed that they will behave well for things like raytracing. In this document raytraced screenshots are included to aid visualization. Most of them are simple but there are sometimes a number of extra steps needed to actually allow the objects to be raytraced with the results seen here.

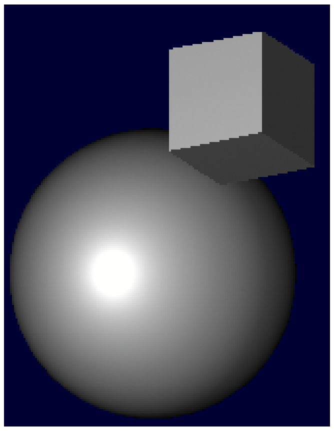
[6]*path_lhs* will be set to "/" for these simple cases - this simply means we will be working with combinations that are not contained within any other combination or region. "/" denotes the toplevel lhs path, or the "root of all trees" in the database.

[7] This document will respect the normal BRL-CAD naming convention: use the .s extension for primitives, the .c extension for combinations below regions, and the .r extension for regions. Combinations above regions have no extension.

[8]The **B** abbreviation stands for "blast" - i.e. remove all objects from being displayed, and draw only the specified objects.







Before beginning the editing process, the **l** command can be used to view both the combination and its component primitives:

Note

Note that this command is the lower case letter L (l) and not the numeral one (1).

```
mged> l object1.c
object1.c:  --
   u sphere.s
   u cube.s

mged> l sphere.s
sphere.s:  ellipsoid (ELL)
        V (0, 0, 0)
        A (4, 0, 0) mag=4
        B (0, 4, 0) mag=4
        C (0, 0, 4) mag=4
        A direction cosines=(0, 90, 90)
        A rotation angle=0, fallback angle=0
        B direction cosines=(90, 0, 90)
        B rotation angle=90, fallback angle=0
        C direction cosines=(90, 90, 0)
        C rotation angle=0, fallback angle=90

mged> l cube.s
cube.s:  ARB8
        1 (5, 5, 0)
        2 (8, 5, 0)
        3 (8, 5, 3)
        4 (5, 5, 3)
        5 (5, 8, 0)
        6 (8, 8, 0)
        7 (8, 8, 3)
        8 (5, 8, 3)
```

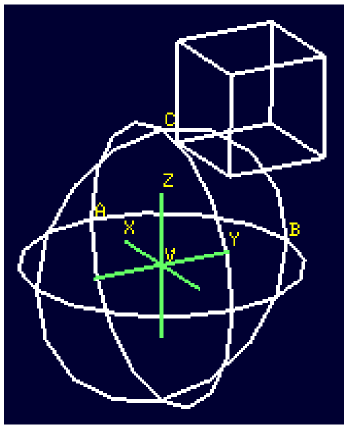
For the first task the goal is to shift both the sphere and the arb8 5 mm up the z axis. First, select the combination for editing:

```
oed / object1.c/sphere.s
```

Note

If in the course of editing an object you make a mistake, type **reject** to revert to the pre-object-edit-mode values and exit object edit mode.

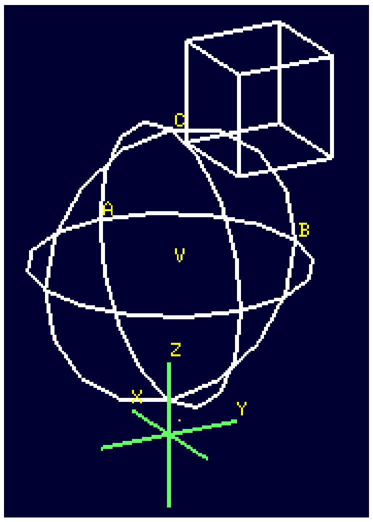
The object should turn white, as below:



Once selected, use the **translate** command to shift the combination up the z axis.

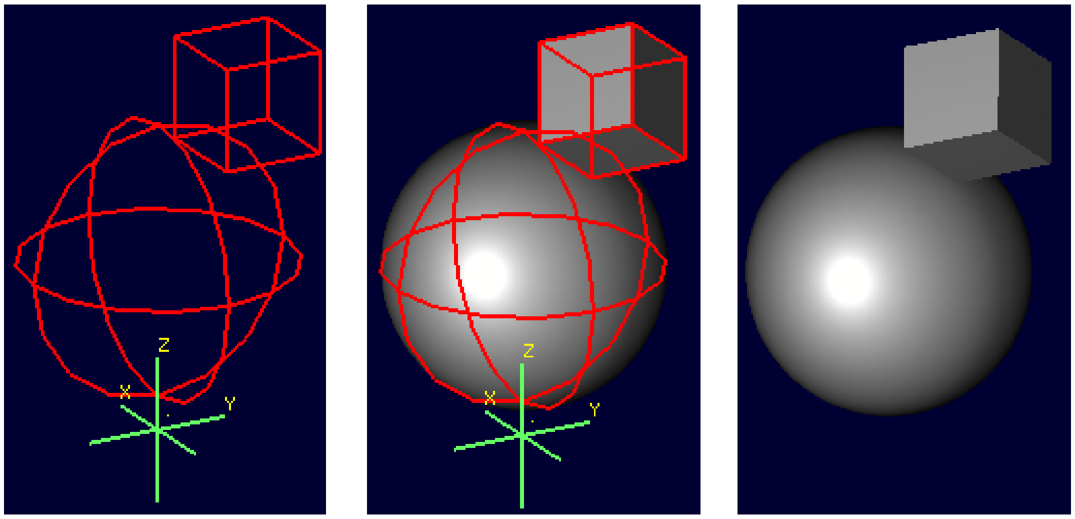
```
translate 0 0 5
```

Both the sphere and the cube should have shifted together.



To accept the edit and end object edit mode type **accept**:

```
accept
```

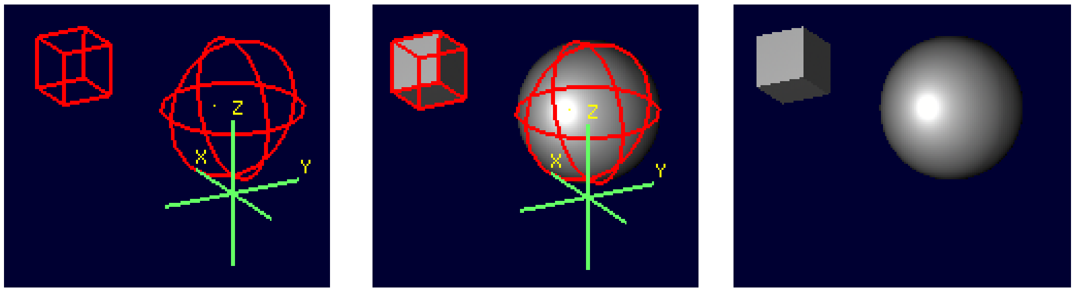


Now, use **l** to again examine the combination and its component primitives.

```
mged> l object1.c
object1.c:  --
   u sphere.s [0,0,5]
   u cube.s [0,0,5]

mged> l sphere.s
sphere.s:  ellipsoid (ELL)
        V (0, 0, 0)
        A (4, 0, 0) mag=4
        B (0, 4, 0) mag=4
        C (0, 0, 4) mag=4
        A direction cosines=(0, 90, 90)
        A rotation angle=0, fallback angle=0
        B direction cosines=(90, 0, 90)
        B rotation angle=90, fallback angle=0
        C direction cosines=(90, 90, 0)
        C rotation angle=0, fallback angle=90

mged> l cube.s
cube.s:  ARB8
        1 (5, 5, 0)
        2 (8, 5, 0)
        3 (8, 5, 3)
        4 (5, 5, 3)
        5 (5, 8, 0)
        6 (8, 8, 0)
        7 (8, 8, 3)
        8 (5, 8, 3)
```

Notice that the primitives have not changed, but the combination now contains additional information. It has recorded that both sphere.s and cube.s have been shifted up the z axis 5 mm. Select object1.c again and apply a rotation as well:

```
oed / object1.c/sphere.s

rot 0 0 90

accept
```



Another check with **l** shows still more information stored at the combination level, but the primitives are again unchanged.

```
mged> l object1.c
object1.c:  --
   u sphere.s az=90, el=0,  [0,0,5]
   u cube.s az=90, el=0,  [0,0,5]

mged> l sphere.s
sphere.s:  ellipsoid (ELL)
        V (0, 0, 0)
        A (4, 0, 0) mag=4
        B (0, 4, 0) mag=4
        C (0, 0, 4) mag=4
        A direction cosines=(0, 90, 90)
        A rotation angle=0, fallback angle=0
        B direction cosines=(90, 0, 90)
        B rotation angle=90, fallback angle=0
        C direction cosines=(90, 90, 0)
        C rotation angle=0, fallback angle=90

mged> l cube.s
cube.s:  ARB8
        1 (5, 5, 0)
        2 (8, 5, 0)
        3 (8, 5, 3)
        4 (5, 5, 3)
        5 (5, 8, 0)
        6 (8, 8, 0)
        7 (8, 8, 3)
        8 (5, 8, 3)
```

What if a modeler DID want the primitives to be the elements changed? There exists a command called **push** that will perform this operation. (So called because it "pushes" the transformations at the upper levels down to the primitives.) Be warned that this change, once done, is difficult to undo. Witness its effect on this example:

```
push object1.c


mged> l object1.c
object1.c:  --
   u sphere.s
   u cube.s

mged> l sphere.s
sphere.s:  ellipsoid (ELL)
        V (0, 0, 5)
        A (0, -4, 0) mag=4
        B (4, 0, 0) mag=4
        C (0, 0, 4) mag=4
        A direction cosines=(90, 180, 90)
        A rotation angle=270, fallback angle=0
        B direction cosines=(0, 90, 90)
        B rotation angle=0, fallback angle=0
        C direction cosines=(90, 90, 0)
        C rotation angle=0, fallback angle=90

mged> l cube.s
cube.s:  ARB8
        1 (5, -5, 5)
        2 (5, -8, 5)
        3 (5, -8, 8)
        4 (5, -5, 8)
        5 (8, -5, 5)
        6 (8, -8, 5)
        7 (8, -8, 8)
        8 (8, -5, 8)
```

Now the primitives have changed, and the combination is back to being just a boolean operation on primitives. These operations COULD be undone by more transformations and another push to return things to their original state, but anything much more complex would become hard to undo - use **push** with care!

Right Hand Path Selection - Reasons and Implications

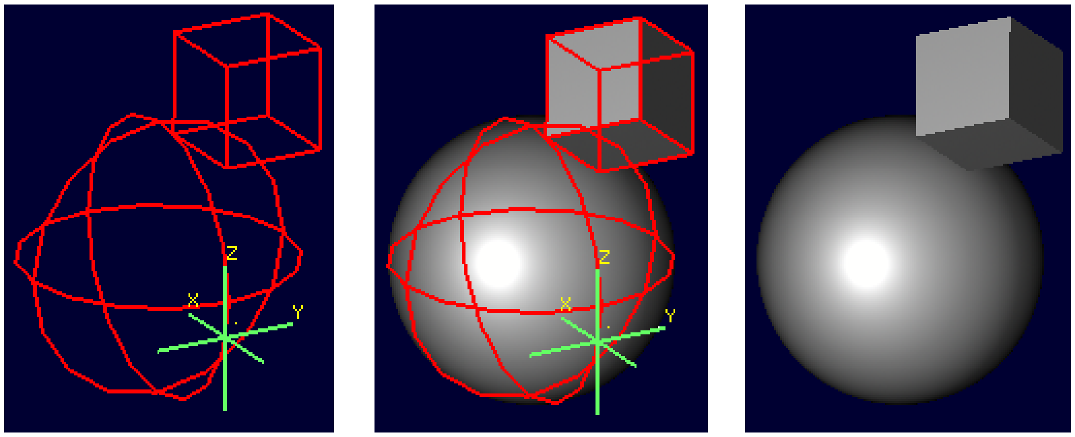
Notice in the previous section that sphere.s was selected when using the **oed** command as part of the path_rhs. What would the impact have been had cube.s been selected instead?

Using the commands shown below, clear the old object1.c tree from MGED, re-insert the primitives, and make a combination as before. This time make two objects using the same primitives, for later use. At the moment, only the object2.c combination will be displayed.

```
killtree object1.c

in sphere.s sph 0 0 0 4

in cube.s arb8 5 5 0 8 5 0 8 5 3 5 5 3 5 8 0 8 8 0 8 8 3 5 8 3

comb object1.c u sphere.s u cube.s
comb object2.c u sphere.s u cube.s

B object2.c
```

In the previous section, the **translate** command was used to shift the object up the z axis. That was a deliberate choice - **translate** moves to an absolute rather than a relative position. Attempt the same operation, this time with the cube.s primitive selected:

```
oed / object2.c/cube.s

translate 0 0 5

accept
```



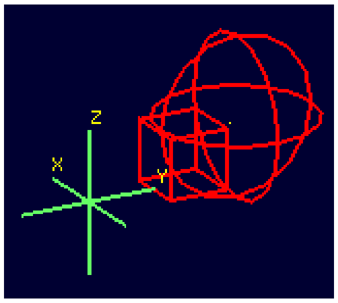
Compare the results to the previous section. The model is indeed shifted up the z axis, but the distance is somewhat different and the cube now has one edge lined up with the z axis. This is because of how **translate** works - it moves a *point* to an absolute position, rather than shifting everything selected some delta in x, y and z (the **tra** command uses relative position coordinates and its effects are indeed independent of primitive selected.) In the previous section, the sphere's origin was the reference point. Now, the cube's first coordinate is being moved to the same absolute position - with different overall results for the model.

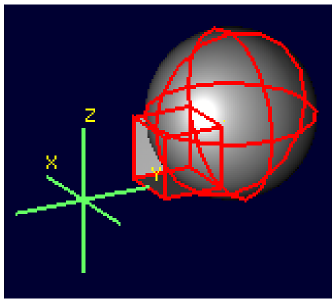
As one further illustration, attempt a **rot** command with the cube selected and then again with the sphere selected:

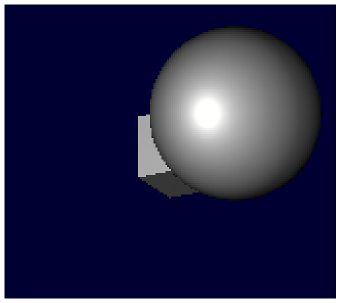
```
oed / object2.c/cube.s

rot 0 90 0

accept

oed / object2.c/sphere.s

rot 0 90 0

accept
```

The first **rot** command rotated the model around the y axis using the first coordinate of cube.s. The second rotation started from the results of the previous rotation and rotated again around the y axis, but this time using the origin of sphere.s.

The **l** command provides a look at the final result:







```
mged> l object2.c
object2.c:  --
   u sphere.s az=180, el=0,  [-5,5,5]
   u cube.s az=180, el=0,  [-5,5,5]
```

Selection of a particular primitive when using **oed** will depend on the particular situation. Combinations do not have control points of their own, and thus cannot provide any basis for these operations - a primitive MUST be supplied for every **oed** operation. [9]

Flexible Manipulation with *keypoint*

As seen in the previous section, the **oed** requires a point from which translations/rotations/etc. are defined. BRL-CAD's term for this point is the *keypoint* and BRL-CAD does offer an option for explicit control of the keypoint when the default primitive options are not sufficient.

For example, to rotate object2.c around the z axis intersecting point (2,2,0) the keypoint must be set explicitly - this is not a point that can be selected by identifying a primitive.

First, check the current keypoint value: [10]

```
oed / object2.c/sphere.s

keypoint

(null) (-5, 5, 5)
```

In order to set a new keypoint, we simply supply an x y z style coordinate option to the keypoint command:

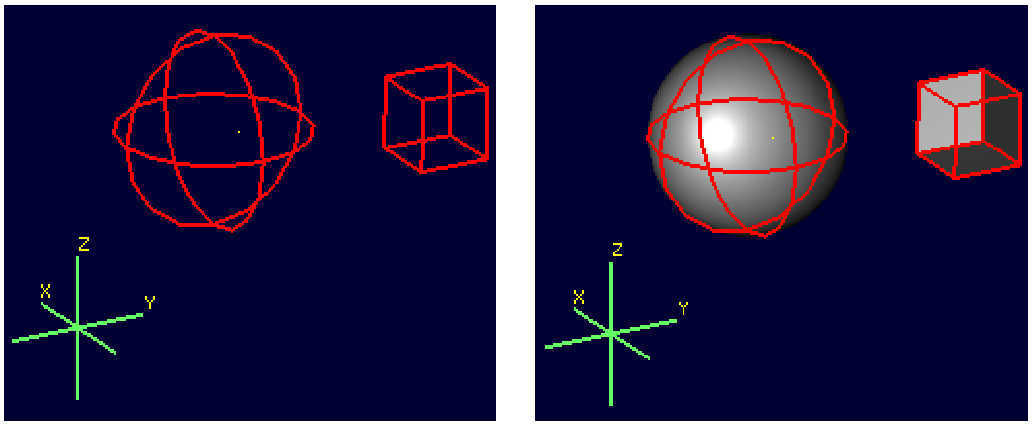
```
keypoint 2 2 0

keypoint

user-specified (2, 2, 0)
```

Notice that the keynote report identifies this keypoint as user-specified. Having set this new keypoint, we can now rotate about it:

```
rot 0 0 90

accept
```

[9] It might be reasonable to expect the **oed** command to use the center of the combination bounding box as a default if no primitive is supplied and/or take as an optional parameter an explicit keypoint setting, but this is not the current behavior of BRL-CAD as of version 7.12 - a primitive is required.

[10] Note that keypoint is a meaningless concept until in object edit mode, so the first step is to enter that mode.



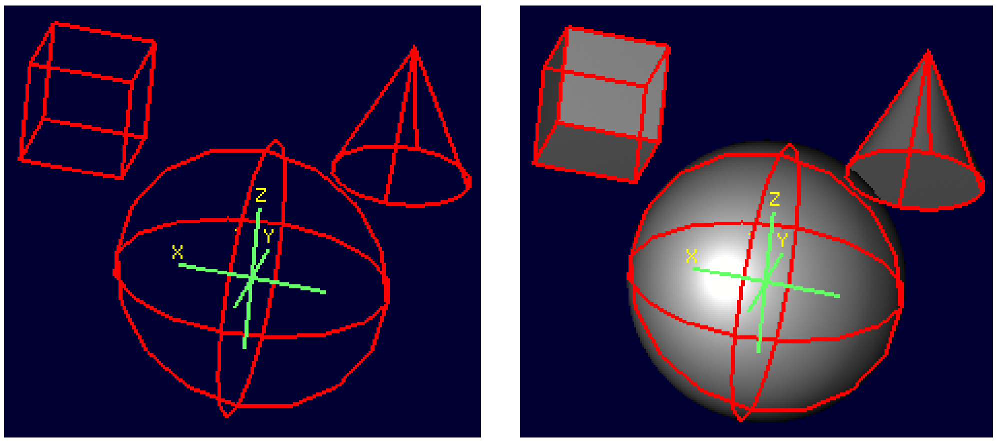
```
mged> l object2.c
object2.c:  --
   u sphere.s az=270, el=0,   [5,9,5]
   u cube.s az=270, el=0,   [5,9,5]
```

Notice that it is getting increasingly difficult to identify the transformations that will restore the original shape positions. There is no keypoint history mechanism so remember to carefully track what is done if retracing the steps performed on an object is important.

Sub-Combination Editing - using Left Hand Path Selection

The importance of the *path_lhs* portion of the **oed** command is better understood in the case of more complex objects. To illustrate such a case, a new shape and additional combination structures are added:

```
in cone.s trc -4 0 4 0 0 4 2 .01

comb object3.c u cone.s u object1.c

r bigobject.r u object1.c u object3.c

B bigobject.r
```



```
mged> tree bigobject.r
bigobject.r/R
        u object1.c/
                u sphere.s
                u cube.s
        u object3.c/
                u cone.s
                u object1.c/
                        u sphere.s
                        u cube.s
```

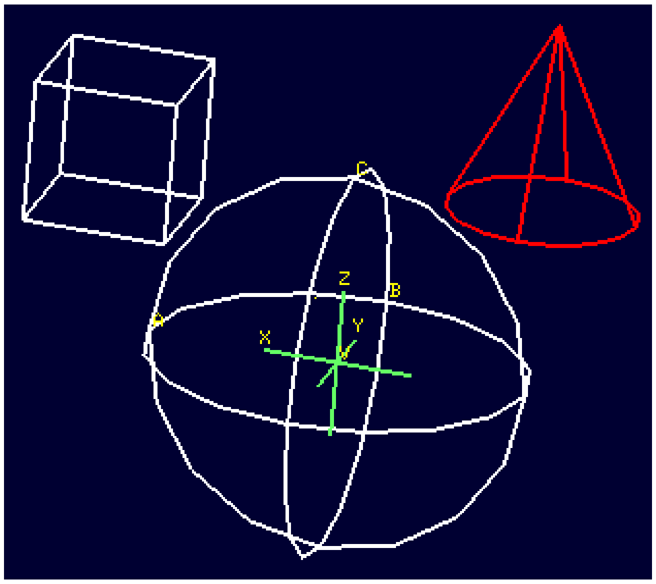
The first goal is to translate object1.c inside bigobject.r 4mm in the positive z direction without impacting any other part of the model. This means the object1.c inside object3.c inside bigobject.r should NOT be changed. A first attempt might be to work directly with object1.c:

```
mged> l object1.c
object1.c:  --
   u sphere.s
   u cube.s
```

```
oed / object1.c/sphere.s

Error: Unable to find solid matching path
```

An error is returned, because this command attempts to edit object1.c as a top level object and it is not currently in display as a top level object due to the previous **B** cleanup. However, MGED does not *force* object1.c out of the display when bigobject.r is displayed. Assuming it was still present (simulate this by entering **B bigobject.r object1.c** into the MGED prompt) the previous command would have a different result:

```
B bigobject.r object1.c

oed / object1.c/sphere.s
```

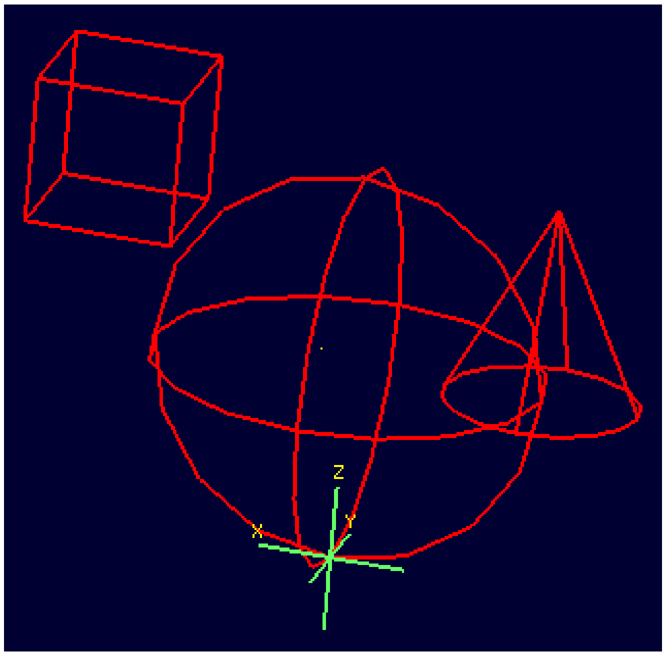


BRL-CAD is now in object edit mode, and visually it looks like it is highlighting precisely the part of the model targeted for translation. However, when translated:

```
tra 0 0 4
```

```
accept
```

```
B bigobject.r object1.c
```



BOTH the object1.c present in bigobject.r and the definition of object1.c in object3.c have been translated - only one instance of the sphere and cube combination is visible. This is a subtle problem, but remember the original goal was to move ONLY the object1.c inside bigobject.r - this technique moved more than that. It would be especially problematic if a modeler didn't realize that object1.c was still in the display (assuming it is intended only as a sub-object for other objects) and the above command visually "did the right thing" - before re-running the **B** command the result would look correct. There are two reliable hints something is wrong. If the **l** is run on bigobject.r, no transformation matrix is observed next to object1.c:

```
mged> l bigobject.r
bigobject.r:  REGION id=1005  (air=0, los=100, GIFTmater=1) --
   u object1.c
   u object3.c
```

and examining the **l** readout for all object1.c instances the results are identical, when the bigobject.r's object1.c was intended to change:

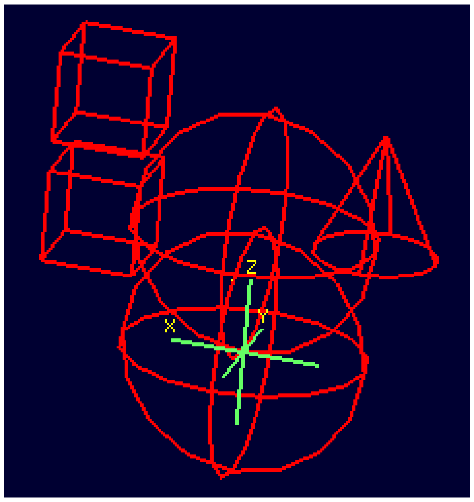
```
mged> l bigobject.r/object1.c
bigobject.r/object1.c:  --
   u sphere.s [0,0,4]
   u cube.s [0,0,4]

mged> l bigobject.r/object3.c/object1.c
bigobject.r/object3.c/object1.c:  --
   u sphere.s [0,0,4]
   u cube.s [0,0,4]

mged> l object1.c
object1.c:  --
   u sphere.s [0,0,4]
   u cube.s [0,0,4]
```

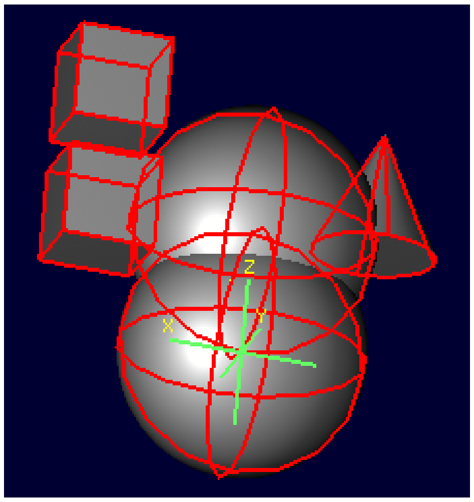
The correct way to do the above task would be to use *path_lhs* to identify precisely where the transformation is to occur. Remember in the beginning of the article the lollipop example showed instances of lhs path usage - this is an example where it is needed. First, object2.c must be returned to its previous position:

```
oed / object1.c/sphere.s

tra 0 0 -4

accept

B bigobject.r
```

Next the correct commands are entered:

```
oed /bigobject.r object1.c/sphere.s

tra 0 0 4

accept

B bigobject.r
```





Visually it is already clearer - there are now two offset object1.c combinations in the display. Repeating the **l** command also shows the expected results, with the combination showing a transformation matrix and the object1.c reports showing differences:

```
mged> l bigobject.r
bigobject.r:  REGION id=1005  (air=0, los=100, GIFTmater=1) --
   u object1.c [0,0,4]
   u object3.c

mged> l bigobject.r/object1.c
bigobject.r/object1.c:  --
   u sphere.s [0,0,4]
   u cube.s [0,0,4]

mged> l bigobject.r/object3.c/object1.c
bigobject.r/object3.c/object1.c:  --
   u sphere.s
   u cube.s

mged> l object1.c
object1.c:  --
   u sphere.s
   u cube.s
```

There is a lot of potential here for unintended consequences. On the other hand, in some cases the modeler may *want* all instances of object1.c to pick up the changes. Awareness of the dangers inherent to this type of operation is an important skill for a modeler to acquire. [11]

Summary

The major points of the **oed** command are:

- **oed** is the standard tool when working with combinations and regions instead of primitives.

[11](Obviously, this example was intended for behavior demonstration and not as an example of best-practice modeling.)

- Object edit mode does not alter primitives directly but instead works on a transformation matrix which is applied to the primitive by BRL-CAD.
- BRL-CAD requires that a primitive shape be supplied at the end of the *path_rhs* for all object edit mode operations.
- **push** is used to force changes corresponding to the applicable changes down to the primitives, but the operation is destructive as far as the original primitive information is concerned.
- *keypoint* is used in object edit mode as the point moved by **translate** operations and around with rotations occur - it is set from the primitive supplied to **oed** but can also be set manually when in object edit mode.
- When editing objects inside other objects it is important to remember to use *path_lhs* to precisely identify the shape to be worked on - subtle and messy errors are possible if the wrong path is used.