

Section 3: Tutorial

3.1: Introduction

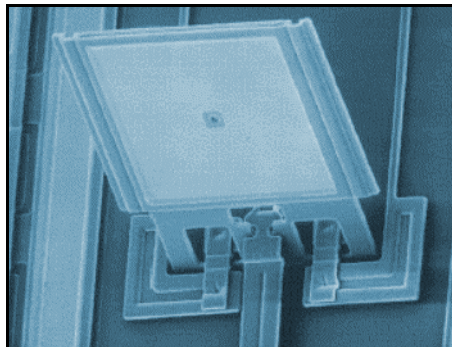
The ability to manipulate light in free space where losses are low allows the creation of complex optical systems. These systems can be designed with far fewer amplifiers, and in some cases without any amplification at all. The compact nature of MEMS optics also enables applications in which devices can replace conventional macroscopic optics, to provide a lower cost solution.

This section provides an opportunity to gain experience with Designer while creating a practical system design. The tutorial presents step-by-step guidance for building a thermally-actuated optical mirror assembly. The finished assembly is an example of a device that may be used in various optical applications. It features a moving mirror and a thermal actuator, known as a heatuator. A 3-D simulation of the final assembly is shown in [Figure D3-3](#).

3.1.1: The Thermally-Actuated Pop-Up Mirror

The thermally actuated mirror design has numerous applications, including optical switching and scanning. [Figure D3-1](#) shows an image of a Multi-User MEMS Processes (MUMPS)-fabricated pop-up mirror. This image was captured using a scanning electron microscope and is similar to the one you will build in this tutorial.

Figure D3-1 SEM Image of Pop-up Mirror



The mirror is controlled by an array of actuators connected to the mirror, as shown in [Figure D3-2](#).

Figure D3-2 SEM Image of Complete Scanning Micromirror Assembly

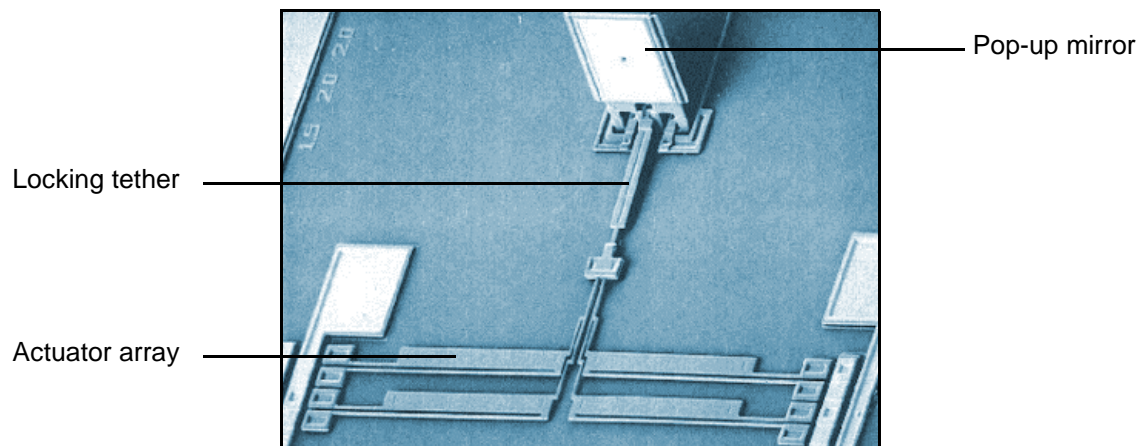
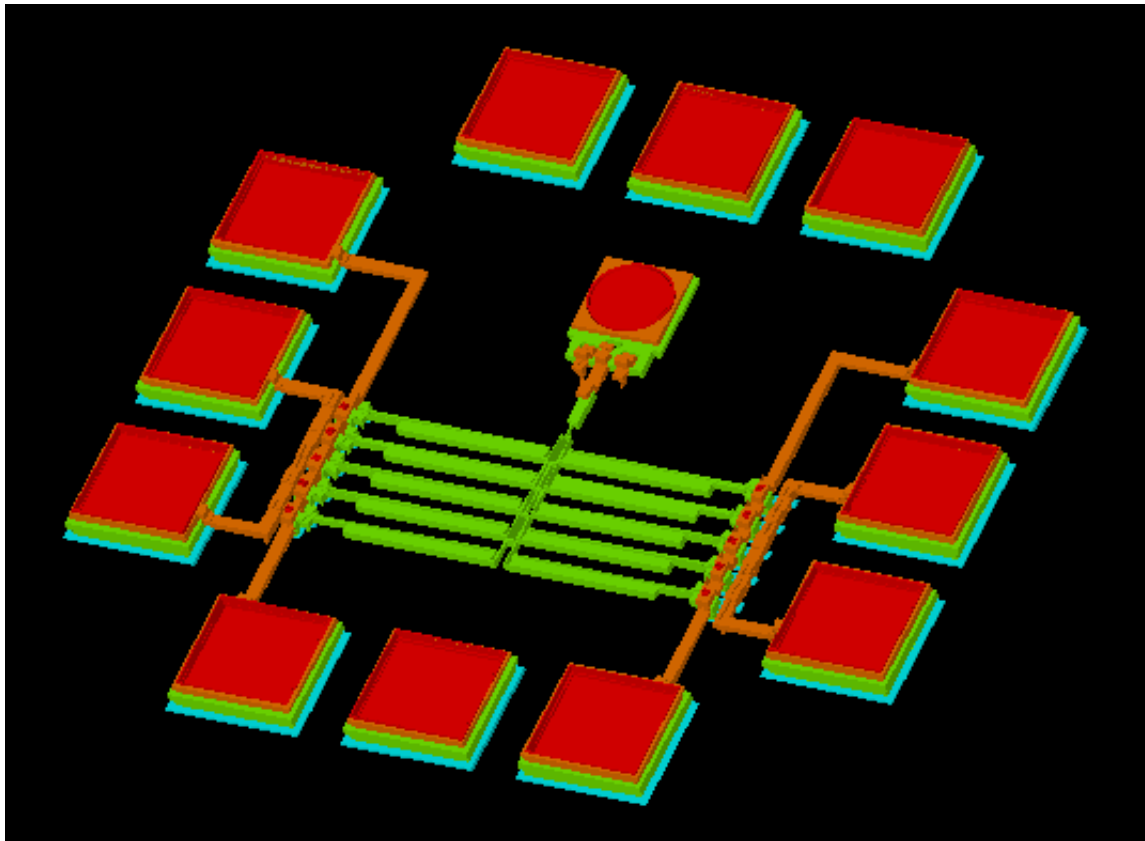


Figure D3-3 Designer 3-D Model of Micromirror Assembly

3.1.2: Additional Technical Details

The mirror that makes up part of the device is known as a pop-up mirror because it is flat when fabricated, but extends out from the wafer plane when in use. It uses a layer of gold as its optical reflector. In this design, the mirror is manually assembled to a nearly vertical position and locked in place by a rod connected to the actuator. The mirror rotates around pins that are held to the substrate by staple-like structures that function as hinges.

The thermal actuator, or heatuator, uses differential thermal expansion to provide high forces and substantial linear motion. To increase the available force, this design uses a parallel combination of ten thermal actuators. The heat is generated by passing current through the device. This actuator is designed to pull the mirror in order to avoid flexing the connecting rod. Each actuator is capable of over $20\mu\text{N}$ of force and over $10\mu\text{m}$ of deflection at an input electrical power of 25mW (at 5V and 5mA). A 5×2 array used here can provide $200\mu\text{N}$ of force while consuming 250mW .

The conductors used to feed this device are thick enough to prevent significant parasitic voltage drops for 50mA of current and to reduce the associated power loss. Because this is a significant amount of power, the fabricated chip must be bonded to a thermally efficient heat sink.

3.2: Using the Tutorial

This tutorial is written for two different participant levels. For each major procedural sequence, general procedural guidelines are provided for users who have used the Layout Editor before, have been through this tutorial more than once, or who can easily figure out how to perform the required steps with minimal instruction. Detailed procedures have been included for less-experienced users. These guidelines are specific and include screen illustrations and explanations for additional clarity.

3.2.1: Detailed File Description

File Name	Description of provided files
foundry.cat	Template file with prespecified layers used in creating your first library. Select this file from the navigation window that appears after you start the Layout Editor and select from the menu bar <i>File > New > From Template ...</i>
foundry.proc	Process Editor file used to create the 3-D solid model. This file is in the <i>Devices</i> directory and is selected through the Browse function of the Process field on the <i>Foundry</i> tab.
foundry.mpd	MPD file used to store materials used by Process Editor. This file is in the <i>Devices</i> directory and is selected through the Browse function of the Materials field on the <i>Foundry</i> tab.
partial_cells.cat	Library containing partial design assemblies prebuilt to save time in completing the tutorial.
completed.cat	A completed library that contains all the cells and assemblies used in the tutorial sequence. Use this library to check your work or to copy completed cells to your own library if necessary.
micromirror.cat	Name of the library file you will create while running the tutorial (it does not exist initially). This file will reside in the same directory as the other tutorial libraries.

Design Kits and Design Rules

Typically, a template file, process file, mpd file, and Design Rules are included in a foundry design kit. Accordingly, sample Design Kit files have been included in this tutorial. These are designated *foundry.cat*, *foundry.proc*, and *foundry.mpd* and are described above.

Design rules are limitations or considerations that must be taken into account when constructing a drawing to ensure that model fabrication is actually possible. Because the purpose of this tutorial is to provide experience with the Coventor Layout Editor, these considerations were taken into account when the tutorial was created and need not concern the user while building the model. This is intended to allow the student to focus more fully on the capabilities and functionality of the tool. For more information on design kits, see [“Design Kit Components” on page D2-13](#).

File Name	Description of generated files
Work files	Build Model files created by the Layout Editor when building a 3-D model.
Temp files	Temporary program files with *.log and *.cmd extensions and cat*.tmp directories.
Solid Model file	The sat file must be named before the model can be built. Select the name or browse to a file to be replaced from the Browse function of the Solid Model field on the <i>Solid Model</i> tab.



How to Save Your Work

Be sure to save your work in the event of a computer crash. Saving your library saves your work to disk. However, **saving a cell does not save to disk.**



1. From the upper horizontal icon row, click on *Save File*. Your library work is saved.
2. Even better, click on the arrow next to *Save File* and select *Save File As...* Save your work to a new name, using some designation to show how far along the backup file has progressed (such as *micromirror_03.cat* if you have successfully completed Step 3 of this tutorial).

3.2.2: Recovering from Mistakes

The Layout Editor is a flexible tool that allows you to complete sequences in many different ways. If you do not successfully complete a part of the tutorial, you can almost always get back to a safe point or successfully complete the task in a different way. If you get into trouble, here are some recommendations:

Interrupt a Current Command

While drawing or performing another action, you may have made a mistake. You can stop and cancel out of a command sequence at any time in one of two ways:

1. Click on the red *Stop* icon in the lower right corner of the window; or
2. Press Esc on the keyboard.

Undo an Action

The Layout Editor offers unlimited sequential levels of Undo while drawing in a specific cell. This feature resets each time the cell is saved.



1. From the lower horizontal icon row, select *Undo*. Your last action is undone. You may continue clicking on *Undo* to back out of as many commands as desired.
2. You may also click on the arrow next to *Undo*. You can undo as many listed actions as desired.

Redo an Action

The Layout Editor offers unlimited sequential levels of Redo after performing Undo operations.



1. After you have performed an Undo, you may redo an action by clicking on the *Redo* icon. Your last action is redone. You may continue clicking on *Redo* until the list is exhausted.
2. You may also click on the arrow next to *Redo*. You can redo as many listed actions as desired.

Redraw the Screen

Occasionally, you may find that the drawing area displays information from previous operations that is no longer valid. You can clean up these artifacts very simply. This procedure may be especially useful if you are having a difficult time selecting an object — it may not really be there.

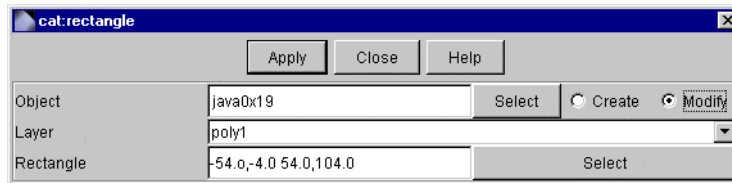


1. From the lower horizontal row, click on the *Refresh screen* icon.
2. To be sure that the canvas screen automatically refreshes (for most operations), click on the *arrow* next to the *Refresh screen* icon and be sure that the *Auto-refresh* menu entry is checked (it is checked by default).

Verify Accuracy of Your Work

After drawing an object, you may not be sure that it is on the correct layer, or that its dimensions are correct. The *Modify > Object* command allows you to check any object on the canvas.

1. From the menu bar, select *Modify > Object ...*
2. Click on the desired object to select it.
3. Review the object's properties in the dialog window that opens:



A different dialog window opens for each different object type (rectangle, arc, etc.).

Object

Each dialog window has an object field. The java reference is a unique identifier that can be ignored.

Layer

Single object windows display the layer. Change the layer name by overwriting the field or by clicking on the down arrow and selecting a layer.

Rectangle

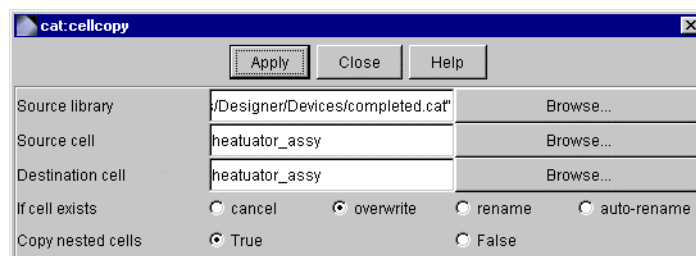
Every window has a coordinate entry. In this example, the coordinates of the lower left and upper right vertices defining a rectangle are shown. Overwrite any number in the field to change the rectangle dimensions.

4. **Apply** and **Close** to make changes and end the sequence.

Copy Cells from Another Library

If your work is incorrect and cannot be fixed, or if you want to start from a point in the tutorial other than the beginning, you may import or overwrite your cells with cells from the *completed.cat* file into your *micromirror.cat* library. Simply copy the cell or cells called out in the tutorial, and the design will be complete up to that point.

1. From the menu bar, select *Cell > Copy ...*
2. In the dialog window, enter the fields as shown in this illustration:



3. The source library for this tutorial is the *completed.cat* file.
4. Choose a Source cell from this library by clicking on the **Browse** button.
5. The Destination cell should have the same name.

6. If cell exists, you normally want to *overwrite* to substitute the known good cell from *completed.cat*.
7. Always *Copy nested cells* to be sure that all the cell references are copied to your new library.
8. **Apply** and **Close** to end the sequence.

3.3: Draw a Four-Layer Optical Mirror

3.3.1: Objective

Start from a blank canvas screen and build the mirror mechanism.

3.3.2: Specific Skills

- How to start Designer
- How to use a template file
- How to set the grid
- How to use the Terminal window
- How to select from the Layer list
- How to zoom to view all objects
- How to place coordinates with the mouse
- How to enter coordinates from the keyboard
- How to build a polygon
- How to build a circle
- How to use the Repeat Mode
- How to save your work

3.3.3: Procedural Guidelines for Advanced Users

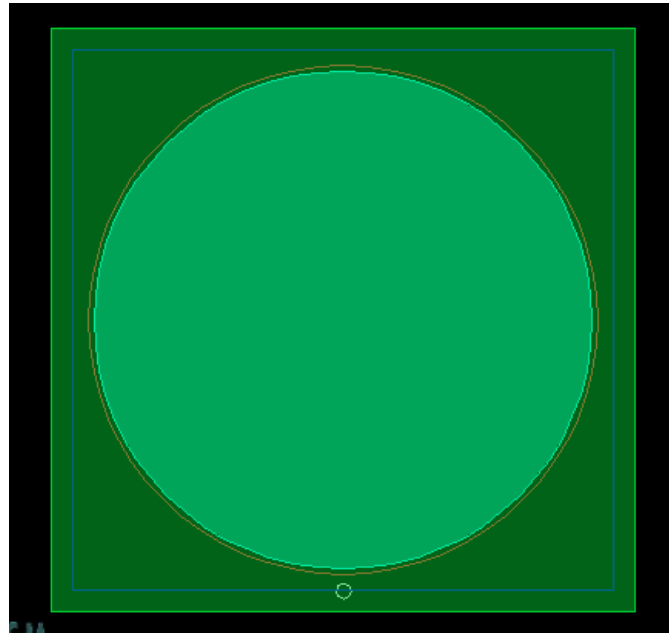
1. Start Designer. (New users go to [“Procedure for New Users” on page D3-8](#))
2. Create a new file *micromirror.cat* from the template file *foundry.cat*.
3. Draw a four-layer mirror using [Table D3-1](#) as a guide.
4. Save the cell as *mirror*.

Table D3-1 Mirror Object Summary


Layer	Color	Fill	Object	First coord	Value	Second coord	Value
poly2	blue	none	rectangle	lower left vertex	-50, 0	upper right vertex	50, 100
p12via	orange	none	circle	center	0, 50	point on radius	47, 50
metal	cyan	solid	circle	center	0, 50	point on radius	46, 50
poly1	green	solid	rectangle	lower left vertex	-54, -4	upper right vertex	54, 104


The completed work should look like that shown in [Figure D3-4](#):

Figure D3-4



3.3.4: Procedure for New Users

Step 1-a	What To Do	What is accomplished
Start CoventorWare	<ol style="list-style-type: none"> NT users: Click on the desktop icon. UNIX users: Type the command <i>coventorware</i> to launch the application. 	<ul style="list-style-type: none"> ■ During installation, the desktop icon shortcut is configured to point to the correct files. ■ Screen illustrations appear on page D3-10.
Import the tutorial	<ol style="list-style-type: none"> Select the <i>Import Tutorial</i> icon Scroll down and select Designer. Click on Open and then OK. The Designer project just imported is selected by default from the project list. Enter <i>designer.mps</i> and click on Open. 	<ul style="list-style-type: none"> ■ You must specify a project and name the Designer Project Settings (<i>.mps</i>) file to proceed. ■ The program generates a default name for the Project Settings file, which may be accepted or changed.
Start the Layout Editor 	Select the <i>Start Layout Editor</i> icon.	It is not necessary to select a template on the Layout tab. The template is selected inside the Layout Editor.
Create a new file from the template file <i>foundry.cat</i> .	<ol style="list-style-type: none"> From the Layout Editor menu bar, select <i>File > New > From Template...</i> In the Template file name navigation window that opens, select <i>foundry.cat</i>, and click on Open. 	<ul style="list-style-type: none"> ■ The new file will have some settings from a previously prepared file. The settings transfer to the new file, acting as a template. ■ The saved file is your working library. ■ When the new file is opened, it automatically opens a new unnamed cell in an unnamed library. ■ When using a foundry specific cat file, substitute that file name.

Step 1-a	What To Do	What is accomplished
Save the library file 	a. From the upper horizontal icon row, click on the arrow next to the diskette icon. b. Select <i>Save File As...</i> c. Save the file as <i>micromirror.cat</i> .	<ul style="list-style-type: none"> ■ This action saves the new cat file in the same directory as the other tutorial files. ■ Save your work often.
Verify the workspace	a. Move the cursor to the lower left corner of the black window area; observe the coordinates in the lower left of the screen. b. Do the same for the upper right corner.	If you haven't changed the default size, your visible workspace is about 60 x 60 units. More workspace will be needed to complete this initial sequence.
Change the grid setting	a. Slowly move the mouse to detect the allowable incremental (snap) movement. b. From the menu bar, select <i>Other > Grid ...</i> c. Change the Working Grid to <i>1.0</i> . d. Click on Apply , then Close the window.	<ul style="list-style-type: none"> ■ Your default working grid is 0.5 units, and your display grid is twice that or 1 unit. ■ This changes the grid to 1.0 unit. The multiple of 2 means that the dot spacing increases to double the grid setting. The Display Grid Multiple should not be changed. ■ Note that the coordinate range of the canvas does not change. You cannot build and view a larger object with only a grid change.
Open the Terminal window.	Click on the small square to the left of the prompt line at the bottom of the drawing area.	You can observe the command execution in more detail in this window. If it is distracting, you can close or minimize it at any time.



Coordinate Entry

In the next sequence, you will be instructed to use the mouse to place drawing coordinates. If you have problems in navigating to the exact coordinates, you may type the coordinates right next to the one-line prompt at the bottom of the canvas window.



Refer to [“Deposited Layers” on page D4-16](#) for more details on the layers and layer names used in this design.



To save your work:

You must save the library file, not just the cell. Click on the top icon row diskette icon.



If you make a mistake: Refer to [“Recovering from Mistakes” on page D3-4](#). If you make a serious mistake, refer to [“Copy Cells from Another Library” on page D3-5](#)

If you are having a difficult time using the mouse to place coordinates:

Type the coordinates in the Command Line at the bottom of the canvas window.

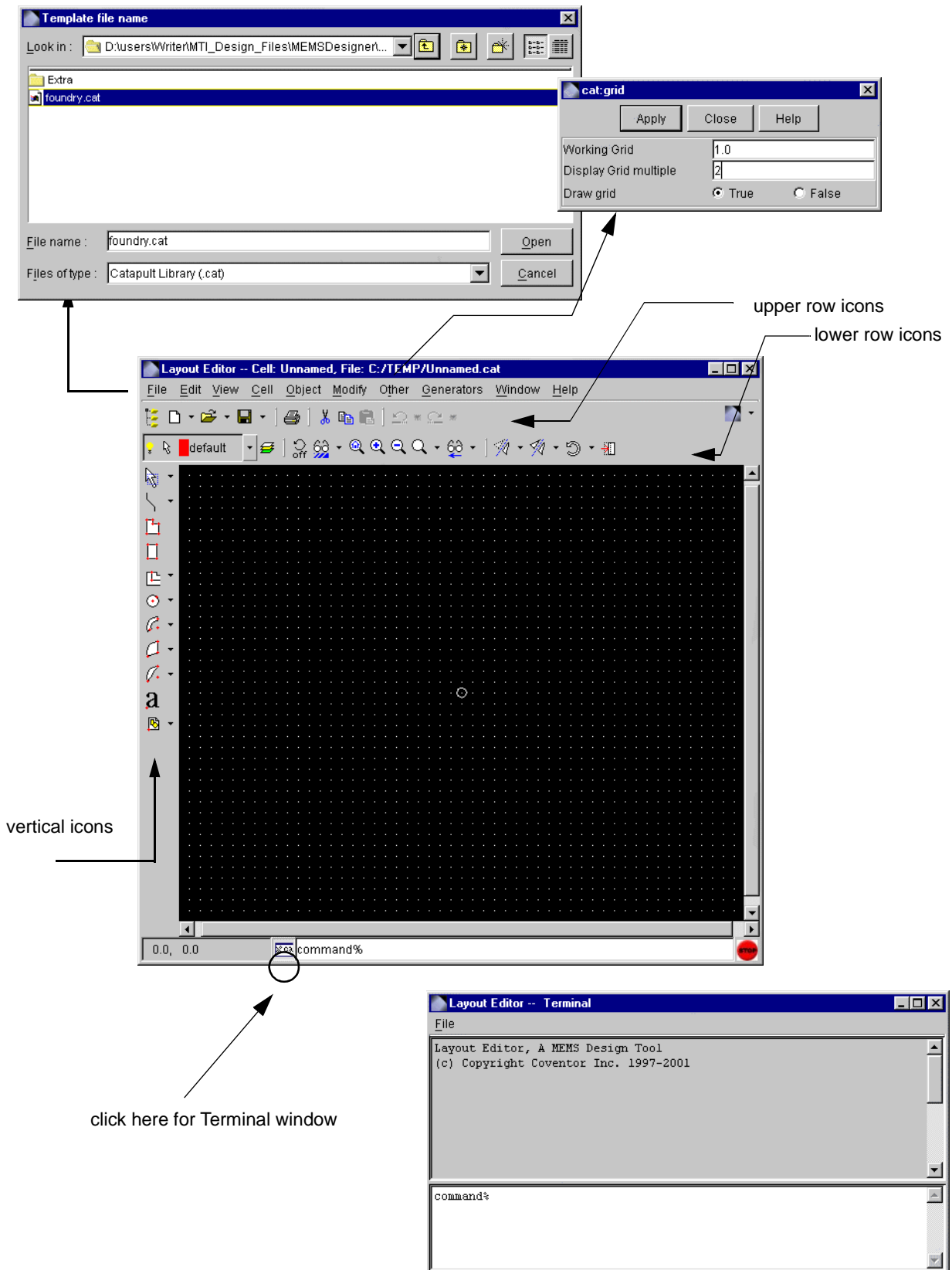
If you need to check the coordinates or layer name of any placed object:







Refer to [“Verify Accuracy of Your Work” on page D3-5](#).

If the screen appears to have unusual leftover graphic information:

From the lower horizontal row, click on the *Refresh screen* icon.

Figure D3-5 Screen Illustrations



Step 1-b	What to do	What is accomplished
Using the Current layer selector 	a. Along the top of the window, observe the left-most field in the lower horizontal icon row. Move the mouse over the area to see it identified as <i>Current layer</i> . b. Click on the arrow to the right of the layer name.	<ul style="list-style-type: none"> ■ The Current layer is a short form view of the Layer Browser window. ■ You can view and select from any of the layers created for the cell from the Template file.
Build your first rectangle (100 by 100 units)   	a. From the Current layer list, select <i>poly2</i> . b. Along the vertical icon column, select the <i>Rectangle</i> icon. c. While viewing the coordinate reading in the lower left corner of the canvas window, move the mouse to the left in an attempt to reach coordinate $-50, 0$. d. If you run out of room, click on the <i>Zoom Out</i> icon in the lower horizontal row while still in the Rectangle command. e. Now move to coordinate $-50, 0$ and click. f. Move the mouse to coordinate $50, 100$ and click, using <i>Zoom Out</i> as required. g. View your work by selecting the <i>View All</i> icon in the lower horizontal row.	<ul style="list-style-type: none"> ■ You can start drawing in the unnamed cell at this time without having to name it. ■ The cursor moves in 1 unit increments. ■ You can change magnification without terminating the command. ■ You have entered the opposite diagonal coordinates of the rectangle. ■ Zoom to <i>View All</i>, to see the entire rectangle. ■ The rectangle should be a blue outline. See Figure D3-6.
With <i>Repeat Mode</i> on,  build a circle  (47 unit radius)	a. From the Current layer list, select <i>p12via</i> . b. Along the lower horizontal icon row, click on <i>Turn Repeat Mode On</i> . c. From the vertical icon column, select the <i>Circle</i> icon. d. In response to the Enter center coordinate prompt, move the mouse to coordinate $0, 50$ and click (to define the center). e. In response to the Enter point on radius prompt, move the mouse to coordinate $47, 50$ and click (to define the radius).	<ul style="list-style-type: none"> ■ Turning Repeat Mode On allows you build additional circles without having to select the icon again. ■ The first coordinate is the circle center. ■ The second coordinate is the radius, entered as a coordinate on the circle. ■ The circle should be an orange outline nested within the blue rectangle.
Build another circle (46 unit radius)	a. From the Current layer list, select <i>metal</i> . b. Place coordinate $0, 50$. c. Place coordinate $46, 50$. d. Right click to end the prompts for more circle coordinates.	<ul style="list-style-type: none"> ■ The circle should be a cyan filled object nested within the orange circle. ■ Repeat Mode is still on for any new actions.
Build another rectangle (108 by 108 units)	a. From the Current layer list, select <i>poly1</i> . b. Select the <i>Rectangle</i> icon. c. Place coordinate $-54, -4$ (zoom as necessary). d. Place coordinate $54, 104$. e. Right click to end the rectangle coordinate prompts.	<ul style="list-style-type: none"> ■ The rectangle should be a green filled object that overlaps all previous objects and partially obscures them. ■ When you right click to cancel from a command, you must reselect the command the next time.



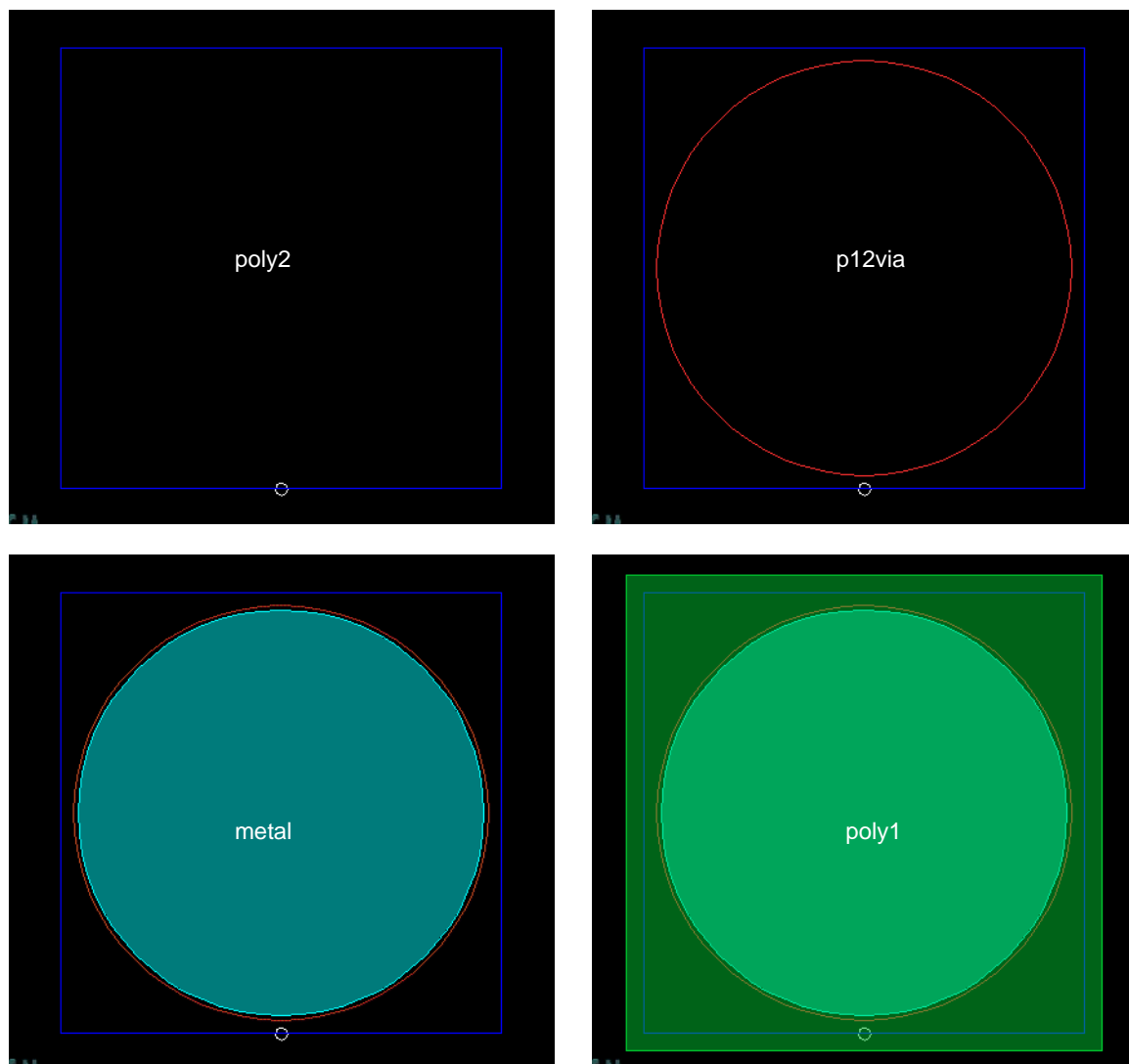
Step 1-b	What to do	What is accomplished
Save your work  and Refresh screen 	a. Along the top icon row, click on the arrow next to the diskette icon and select <i>Save Cell As...</i> b. In the window, enter <i>mirror</i> . c. Click on OK . d. Click on the diskette icon to save the library. It will overwrite your <i>micromirror.cat</i> file. e. Click on the lower icon row <i>Refresh screen</i> icon to redraw the screen (if necessary).	<ul style="list-style-type: none"> ■ Your working cell is now named. ■ Note that saving a cell does not write information to disk. ■ Save your work by saving the library.

Figure D3-6 Four Sequenced Layers



3.3.5: Review Questions

Where did all these different colored layers come from?

The complete layer list was prepared for you and included in the *foundry.cat* file. When you used this file as a template, all the layer settings transferred to your new *micromirror.cat* file that you are in the process of creating.

Why do you have to enter two numbers to define the radius of a circle?

The Layout Editor is set up for X,Y coordinate entry for all shapes, including the circle. To make it easier to calculate the coordinate required, choose the radius line to lie on the X axis defined by the circle center (or in other words, at the 3 o'clock position on the circle). Then the coordinate to define the radius can be reduced to a simple formula: ($X_{\text{radius}} = X_{\text{center}} + \text{radius}$) ($Y_{\text{radius}} = Y_{\text{center}}$)

Can you change the sequence of the steps used to create the shapes shown?

Depending on what you are trying to accomplish, you often can perform these steps in different sequences. Specific polygons can be built in any sequence desired. Commands can be executed with interruptions from other commands and still work properly. This feature in the Layout Editor is known as nesting. The Layout Editor will tell you if you are trying to nest commands in an illegal sequence, so feel free to try various ways of completing a task.

If I save a cell and my computer system crashes, is the information saved to disk?

No. Saving a cell performs only a local memory save. To be sure that your work is saved at any given point, you must also save the library file. Saving the library file updates the file stored on disk.

3.4: Add Components and Create 3-D Model

3.4.1: Objective

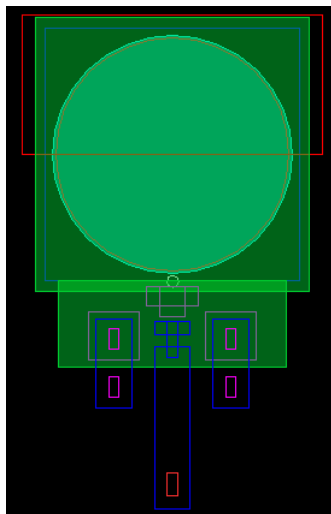
Add a previously drawn cell to the existing mirror, supply process file information, and build and render a 3-D model of the mirror assembly.

3.4.2: Specific Skills

- How to place a reference cell
- How to copy cells from other libraries
- How to view hierarchy levels
- How to create a new layer
- How to set the file paths
- How to build a 3-D model
- How to view a 3-D model
- How to use a clip layer

3.4.3: Procedural Guidelines for Advanced Users

1. Start a new cell.
2. Add the *mirror* as a cell reference at origin $0, 0$.
3. Copy *popupmech* from *partial_cells.cat* and add as a cell reference at origin $0, 0$.
4. Copy the remaining cells in *partial_cells.cat* for future steps.
5. Add a red clip layer with coordinates $-59, 50 \ 59, 105$.
6. Save your assembly as *popup*.
7. In the Designer Setup window, enter the file path for the work directory, the *foundry.proc* file, and the MPD file (see [page D3-3](#)). Be sure the Layout Editor Top Cell is *popup*.
8. Build a 3-D model using the *clip* layer.
9. View the model in the Preprocessor.



3.4.4: Procedure for New Users





Step 2-a	What to do	What is accomplished
Start a new cell 	a. Along the top icon row, click on the arrow next to <i>New File</i> . b. Select <i>New Cell</i> .	<ul style="list-style-type: none"> ■ This starts a new unnamed cell. ■ Do not click on the icon. Doing so starts a new library.
Create a cell reference  	a. From the vertical icon column, select the <i>Reference</i> icon. b. In the dialog window that opens, (see Figure D3-7) click on the Browse button next to Cell, and select <i>mirror</i> . c. In the Origin field, enter <i>0, 0</i> . d. Click on Apply and Close . e. Click on the <i>View All</i> icon in the lower horizontal row.	<ul style="list-style-type: none"> ■ This adds the completed <i>mirror</i> cell to the current cell by linking it as a reference. ■ You should now see the entire assembly.
Copy a cell from the <i>partial_cells</i> library	a. From the menu bar, select <i>Cell > Copy ...</i> b. In the dialog window that opens, next to the Source library field, click on Browse... and select the <i>partial_cells.cat</i> file. c. Next to the Source cell field, click on Browse... and select <i>popupmech</i> . d. In the Destination field, type <i>popupmech</i> . e. Click on Apply	<ul style="list-style-type: none"> ■ You are copying a pre-built cell from the <i>partial_cells.cat</i> library. ■ Copying makes it easier to complete the tutorial, because you don't have to build the cell yourself. ■ If you want to skip steps later on, you can copy completed cell assemblies from the <i>completed.cat</i> file (See "Copy Cells from Another Library" on page D3-5). ■ See Figure D3-8 for a detailed explanation of the cell copy concept. ■ Do not close the dialog window yet.
Copy the other three cells	a. Continue using the same copy procedure to copy the other four cells into your existing library. b. When finished, Close the dialog window.	All of these cells will be used in the tutorial.
Check to see that the cells are copied 	a. From the upper icon row, click on the <i>Cell browser</i> icon at the far left. b. Verify that the cell list looks as shown in item #4 of Figure D3-8	<ul style="list-style-type: none"> ■ The browser lists all cells in the design. ■ Your current <i>Unnamed</i> cell is in blue. ■ Keep the Layout Editor Cell Browser open.

Figure D3-7 Reference Dialog Window

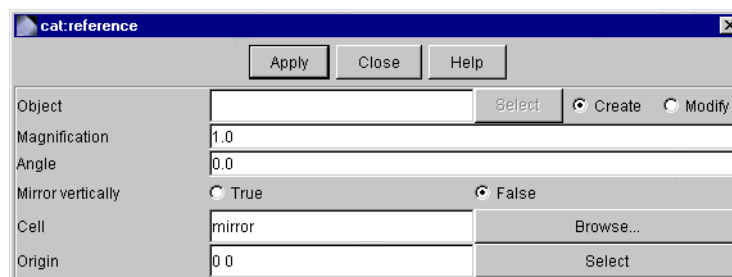
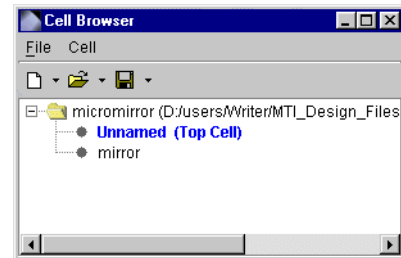
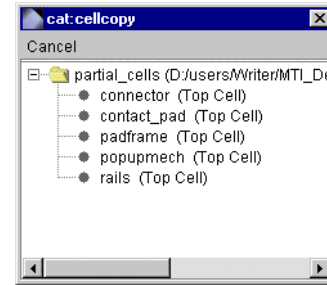


Figure D3-8 Illustration of the Concept of Copied Cells

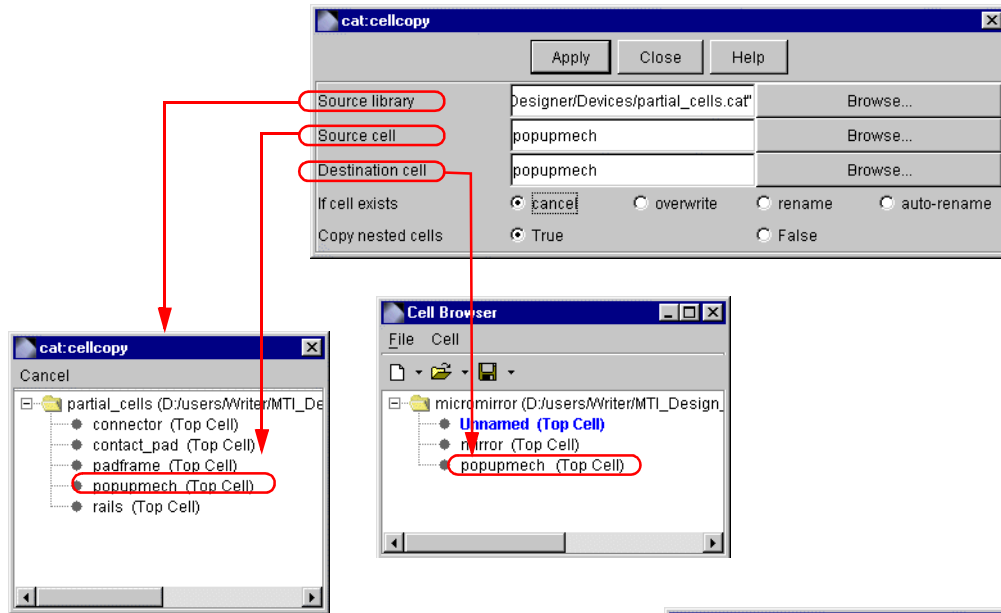
- 1 The current working library is micromirror.cat.
It contains the mirror cell saved in Step 1.
It also contains the new current working Unnamed cell.



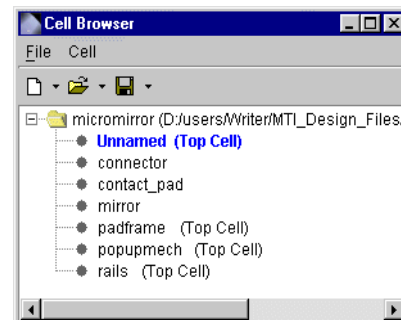
- 2 The library named *partial_cells.cat* contains five cells previously built for your convenience.



- 3 Use the *Cell > Copy* command to copy cells from the *partial_cells* (source) library to your working (destination) library. The cell names are not changed during the copy procedure.



- 4 After copying all five cells from *partial_cells.cat*, your working *micromirror.cat* library will look like this:




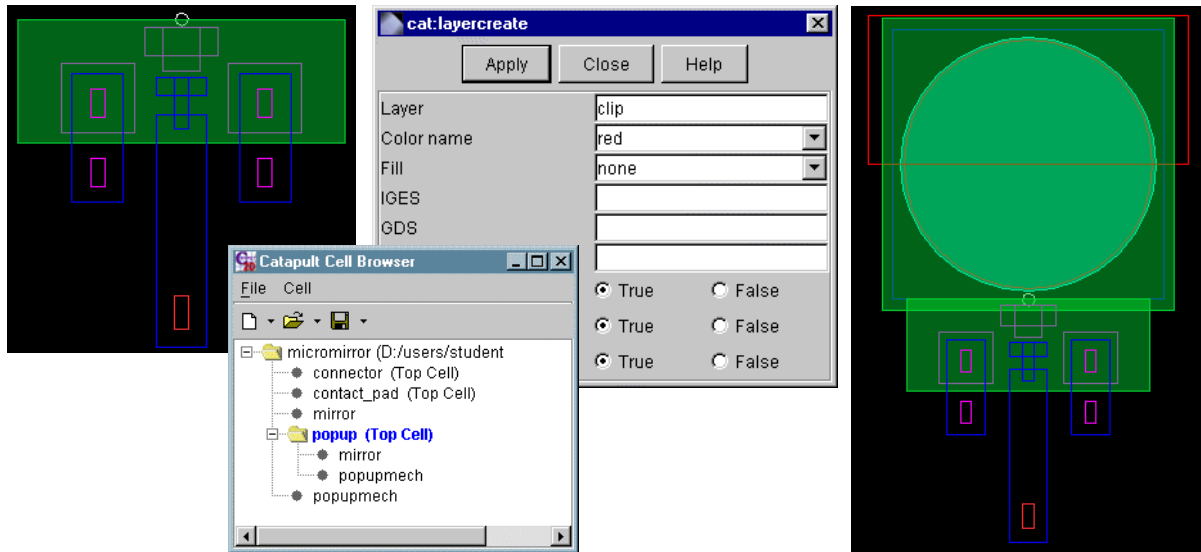
Step 2-b	What to do	What is accomplished
Create another cell reference (<i>popupmech</i>)	<ol style="list-style-type: none"> From the vertical icon column, select the <i>Reference</i> icon. In the dialog window that opens, click on the <i>Browse</i> button next to Cell, and select <i>popupmech</i>. In the Origin field, enter <i>0, 0</i>. Click on Apply and Close. Click on <i>View All</i>. 	<ul style="list-style-type: none"> ■ You are adding another existing cell to the current cell by linking it as a reference. ■ The cell is a hinge mechanism that allows the mirror to pop up. ■ This reference cell can be edited without opening it; all changes are reflected in the cell when you save it.
Create a new <i>clip</i> layer 	<ol style="list-style-type: none"> Click on the <i>Layer browser</i> icon, next to the Current layer list. In the window that opens, from the menu bar, select <i>Layer > New...</i> In the dialog window, enter the Layer name <i>clip</i>. Click on the Color name arrow and select the color <i>red</i> from the menu. Click on Apply and Close. 	<ul style="list-style-type: none"> ■ The clip layer will be used in the next sub-step. ■ The <i>layercreate</i> dialog box is shown in Figure D3-9.
Build a <i>clip</i> rectangle	<ol style="list-style-type: none"> Select the <i>clip</i> layer. Select the <i>Rectangle</i> icon. Place coordinates <i>-59, 50</i> and <i>59, 105</i>. Right click to end the prompts for more rectangle coordinates. 	<ul style="list-style-type: none"> ■ The clip layer is a red outline that cuts the underlying objects in half. ■ Repeat Mode is still on for any new actions.
Save the cell and library	<ol style="list-style-type: none"> Using the arrow next to the diskette icon, select <i>Save Cell As...</i> In the window, enter <i>popup</i>; click on OK. Click on the diskette icon to save your <i>micromirror.cat</i> file. 	<ul style="list-style-type: none"> ■ The working cell is now named. ■ Your library is overwritten with the latest data.
Check the hierarchy of the reference cells	<ol style="list-style-type: none"> From the menu bar, select <i>View > Levels</i> and uncheck <i>Level 1</i>. Observe results. When finished, from the menu bar, select <i>View > Levels > All</i>. In the Layout Editor Cell Browser window, click on the + next to <i>popup</i> and observe the reference cells. 	<ul style="list-style-type: none"> ■ Placing cell references creates hierarchy in the design. ■ The references are located at Level 1. ■ When Level 1 is turned off, only the clip rectangle remains.

Figure D3-9 Creating the Clip Layer





Step 2-c	What to do	What is accomplished
Set Source Catapult File and Top Cell fields	<ol style="list-style-type: none"> On the <i>Layout</i> tab of the Function Manager, verify or set the Source Catapult File to <i>Designer\Devices\micromirror.cat</i>. Verify or set the Top Cell field to <i>popup</i>. 	Use information in the top level <i>popup</i> cell to build the model. This cell is part of the <i>micromirror.cat</i> library.
Begin setting file paths	Select the <i>Foundry</i> tab. See Figure D3-10	Both a process (. <i>proc</i>) file and MPD (material properties database) file are necessary for creating a solid model.
Set the Process file path 	In the window of the Process field, set the path to the <i>Designer\Devices</i> directory and select the <i>foundry.proc</i> file. Navigate using the folder icon next to the field.	<ul style="list-style-type: none"> The Process Editor file provides the depth information to create a 3-D model. For this and the remaining steps on this page, refer to page D3-3 for more details on the specified files.
View the Process Editor file  (Setup window icon)	<ol style="list-style-type: none"> Select the Foundry tab. Click on the icon to the right of the Process File field to open the process Editor. <i>Close</i> when finished. 	The Process Editor window (Figure D3-11) shows the complete process sequence for the design.
Create file name for solid model	<ol style="list-style-type: none"> From the Function Manager, select the Solid Model tab. A default <i>sat</i> file will appear in the Solid Model field. Verify that the Solid Model File is named <i>micromirror.sat</i> 	<ul style="list-style-type: none"> Use information in the top level <i>popup</i> cell to build the model. This cell is part of the <i>micromirror.cat</i> library. All files necessary for building a solid model are selected or named. For now, ignore the <i>Clip Device with Mask</i> check box and field. Ensure that no other options are selected.

Figure D3-10

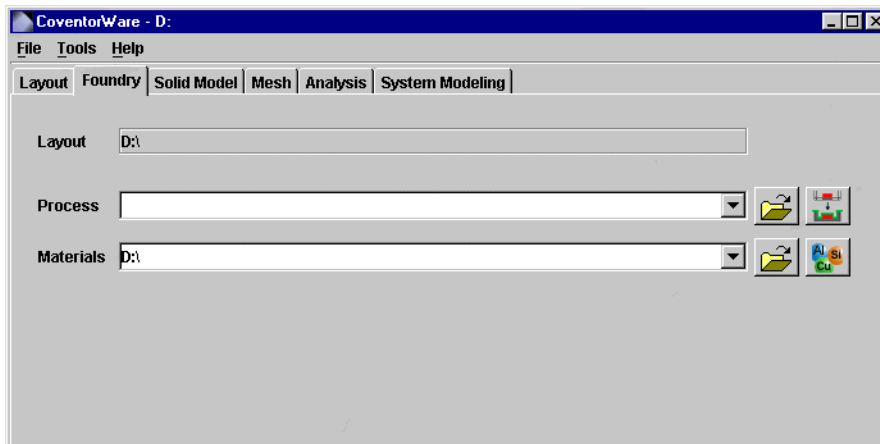


Figure D3-11 Process Editor Window

Step	Action	Material	LayerName	Type	Thickness	Mask	EtchDepth	Polarity	Offset	SidewallAngle
0	Base	SILICON	Substrate		20.0	base				
1	Deposit	SI3N4	Nitride	Stacked	0.6					
2	Deposit	POLYSILICON	Poly0	Stacked	0.5					
3	Etch					poly0	0.5	+	0.0	0.0
4	Deposit	PSG	PSG1	Conformal	2.0					
	Etch					dimple	0.75	-	0.0	0.0
5	Etch					anchor1	2.0	-	0.0	0.0
6	Etch					anchor2	2.0	-	0.0	0.0
7	Deposit	POLYSILICON	Poly1	Conformal	2.0					
8	Etch					poly1	2.0	+	0.0	0.0
9	Etch					anchor2	2.0	-	0.0	0.0
10	Deposit	PSG	PSG2	Conformal	0.75					
11	Etch					p12via	0.75	-	0.0	0.0
12	Etch					anchor2	0.75	-	0.0	0.0
13	Deposit	POLYSILICON	Poly2	Conformal	1.5					
14	Etch					poly2	1.5	+	0.0	0.0
15	Deposit	GOLD	Metal	Planar	0.5					
16	Etch					metal	0.5	+	0.0	0.0
17	Sacrifice	PSG								

Step 2-e	What to do	What is accomplished
Build a 3-D Model	<ol style="list-style-type: none"> Click on Build Model. The Preprocessor opens automatically after a successful build. 	<ul style="list-style-type: none"> The 3-D model is built. Progress may be observed through the Log Window. If the build is not successful, the message <i>AutoBuilder failed</i> appears at the bottom of the Function Manager. Select the down arrow to view the log.


Step 2-e	What to do	What is accomplished
View the 3-D Model  (Preprocessor icons)	<ol style="list-style-type: none"> Click on <i>View Model</i>. At the top of the Preprocessor window, click on the <i>Isometric View</i> and <i>Normalize</i> icons to adjust the view. Compare your view to Figure D3-12. 	<ul style="list-style-type: none"> ■ The Preprocessor window opens. ■ The 3-D model is displayed. Figure D3-12
Repeat Build and View with Clip layer	<ol style="list-style-type: none"> In the Function Manager <i>Solid Model</i> Tab, check the box next to <i>Clip Device with Mask</i> and verify that the layer name field is set to <i>clip</i>. Verify that the Top Cell is still <i>popup</i>. Click on Build Model. Click on <i>Isometric View</i> and <i>Normalize</i>. Compare your view to Figure D3-13. Select <i>File > Quit</i> to close the Preprocessor. In the Designer Setup window, uncheck the box next to <i>Clip layer</i>. 	<ul style="list-style-type: none"> ■ The Clip layer displays the cross-section of the deposited and etched layers. ■ See "Simulating the Process in the Process Editor" on page D4-4 for an explanation of how the Process Editor layers map to the cross-section you see. ■ Always check the Top Cell before building a model. If the Setup window is closed and reopened, a different Top Cell name may appear.

Figure D3-12 Mirror Assembly

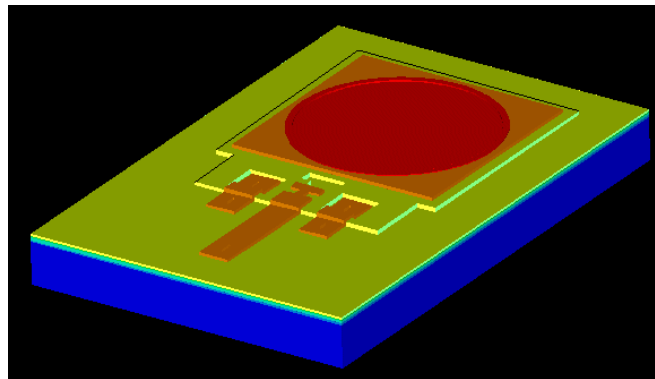
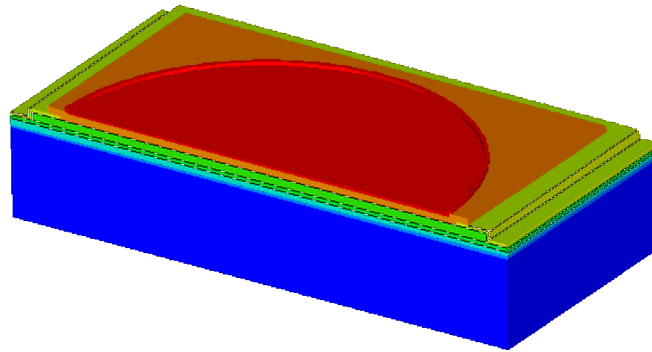


Figure D3-13 Clip Layer View

3.4.5: Review Questions

Why does the cross-section diagram show additional thickness along the walls of the layer steps?

The solid model is an approximation of the way a design is processed in a foundry. When the solid model algorithm builds a conformal layer, it adds a thickness equal to the depth of the layer to each vertical wall. For example, in the case of the orange poly2 layer shown in the cross-section, the 1.5μ is deposited along all surfaces of the model before etch. This results in a slight reduction of the etch opening. An actual circuit has a slope to the etch profile and is not a sharp vertical step as shown in the solid model picture. Depending on how the design is fabricated and how that slope is controlled, that lip may or may not be there in final silicon. See [“Deposit and Etch Basics” on page D4-1](#) for more information on this process.

Why would I want to use the clip capability in a real design?

The clip feature has two major uses. For solid modeling, it provides a way to build a portion of a design so you can see only the parts you want extruded into a 3-D model. The clip feature also can be used in a simulation, where some modules allow the use of symmetry. When this symmetry feature is enabled, a symmetrical portion of the design (such as a quadrant) can be built, allowing the software to run in less time, while still enabling it to simulate the characteristics of the complete model.

3.5: Draw a Heatuator

3.5.1: Objective

Build a heatuator consisting of 11 objects. See [page D3-2](#) for an explanation.

3.5.2: Specific Skills

- How to select multiple objects
- How to Undo operations
- How to Mirror objects
- How to Nudge (move) objects
- How to Copy and Paste objects

3.5.3: Procedural Guidelines for Advanced Users



1. Start a new cell.
2. Draw the heatuator using [Table D3-2](#) as a guide. All objects are rectangles.
3. Save the cell as *heatuator*.

Table D3-2 Heatuator Object Summary

Layer	Color	Fill	Location	Description	1st coord.	2nd coord.
poly1	green	solid	Lower left	Anchor pad	0, 0	11, 11
			Bottom half	Long, thin arm	11, 9	219, 11
anchor1	lightorange	none	On lower anchor pad	Small anchor	4, 4	7, 7
poly1	green	solid	Upper left	Anchor pad	0, 13	11, 24
			Upper half	Long, thin arm	11, 13	219, 15
anchor1	lightorange	none	On upper anchor pad	Small anchor	4, 17	7, 20
poly1	green	solid	Upper half	Long, thick arm	51, 13	219, 27
			Extreme right	Vertical arm connection	214, 9	219, 27
dimple	red	none	On thick arm	Left dimple	74, 19	77, 22
			On thick arm	Middle dimple	127, 19	130, 22
			On thick arm	Right dimple	180, 19	183, 22



3.5.4: Procedure for New Users

Step 3-a	What to do	What is accomplished
Start a new cell	Along the top icon row, click on the arrow next to <i>New File</i> and select <i>New Cell</i> .	A new unnamed cell is opened.
Build lower anchor pad in <i>poly1</i>	<ol style="list-style-type: none"> Select <i>poly1</i>. Select the <i>Rectangle</i> icon. Place coordinates <i>0, 0</i> and <i>11, 11</i>. 	<ul style="list-style-type: none"> You built a square in the solid green <i>poly1</i> layer. Repeat Mode should still be on.
Build lower long arm	Place coordinates <i>11, 9</i> and <i>219, 11</i> .	The arm is also in <i>poly1</i> .
Build lower anchor	<ol style="list-style-type: none"> Select <i>anchor1</i>. Place coordinates <i>4, 4</i> and <i>7, 7</i>. Right click to end the <i>Rectangle</i> command. 	<ul style="list-style-type: none"> The coordinates define the diagonal of the rectangle.
Create a mirrored copy of the three objects  (third icon from right)	<ol style="list-style-type: none"> Click on one of the three components. Press and hold Shift while you select the other two objects. From the lower icon row, next to the <i>Mirror</i> icon, click on the arrow. (The <i>Mirror</i> icon is third from the right, while the similar-looking <i>Flip</i> icon is to its left.) Select <i>Mirror Up</i>. 	<ul style="list-style-type: none"> You can select a single object with the mouse without using an icon or menu bar command. Select groups with Shift, or <i>Select rectangular area</i> from the <i>Select objects</i> vertical icon menu. A <i>Mirror Up</i> operation retains the original and makes a mirrored copy directly above the original's bounding box.
Nudge the copy up 2 units 	<ol style="list-style-type: none"> From the lower icon row, to the far right, select the <i>Nudge</i> icon. Click twice in the top middle section of the canvas. 	<ul style="list-style-type: none"> The <i>Nudge</i> command moves the selected object incrementally by the Working Grid setting (which is 1 unit). Multiple nudges work when Repeat Mode is on. The nudge direction is determined by where you click in the drawing area (see "Nudge an Object" on page D2-30 for details). Following this procedure results in a mirrored copy displaced 2 units above the original.

drawn objects





Mirror Up



Nudge



Step 3-b	What to do	What is accomplished
Build long thick arm	a. Select <i>poly1</i> . b. Select the <i>Rectangle</i> icon. c. Place coordinates <i>51, 13</i> and <i>219, 27</i> .	A long, thick rectangular arm is built on the <i>poly1</i> layer.
Build vertical connect	Place coordinates <i>214, 9</i> and <i>219, 27</i> .	This rectangle connects the previously built objects. Overlapping has no effect on the final model.
Build dimple	a. Select the <i>dimple</i> layer. b. Place coordinates <i>74, 19</i> and <i>77, 22</i> . c. Right click to end the <i>Rectangle</i> command.	The dimple acts as a standoff for the sliding actuator arm.
Copy and paste remaining dimples  	a. Click on the dimple to select it. b. From the upper horizontal icon row, select <i>Copy</i> . c. Click on the lower left corner of the dimple as the FROM point. If this is difficult, click when the coordinate readout is at <i>74, 19</i> . d. From the upper horizontal icon row, select <i>Paste</i> . e. Place two copies of the dimple at coordinates <i>127, 19</i> and at <i>180, 19</i> . f. Right click to end the <i>Paste</i> mode.	<ul style="list-style-type: none"> ■ When copying the dimple, the coordinate you used as the FROM point is used as a reference coordinate during the paste operation. ■ Three dimples are placed along the thick moving arm.
Save your work	a. Save the cell as <i>heatuator</i> . b. Save the library.	The working cell is now named and all changes to the project are saved.



3.5.5: Review Questions

*What if I wanted to build all the *poly1* objects as a single polygon?*

The entire arm and vertical connect structure can be drawn as a single *poly1* polygon. It makes no difference to the Layout Editor or to the final mask export file if polygons of the same layer overlap. There are many ways to accomplish the same task; pick the technique with which you are most comfortable.

How are dimples used in a MEMS design?

Because you are at only the 2-D level in the design, it is difficult to visualize the 3-D effect of a dimple. The dimple is a protrusion from the sliding arm. When the thermally actuated arm moves, it needs to have enough freedom to move with minimal friction effects. After the sacrificial oxide is etched away and the chip is operational, the dimples that stick out from the arm allow it to slide easily across the underlying silicon nitride.

3.6: Complete the Heatuator Assembly

3.6.1: Objective

Complete the heatuator assembly by adding power connections to the anchor pads and a linkage arm to the assembly.

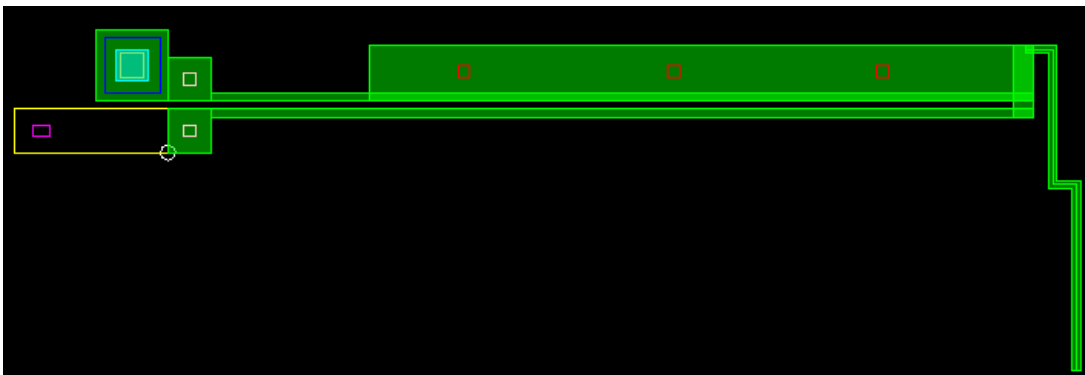
3.6.2: Specific Skills

- How to set a path width
- How to build a path

3.6.3: Procedural Guidelines for Advanced Users

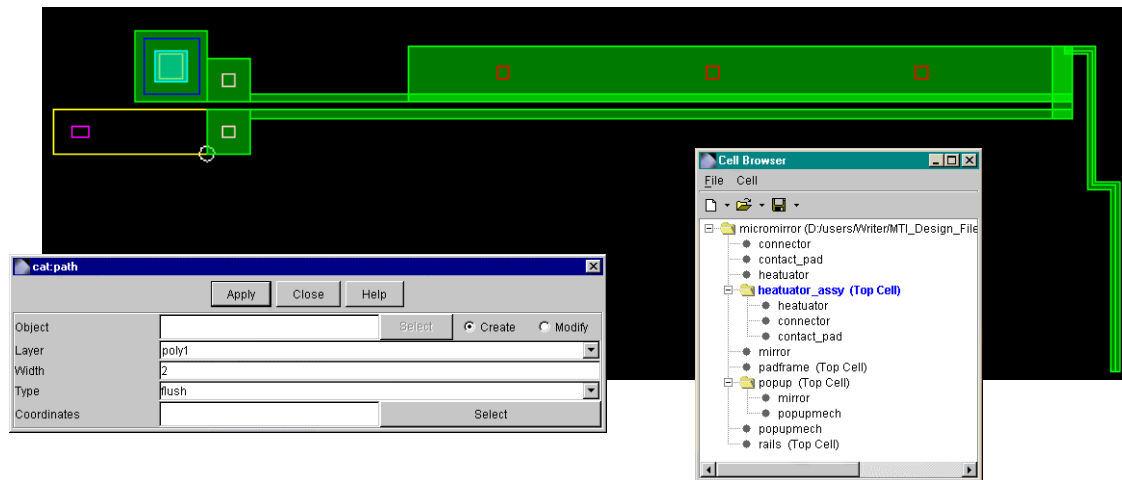
1. Start a new cell.
2. Add *heatuator* as a cell reference at origin $0, 0$.
3. Add *connector* as a cell reference at origin $-39, 0$.
4. Add *contact_pad* as a cell reference at origin $-9, 22$.
5. Draw the linkage mechanism in *poly1* as a path of width 2.
Enter coordinates $217, 26$ $224, 26$ $224, -8$ $230, -8$ $230, -55$.
6. Save the cell as *heatuator_assy*.

Figure D3-14 Heatuator Assembly



3.6.4: Procedure for New Users

Step 4	What to do	What is accomplished
Start a new cell	Select <i>New Cell</i> from the upper icon row.	You are starting a new unnamed cell.
Create a cell reference (<i>heatuator</i>)	<ol style="list-style-type: none"> From the vertical icon column, select the <i>Reference</i> icon. In the dialog window that opens, in the Cell field, select <i>heatuator</i> from the cell window. In the Origin field, enter <i>0, 0</i>. Click on Apply. <i>Zoom</i> to <i>View All</i>. 	<ul style="list-style-type: none"> ■ This adds the heatuator cell you just built. ■ Do not close the window yet.
Create another cell reference (<i>connector</i>)	<ol style="list-style-type: none"> Place <i>connector</i> as a cell reference at origin <i>-39, 0</i>. Click on Apply. <i>View All</i> to see your work. 	<ul style="list-style-type: none"> ■ This adds another existing cell to the current cell by linking it as a reference. ■ Leave the window open. ■ The cell is a connector to a power line.
Create another cell reference (<i>contact_pad</i>)	<ol style="list-style-type: none"> Place <i>contact_pad</i> as a cell reference at origin <i>-9, 22</i>. Click on Apply. Click on Close. Select the <i>View All</i> icon to see the assembly. 	The contact pad is another power connector.
Build linkage mechanism using a path	<ol style="list-style-type: none"> Select <i>poly1</i>. From the menu bar, select <i>Object > Path</i>. In the dialog window, set a width of <i>2</i>. Click on Apply and Close. From the vertical icon column, select <i>Path</i>. Start the path at coordinate <i>217, 26</i> and move right. Click at coordinate <i>224, 26</i> and move down. Click at coordinate <i>224, -8</i> and move right. Click at coordinate <i>230, -8</i> and move down. Click at coordinate <i>230, -55</i>. Right click to end. 	<ul style="list-style-type: none"> ■ Using a Path is an easy way to draw a line with thickness. ■ The new width setting is retained for your Layout Editor session. ■ The default flush endcap option starts and stops the path at the coordinates you enter. The other options will extend the path length beyond the mouse coordinates. ■ The linkage mechanism ends at the origin.
Save your work	Save the cell as <i>heatuator_assy</i> . Also save library.	The assembly is saved.
Verify the design hierarchy	<ol style="list-style-type: none"> Click on the upper horizontal row Cell Browser icon. Expand the entries that have + before them. 	<ul style="list-style-type: none"> ■ The browser shows how your cells are organized. ■ All cell references are parts of other cells. ■ Cells can appear in more than one place.



3.6.5: Review Questions

Why does the path object have a center line? Can you turn it off?

The center line is a reference line that makes it easier to see the placement of the thick line with respect to the rest of the circuitry or shapes. You can turn off this line using the Object Browser. A complete discussion of the Object Browser, including how to deal with visibility attributes for paths, can be found in the Reference section under [“Object Browser” on page D5-68](#).

What does (Top Cell) mean when placed next to a cell entry in the Cell browser window?

This designation means that the cell is at the top of the cell hierarchy and is not referenced by any other cells. The *heatuator_assy* cell is the current working top cell in the design. Other cells have this designation because they haven't been used yet in the sequence. When a design is completed, there should be only one top cell listing.

3.7: Create a Heatuator Array

3.7.1: Objective

Create an array of ten heatuator assemblies and connect the array to a set of power rails.

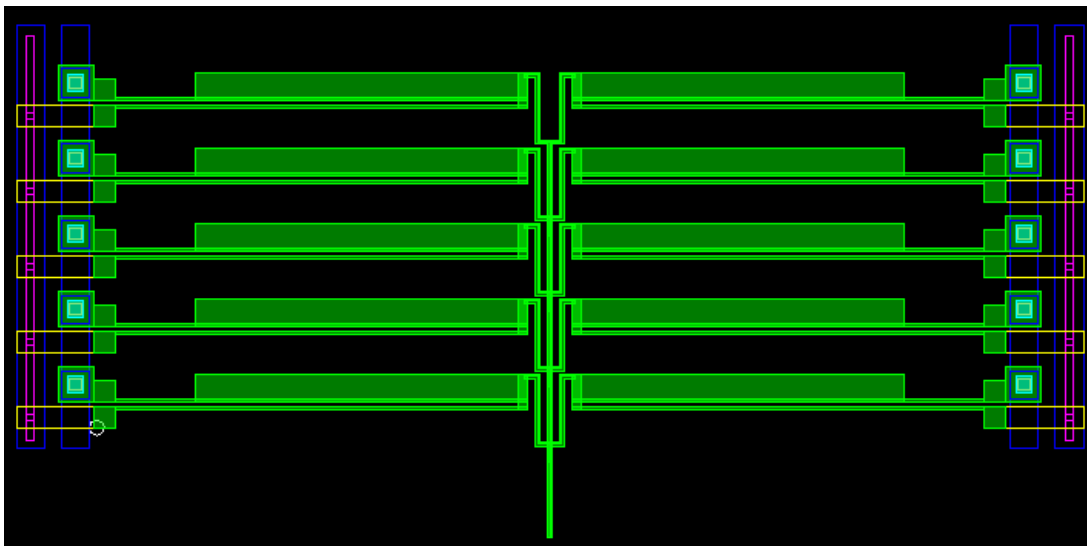
3.7.2: Specific Skills

- How to create an array reference
- How to use the Object Browser
- How to use the Ruler
- How to delete objects
- How to calculate placement based on extents
- How to use *Modify > Object* to find out more information about an object
- How to mirror a large group of objects horizontally
- How to align one cell structure to another for connectivity


3.7.3: Procedural Guidelines for Advanced Users

1. Create a new cell.
2. Place an Array Reference of *heatuator_assy* cells:
 - a. Set the Array for a 40 unit Row distance (-46 unit Row spacing).
 - b. Make the Array 1 column wide and 5 rows high.
 - c. Place the Origin at -1, 0.
3. Create a cell reference using the *rails* cell. Align *anchor2* polygons with an origin of -39, -10.
4. *Mirror Right* to create a ten-cell array with full rail connections.
5. Shift the mirrored portion two units to the left so the common poly is lined up.
6. Save the cell as *heatuator_array*.

Figure D3-15 Heatuator Array



3.7.4: Procedure for New Users

Step 5	What to do	What is accomplished
Create new cell	Select <i>New Cell</i> from the top icon row.	A new cell is opened.
Analyze the <i>heatuator_assy</i> cell 	<ol style="list-style-type: none"> From the vertical icon column, click on the <i>Reference</i> icon. In the dialog window that opens, in the Cell field, enter <i>heatuator_assy</i>. Set the Origin to <i>0, 0</i>. Click on Apply and Close. From the menu bar, select <i>View > Object types > Properties...</i> In the Object Browser window that opens (see Figure D3-16), click on the + sign next to <i>reference</i>, and check the <i>Visible Extents</i> box. It may be helpful to click on the <i>Refresh screen</i> icon. From the menu bar, select <i>Other > Ruler</i> and measure the height of the outside extents box. Right click to end the Ruler mode. Click on the <i>heatuator_assy</i> structure to select it, and then <i>Cut</i> the object with the horizontal menu icon. 	<ul style="list-style-type: none"> ■ You will find out more about this cell before using it in the design. ■ The Object Browser allows you to view the properties you choose for an object. ■ Extents are the boundaries of the object. The display shows several white boxes. No part of the object is outside the largest box. ■ The height of the box is 86 units. ■ You don't need the single Cell Reference for the design.
Create an Array Reference of 5 <i>heatuator_array</i> cells	<ol style="list-style-type: none"> From the vertical icon column, click on the arrow next to the <i>Reference</i> icon, selecting <i>Array Reference</i>. This opens the arrayref dialog window, shown in Figure D3-16. In the window next to the Cell field, click on the <i>Browse...</i> button and select <i>heatuator_assy</i>. The desired repeating distance (known as the vertical pitch or Row distance) is 40. Therefore, set the <i>Row distance</i> field to <i>40</i>. Note that this setting causes the cells to overlap, but only in the linkage mechanism area. Set Columns to <i>1</i> and Rows to <i>5</i>. Set Origin to <i>-1, 0</i>. Apply and Close the window. 	<ul style="list-style-type: none"> ■ An Array Reference allows you to place multiple copies of a cell in an X Y matrix. ■ The row spacing can be used instead. Row spacing is the distance between the bottom of one cell and the top of the next. The formula is Row spacing = Row distance - extent height = -46. ■ The value is negative because the cell boundaries overlap.
Create a cell Reference (<i>rails</i>) to connect power to the array	<ol style="list-style-type: none"> From the vertical icon column, click on the arrow next to the <i>Reference</i> icon and select the <i>Reference</i> option. In the window that opens, select the <i>rails</i> cell. Set Origin to an arbitrary value. Apply and Close the window. Use the <i>Edit > Move</i> menubar option to line up the <i>rails</i> cell with the <i>heatuator_assy</i> array (see detailed graphics in Figure D3-17). <ul style="list-style-type: none"> ● If the extents are still visible, the left extent edge of the <i>heatuator_assy</i> and that of the <i>rails</i> should be aligned. In addition, the <i>anchor2</i> rectangle edges should also touch. ● In the vertical direction, the <i>rails</i> cell should overlap all the <i>connector</i> and <i>contact_pad</i> cells of the <i>heatuator_assy</i> cells. 	<ul style="list-style-type: none"> ■ When you have finished lining up the rails, click on <i>Modify > Object</i> and check the origin. ■ It should be around <i>-39, -10</i>. ■ The exact vertical position is not critical, as long as the rails have <i>poly2</i> fully covering the <i>contact_pad</i> contact area. ■ For easier visual alignment, try changing layer fill patterns (see page D2-25 for help).


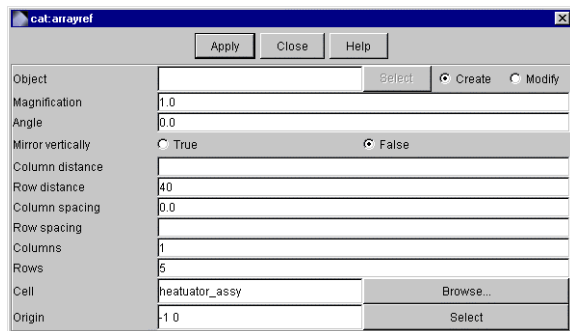
Step 5	What to do	What is accomplished
<p>Create a copy of the entire placement</p> 	<p>a. Select all the objects on the canvas:</p> <ul style="list-style-type: none"> ● Click on the arrow next to the <i>Select objects</i> icon. ● Choose <i>Select rectangular area</i>. ● Draw a box around the entire assembly to select it. <p>b. From the horizontal icon menu, select <i>Mirror Right</i>.</p> <p>c. <i>Nudge</i> or <i>Edit > Move</i> to shift the mirrored portion two units to the left. The vertical path <i>poly1</i> linkage portions of the two assemblies should now overlap.</p> <p>d. Turn off the <i>Visible Extents</i> property.</p>	<ul style="list-style-type: none"> ■ The Mirror operation makes a mirror image of the selected objects and leaves the original in place. ■ The mirroring is about the bounding box of the array and to the right. It needs to be shifted so the <i>poly1</i> sections overlap. ■ Ten heatuator assemblies are connected by power rails.
<p>Save work</p>	<p>Save the cell as <i>heatuator_array</i>. Also save <i>micromirror.cat</i>.</p>	<p>The assembly is saved.</p>

Figure D3-16

Array Reference dialog window



Object Browser makes Extents visible

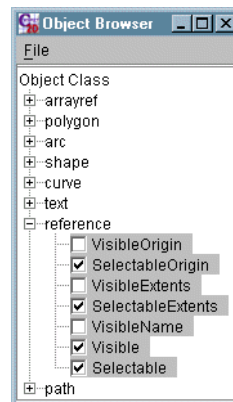
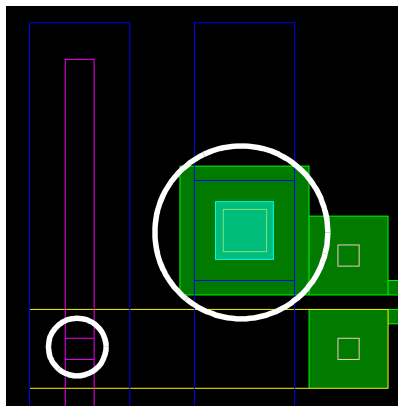
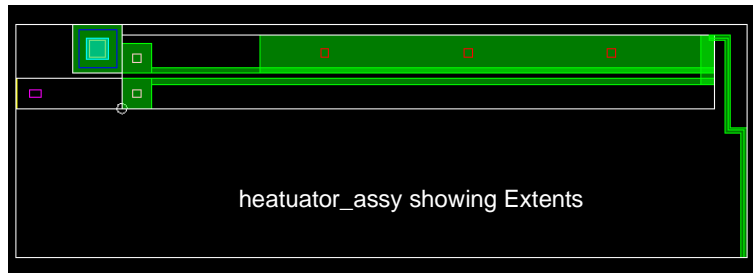
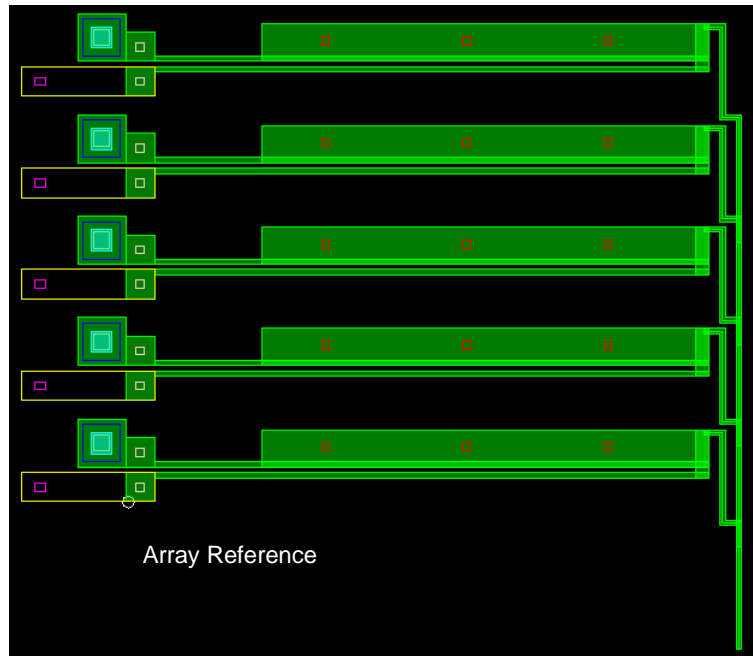
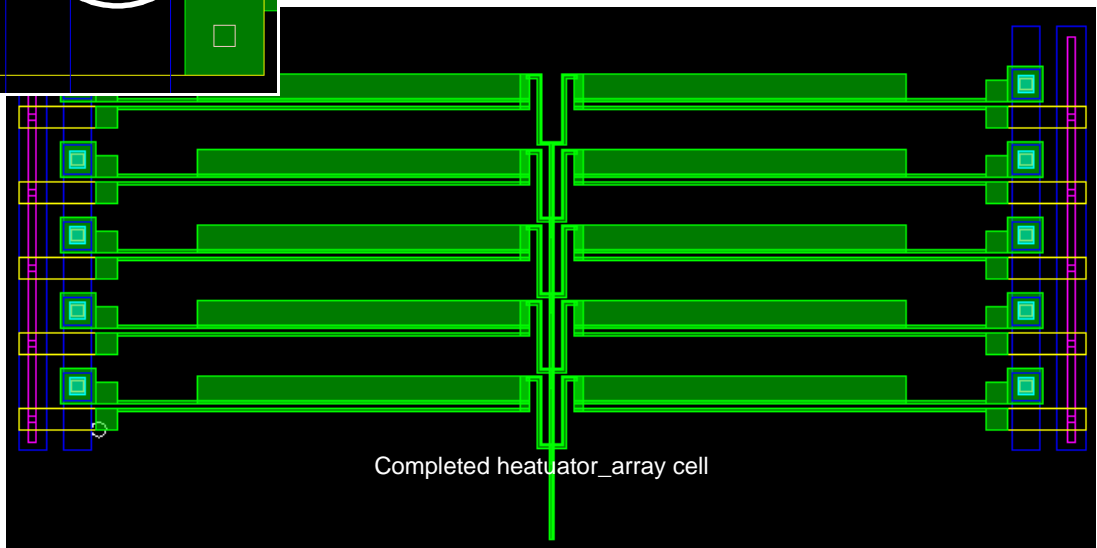


Figure D3-17



Blowup of rails cell. The white circles show the areas where the heatuator_assy and rails cells should align horizontally.



3.8: Connect the Heatuator Array and Mirror

3.8.1: Objective

Place the completed *heatuator_array* and *popup* cells, and connect them with *poly2*.

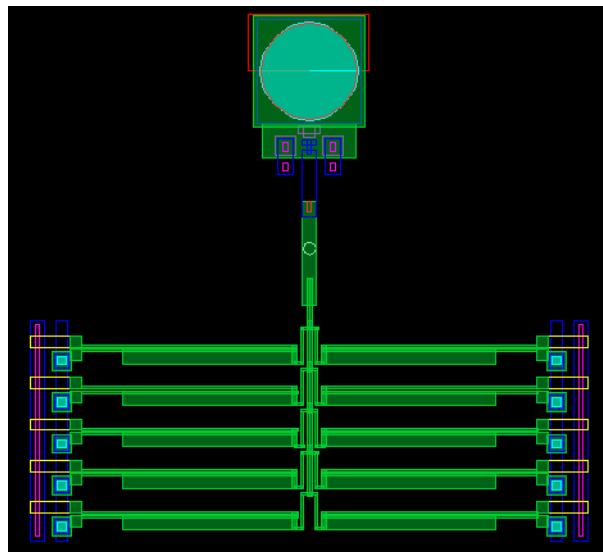
3.8.2: Specific Skills

- How to place and connect completed assemblies
- How to place at an angle of rotation

3.8.3: Procedural Guidelines for Advanced Users

1. Create a new cell.
2. Create a cell reference using the *heatuator_array* cell. Rotate 180 degrees and place at $229, -30$.
3. Create a cell reference using the *popup* cell. Place at $0, 120$.
4. Connect the *poly1* linkage arms of the heatuator array and the long center connector of the popup mirror hinge assembly with a new *poly1* rectangle. Exact coordinates are $-7, 0$ and $7, 48$.
5. Save the cell as *mirror_array*.

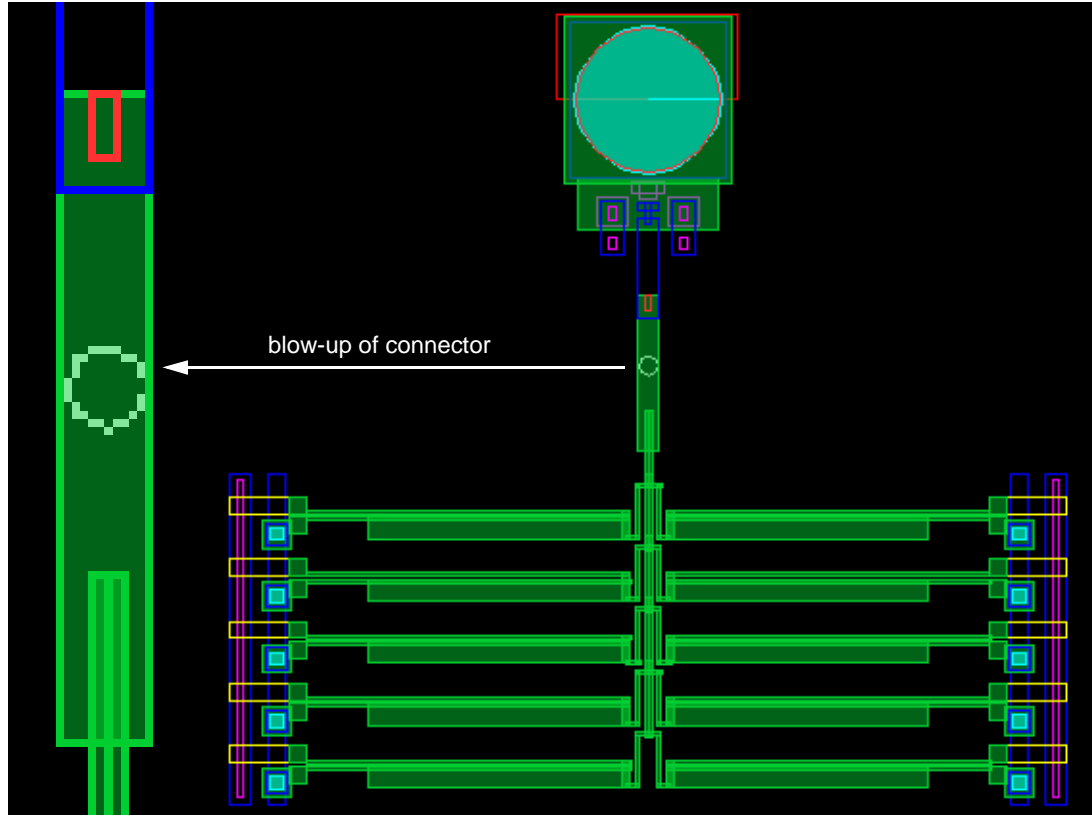
Figure D3-18 Mirror Array



3.8.4: Procedure for New Users

Step 6	What to do	What is accomplished
Create a new cell	From the top icon row select <i>New Cell</i> .	Most of the work in this cell will consist of references to other cells
Create a cell reference of the <i>heatuator_array</i> cell	<ol style="list-style-type: none"> From the vertical icon column, click on the <i>Reference</i> icon. In the window that opens, select the <i>heatuator_array</i> cell. Set the Angle at <i>180</i> degrees. Set the Origin to <i>229, -30</i>. Apply and Close the window. 	<ul style="list-style-type: none"> The array orientation is flipped from its original position. As an alternative to changing the Angle, check <i>Reflect vertically True</i> instead.
Create a cell Reference of the <i>popup</i> mirror cell	<ol style="list-style-type: none"> From the vertical icon column, click on the <i>Reference</i> icon. In the window that opens, select the <i>popup</i> cell. Set the Origin to <i>0, 120</i>. Apply and Close the window. 	This is the assembly built in Steps 1 and 2.
Connect the two cell placements	<ol style="list-style-type: none"> Select the <i>Rectangle</i> icon. Connect the <i>poly1</i> linkage arms of the heatuator array and the long center connector of the popup mirror hinge assembly. For exact placement, the coordinates are <i>-7, 0</i> and <i>7, 48</i>. 	<ul style="list-style-type: none"> The <i>poly1</i> layer should still be selected. The assembly is now complete, except for the external connections through the bond pads.
Save your work	Save the cell as <i>mirror_array</i> . Also save <i>micromirror.cat</i> .	The assembly is saved.

Figure D3-19 Mirror Array



3.9: Finalizing the Project

3.9.1: Objective

Place the completed *mirror_array* cell, create a pad frame of bonding pads around the periphery of the layout, and connect the bond pads to the power rails of the heatuator assembly.

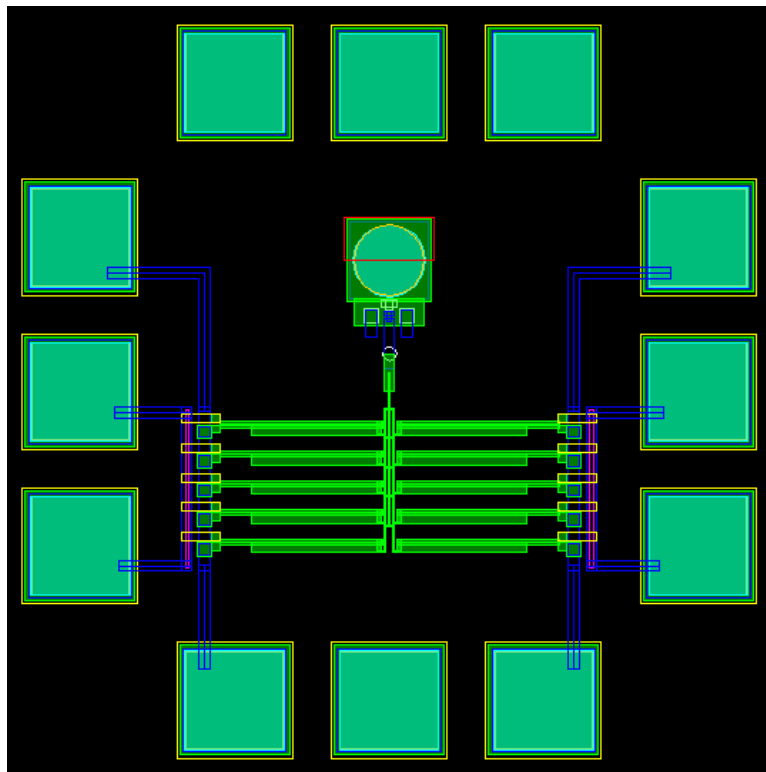
3.9.2: Specific Skills

- How to place bond pads.
- How to connect power wiring for a device.
- How to adjust the Preprocessor display for clarity.

3.9.3: Procedural Guidelines for Advanced Users

1. Create a new cell.
2. Create a cell reference using the *padframe* cell. Place at $0, 0$.
3. Create a cell reference using the *mirror_array* cell. Place at $0, -50$.
4. Draw connector wires fourteen units thick in *poly2* from the power rails to eight of the pad cells. Connect rail tops and bottoms to different pads for optimal power distribution.
5. Save the cell as *scan_assy*.

Figure D3-20 Mirror Array with Padframe



3.9.4: Procedure for New Users

Step 7	What to do	What to expect
Create new cell	From the top icon row, select <i>New Cell</i> .	Most of this cell consists of references.
Create <i>padframe</i> cell reference	<ol style="list-style-type: none"> From the vertical icon column, select the <i>Reference</i> icon. In the dialog window that opens, click on the <i>Browse</i> button next to <i>Cell</i>, and select <i>padframe</i>. In the <i>Origin</i> field, enter <i>0, -50</i>. Select Apply and Close. <i>View All</i> to see the entire padframe. 	<ul style="list-style-type: none"> ■ Twelve pads are used to provide anchors for the device. ■ A padframe generator can also be used to complete this procedure.
Create <i>mirror_array</i> cell reference	<ol style="list-style-type: none"> From the vertical icon column, click on the <i>Reference</i> icon. In the window that opens, select <i>mirror_array</i>. Set the Origin to <i>0, -50</i>. Apply and Close the window. 	This places the components of the assembly in the center of the padframe.
Hook up bond pads on right side	<ol style="list-style-type: none"> Select <i>poly2</i>. Connect the <i>poly2</i> of the two right side rails to the <i>poly2</i> of the pads: <ul style="list-style-type: none"> ● Use a path object of width <i>14</i>. ● Connect the top and the bottom of each of the rails for a total of four connections. ● Connect to the nearest bond pad. ● Four pads are required. 	<ul style="list-style-type: none"> ■ See page D3-26 for reference on how to set the path width. ■ Exact placement is not critical. ■ It is permissible for the <i>poly2</i> polygons to overlap because they are all the same material.
Mirror your work	<ol style="list-style-type: none"> Select all the path polygons just created. From the lower icon row, click on the <i>Mirror</i> icon. Draw a line along the Y-axis and through the origin (which is visible as a small circle in the middle of the drawing area). 	<ul style="list-style-type: none"> ■ With this simple procedure, you have mirrored the four connectors about the Y origin and connected the remaining four pads. See Figure D3-20. ■ This <i>Mirror</i> command allows you to set the mirror axis anywhere you wish.
Save cell	Save the cell as <i>scan_assy</i> . Also save library.	The assembly is saved.
Build a 3-D Model	<ol style="list-style-type: none"> On the <i>Layout</i> tab of the Function Manager, select <i>scan_assy</i> as the Top Cell. Click on the <i>Solid Model</i> tab of the Function Manager. Be sure the <i>Clip Device with Mask</i> option is unchecked. Click on Build Model. 	<ul style="list-style-type: none"> ■ The 3-D model is built. ■ It will take several minutes to finish the build. ■ When finished, a window appears with the message "Build model finished successfully." ■ The Preprocessor opens automatically after a successful build.
View the 3-D Model	<ol style="list-style-type: none"> Select <i>Edit > Edit Model</i> from the Preprocessor menu bar. Increase the <i>Z Scale</i> field value to see the layer depth in more detail. Select <i>Part Display</i> in the <i>Edit Model</i> window. Remove some layers by highlighting layers in the left column and clicking on the <i>Remove</i> arrow icon. to see only the active layers. When finished, from the Preprocessor menu bar, select <i>File > Quit</i>. 	<ul style="list-style-type: none"> ■ The 3-D model is displayed. ■ Several views with different Z depth, rotation, and visible layers are shown in Figure D3-21.

The Preprocessor display can be adjusted for a variety of views:

Figure D3-21

