Rational. Rhapsody

Java Tutorial

Java Tutorial for Rational Rhapsody

Before using the information in this manual, be sure to read the “Notices” section of the Help or the PDF available from **Help > List of Books**.

This edition applies to IBM® Rational® Rhapsody® 7.4 and to all subsequent releases and modifications until otherwise indicated in new editions.

Contents

Lesson 1: Creating a Use Case Diagram

Use case diagrams (UCDs) show the main functions of the system (use cases) and the entities that are outside the system (actors). Use case diagrams allow you to specify the requirements for the system and show the interactions between the system and external actors.

Goals for this Lesson

In this lesson, you are going to determine who are the users of the system and what are the requirements for the embedded system. Then you are going to create the Dishwasher use case diagram.

Since this is the first lesson in the tutorial, first you create a new IBM® Rational® Rhapsody® project.

Creating a Rational Rhapsody Project

To create the Rational Rhapsody project for the tutorial:

1. Launch Rational Rhapsody (**Start** > **Programs** > **IBM Rational**> **IBM Rational Rhapsody** > **Rhapsody Developer Edition** > **Rhapsody in J**).

2. Click the **New** button 🗋 on the main toolbar or select **File** > **New**. The New Project dialog box opens.

3. In the **Project name** box, replace the default project name with `Dishwasher`.

4. In the **In folder** box, browse to find an existing folder or enter a new folder name.

   Note: To avoid overwriting the sample Dishwasher project provided with the Rational Rhapsody product, do not create your project in `<Rational Rhapsody installation>\Samples\JavaSamples`. Also, to avoid potentially long pathnames, do not create the project on the desktop.

5. In the **Type** box, accept **Default**, which provides all of the basic UML structures. It is useful for most Rational Rhapsody projects.

Note: For a description of the available project types that you can select from the **Type** drop-down list, refer to the *IBM Rational Rhapsody User Guide*. (Do a search of the user guide PDF file for “specialized profile.”)

6. Click **OK**. If the specified location does not exist, Rational Rhapsody asks whether you want to create it. Click **Yes**.

   Rational Rhapsody creates your project in the new **Dishwasher** subfolder, opens the project, and displays the Rational Rhapsody browser in the left pane and the drawing area for an object model diagram.

Creating a Standard Java Project Structure

As can be seen in the tree in the Rational Rhapsody Browser, project elements are contained in Packages. In Rational Rhapsody in J, these packages correspond to Java code packages when code is generated.

1. In the Rational Rhapsody browser, right-click the **Packages** category, and select **Add New Package**.
2. Name the new package `com`.
3. Right-click the `com` package, and select **Add New** > **Package**.
4. Name the new package.
5. Repeat the previous two steps to create a package called `dishwasher` under the project.

Analyzing the Dishwasher System

Before using Rational Rhapsody, you should determine the requirements for the embedded system. To analyze the dishwasher system used in this tutorial, answer these questions:

- Who might use the system?
- How they might use it?
- What are the major actions of the system?
- When do these actions occur?
- What are the relationships, similarities, or differences between the actions?
- What is standard behavior?
- What can go wrong?

Some simplified answers to these questions might be as follows:

- The system users or “actors” would include a “user” and a “service person.”
- The system washes, rinses, and then dries dishes.
- The “user” loads the dishes into the dishwasher, starts the dishwasher, and removes dishes after they are washed.
- The system might fail to wash, rinse, or dry the dishes and require service.

During this analysis phase, you identify actors for the system. The three types of actors to consider are:

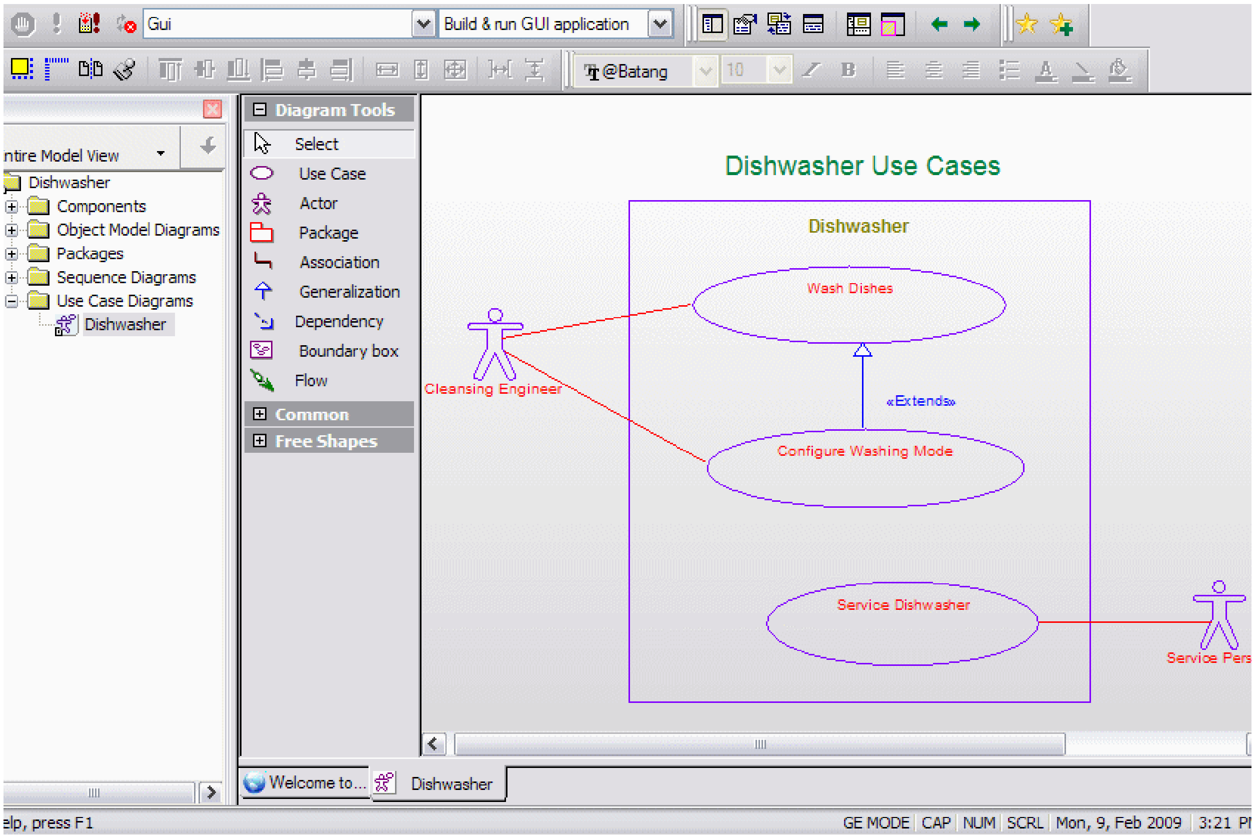
- Users of the system
- External components providing information to the system
- External components receiving information from the system

Creating a Use Case Diagram

In this exercise you are going to create a use case diagram for the dishwasher system. A use case diagram shows typical interactions between the system being designed and the external actors who might interact with it.

The following figure shows the Dishwasher use case diagram that you are going to create in this exercise.

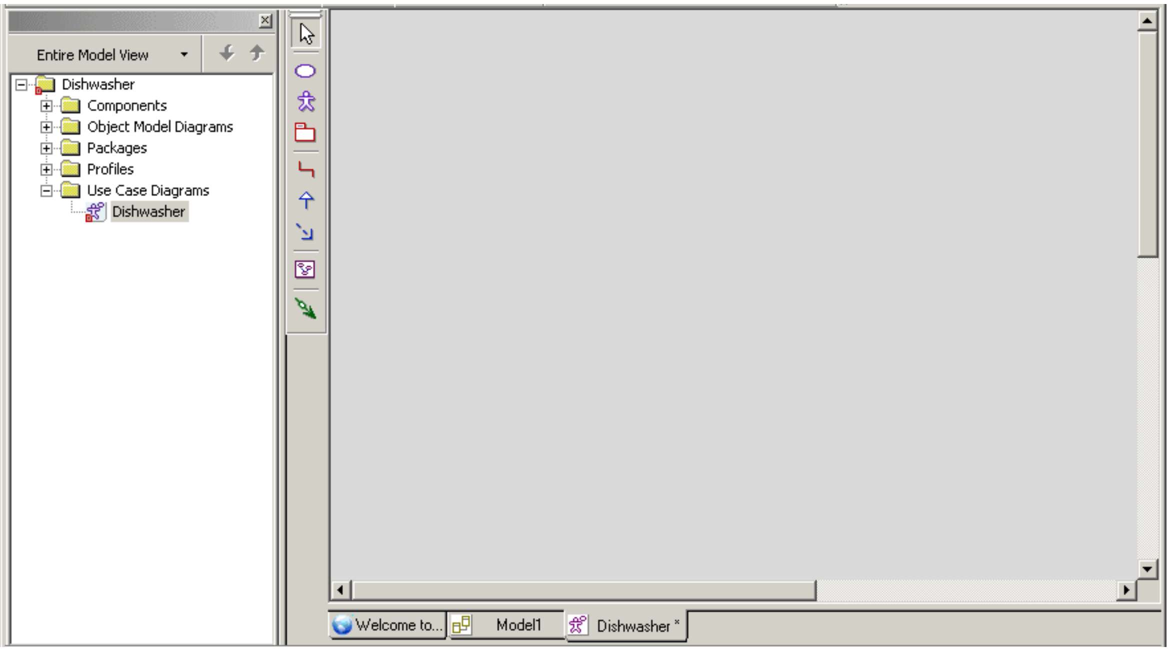
Dishwasher Use Case Diagram



To create the use case diagram, carry out the following steps:

1. Right-click the `dishwasher` package in the Rational Rhapsody browser, and select **Add New** > **Use Case Diagram** to open the New Diagram dialog box.

2. When the New Diagram dialog box is displayed, type `Dishwasher` as the name of the diagram, and then click **OK**.
Rational Rhapsody automatically adds the **Use Case Diagrams** category and the name of the new diagram to the Rational Rhapsody browser and opens the new diagram in the drawing area, as shown in the following figure:



Note

You can also create a diagram by using the Tools menu or the **Diagrams** toolbar. Also, once you create a diagram you can open it using the **Diagrams** toolbar. Refer to the *IBM Rational Rhapsody User Guide* for more information.

3. Click the **Create Boundary box** button on the **Drawing** toolbar.
4. Click the drawing area and drag to create a boundary box. Rational Rhapsody creates a boundary box named `System Boundary Box`.
5. Rename the boundary box `Dishwasher` and then press **Enter**.
6. Click the **Create Actor** button on the **Drawing** toolbar.
7. On the drawing area, click to the left side of the boundary box. Rational Rhapsody creates an actor with a default name.
8. Rename the actor `User` and then press **Enter**.

   Note: Because code can be generated using the specified names, do not include spaces in the names of actors.

9. Draw another actor outside the boundary box named `ServicePerson`.

10. In the browser, you will see a category called `Actors` under the `dishwasher` package. If you expand `Actors`, you will see the two actors that you just created.

> **Note:** To quickly find the actors in the Rational Rhapsody browser, right-click an actor on the use case diagram and click **Locate** or press **Ctrl+L**. You can use this technique with other objects on a diagram as well.

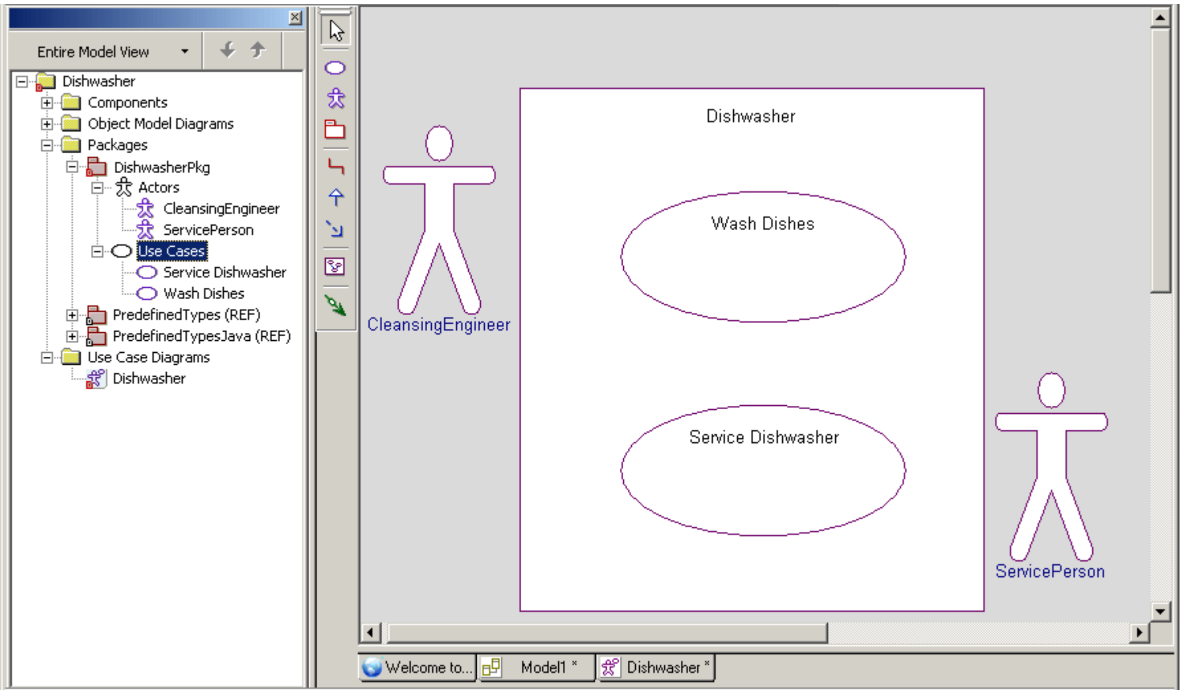
Adding Use Cases to the Diagram

During the analysis phase, you identified user-visible functions or important goals of the system. These are *use cases*. A *use case* represents a particular function of the system. To draw the use cases, follow these steps:

1. Click the **Create Use Case** button ○ on the **Drawing** toolbar.
2. Click inside the top half of the boundary box. Rational Rhapsody creates a use case with a default name.
3. Rename the use case `Wash Dishes` and then press **Enter**.

   > **Note:** For use case names, you can use spaces because use case names do not appear in generated code.

4. Create another use case inside the boundary box named `Service Dishwasher`.
5. In the browser, you can expand the **Use Cases** category to view the use cases you created, as shown in the following figure:



Associating Actors with Use Cases

The **User** washes dishes and configures the washing mode, while the **ServicePerson** only services the dishwasher as needed.

To incorporate the relationships of the actors to the use cases into the design, you draw association lines between the actors and use cases. An *association* represents a connection between objects or users.To draw association lines, follow these steps:

1. Click the **Create Association** button on the **Drawing** toolbar.
   Notice that once you move your cursor over the drawing area the mouse pointer turns into a crosshairs pointer to signify that it is enabled and that it changes into a circled crosshairs pointer when drawing is possible.

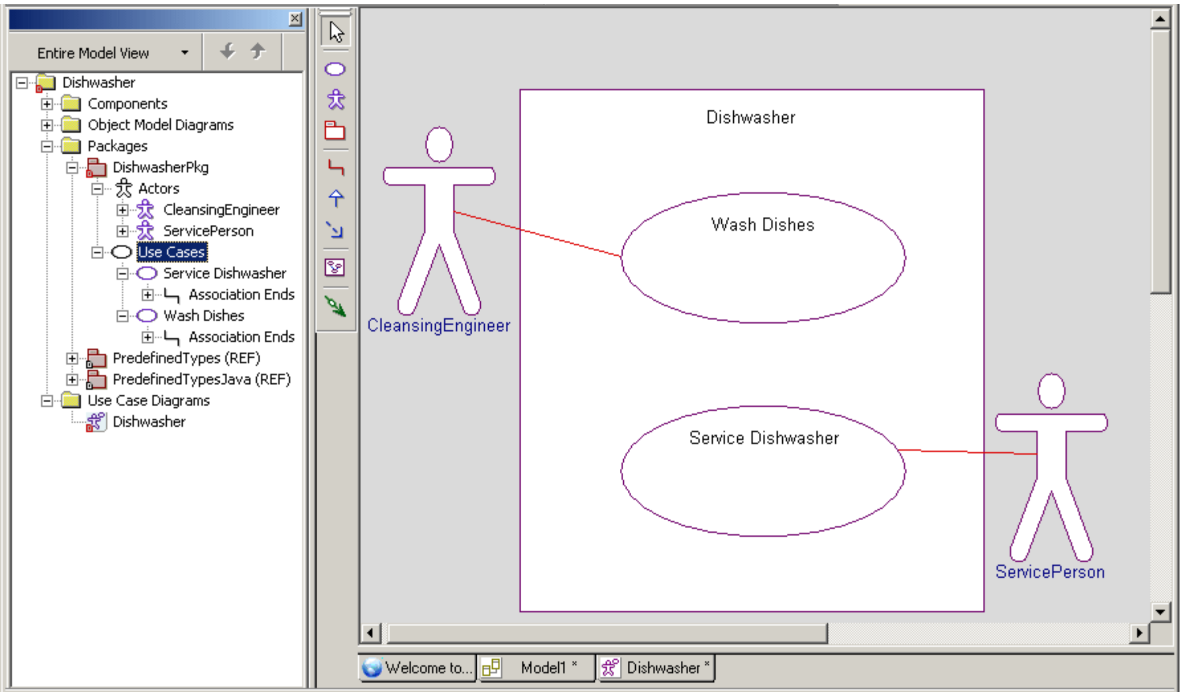
2. Click the edge of the **User** actor and then click the edge of the **Wash Dishes** use case.
   Rational Rhapsody creates an association line with the name label highlighted. You do not need to name this association, so click the mouse button again (this is the same as pressing **Enter**).

   Note: To keep a line straight as you draw it, press the **Ctrl** key as you are drawing the line.

3. Create an association between the **ServicePerson** actor and the **Service Dishwasher** use case and then click the mouse button again or press **Enter**.

4. Click the **Save** button to save your model.

   Your use case diagram should resemble the following figure:



Adding a Diagram Title

Each diagram has its name in the diagram table and in the title bar of the window that displays the diagram. However, it is also useful to add a title onto the diagram itself to help other members of your team understand the content and purpose of a diagram.

To add an optional title to your diagram, follow these steps:

1. With the diagram displayed in the drawing area, click **A** on the **Free Shapes** toolbar.

2. Click above the system boundary box in the diagram and type, for example, `Dishwasher Use Case Diagram`, and press **Ctrl+Enter**.

   Note: If you press **Enter**, you move your cursor to a new line. In this case, to exit typing mode, you have to press **Ctrl+Enter** to end your action. Or you can click out of the typing area.

3. Make the following changes if you want:

   a. Reposition the title by dragging it into another location.

   b. Use the tools on the **Format** toolbar to change the font styles.

4. Click the **Save** button 💾 to save your model.

For more information about the **Free Shapes** and **Format** toolbars, refer to the *IBM Rational Rhapsody User Guide*.

Summary

In this lesson, you determined who are the users of the system and what are the requirements for the embedded system. Then you created a use case diagram that shows the functions and requirements of the dishwasher. You became familiar with the parts of a use case diagram and created the following:

- System boundary box
- Actors
- Use cases
- Association lines
- Title for your diagram

You are now ready to proceed to the next lesson, where you are going to define how the system components are interconnected using an object model diagram.

Lesson 2: Creating an Object Model Diagram

Object model diagrams (OMDs) specify the types of objects in the system, the attributes and operations that belong to those objects, the static relationship that can exist between classes (types), and the constraints that might apply. The Rational Rhapsody code generator directly translates the elements and relationships modeled in OMDs into Java source code.

Goals for this Lesson

In this lesson, you are going to create an object model diagram that shows how the system components are interconnected.

In this lesson, you are going to:

- Create an object model diagram
- Create classes in the object model diagram
- Add attributes to a class
- Add operations to a class

Creating an Object Model Diagram

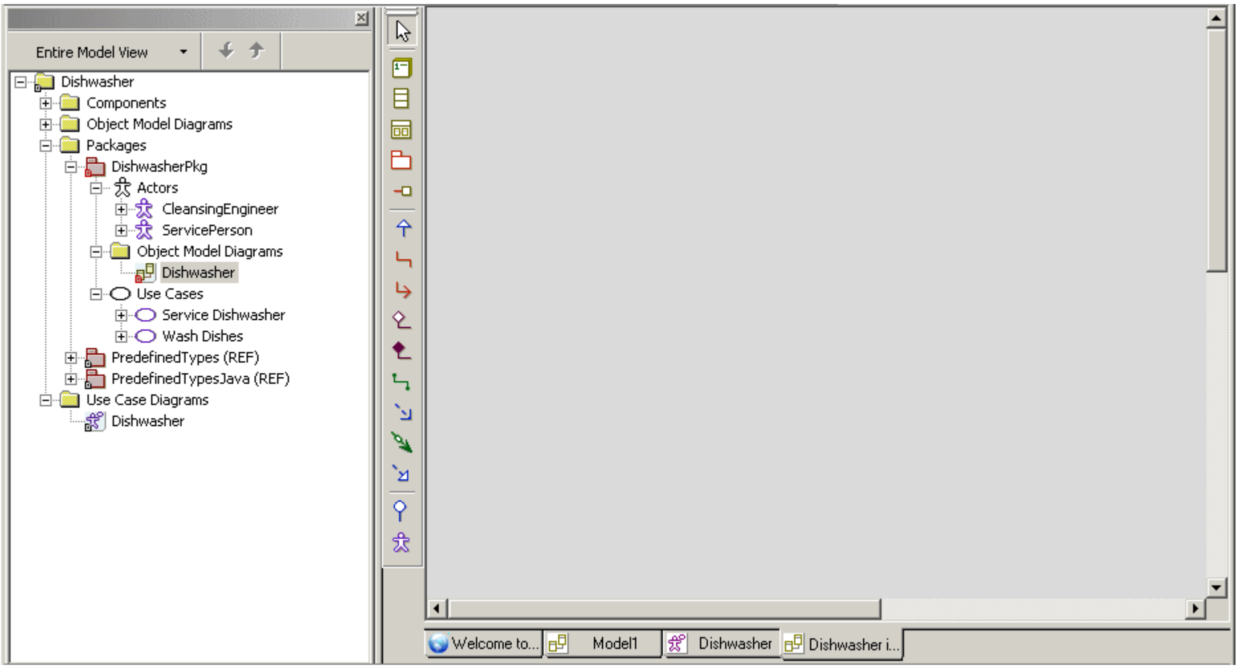
To create the object model diagram, follow these steps:

1. Start Rational Rhapsody and open the Dishwasher model you created if they are not already open.

2. In the browser, right-click the `dishwasher` package and then select **Add New** > **Object Model Diagram**.

3. When the New Diagram dialog box is displayed, type `Dishwasher` and then click **OK**.

Rational Rhapsody adds the **Object Model Diagrams** category underneath the `dishwasher` package, and adds the name of the new object model diagram to the browser. Rational Rhapsody also opens the new object model diagram in the drawing area, as shown in the following figure:



Adding Classes and Objects to the Diagram

1. Click the **Class** button on the Drawing toolbar.

   Notice that once you move your mouse pointer over the drawing area, a class icon appears along with it.

2. Click-and-drag on the drawing area and create a tall rectangular class.

3. Rename the class `Dishwasher` and then press **Enter**.

4. Select the `Dishwasher` class and change to Structured view by clicking the Specification/ Structured View button on the toolbar.

5. Click the **Object** button on the Drawing toolbar, and use it to draw an object inside the `Dishwasher` class. For the name, type `jet:Jet`. Click `Yes` when you are asked whether you want to create a class called Jet. This will create an object called jet based on a class called Jet.

6. Using the **Object** button again, draw another object inside the `Dishwasher` class and name it `heater:Heater`. This will create an object called heater based on a class called Heater.

   Note: The `jet` and `heater` objects were only created here to illustrate the creation of parts in a class. They will not be referred to in the tutorial.

7. Select the `Dishwasher` class and change it back to Specification view by clicking the Specification/Structured View button a second time.

8. Right-click the `Dishwasher` class select **Display Options**.

9. On the **General** tab, click the **Compartments** button.

10. In the **Available** list, select **Part**, and then click << **Display** to add it to the **Displayed** list. (Verify that **Attributes** and **Operations** are also in the **Displayed** list.)

11. Click **OK**.

12. Click **OK** to close the **Display Options** dialog box. You should now see the objects you created displayed in a compartment.

13. Create another class beside the `Dishwasher` class and name it `Display`.

Adding Attributes and Operations to a Class

1. In the object model diagram you created, right-click the Dishwasher class to display the context menu.

2. Select **New Attribute**.

3. Name the attribute `washTime`.

4. Repeat the previous steps to create another two attributes called `rinseTime` and `dryTime`.

5. Right-click the Dishwasher class and select **Features**.

6. On the **Attributes** tab of the Features dialog box, you should see the three attributes you created. Verify that they have `Public` visibility and are of type `int`. If not, use the drop-down lists to modify the visibility and/or type.

7. Click **OK** to close the Features dialog box.

8. Right-click the Dishwasher class and select **New Operation**. Name the operation `setup`.

9. Right-click the Dishwasher class and select **Features**.

10. On the **Operations** tab of the Features dialog box, double-click the `setup` operation. This will open the Features dialog box for the operation.

11. On the **Implementation** tab, type in the following Java code:

```
washTime = 5000;
rinseTime = 4000;
dryTime = 5000;
```

12. Click **OK** to close the Features dialog box for the `setup` operation.

13. Click **OK** to close the Features dialog box for the `Dishwasher` class.

14. Save your project.

Summary

In this lesson, you created an object model diagram that specified the types of objects in the system and the attributes and operations that belong to those objects.

You are now ready to proceed to the next lesson, where you will create a statechart for the `Dishwasher` class.

Lesson 3: Creating a Statechart

Statecharts define the behavior of objects, including the various states that an object can enter over its lifetime and the messages or events that cause it to transition from one state to another. Each statechart defines the life cycle behavior of a single reactive class. Therefore, a single reactive class can be associated with only one statechart.

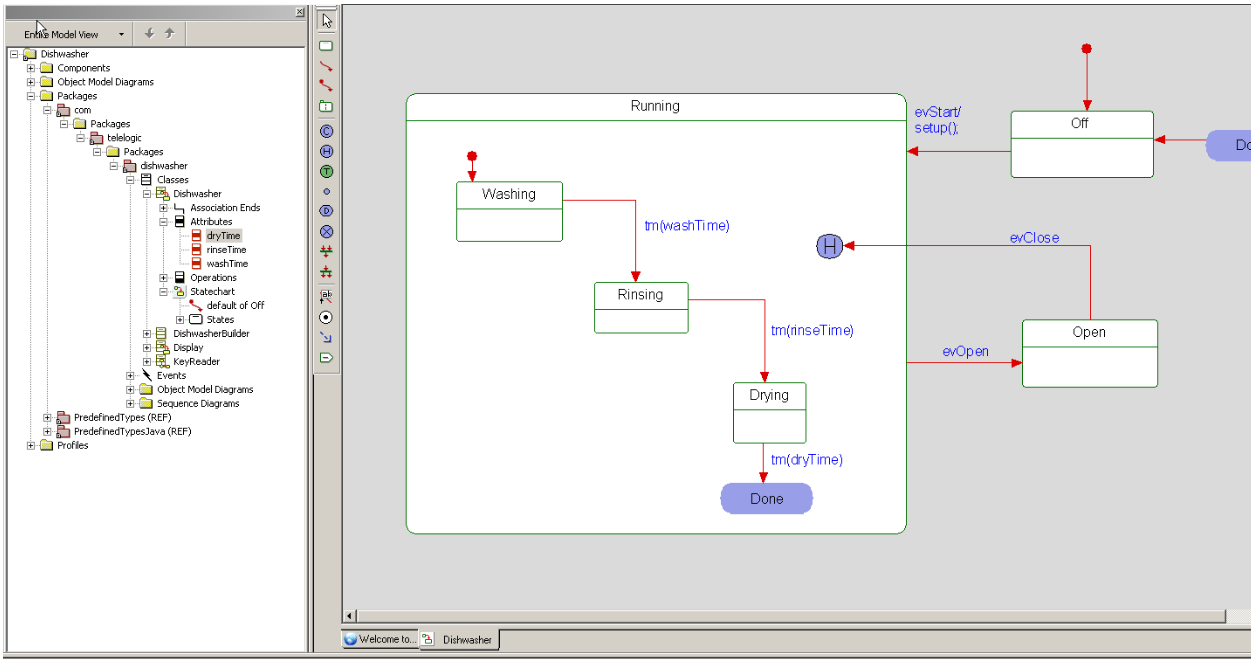
Goals for this Lesson

In this lesson you will learn to perform the following tasks:

- Draw a statechart
- Draw states and nested states
- Draw transitions
- Specify entry and exit actions
- Draw history connectors

Creating a Statechart

The following figure shows the Dishwasher statechart that you are going to create in this exercise.



To create a statechart, follow these steps:

1. Start Rational Rhapsody and the Dishwasher model if they are not already open.
2. In the Rational Rhapsody browser, right-click the **Dishwasher** class.
3. Select **Add New** > **Statechart**.

   Rhapsody automatically adds the new statechart under the **Dishwasher** class in the browser. In addition, Rhapsody opens the new statechart in the drawing area.

Adding States to a Statechart

To draw a state, follow these steps:

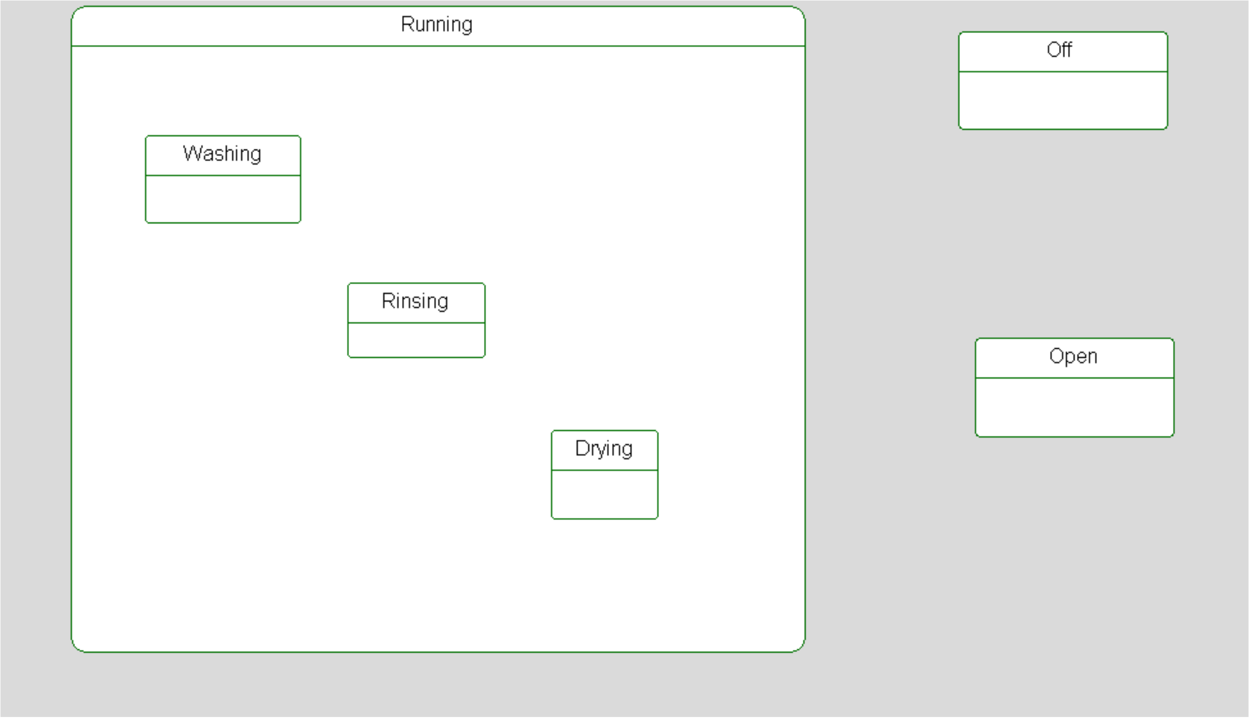
1. Click the **State** button ▭ in the **Drawing** toolbar.
2. Click-and-drag on the drawing area to create a large state, and name the state `Running`.

3. Using the completed statechart screen capture as a reference, draw the following states inside the **Running** state:

- `Washing`
- `Rinsing`
- `Drying`

4. Outside the **Running** state, draw two more states and name them `Off` and `Open`.

Your statechart should resemble the following figure:



Drawing History and Diagram Connectors

If you open and close the door during operation, the dishwasher must start up again where it left off in the wash cycle. In other words, you want the dishwasher to save its history so it can continue where it left off after an interruption. *History connectors* store the most recent active configuration of a state. A transition to a history connector restores this configuration.

When the dishwasher is done drying, the cycle should start over again at the beginning, to handle future loads. To define the cycle restart, use *diagram connectors* to connect the end of one part of a statechart to the beginning of another part. These connectors physically join distant transition segments. Diagram connectors have the same name to indicate they are a pair of connectors. This tells the system to jump from one to the other even if they are located on different statecharts.

To draw these connectors, follow these steps:

1. Click the **History connector** button Ⓗ on the **Drawing** toolbar and then click inside the **Running** state.

2. Click the **Diagram connector** button Ⓓ on the **Drawing** toolbar and create the following diagram connectors and label them `Done` in the following locations:

   – Inside the `Running` state, below the `Drying` state. This is the source diagram connector.

   – Outside the `Running` state, next to the `Off` state. This is the target connector.

3. Save your model.

Drawing Default Connectors

One object must be assigned the *default* state. In the default state, the object knows to start the system. When the dishwasher first starts, it is in the `Off` state.

Note that once you have drawn a default connector in a statechart, Rational Rhapsody does not allow you to draw another one in the same chart. Each object can have only one default state.

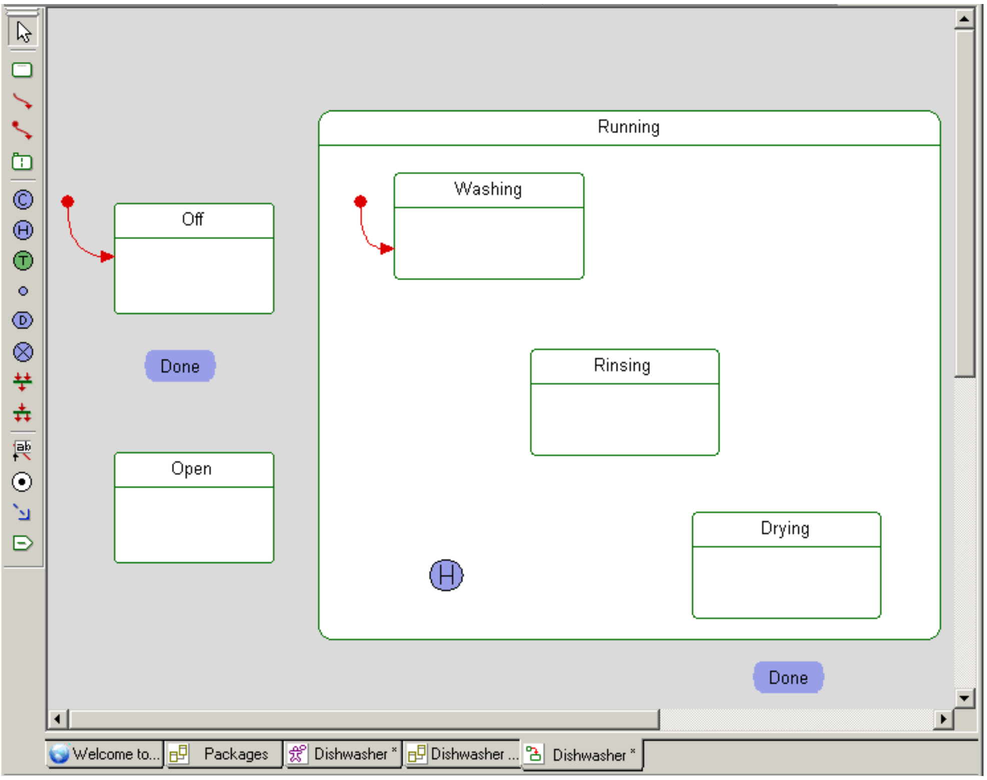
To assign the default states for classes in the statechart, follow these steps*:*

1. Click the **Default connector** button ↘ on the **Drawing** toolbar.

2. Click in the drawing area above and away from the `Off` state, then click an edge of the `Off` state, and then click away from the connector to skip naming the connector (or press **Ctrl+Enter**).

3. Use the same method to draw a default connector to the **Washing** state, keeping the connector inside the **Running** state.

   At this point, your statechart should resemble the following figure:



Drawing Transitions

A *transition* represents a message or event that causes an object to switch from one state to another.

To add transitions, use the following steps:

1. Click the **Transition** button on the **Drawing** toolbar.
2. Click an edge of the **Off** state to anchor the start of the transition and then click an edge of the **Running** state to anchor the end of the transition.
3. Type `evStart/setup();` as the label and then press **Ctrl**+**Enter** to dismiss the edit box. (Pressing **Enter** only adds a new line.)

Note: To change the text of a label or add a label to a previously drawn transition, click the **Transition Label** on the **Drawing** toolbar. Click the transition line and type/edit label text.

4. Draw a transition from the `Running` state to the `Open` state and type `evOpen` as the label.

5. Draw a transition from the `Open` state to the `H` history connector and type `evClose` as the label.

6. Inside the `Running` state, draw a transition from the `Washing` state to the `Rinsing` state and label it `tm(washTime)`.

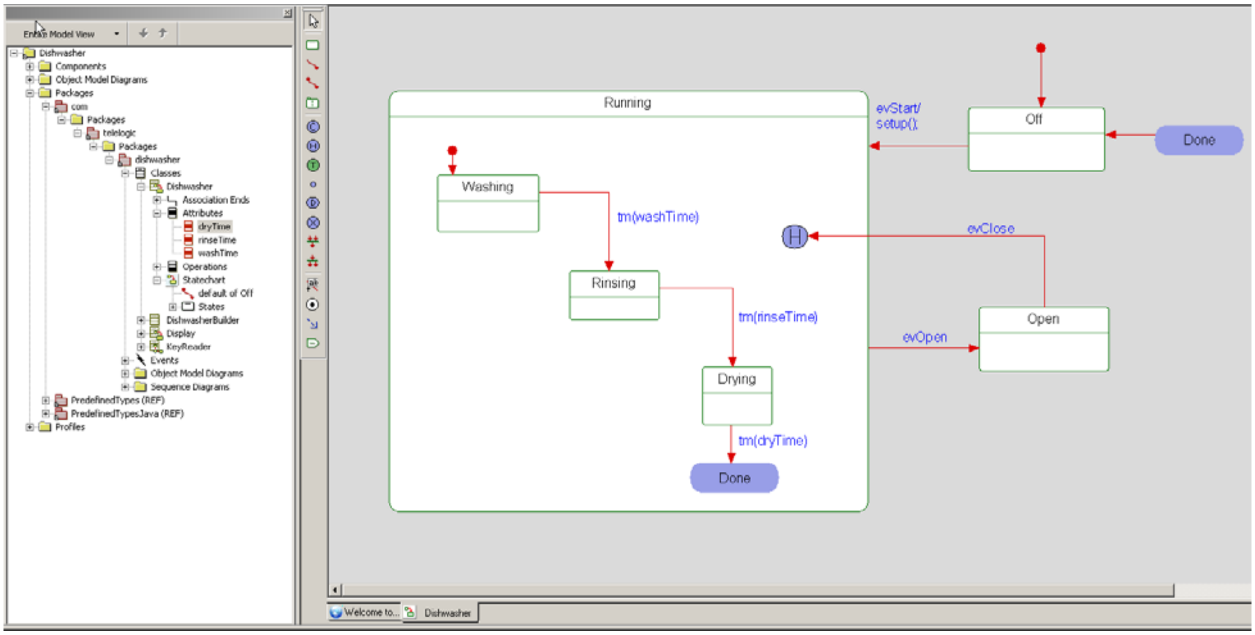
   Note: `tm` represents a timeout.

7. Draw a transition from the `Rinsing` state to the `Drying` state and label it `tm(rinseTime)`.

8. Draw a transition from `Drying` state to the `Done` diagram connector and label it `tm(dryTime)`.

9. Draw an unlabeled transition from the `Done` target diagram connector to the `Off` state.

   At this point, your statechart should shows the Dishwasher with all of the transitions between the various states, and your diagram should resemble the following figure:

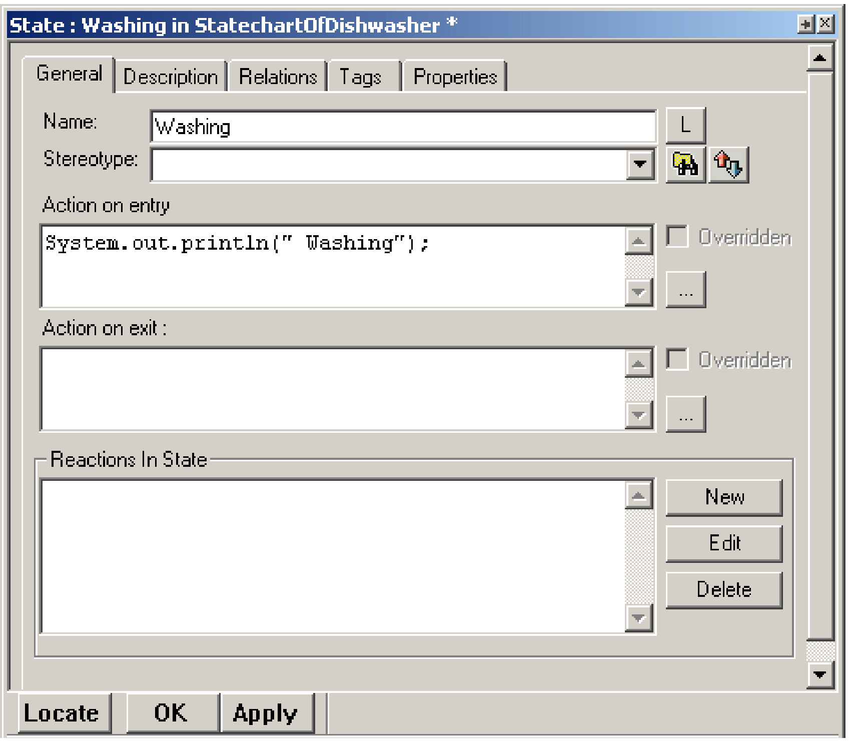


Adding Actions to States

To define actions that should be carried out upon entry into a state or exit from a state, follow these steps:

1. Double-click the `Washing` state on the statechart to open the Features dialog box.
2. On the **General** tab, type the following code in the **Action on entry** box, as shown in the following figure:

```
System.out.println("Washing");
```


State : Washing in StatechartOfDishwasher *

Name: Washing

Stereotype:

Action on entry

```
System.out.println(" Washing");
```

Action on exit :

3. Click **OK** to apply your changes. On the statechart, notice that the `Washing` state has an icon ⟳ in the upper right corner. This indicates that the `Washing` state now has underlying actions.
4. Double-click the `Rinsing` state, and type the following code in the **Action on entry** box, and click **OK**:

```
System.out.println("Rinsing");
```

5. Double-click the `Drying` state, and type the following:

   a. In the **Action on entry** box:

   ```
   System.out.println("Drying");
   ```

   b. In the **Action on exit** box:

   ```
   System.out.println("Dishwasher Cycle Complete");
   ```

6. For the **Open** state, type the following:

   a. In the **Action on entry** box:

   ```
   System.out.println("Door Opened");
   ```

   b. In the **Action on exit** box:

   ```
   System.out.println("Door Closed");
   ```

7. Save your model.

Summary

In this lesson, you created a statechart, which identifies the state-based behavior for your dishwasher model. You became familiar with the parts of a statechart and created the following:

- States and nested states
- Default connectors
- Transitions
- Actions

You are now ready to proceed to the next lesson, where you will create a simple console interface that will allow you to control the basic functions of the dishwasher.

Lesson 4: Creating a Console User Interface

In this lesson, you will create the elements necessary to allow you to use input from a command line to input events connected to the operation of the dishwasher. Specifically, you will

- create a new class called KeyReader
- add a statechart for the Display class
- add additional operations and parts to the Display class
- create an activity diagram for the KeyReader class

Create the KeyReader Class

The following steps will create a new class that will be responsible for reading the input provided by the user in the command-line.

1. Right-click the dishwasher package and select **Add New** > **Class**.
2. Name the class `KeyReader`.
3. In the browser, double-click the `KeyReader` class to open up the Features dialog box.
4. On the **General** tab, set **Concurrency** to `active`.

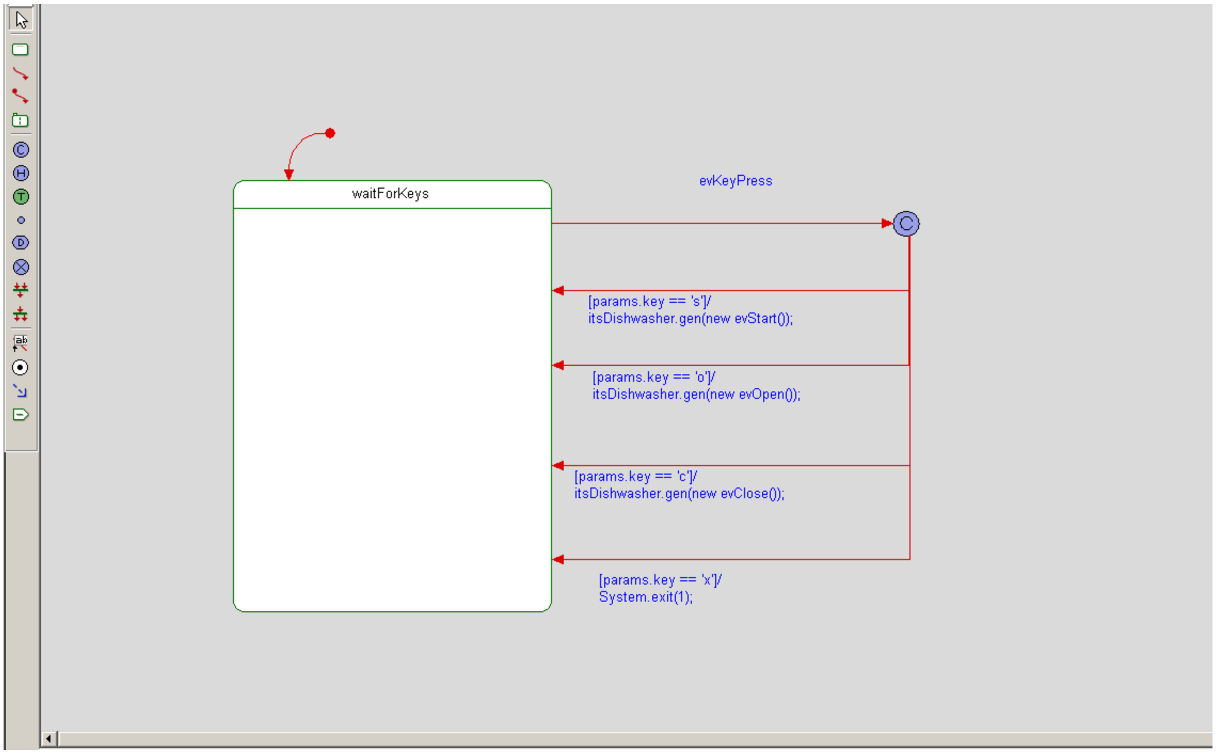
Add a Statechart for the Display Class

The following steps will create a statechart that specifies the behavior of the Display class when different events are sent from the command-line.

1. In the browser, right-click the `Display` class and select **Add New** > **Statechart**.
2. Add a state called `WaitForKeys` to the statechart.
3. Draw a default transition leading to the `WaitForKeys` state.
4. Add a condition connector to the diagram.
5. Draw a transition from `WaitForKeys` to the condition connector and label it `evKeyPress`.

6. Open the Features dialog box for the `evKeyPress` event.
7. Go to the **Arguments** tab, and click <**New**> to create a new argument called `key`.
8. Use the drop-down list to set the argument type to `char`.
9. Draw a transition from the condition connector to the `WaitForKeys` state and enter the following label:
   ```
   [params.key == 's']/itsDishwasher.gen(new evStart());
   ```
10. Draw another transition from the condition connector to the `WaitForKeys` state and enter the following label:
    ```
    [params.key == 'o']/itsDishwasher.gen(new evOpen());
    ```
11. Draw another transition from the condition connector to the `WaitForKeys` state and enter the following label:
    ```
    [params.key == 'c']/itsDishwasher.gen(new evClose());
    ```
12. Draw another transition from the condition connector to the `WaitForKeys` state and enter the following label:
    ```
    [params.key == 'x']/System.exit(1);
    ```

Your statechart should now look like the following:



Add Part/Operation to Display Class

The following steps will establish the relationship between the Display class and the new KeyReader class that you created.

1. In the browser, right-click the `Display` class and select **Add New** > **Part**. When the list of available classes is displayed, select KeyReader from the list.
2. Press Enter to accept the default name provided for the new part, `itsKeyReader`.
3. Double-click the part you created (`itsKeyReader`) to open the Features dialog box.
4. On the **General** tab, in the section **Relation to whole**, check **knows Display as** and enter `itsDisplay`.
5. Click **OK** to apply the changes.
6. In the browser, double-click the `Display` class to open the Features dialog box.
7. Go to the **Operations** tab, click **<New>**, and then select **Primitive Operation** from the list displayed to create a new operation, and name it `processKey`.
8. Double-click the name of the operation you created to open the Features dialog box for `processKey`.
9. Go to the Arguments tab, and click **<New>** to create an argument called `key` of type **char**.
10. Click **OK** to apply the changes.

Create an Activity Diagram for the KeyReader Class

The following steps will create an activity diagram that specifies the behavior for the KeyReader class to allow it to take the user input and initiate the event that the Display class waits for.

1. In the browser, right-click the `KeyReader` class and select **Add New** > **Activity Diagram**. The new diagram will be opened in the drawing area.
2. Use the Action tool on the Drawing toolbar to add an action to the activity diagram.
3. Enter the following code in the **Action** box for the action you created:

   ```
   System.out.println("Enter command:");
   ```
4. Use the Default Flow tool to draw a default flow leading to the action you added.
5. Use the Action tool on the Drawing toolbar to add a second action to the activity diagram.

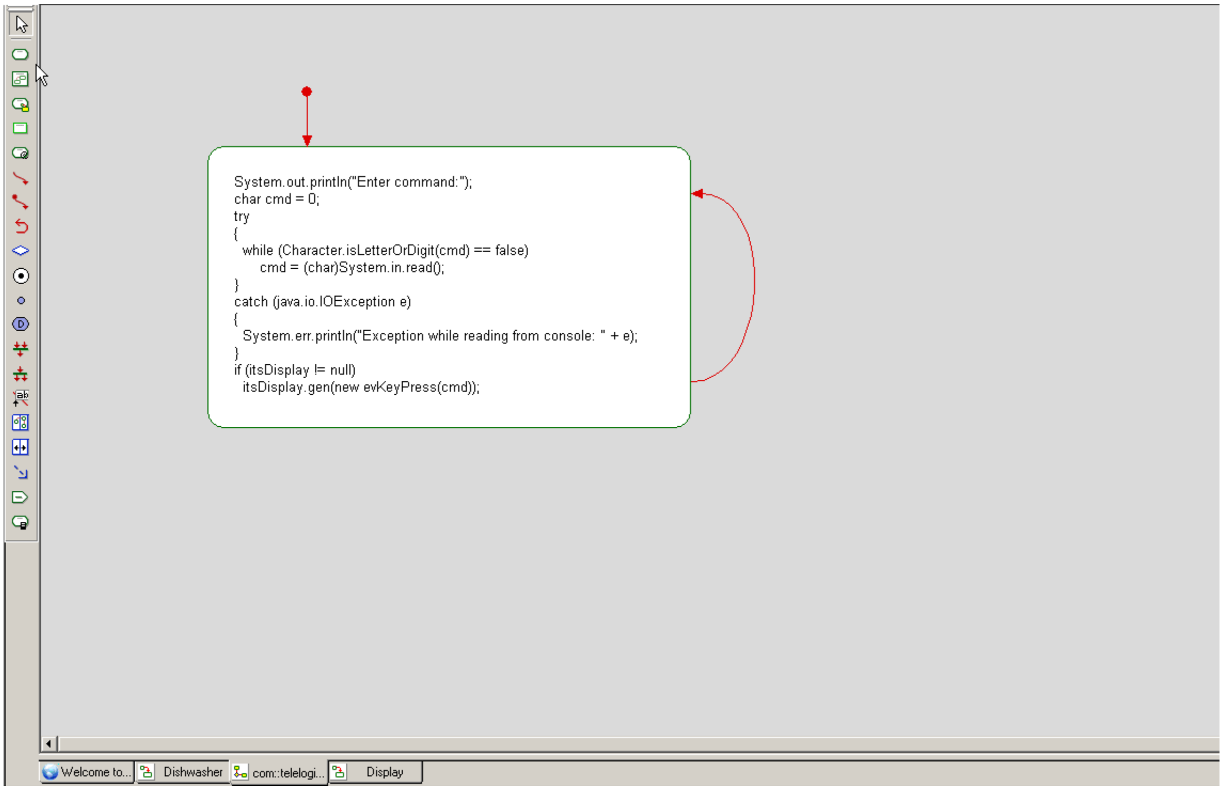
6. Use the Activity Flow tool to add an activity flow from the first action you added to the second action you added.

7. Enter the following code in the **Action** box for the second action you created:

```
char cmd = 0;
try
{
    while (Character.isLetterOrDigit(cmd) == false)
    cmd = (char)System.in.read();
}
catch (java.io.IOException e)
{
    System.err.println("Exception while reading from console: " + e);
}
if (itsDisplay != null)
itsDisplay.gen(new evKeyPress(cmd));
```

8. Use the Activity Flow tool to add an activity flow from the second action you added, leading back to itself.

Your activity diagram should now look like the following:



```
System.out.println("Enter command:");
char cmd = 0;
try
{
  while (Character.isLetterOrDigit(cmd) == false)
      cmd = (char)System.in.read();
}
catch (java.io.IOException e)
{
  System.err.println("Exception while reading from console: " + e);
}
if (itsDisplay != null)
  itsDisplay.gen(new evKeyPress(cmd));
```

Summary

In this lesson, you

- created a new class called KeyReader to handle the user input
- added a statechart for the Display class to specify its behavior when different events are sent from the command-line
- added a part based on the KeyReader class to establish the relationship between the Display class and the KeyReader class
- created an activity diagram that specified how the KeyReader class should respond to input entered by the user

In the next lesson, you will construct a sequence diagram that shows how the various elements of the system communicate with one another over time.

Lesson 5: Creating Sequence Diagrams

Sequence diagrams show structural elements communicating with one another over time. They also identify required relationships and messages. A high-level sequence diagram shows the interactions between actors, use cases, and blocks. Lower-level sequence diagrams show communication between classes and objects.

Sequence diagrams have an executable aspect and are a key *application animation* tool. When you animate the model to see the application's operations, Rational Rhapsody dynamically builds sequence diagrams that record the object-to-object or block-to-block messaging.

Goals for this Lesson

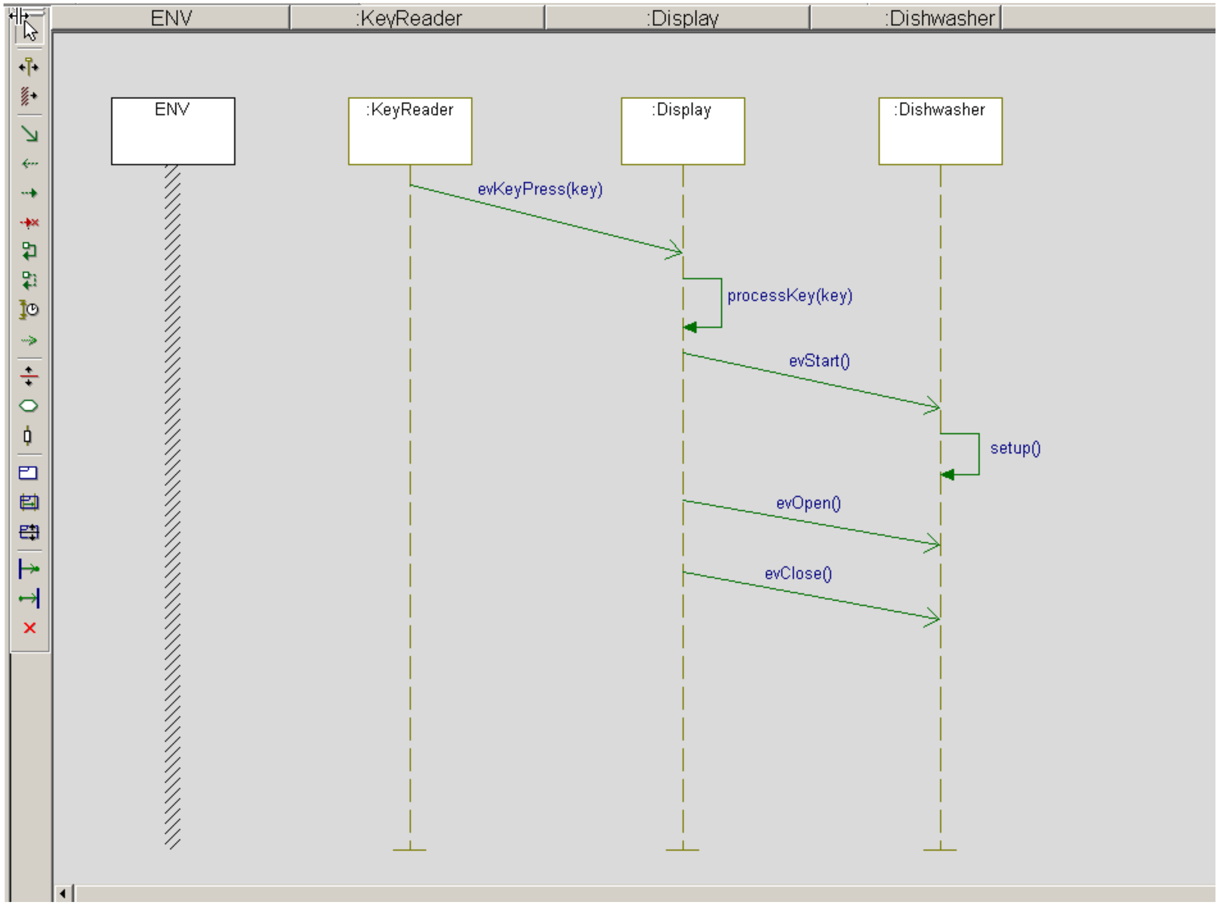
In this lesson you will learn to perform the following tasks:

- Draw a sequence diagram

Creating the Execution Sequence Diagram

The following figure shows the Execution sequence diagram that you are going to create in this exercise.

Execution Sequence Diagram



Rational Rhapsody separates sequence diagrams into a Names pane and a Message pane. The Names pane contains the name of each instance line or classifier role. The Message pane contains the elements that make up the interaction.

To create a new sequence diagram, follow these steps:

1. In the Rational Rhapsody browser, right-click the `dishwasher` package, and select **Add New** > **Sequence Diagram**.
2. When the New Diagram dialog box is displayed:

   a. Name the diagram Execution

   b. Select the **Design** option

   c. Click **OK**.

3. Click the **System Border** button on the **Drawing** toolbar and click on your sequence diagram. Rational Rhapsody creates an item named **ENV** (for environment) that represents the system border.

4. Drag the `KeyReader` class from the Rational Rhapsody browser to the right of the system border.

5. Drag the `Display` class from the browser to the right of the `KeyReader` line that you added.

6. Drag the `Dishwasher` class from the browser to the right of the `Display` line.

7. Using the **Message** button ↘ on the **Drawing** toolbar, draw a diagonal message from the `KeyReader` class to the `Display` class, and then open the context menu for the message and select **Select Message** > **evKeyPress**.

8. Using the **Message** button once again, draw a message from the `Display` line back to the `Display` line (message to self) below the previous message, and then open the context menu for the message and select **Select Message** > **processKey.**

9. Draw a diagonal message from the `Display` line to the `Dishwasher` line, below the previous message, and then open the context menu for the message and select **Select Message** > **evStart.**

10. Draw another message to self, this time on the `Dishwasher` line, below the previous message, and then open the context menu for the message and select **Select Message** > **setup.**

11. Draw a diagonal message from the `Display` line to the `Dishwasher` line, below the previous message, and then open the context menu for the message and select **Select Message** > **evOpen.**

12. Draw a diagonal message from the `Display` line to the `Dishwasher` line, below the previous message, and then open the context menu for the message and select **Select Message** > **evClose.**

13. Save your model.

Summary

In this lesson, you created a sequence diagram, which show structural elements communicating with one another over time for your dishwasher model. You became familiar with the parts of a sequence diagram and created the following:

- System border
- Classifier roles
- Workflow with messages and events.

You are now ready to proceed to the next lesson, where you are going to build an additional object model diagram that will represent the objects created during execution of the application.

Lesson 6: Creating Objects

In this lesson, you construct an object model diagram that represents the objects that are created when you run the application.

You will also learn to specify the features of a Rational Rhapsody configuration, which represents the details of how you want an application to be built.

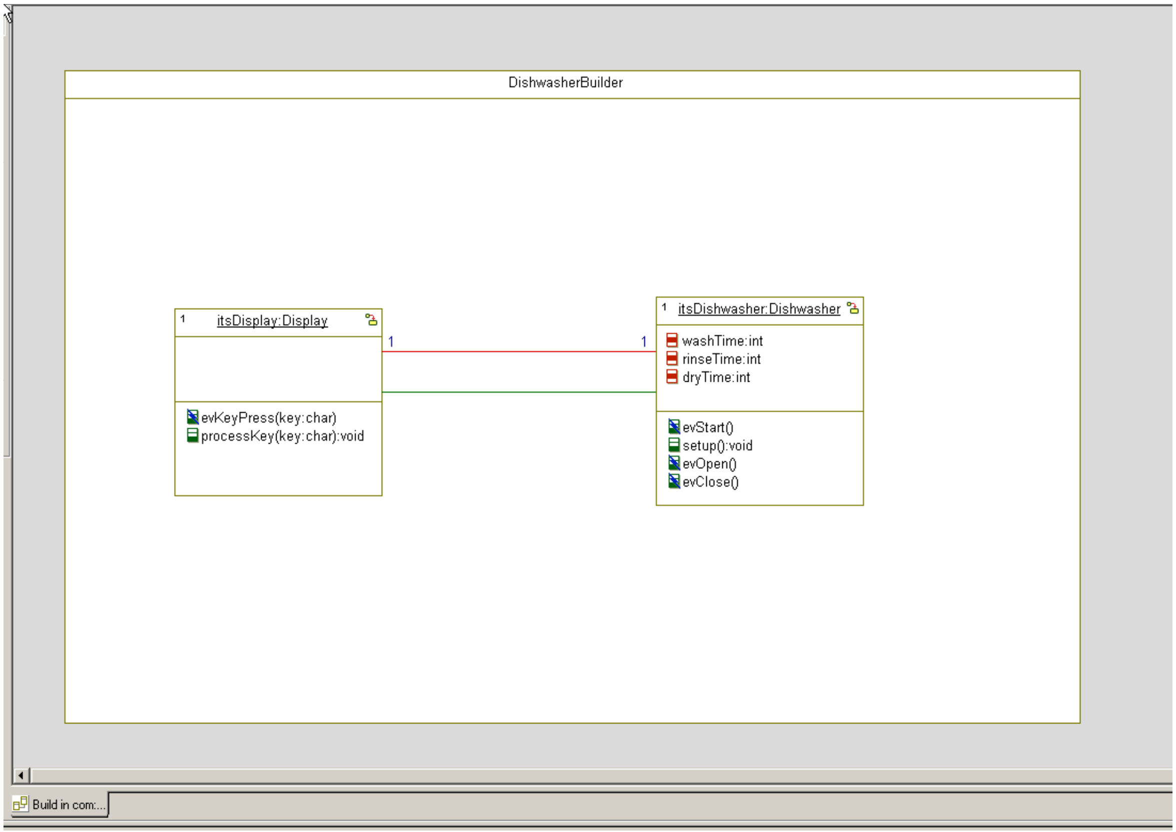
Creating the Build Object Model Diagram

To construct an object model diagram that represents the objects that are to be created when the application is run, follow these steps:

1. Right-click the `dishwasher` package in the browser, and select **Add New** > **Object Model Diagram**. Name the diagram `Build`.
2. Using the Composite Class tool in the Drawing toolbar, add a large composite class called `DishwasherBuilder` to the diagram.
3. Drag the `Display` and `Dishwasher` classes from the browser into the new composite class that you created.
4. Right-click the `Display` class and select **Make an Object**.
5. Right-click the `Dishwasher` class and select **Make an Object**.
6. Using the Association tool in the Drawing toolbar, draw an association between `Display` and `Dishwasher`.
7. Using the Link tool in the Drawing toolbar, draw a link between `Display` and `Dishwasher`.

   Note: Links represent instances of an association.

At this point, your object model diagram should resemble the following figure:



Specifying the Features of a Rational Rhapsody Configuration

To specify how Rational Rhapsody should build the executable for your application, follow these steps:

1. In the Rational Rhapsody browser, open the Components category.
2. Select the component named DefaultComponent, press **F2**, and rename the component `EXE`.
3. Double-click the `EXE` component to open its Features dialog box.
4. On the **Scope** tab of the Features dialog box, select the **All Elements** option.
5. In the browser, under the `EXE` component, open the Configurations category.

6. Select the configuration DefaultConfig, press F2, and rename the configuration `Host`.

7. Double-click the `Host` configuration to open its Features dialog box.

8. On the **Settings** tab of the Features dialog box, set the Instrumentation Mode to **Animation**.

9. On the **Initialization** tab, choose the **Explicit** option under **Initial Instances**, and then open the tree of elements and select the check box for `DishwasherBuilder`.

10. Save the model.

Summary

In this lesson, you:

- created an object model diagram that represents the objects that are created when you run the application
- modified the settings of a Rational Rhapsody configuration to instruct Rational Rhapsody how it should build the executable for your application

Lesson 7: Generating Code, Building and Running your Application

In this lesson, you will:

- Generate Java code for your model
- Build your application from your model
- Run your application using Rational Rhapsody's animation feature

Generating Code from the Model

Your model can contain more than one component. In turn, each component can contain a number of configurations.

When you generate code with Rational Rhapsody, it generates code for the *active* configuration of the *active* component. In the Rational Rhapsody browser, the active component and configuration are displayed in bold.

The active component and configuration are also displayed in the Code toolbar.

In the model built in this tutorial, there is only a single component with a single configuration. So in this case, you do not have to concern yourself with making sure these are the active component/configuration before generating code. Keep in mind that when working with models with multiple components/configurations, you have to check that the correct component and configuration are designated as active before you generate code.

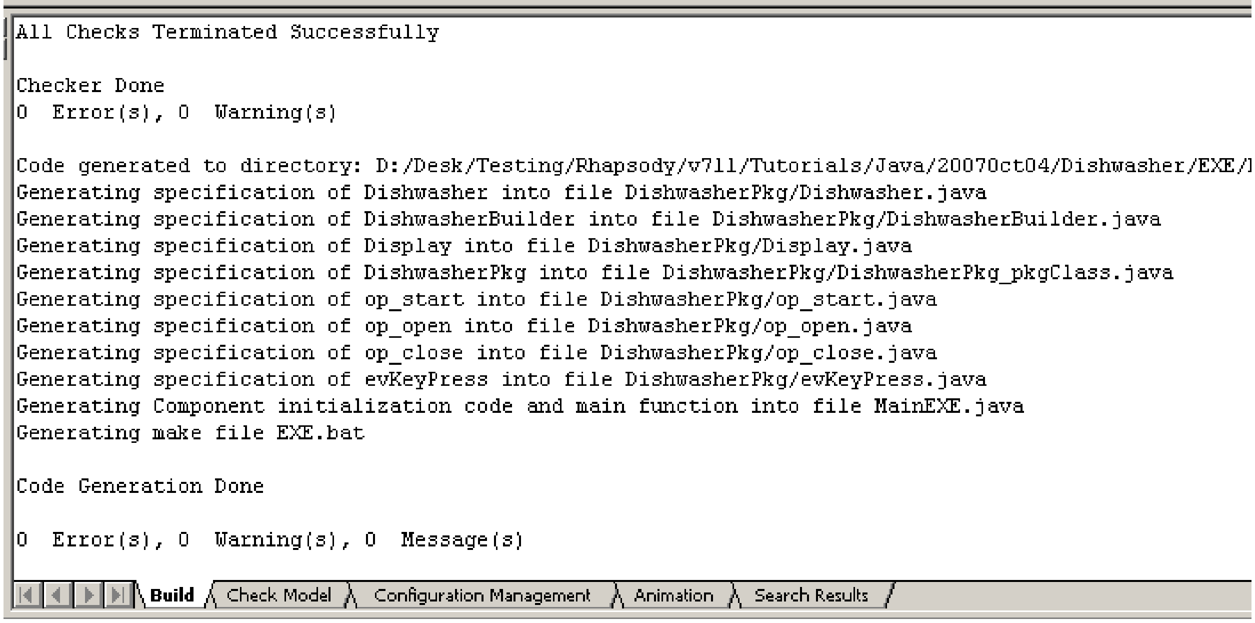
Note

To make a component/configuration active, you can open the context menu for the component/configuration and select **Set as Active**. Alternatively, you can select the component and configuration from the drop-down lists that are included in the Code toolbar.

1. Select **Code** > **Generate** > **Host**. Rational Rhapsody displays a message that the output directory for the **Host** configuration does not yet exist and asks you to confirm its creation.

2. Click **Yes**. Rational Rhapsody places the source files generated in the new `Host` directory.

Rational Rhapsody generates the code and displays output messages in the **Log** tab of the Output window, as shown in the following figure:



```
All Checks Terminated Successfully

Checker Done
0  Error(s), 0  Warning(s)

Code generated to directory: D:/Desk/Testing/Rhapsody/v711/Tutorials/Java/2007Oct04/Dishwasher/EXE/
Generating specification of Dishwasher into file DishwasherPkg/Dishwasher.java
Generating specification of DishwasherBuilder into file DishwasherPkg/DishwasherBuilder.java
Generating specification of Display into file DishwasherPkg/Display.java
Generating specification of DishwasherPkg into file DishwasherPkg/DishwasherPkg_pkgClass.java
Generating specification of op_start into file DishwasherPkg/op_start.java
Generating specification of op_open into file DishwasherPkg/op_open.java
Generating specification of op_close into file DishwasherPkg/op_close.java
Generating specification of evKeyPress into file DishwasherPkg/evKeyPress.java
Generating Component initialization code and main function into file MainEXE.java
Generating make file EXE.bat

Code Generation Done

0  Error(s), 0  Warning(s), 0  Message(s)
```

Note

If the Output window is not visible at the bottom of the Rational Rhapsody window, select **View** > **Output Window** from the main menu.

The messages inform you of the code generation status, including:

- Success or failure of internal checks for the correctness and completeness of your model. These checks are performed before code generation begins.
- Names of files generated for classes and packages in the configuration.
- Names of files into which the **main()** function is generated.
- Completion of code generation.

Fixing Code Generation Errors

If you receive code generation errors, double-click the error in the Output window to go to the source of the error. The source of the error appears as a highlighted element. Once you fix the problem, regenerate the code (choose **Code > Re Generate > Host**) until there are no error messages.

Examining Generated Source Files

To view the code generated for a specific class, right-click on the class in the browser and select **Edit Code**.

If you want to toggle the display of line numbers in the code, do the following:

1. Right-click in the code window and select **Properties** to open the Window Properties dialog box.
2. On the **Misc** tab, in the **Line Numbering** area, select a numbering style from the drop-down list (for example, **Decimal**).
3. Click **OK**.

Building an Application with Rational Rhapsody

Once you generate code without any errors, you are ready to build the model.

To build the model, do one of the following:

- Select **Code** > **Build** > **Build Entire Project**, or
- Click the **Make** button on the **Code** toolbar.

Build messages, including any compilation errors that might have occurred are displayed on the **Build** tab of the Output Window.

If you encounter any compilation errors, double-clicking the error will take you to the problematic model element or problematic code.

Running an Application with Animation

Now that the application has been built, you can run the application and use the Rational Rhapsody animation feature to verify that the application runs correctly.

1. In the Rational Rhapsody browser, double-click the `Execution` sequence diagram to open the diagram.
2. To run the application, do one of the following:

   a. Select **Code** > **Run MainEXE.class**, or

   b. Click the **Run Executable** button ! on the **Code** toolbar.

3. After the console window opens, return to the Rational Rhapsody window. You will see that a dynamic (animated) version of the `Execution` sequence diagram has been opened. At this point, it will only display the various instance lines.

4. Click the **Go** button on the Animation toolbar. You will see Create() messages in the animated sequence diagram, representing the creation of the initial objects.

5. Right-click the `Dishwasher` instance line, and select **Open Animated Statechart**. A dynamic (animated) version of the `Dishwasher` statechart will be opened.

6. Resize the console window that was opened when you ran the application and the Rational Rhapsody window so that you can align the windows side-by-side to see both at once.

7. Enter `s` in the console window and press Enter.

8. Watch the animated statechart as the application progresses through the various states that you defined. The active state at any given moment is highlighted in magenta.

9. In order to simulate the opening of the dishwasher door, enter `s` in the console window and press Enter, and immediately afterwards enter `o` in the console window and press Enter. The application will move to the Open state in the statechart.

    Note: When we earlier defined the attributes that control the movement between the `Washing`, `Rinsing`, and `Drying` states, we used very small numbers (4-5 seconds). If you find that this does not give you enough time to enter the character for simulating the door opening event, you can go to the **Implementation** tab of the Features dialog box for the `setup` operation of the `Dishwasher` class and change the numbers. You will then have to regenerate the code and rebuild the application before running the application (using the **Regenerate** and **Rebuild** options in the **Code** menu).

10. Enter `c` in the console window and press Enter. The application will return to the `Running` state. Note that the application is able to return to the state where it was when the door was opened because we used a History connector in the statechart.

11. Enter `x` in the console window and press Enter. The console window will close and the application will stop running.

Injecting Events with the Animation Toolbar

In order to facilitate the simulation of events for our application, we included a console-based control panel. While this was useful for the limited number of events in this application, it would not be very convenient for a system with dozens of events.

Rational Rhapsody provides an easy way to simulate all of the events you have defined for your application. In this section, you will use this event-injection mechanism.

Note

Since it will probably take you a little while to get used to the GUI controls used in Rational Rhapsody for simulating events, you might want to change the values for the attributes that control the timing of movement between the `Washing`, `Rinsing`, and `Drying` states so that the application stays in the different states for a longer period.

1. In the Rational Rhapsody browser, double-click the `Execution` sequence diagram to open the diagram.

2. Run the application by doing one of the following:

   a. Select **Code** > **Run MainEXE.class**, or

   b. Click the **Run Executable** button on the **Code** toolbar.

3. After the console window opens, return to the Rational Rhapsody window. You will see that a dynamic (animated) version of the `Execution` sequence diagram has been opened. At this point, it will only display the various instance lines.

4. Click the **Go** button on the Animation toolbar. You will see Create() messages in the animated sequence diagram, representing the creation of the initial objects.

5. Right-click the `Dishwasher` instance line, and select **Open Animated Statechart**. A dynamic (animated) version of the `Dishwasher` statechart will be opened.

6. Click the **Event Generator** button on the **Animation** toolbar.

7. When the **Events** dialog is displayed, click the **Select** button and select `DishwasherBuilder[0]->itsDishwasher` from the list of instances.

8. From the drop-down list of events, select `evStart`.

9. Click **OK**.

10. Watch the animated statechart as the application progresses through the various states that you defined. The active state at any given moment is highlighted in magenta.

11. Click the **Event Generator** button on the **Animation** toolbar.

12. When the **Events** dialog is displayed, click the **Select** button and select `DishwasherBuilder[0]->itsDishwasher` from the list of instances.

13. From the drop-down list of events, select `evOpen`.

14. Click **OK**. The application will move to the Open state in the statechart.

15. Click the **Event Generator** button on the **Animation** toolbar.

16. When the **Events** dialog is displayed, click the **Select** button and select `DishwasherBuilder[0]->itsDishwasher` from the list of instances.

17. From the drop-down list of events, select `evClose`.

18. Click **OK**. The application will return to the `Running` state. Note that the application is able to return to the state where it was when the door was opened because we used a History connector in the statechart.

19. Click the **Stop Make/Execution** button on the **Code** toolbar. The application will stop running.

Using Breakpoints with Animation

Rational Rhapsody allows you to add breakpoints to stop execution at various points.

In the model we have been using in this tutorial, once the dishwashing cycle has started, the cycle continues until completed. In this section, we will use a breakpoint to have the application stop when it reaches the `Drying` state.

1. In the Rational Rhapsody browser, double-click the `Execution` sequence diagram to open the diagram.

2. Run the application by doing one of the following:

   a. Select **Code** > **Run MainEXE.class**, or

   b. Click the **Run Executable** button on the **Code** toolbar.

3. After the console window opens, return to the Rational Rhapsody window. You will see that a dynamic (animated) version of the `Execution` sequence diagram has been opened. At this point, it will only display the various instance lines.

4. Click the **Go** button on the **Animation** toolbar. You will see Create() messages in the animated sequence diagram, representing the creation of the initial objects.

5. Right-click the `Dishwasher` instance line, and select **Open Animated Statechart**. A dynamic (animated) version of the `Dishwasher` statechart will be opened.

6. Click the **Breakpoints** button on the **Animation** toolbar.

7. When the Breakpoints dialog box is displayed, click **New**. The Define Breakpoint dialog box is displayed.

8. Click **Select**, and choose `DishwasherBuilder[0]->itsDishwasher` from the list of instances.

9. From the **Reason** drop-down list, select **State Entered**.

10. In the **Data** field, enter `Drying`.

11. Click **OK**.

12. Click the **Event Generator** button on the **Animation** toolbar.

13. When the **Events** dialog is displayed, click the **Select** button and select `DishwasherBuilder[0]->itsDishwasher` from the list of instances.

14. From the drop-down list of events, select `evStart`.

15. Click **OK**.

16. On the animated statechart you will see that the application progresses through the various states, however, it stops after entering the `Drying` state. You will also see on the **Animation** tab of the **Output** window a message indicating that a breakpoint was reached.

17. To allow the application to resume, click the **Go** button on the **Animation** toolbar. Now, the dishwashing cycle will continue until completion.

18. Click the **Stop Make/Execution** button on the **Code** toolbar. The application will stop running.

Summary

In this lesson, you:

- Generated Java code from the model.
- Built the application.
- Ran the application.
- Ran the application with animation.
- Injected events using the Animation toolbar
- Used breakpoints with animation.

This completes the hands-on part of the tutorial. In the next lesson, you find a list of additional Java-specific features provided by Rational Rhapsody, as well as descriptions of many advanced features that were not used in the framework of this tutorial.

Additional Rational Rhapsody Features

This section lists additional Java-specific features of Rational Rhapsody that were not demonstrated in this tutorial.

It also contains descriptions of key Rational Rhapsody features that were not used in the tutorial.

Java-specific Features

Rational Rhapsody includes the following Java-specific features that were not used in this tutorial. You can find information on these features in the *IBM Rational Rhapsody User Guide*.

- Java annotations
- Java enums
- Static import
- Static blocks
- Javadoc
- Java reference model

Additional Rational Rhapsody Features

The following are important features of Rational Rhapsody that were not used in this tutorial. You can find information on these features in the *IBM Rational Rhapsody User Guide*.

- *Reverse engineering*
  Rational Rhapsody can analyze existing code and build a Rational Rhapsody model based on the code.
- *Roundtripping*
  In addition to one-shot analysis of existing code, you can make manual changes to code generated by Rational Rhapsody and then have Rational Rhapsody bring these changes into the model and regenerate code from the updated model.
- *Model reports*
  Rational Rhapsody includes a highly-configurable reporting tool called ReporterPLUS that you can use to generate detailed reports from your model, including text and

diagrams. When you don’t need the flexibility provided by ReporterPLUS, you can use the Rational Rhapsody internal report generator to create basic model reports.

- *Rational Rhapsody API*
  Rational Rhapsody provides an API that can be used to perform most Rational Rhapsody actions from within a script. Two versions of the API are provided: a COM-based API that can be used with C++ or VB/VBA/VBScript, and a Java API that can be used to perform Rational Rhapsody actions from within a Java program.
- *Rational Rhapsody command-line interface*
  A command-line version of Rational Rhapsody is provided to allow you to easily perform Rational Rhapsody actions that do not require the GUI, for example, code generation. The commands provided can be included in scripts in order to perform tasks such as nightly builds.

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