

Using the Beans Development Kit 1.0
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A Tutorial

Alden DeSoto



2550 Garcia Avenue
Mountain View, CA 94043 U.S.A.
408-343-1400

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Getting Started



JavaBeans is a portable, platform-independent software component model written in Java. It enables developers to write reusable components once and run them anywhere - benefiting from the platform-independent power of Java.

Beans may be manipulated in a visual builder tool and composed together into applications. A Bean is any Java class which adheres to certain property and event interface conventions. This short tutorial provides simple examples of how to program to these conventions.

Beans Development Kit (BDK)

The Beans Development Kit (BDK) is a pure Java application whose only dependency is the Java Development Kit (JDK) 1.1. The BDK provides support for the JavaBeans APIs, a test container (the “BeanBox” to test Bean behavior), sample Beans complete with their source code, the JavaBeans Specification, and this Tutorial.

The BeanBox

The BeanBox is a sample container for testing Beans. Currently the BeanBox handles visible Beans, those Beans that have a visual element that an application user can interact with. Invisible Beans, for example purely computational objects, cannot be tested in the BDK 1.0 BeanBox.

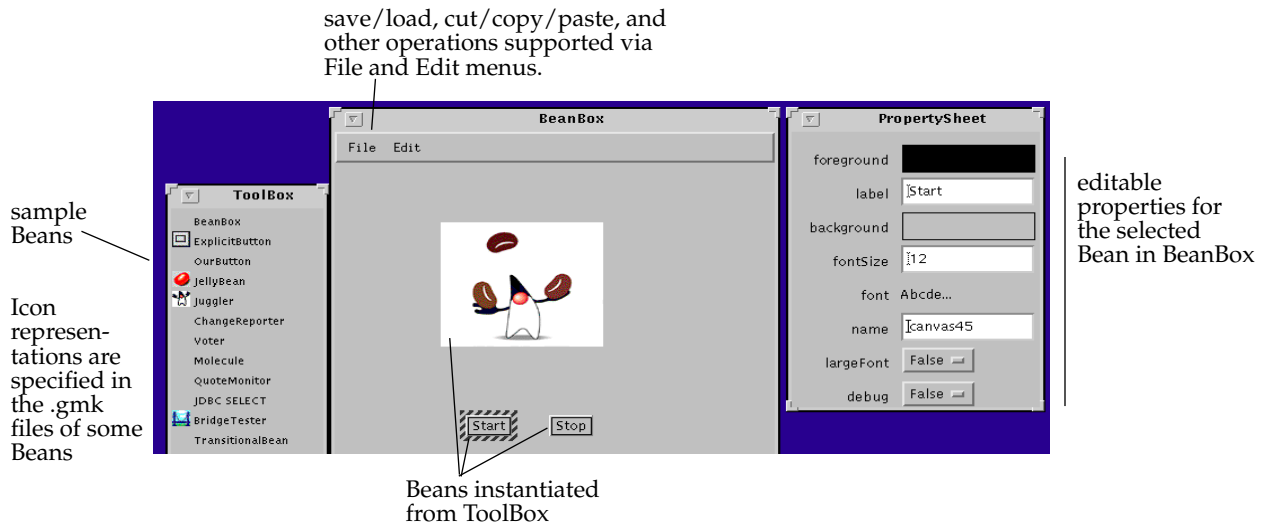
When you start the BeanBox, a ToolBox of sample Beans is displayed. Source code for these Beans is provided in the `demo\sunw\demo\` subdirectory of the distribution.

Testing Sample Beans

Start the BeanBox with the following commands:

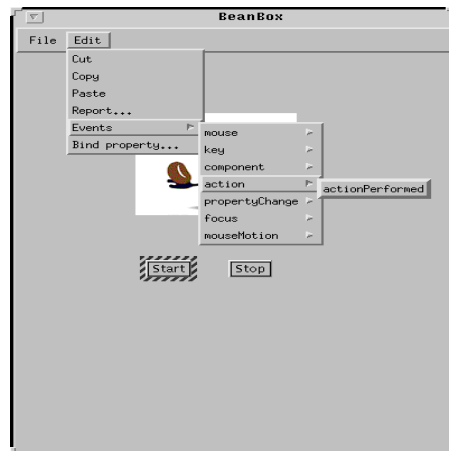
```
C:>cd beanbox
C:>nmake run
```

The BeanBox, ToolBox, and PropertySheet appear on the screen. To instantiate a Bean in the BeanBox, click on the desired Bean in the ToolBox and then click in the BeanBox area. In the example below, a Juggler and two OurButtons have been instantiated in the BeanBox. The buttons have been labeled “Start” and “Stop” by editing the label property in the PropertySheet.



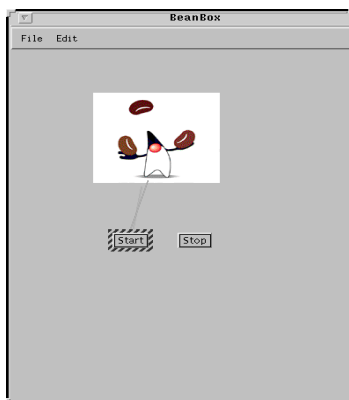
To test the OurButton and Juggler sample Beans:

1. Instantiate two OurButtons and a Juggler in the BeanBox as shown above. Label one button “start” and the other “stop” in the PropertySheet.
2. Select the “start” button.



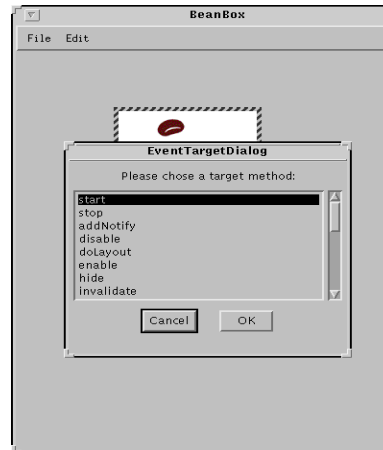
3. Select the Edit-->Events-->action-->actionPerformed pulldown menu as shown above.

The BeanBox positions a line under your mouse arrow which you can use to connect “start” to the Juggler.



4. Connect the line to the Juggler and click the mouse button.

The BeanBox responds with an Event Target Dialog as shown below. Juggler methods which either take no argument or which take an argument of type `actionPerformed` are listed in this dialog.



5. Select the `start` method and press “OK”.

The BeanBox will generate an adapter class. Once the BeanBox has generated this code, press the “start” button in the BeanBox and the Juggler will start juggling.

6. Connect the “stop” button to the Juggler `stop` method in the same fashion.

Test by pressing the “stop” button.

Creating and Testing the Simplest Bean

1. Create a `SimplestBean.java` source file as shown below.

Create a `simplest` directory under `demo\sunw\demo\` and create a `SimplestBean.java` within it.

```
package sunw.demo.simplest;

import java.awt.*;

public class SimplestBean extends Canvas{

    constructor
    sets a visible attribute — public SimplestBean(){
        setBackground(Color.red);
    }

    getMinimumSize — public Dimension getMinimumSize(){
    assures that Bean will be big enough to see in BeanBox return new Dimension(50,50);
    }
}
```

2. Create a SimplestBean.mk file as shown below.

Create this file in the demo\ directory. Refer to the sample Bean .mk files provided in demo\ for additional examples.

```
list of compiled — CLASSFILES= \
class files          sunw\demo\simplest\SimplestBean.class

Beans in — JARFILE= ..\jars\SimplestBean.jar
in this location will
be found by the
BeanBox      .SUFFIXES: .java .class

all: $(JARFILE)

package classes | $(JARFILE): $(CLASSFILES) $(DATAFILES)
"Java-Bean: True" | jar cfm $(JARFILE) <<manifest.tmp sunw\demo\simplest\*.class
causes class to | $(DATAFILES)
appear in Toolbox | Name: sunw/demo/simplest/SimplestBean.class
                  | Java-Bean: True
                  | <<
                  | # Rule for compiling a normal .java file
                  | {sunw\demo\simplest}.java{sunw\demo\simplest}.class :
                  | set CLASSPATH=.
                  | javac $<

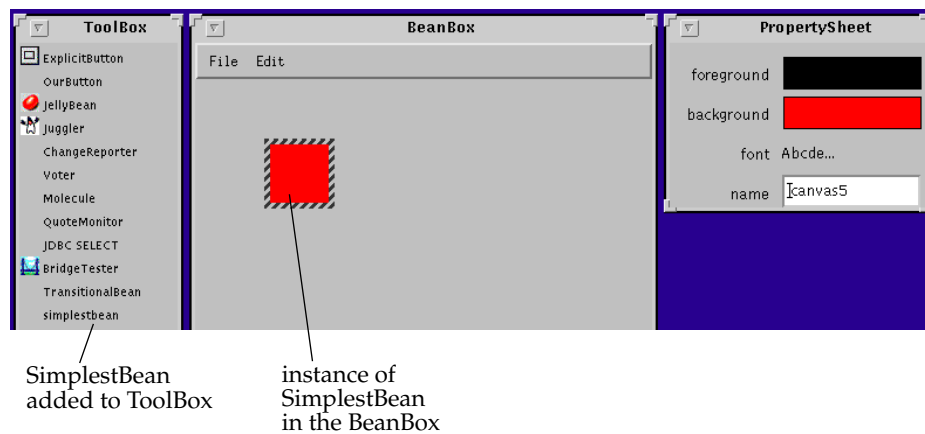
clean:
    -del sunw\demo\simplest\SimplestBean.class
    -del $(JARFILE)
```


3. Build the example

```
C:>nmake -f SimplestBean.mk
```

4. Run the BeanBox and create an instance of your SimplestBean.

Your simplestbean will automatically appear in the ToolBox at startup.



Properties



A property is a single public attribute. Properties can be read/write, read-only or write-only. There are several types of properties: simple, indexed, bound, and constrained.

Simple Properties

A simple property represents a single value and can be defined with a pair of get/set methods. A property's name is derived from the method names. For example the method names `setX` and `getX` indicate a property named "X". A method name `isX` by convention indicates that "X" is a boolean property.

property will — be called ourString	<pre> public class alden2 extends Canvas { String ourString="Hello"; public alden2(){ setBackground(Color.red); setForeground(Color.blue); } "set" property — public void setString(String newString){ ourString = newString; } "get" property — public String getString() { return ourString; } public Dimension getMinimumSize(){ return new Dimension(50,50); } } </pre>
---	---

Indexed Properties

An indexed property represents an array of values. Property element get/set methods take an integer index parameter. The property may also support getting and setting the entire array at once.

The BDK 1.0 BeanBox does not support indexed properties.

dataSet is an — indexed property	<pre>public class alden3 extends Canvas { int[] dataSet={1,2,3,4,5,6}; public alden3(){ setBackground(Color.red); setForeground(Color.blue); } public void setDataSet(int[] x){ dataSet=x; } public void setDataSet(int index, int x) { dataSet[index]=x; } public int[] getDataSet() { return dataSet; } public int getDataSet(int x) { return dataSet[x]; } public Dimension getMinimumSize(){ return new Dimension(50,50); } }</pre>
set entire array —	
set one element— of array	
get entire array —	
get one element — of array	

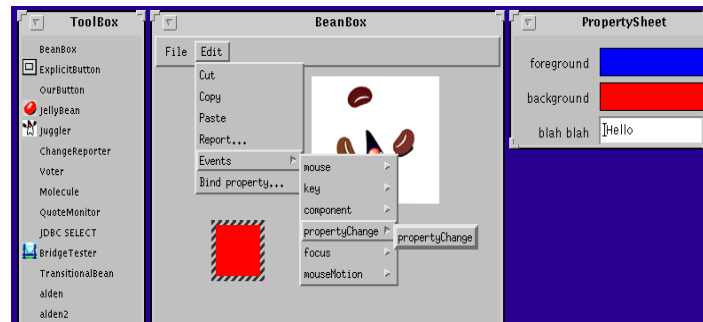
Bound Properties

A bound property notifies other objects when its value changes. Each time its value is changed, the property fires a `PropertyChange` event which contains the property name, old, and new values. Notification granularity is per bean, not per property.

<p>declare and instantiate a property change object</p>	<p>—</p>	<pre> public class alden5 extends Canvas { String ourString="Hello"; private PropertyChangeSupport changes = new PropertyChangeSupport(this); public alden5() { setBackground(Color.red); setForeground(Color.blue); } public void setString(String newString){ String oldString = ourString; ourString = newString; changes.firePropertyChange("string",oldString,newString); } public String getString() { return ourString; } public Dimension getMinimumSize() { return new Dimension(50,50); } public void addPropertyChangeListener(PropertyChangeListener l) { changes.addPropertyChangeListener(l); } public void removePropertyChangeListener(PropertyChangeListener l) { changes.removePropertyChangeListener(l); } } </pre>
<p>send change event to listeners when property is changed</p>	<p>—</p>	
<p>implement methods to add and remove listeners. The BeanBox will call these methods when a connection is made.</p>	<p> </p>	

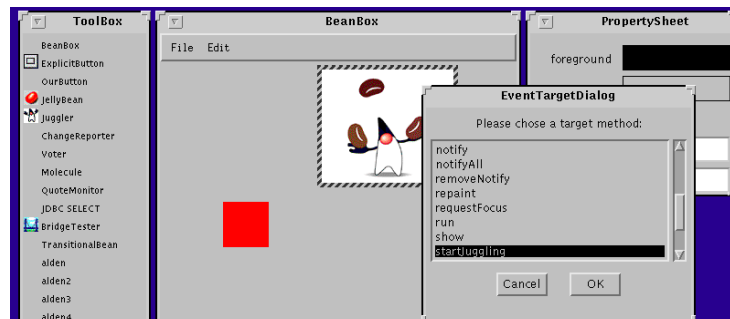
You can test bound properties in the BeanBox as follows.

1. **Instantiate a Bean with bound properties and any other Bean in the Beanbox. Select the Bean with bound properties.**
2. **Select the Edit-->Events-->propertyChange-->propertyChange pulldown menu as shown below.**



3. Connect the Bean with bound properties to the second Bean and select a target method.

The BeanBox will add the second bean to the bound property Bean's list of listeners.



4. When the BeanBox has finished generating code, change the bound property value in the PropertySheet.

The selected method on the listener bean will be invoked.

Constrained Properties

An object with constrained properties allows other objects to veto a constrained property value change. Constrained property listeners can veto a change by throwing a `PropertyVetoException`.

The `JellyBean` class in `demo\sunw\demo\jelly\` has a constrained property called `PriceInCents`.

	<pre> public class JellyBean extends Canvas { private PropertyChangeSupport changes = new PropertyChangeSupport(this); private VetoableChangeSupport vetos = new VetoableChangeSupport(this); public void setPriceInCents(int newPriceInCents) throws PropertyVetoException { int oldPriceInCents = ourPriceInCents; vetos.fireVetoableChange("priceInCents", new Integer(oldPriceInCents), new Integer(newPriceInCents)); ourPriceInCents = newPriceInCents; changes.firePropertyChange("priceInCents", new Integer(oldPriceInCents), new Integer(newPriceInCents)); } public void addVetoableChangeListener(VetoableChangeListener l) { vetos.addVetoableChangeListener(l); } public void removeVetoableChangeListener(VetoableChangeListener l) { vetos.removeVetoableChangeListener(l); } } </pre>
set method throws a <code>PropertyVetoException</code>	
tell vetoers about the change; exception is not caught but passed on to caller.	
change the property and send change event to listeners	
define methods to add and remove veto ers.	

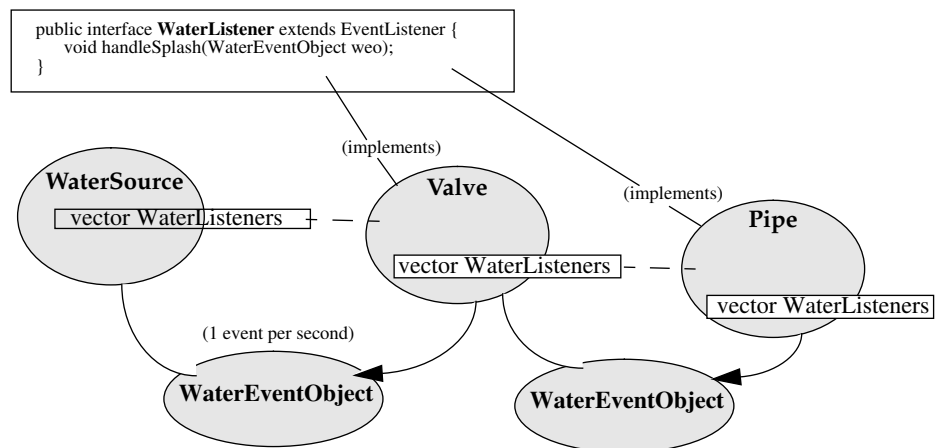
In general, constrained properties should also be bound. As illustrated above with `PriceInCents`, the source should notify any registered `vetoableChange` listeners that a `vetoableChange` has been proposed. If the change is acceptable,

the source notifies any registered `propertyChange` listeners that the change has completed. If any vetoable change listener rejects the change then a new `vetoableChange` event will be delivered reverting to the previous value.

This allows a property watcher to either:

- treat constrained/bound property updates in a "two phase" fashion by registering both a `VetoableChangeListener` and a `PropertyChangeListener`. The watcher ignores the `vetoableChange` event unless it wants to veto the change. At `propertyChange` event time it acts on the new value, as it knows that this new value has successfully passed the `vetoableChange` phase.
- register only a `vetoableChange` listener. In this case, the watcher will be notified about proposed changes and will also get subsequently notified if the proposed change is vetoed. This approach means that the watcher is deliberately choosing to assume that vetoable changes will "pass" and is prepared to act on information that may be subsequently vetoed.

This chapter uses three example Beans to explain Events: WaterSource, Valve, and Pipe. A WaterSource drips one WaterEventObject per second to its list of WaterListeners. The list of WaterListeners may include any number and/or combination of Valves and Pipes. An open Valve passes on WaterEventObjects that it receives to its own list of WaterListeners. A closed Valve does not pass on any WaterEventObjects. A Pipe behaves in the same way as an open Valve.



WaterEventObject

WaterListeners
check timeOfEvent
to determine
whether it is more
than 2 seconds old.

```
public class WaterEventObject extends EventObject {
    long timeOfEvent;

    public WaterEventObject(Object o) {
        super(o);
        timeOfEvent = System.currentTimeMillis();
    }

    public long getTimeOfEvent() {
        return timeOfEvent;
    }
}
```

WaterSource

maintain a list of
of objects which have
registered to receive
water events

```
public class WaterSource extends Canvas implements Runnable {

    private Vector waterListeners = new Vector();
    Thread thread;

    public WaterSource() {
        setBackground(Color.blue);
        thread = new Thread(this);
        thread.start();
    }

    public Dimension getMinimumSize()
    {
        return new Dimension(15,15);
    }

    public void run() {
        while(true) {
            splash();
            try {
                thread.sleep(1000);
            } catch (Exception e) {}
        }
    }
}
```

BeanBox will call these methods to add and remove registered listeners

```
public synchronized void addWaterListener(WaterListener l) {
    waterListeners.addElement(l);
}

public synchronized void removeWaterListener(WaterListener l) {
    waterListeners.removeElement(l);
}
```

send a water event to registered listeners

```
private void splash() {
    Vector l;
    WaterEventObject weo = new WaterEventObject(this);
```

you must copy the vector before sending the event in order to avoid a timing race

```
    synchronized(this) {
        l = (Vector)waterListeners.clone();
    }

    for (int i = 0; i < l.size(); i++) {
        WaterListener wl = (WaterListener) l.elementAt(i);
        wl.handleSplash(weo);
    }
}
```

Valve

```
public class Valve extends Canvas implements WaterListener,
                                                    Runnable {
```

list of listeners
last water event received
open/close valve property

```
    private Vector waterListeners = new Vector();
    private WaterEventObject lastWaterEvent;
    private boolean open = true;
    Thread thread;
```

property get and set methods

```
    public Valve() {
        setBackground(Color.white);
        thread = new Thread(this);
        thread.start();
    }

    public boolean isOpen() {
        return open;
    }

    public void setOpen(boolean x) {
        open = x;
    }
```

this method is specified in the WaterListener interface (which this class implements).

```
public Dimension getMinimumSize() {
    return new Dimension(20,30);
}
```

```
public void handleSplash(WaterEventObject e) {
    lastWaterEvent = e;
    if (isOpen()) {
        setBackground(Color.blue);
        repaint();
        splash();
    }
}
```

make the valve white if a WaterEventObject has not been recieved in the last 2 seconds or if the valve is closed

```
public void run() {
    while(true) {
        try {
            thread.sleep(1000);
        } catch (Exception e) {}

        if (lastWaterEvent != null) {
            long dt = System.currentTimeMillis() -
                lastWaterEvent.getTimeOfEvent();
            if ((dt > 2000) || (!isOpen())) {
                setBackground(Color.white);
                repaint();
            }
        }
    }
}
```

BeanBox will call these methods to add and remove registered listeners

```
public synchronized void addWaterListener(WaterListener l) {
    waterListeners.addElement(l);
}

public synchronized void removeWaterListener(WaterListener l) {
    waterListeners.removeElement(l);
}
```

send a water event to registered listeners

```
void splash() {
    Vector l;
    WaterEventObject weo = new WaterEventObject(this);

    synchronized(this) {
        l = (Vector)waterListeners.clone();
    }
}
```

... method continued on next page

send a water event to
registered listeners

... method continued from
previous page

```

        for (int i = 0; i < l.size(); i++) {
            WaterListener wl = (WaterListener) l.elementAt(i);
            wl.handleSplash(weo);
        }
    }
}

```

Pipe

```

public class Pipe extends Canvas implements WaterListener,
                                             Runnable {

```

list of listeners ——— private Vector waterListeners = new Vector();
last water event received — private WaterEventObject lastWaterEvent;
Thread thread;

```

    public Pipe() {
        setBackground(Color.white);
        thread = new Thread(this);
        thread.start();
    }

```

```

    public Dimension getMinimumSize() {
        return new Dimension(150,10);
    }

```

This method is specified
in the WaterListener
interface (which this object
implements)

```

    public void handleSplash(WaterEventObject e) {
        lastWaterEvent = e;
        setBackground(Color.blue);
        repaint();
        splash();
    }

```

```

    public void run() {
        while(true) {
            try {
                thread.sleep(1000);
            } catch (Exception e) {}
        }
    }

```

make the pipe white if
a water event has not
been received in the
last 2 seconds

```

        if (lastWaterEvent != null) {
            long dt = System.currentTimeMillis() -
                    lastWaterEvent.getTimeOfEvent();
            if (dt > 2000) {
                setBackground(Color.white);
                repaint();
            }
        }
    }

```

BeanBox will call these methods to add and remove registered listeners

```

    }
    }
    public synchronized void addWaterListener(WaterListener l) {
        waterListeners.addElement(l);
    }
    public synchronized void removeWaterListener(WaterListener l) {
        waterListeners.removeElement(l);
    }

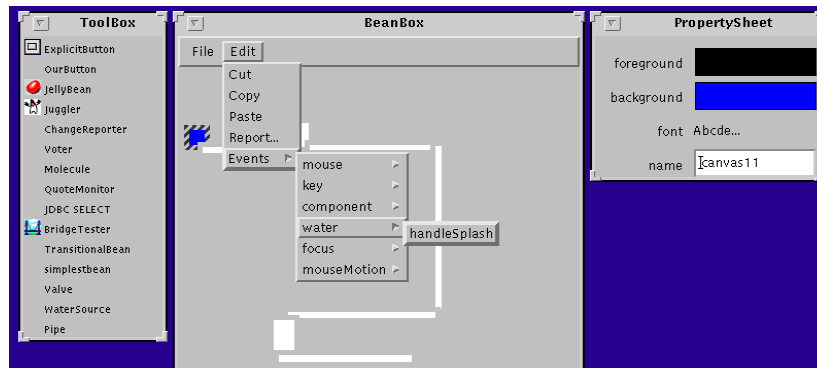
    void splash() {
        WaterEventObject weo = new WaterEventObject(this);

        for (int i = 0; i < waterListeners.size(); i++) {
            WaterListener wl =
                (WaterListener) waterListeners.elementAt(i);
            wl.handleSplash(weo);
        }
    }
}

```

Testing WaterSource, Valve, and Pipe

1. Instantiate a collection of WaterSources, Valves, and Pipes in the BeanBox.
2. Select a WaterSource Bean and invoke the Edit-->Events-->water-->handleSplash pulldown as shown in the picture below.

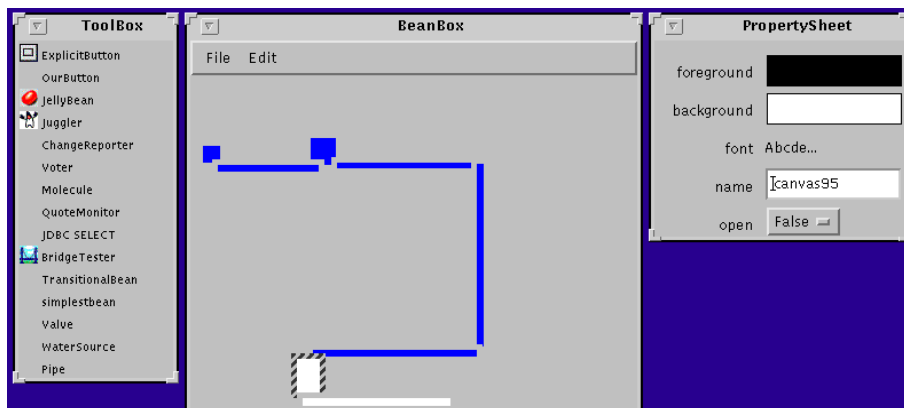


3. Connect the WaterSource to a Pipe or Valve and select the handleSplash method in the EventTargetDialog.

The BeanBox will generate an adaptor class.

4. Continue to connect water event producers to water event consumers as desired.

You can manipulate the water flow by turning valves on and off as illustrated in the example below.



You can customize how a Bean appears and behaves within a builder environment by using the Customizer, PropertyEditor, and BeanInfo interfaces as described in this chapter.

Customizer Interface

Implement the `java.beans.Customizer` interface to provide your own GUI implementation of the property sheet. For example, the `OurButton` bean in `demo\sunw\demo\buttons\` is packaged with a custom property sheet:

```
public OurButtonCustomizer extends Panel implements Customizer {
```

When implementing a custom property sheet such as `OurButtonCustomizer`, be sure to implement `addPropertyChangeListener` and `removePropertyChangeListener`. These will allow the `BeanBox` or other builder environment to add property event listeners for the Bean as required.

```
private PropertyChangeSupport support =
    new PropertyChangeSupport(this);

public void addPropertyChangeListener(PropertyChangeListener l) {
    support.addPropertyChangeListener(l)
}

public void
removePropertyChangeListener(PropertyChangeListener l){
    support.removePropertyChangeListener(l)
}
```

PropertyEditor Interface

Implement the PropertyEditor interface to create a custom editor for a specific property. The MoleculeNameEditor class in demo\sun\demo\molecule\ of the distribution provides a good example of this.

If you provide a custom property editor class, you must refer to this class with a call to PropertyDescriptor.setPropertyEditorClass in a BeanInfo class (see next section).

PropertyEditorSupport
is a basic implementation
of the PropertyEditor
interface

```
public class MoleculeNameEditor
    extends java.beans.PropertyEditorSupport {

    public String[] getTags() {
        String result[] = {
            "HyaluronicAcid",
            "benzene",
            "buckminsterfullerine",
            "cyclohexane",
            "ethane",
            "water"};
        return result;
    }
}
```

BeanInfo Interface

Each Bean class may have a BeanInfo class which customizes how the Bean is to appear in a builder. The BeanInfo can define properties, methods, events, with display names and short help.

The example shown below is from `MoleculeBeanInfo.java` in `demo\sunw\demo\molecule\` of the distribution.

`SimpleBeanInfo`
is a basic implementation
of the `BeanInfo` interface

Point to custom property
editor

```
public class MoleculeBeanInfo extends SimpleBeanInfo {  
    public PropertyDescriptor[] getPropertyDescriptors() {  
        try {  
            PropertyDescriptor pd = new PropertyDescriptor(  
                "moleculeName", Molecule.class);  
            pd.setPropertyEditorClass(MoleculeNameEditor.class);  
            PropertyDescriptor result[] = { pd };  
            return result;  
        } catch (Exception ex) {  
            System.err.println("MoleculeBeanInfo:  
                               unexpected exeption: " + ex);  
            return null;  
        }  
    }  
}
```

The `ExplicitButtonBean` in `demo\sunw\demo\buttons\` also illustrates the use of a `BeanInfo` class. `ExplicitButtonBeanInfo` defines four property descriptors, rather than just one as in `MoleculeBeanInfo`. Note that properties are displayed in the order they are listed in the `PropertyDescriptor`.

`ExplicitButtonBean` also illustrates the use of `EventSetDescriptor` and `BeanDescriptor`. `EventSetDescriptor` allows you to specify the text labels used in event dialogs and pulldowns. `BeanDescriptor` allows you to graphic image files to represent the Bean.

To make fields in a Bean class persistent, simply define the class as implementing `java.io.Serializable`.

```
public class Button implements java.io.Serializable {  
}
```

The fields in any instance of a Bean which implements `Serializable` will automatically be saved. You need do nothing else. You can prevent selected fields from being saved by marking them `transient` or `static`; `transient` and `static` variables are not saved.

What to Save

Generally, a Bean should store the state of any exposed properties. Selected internal state variables may also be saved. Beans should not, however, store pointers to external Beans.

Changes and Versioning

As you update software, you can add fields, add or remove references to classes, change a field's `private/protected/public` status without altering the persistence schema of the class. However, deleting fields from the class, changing a variable's position in the class hierarchy, changing a field to or from `transient/static`, or changing a field's data type will change the persistence schema.

If you need to make changes to a class which alter its persistence, you might define a version id field which can be checked at runtime. For example,

```
static final long serialVersionUID 348749695999L;
```

JavaBeans are distributed through JAR files. A JAR file is a ZIP format archive file that may optionally have a MANIFEST file. The MANIFEST describes the contents of the JAR file. A JAR file may contain .class files, serialized Beans (.ser), help files in HTML format, and resources (images , audio, text).

MANIFEST file

If a JAR file does not have a MANIFEST, then all classes and serialized objects in the package are treated as beans. Providing a MANIFEST file allows you to specify which classes are Beans via "Java-Bean: True" entries (see Example below).

Example

This example .mk file illustrates the compiling and packaging of three Beans and two auxiliary classes. This .mk file was used to package the example discussed in chapter 3, "Events".


```

CLASSFILES= \
    sunw\demo\valves\WaterListener.class \
    sunw\demo\valves\WaterSource.class \
    sunw\demo\valves\Valve.class \
    sunw\demo\valves\Pipe.class \
    sunw\demo\valves\WaterEventObject.class

JARFILE= ..\jars\valves.jar

.SUFFIXES: .java .class

all: $(JARFILE)

# Create a JAR file with a suitable manifest.

$(JARFILE): $(CLASSFILES) $(GIFFILES)
jar cfm $(JARFILE) <<manifest.tmp sun\demo\valves\*.class $(GIFFILES)

do not display _____
in ToolBox      Name: sunw/demo/valves/WaterListener.class
                Java-Bean: False

                Name: sunw/demo/valves/WaterSource.class
                Java-Bean: True

                Name: sunw/demo/valves/Valve.class
                Java-Bean: True

                Name: sunw/demo/valves/Pipe.class
                Java-Bean: True

do not display _____
in ToolBox      Name: sunw/demo/valves/WaterEventObject.class
                Java-Bean: False
                <<

# Rule for compiling a normal .java file
{sunw\demo\valves}.java{sun\demo\valves}.class :
    set CLASSPATH=..\classes;.
    javac $<

clean:
    -del sunw\demo\valves\*.class
    -del $(JARFILE)

```