Using the Beans Development Kit 1.0
February 1997
A Tutorial

Alden DeSoto

JAVASOFT
A Sun Microsystems, Inc. Business

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

Feb97rev3

Contents

1. Getting Started **1-1**

Beans Development Kit (BDK) 1-1

The BeanBox 1-1

Testing Sample Beans 1-2

Creating and Testing the Simplest Bean 1-4

2. Properties **2-1**

Simple Properties 2-1

Indexed Properties 2-2

Bound Properties 2-3

Constrained Properties 2-6

3. Events **3-1**

WaterEventObject 3-2

WaterSource 3-2

Valve 3-3

Pipe 3-5

Testing WaterSource, Valve, and Pipe 3-6

4. Customization 4-1

Customizer Interface 4-1

PropertyEditor Interface 4-2

BeanInfo Interface 4-2

5. Persistence 5-1

What to Save 5-1

Changes and Versioning 5-1

6. Packaging 6-1

MANIFEST file 6-1

Example. 6-1

Getting Started 1

JavaBeans is a software component model which allows third party Java components, or Beans, to interact with one another. Beans may be manipulated in a visual builder tool and composed together into applications. A Bean is a 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.

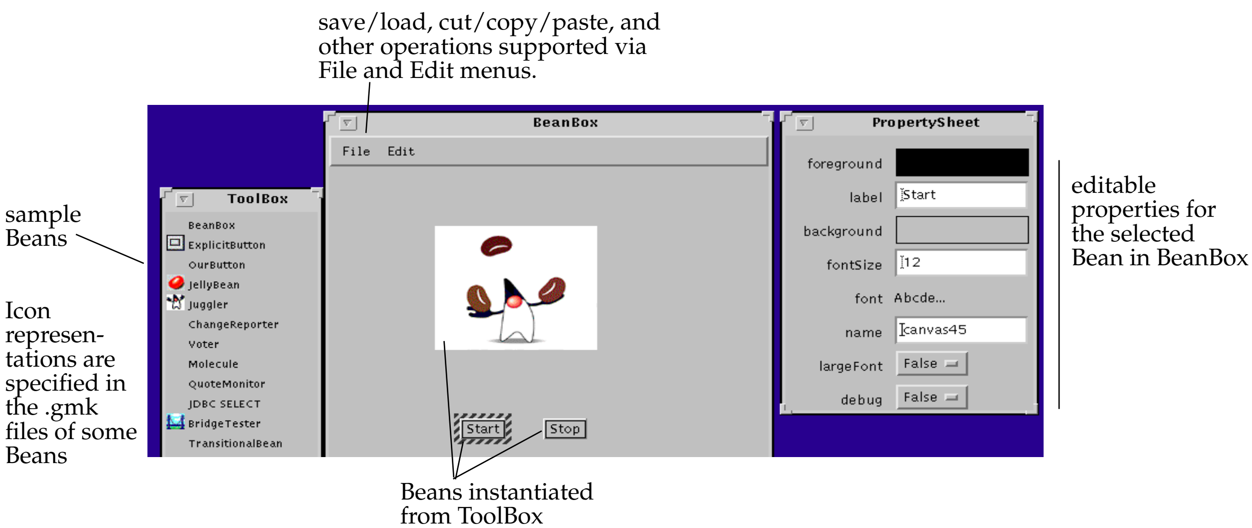
When you start the BeanBox, a ToolBox of sample Beans is displayed. Source code for these Beans is provided in the `demo\sunw\demo\` subdirectory of the distribution.

Testing Sample Beans

Start the BeanBox with the following commands:

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

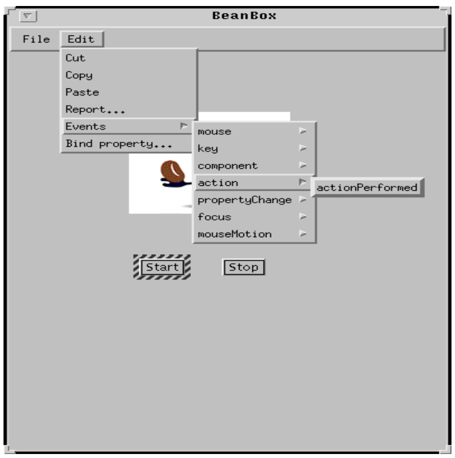
The BeanBox, ToolBox, and PropertySheet appear on the screen. To instantiate a Bean in the BeanBox, click on the desired Bean in the ToolBox and then click in the BeanBox area. In the example below, a Juggler and two OurButtons have been instantiated in the BeanBox. The buttons have been labeled “Start”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



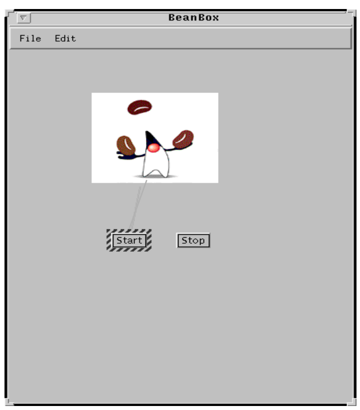
To test the OurButton and Juggler sample Beans:

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

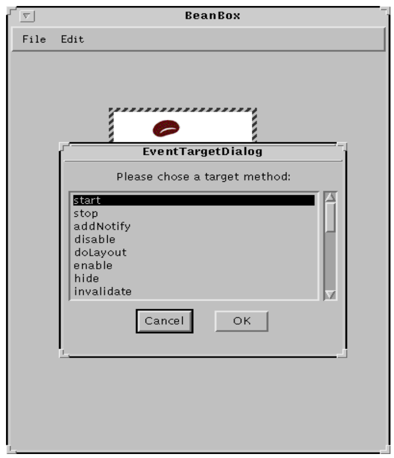
2. **Select the “start” button.**



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.

constructor sets a visible attribute

getMinimumSize assures that Bean will be big enough to see in BeanBox

```
package sunw.demo.simplest;

import java.awt.*;

public class SimplestBean extends Canvas{

  public SimplestBean(){
    setBackground(Color.red);
  }

  public Dimension getMinimumSize(){
    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 class files

Beans in in this location will be found by the BeanBox

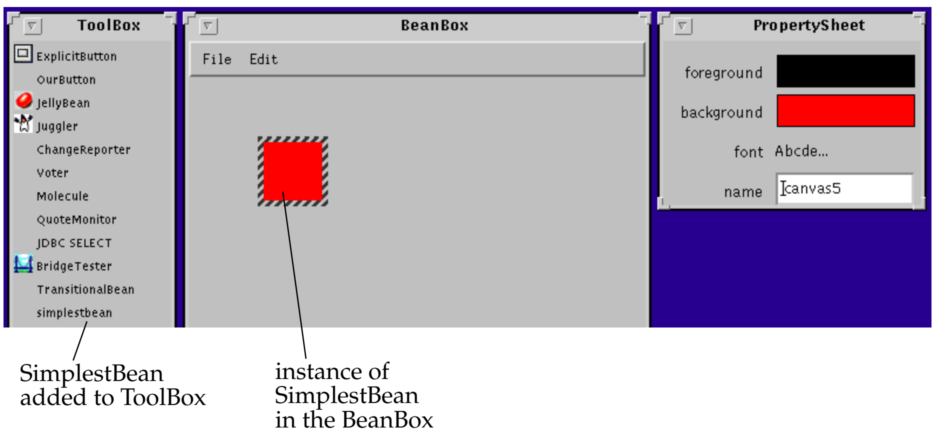
package classes "Java-Bean: True" causes class to appear in Toolbox

```
CLASSFILES= \
        sunw\demo\simplest\SimplestBean.class

JARFILE= ..\jars\SimplestBean.jar

.SUFFIXES: .java .class

all: $(JARFILE)

$(JARFILE): $(CLASSFILES) $(DATAFILES)
    jar cfm $(JARFILE) <<manifest.tmp sunw\demo\simplest\*.class
       $(DATAFILES)
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 2

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

"set" property

"get" property

```
public class alden2 extends Canvas {
  String ourString="Hello";

  public alden2(){
    setBackground(Color.red);
    setForeground(Color.blue);
  }

  public void setString(String newString){
    ourString = newString;
  }

  public String getString() {
    return ourString;
  }

  public Dimension getMinimumSize(){
    return new Dimension(50,50);
  }

}
```

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

set entire array

set one element of array

get entire array

get one element of array

```
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);
  }
}
```

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.

declare and instantiate a property change object

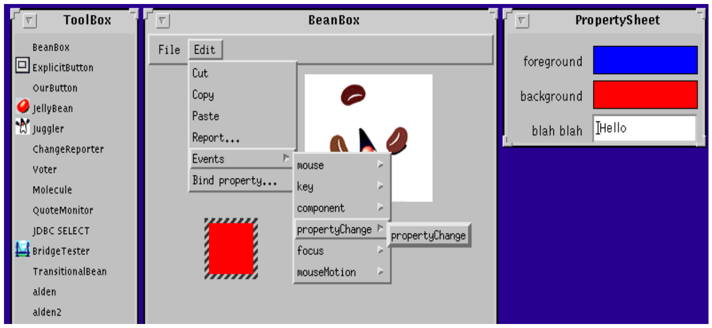
send change event to listeners when property is changed

implement methods to add and remove listeners. The BeanBox will call these methods when a connection is made.

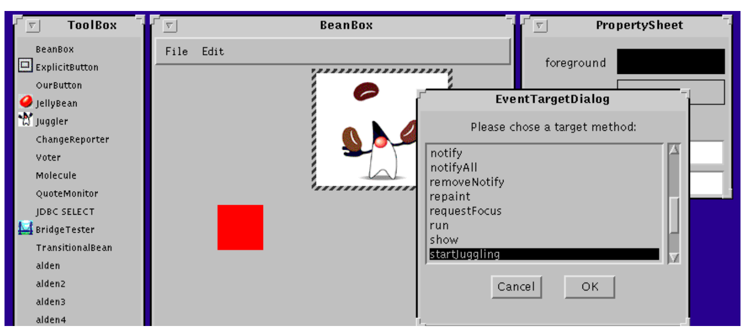
```
public class alden5 extends Canvas {
  String ourString="Hello";
  private PropertyChangeSupport changes =
                       new PropertyChangeSupport(this);

  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);
  }

}
```

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.

set method throws a PropertyVetoException

tell vetoers about the change; exception is not caught but passed on to caller.

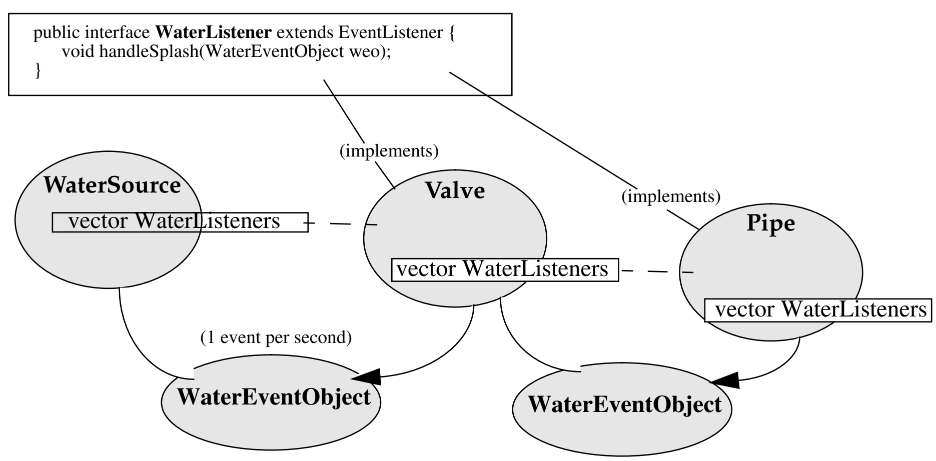
change the property

define methods to add and remove veto ers.

```
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);
    }

 ......
}
```

Events 3

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 objects which have registered to recieve 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

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

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

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

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

}
```

Valve

list of listeners

last water event received

open/close valve property

property get and set methods

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

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


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

public boolean isOpen() {
    return open;
}

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

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

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

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

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();
        }
      }
    }
}
```

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

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

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

BeanBox will call these methods to add and remove registered listeners

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

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

send a water event to registered listeners

... 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
last water event received

```
    private Vector waterListeners = new Vector();
    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) {}

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

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

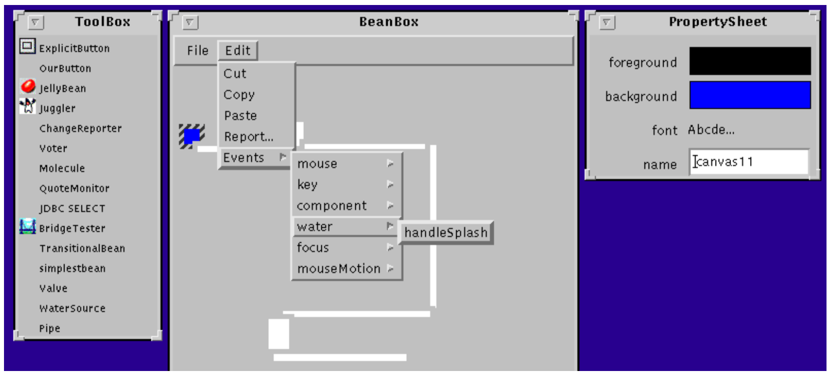
BeanBox will call these methods to add and remove registered listeners

```
            }
        }
    }
    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

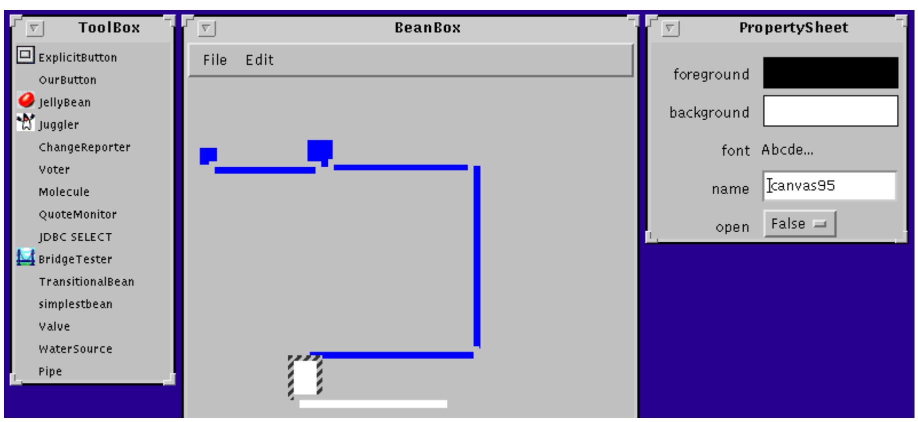
1. **Instantiate a collection of WaterSources, Valves, and Pipes in the BeanBox.**

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.



Customization 4

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.

Persistence 5

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;
```

Packaging 6

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)
```