Cincom

VisualWorks®

Walk Through

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Preface

Since the original publication of the WalkThrough with VisualWorks 5i.2, the system has undergone major changes, all for the better. Updates for versions 5i.3 and 5i.4 were important, and I provided updated versions of the WalkThrough, even though some of my comments poking fun at some idiosyncracies had to be removed, as the objects of comment were.

With VisualWorks 7, major changes have been made to the system, as the result of outstanding work within the VisualWorks engineering team and generous contributions from the VisualWorks user community. An unfortunate casualty of so much advancement was an update the WalkThrough in time for 7. This was corrected for 7.1, but 7.2 and 7.3 were missed. For 7.4, I am catching up again, and so this latest edition of the WalkThrough is presented.

So many changes. The 5i browsers, the object of many disparaging comments, have been replaced with much better browsers based on the Refactoring Browser by Refactory, Inc. These browsers are themselves being refined as experience proves necessary, but the overall quality is much improved.

The general appearance has been improved steadily. Gone are my opportunities to make fun of Eliot's icons, as Vassili has replaced them.

The UI Painter interface has similarly been reworked, and is much more usable, thanks to Sam's diligent efforts.

Similar changes have been made throughout the VisualWorks system, though I neglect to mention them here.

So, with so much of my fun undercut in this way, why bother with an update? Because VisualWorks is much more fun to use now. And, it is still a complex system, requiring the kind of guidance provided by the first edition.

Smalltalk is once again gaining notice in the programming world. With this updated edition of the WalkThrough, I hope to encourage many more explorers to discover VisualWorks.

1

A Walk-Through of VisualWorks

This short document is directed at new users of VisualWorks and Smalltalk. When you first load a new tool, especially a programming tool, it is seldom obvious just what to make of it. This can be all the more true when it is a programming language and environment like Smalltalk.

It's easy to get off on the wrong foot, and so start out thinking about VisualWorks wrong-way around. The purpose of this walk-through is to orient you to the landscape, show you the tools, demonstrate a quick, and common, approach to prototype-application development, and point out a variety of features of VisualWorks and Smalltalk along the way.

At various points, additional reading is suggested, but it is not required for completing the walk-through. Many of the features pointed out are talked about in far more detail in the places mentioned. In the walk-through, I'm content to call them to your attention, and point you to further reading.

The primary additional document is the VisualWorks *Application Developer's Guide*, which contains a pretty comprehensive description of the features of the VisualWorks environment. The *Basic Libraries Guide* describes the main Smalltalk class libraries that you will need when creating a program. For GUI development, the *GUI Developer's Guide* is the primary source. Becoming familiar with these documents will yield great dividends as you continue learning VisualWorks.

In the beginning…

No, I'll not go back that far. In fact, I'm assuming you already have VW 7.4 installed, either a commercial or noncommercial release. If you have an earlier version of VisualWorks, use an earlier edition of this WalkThrough. The tools have been undergoing extensive changes through the 7.x

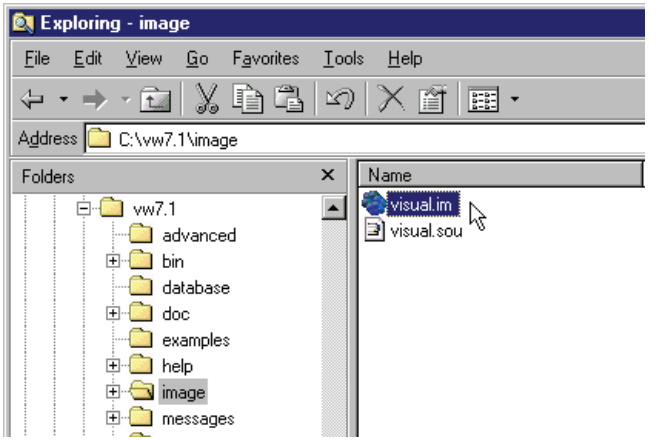
releases, and you should avoid any confusion caused by mismatched tools, if possible. But, VW 7.4 non-commercial is available for free, so you might as well download it and get the latest and greatest available.

Quick Launch

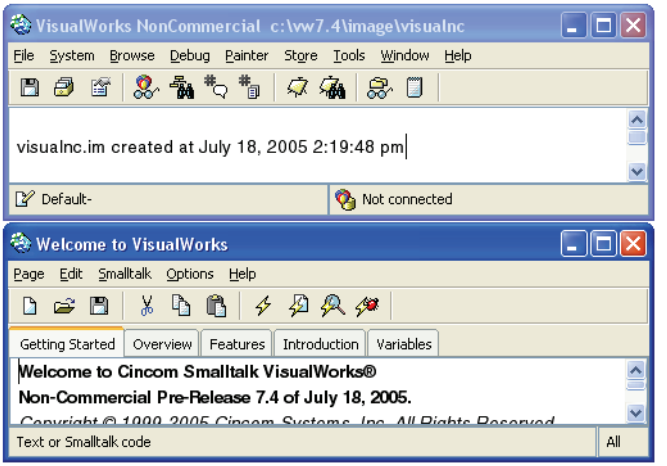
On Windows and MacOs, double-click on the VisualWorks icon.

The *Installation Guide* describes how to install VisualWorks and how to launch it. On Windows and PowerMac systems, a launcher icon is installed, so you can double-click on that to launch VisualWorks

More generally, you can typically find a VisualWorks image file (they have a **`.im`** filename extension) and double-click on it to launch VisualWorks on that image. Most installations set up an association to the VisualWorks executable file. So, for starting, find **`visual.im`** in the image directory and double-click it.



If VW was installed correctly, it will open on this image, and you'll have two windows: The Visual Launcher is on top, and a workspace is below it.



If you installed a Non-commercial version of VisualWorks, the workspace has several pages, as shown, which you may browse at your leisure. Just click on one of the tabs. I'll not be talking about them, but there is some interesting and helpful information in them.

If you have limited screen space, you can close the workspace, the bottom window shown above, but leave the Visual Launcher, the top window, open. You need it for everything.

The installer sets a system variable that holds your VisualWorks Home directory. If for some reason it didn't, some things won't work correctly, like you won't be able to see system source code or load parcels. You can check by looking at the Home setting; in the Visual Launcher select **File → Set VisualWorks Home**... Make sure it is set to the *root* VW installation directory, not one of its subdirectories. For example, if your VisualWorks image file is **`c:\vw7.1\image\visual.im`**, then your VisualWorks Home directory should be **`c:\vw7.1`**.

Make a working image

Working Images

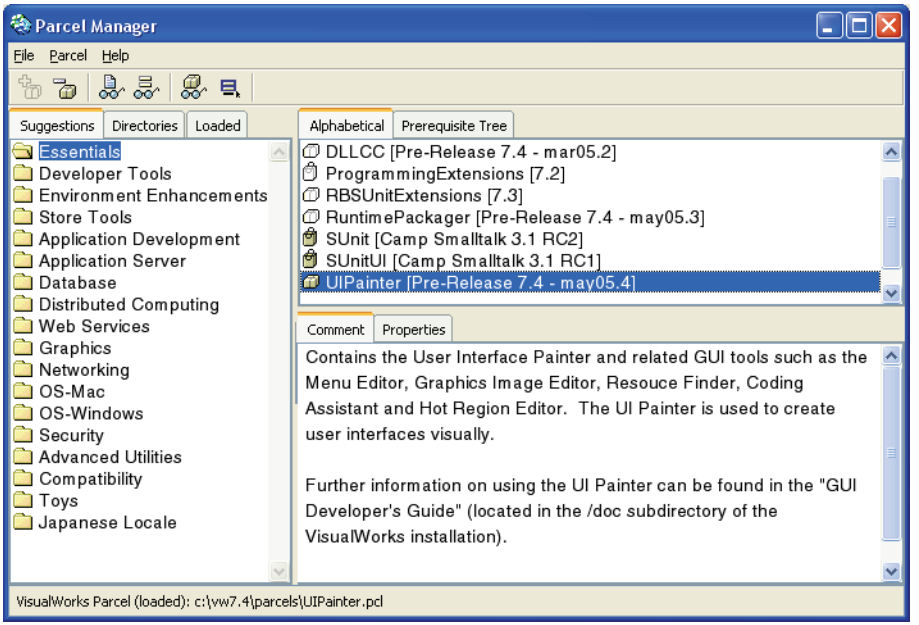
You may end up with several "working" images, images that you save your work in. If you use shortcuts to launch VW, make sure they load a working image and not the standard image.

You never, never, never want to overwrite the **`visual.im`** image file, including saving over it. It's usually write protected and safe, and you can always recover it, so there's no big deal. But, you really want to work in a *working* image, because otherwise you might blow away your copy of **`visual.im`**, and finding the installation media to get a clean copy can be a pain.

The working image will contain any tools or special features you need to use, and your application code. Initially, we need the GUI building tool, called the UI Painter. So, we'll load the UI Painter and save the resulting image as our working image file. (This is already loaded in the non-commercial image, but you can still go through the steps.)

The UIPainter is contained in an external program module, called a *parcel*. To use it, we load it's parcel into a launched image. You already have **`visual.im`** launched, which is a good place to start. So we will load the parcel into it.

In the Visual Launcher, select **System ⟶ Parcel Manager**.



Select **Essentials** in the list on the left, then select **UIPainter** in the list on the right. Then select **Parcel ⟶ Load**.

If the parcel icons have question marks in them, it usually means that the VisualWorks Home directory wasn't set correctly. Make sure the home directory is set correctly (**File ⟶ Set VisualWorks Home**), then reopen the Parcel Manager.

While the parcel is loading, a few status messages are displayed in the Transcript window.

There are dependencies between parcels, so that some features of one parcel really need another parcel to work. They will be available if that other parcel is ever loaded.

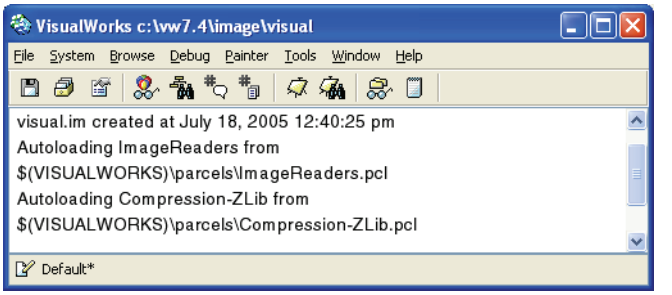
The parcel then finishes loading. Sometimes when loading a parcel, you will see messages displayed in the Visual Launcher saying things like "Autoloading blah blah blah," and "Undefined object blah blah blah." These are normal. Someday you'll understand what they mean, but it's not worth your time right now, so just ignore them. If a message says something like the parcel can't be loaded, then there's a problem.

Parcels

Parcels store VisualWorks code externally to the system for loading when needed.

Parcels are also useful for defining "components," chunks of code that do specific tasks that may be useful to more than one program.

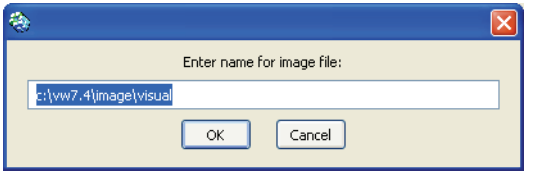
Now we have our working image created. You should see a couple new buttons on the Visual Launcher, looking like a canvas on an easel and something not very recognizable. Compare the launcher on your screen to the image below, to make sure you're close. If you forgot what it looked like before, compare it to the launcher shown back a few pages.



We're done with the Parcel Manager now, so go ahead and close it.

We need to save this image so we can load it later. Let's call it "working".

Select **File → Save Image As…** in the Visual Launcher. The image name prompter displays.



Replace the string in the entry field with **working**, and click **OK**. The image will be saved as **`working.im`**. You don't need to put the ".im" in yourself, but you can and it will still be saved as "working.im".

With the image saved, the title bar in the Visual Launcher should now say **VisualWorks working**.

What's Next?

Now we're ready to get to work.

The rest of this walk-through consists of two simple projects: that old chestnut, the Hello World! program, and a simple GUI oriented program.

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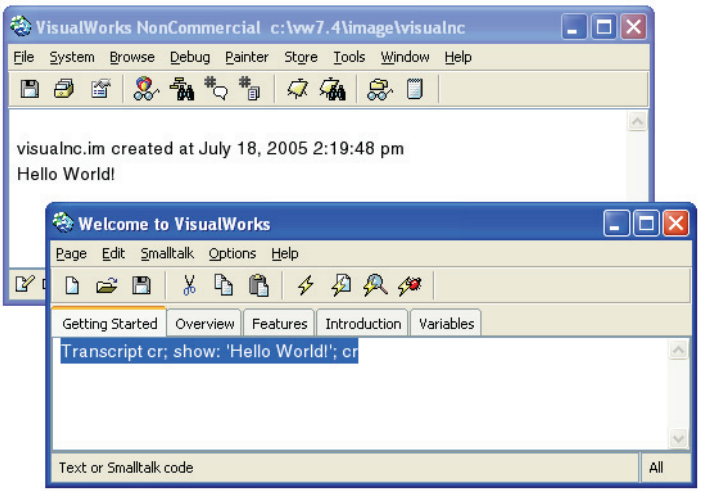
Hello World

For some reason, everyone seems to want to start with a “Hello, World!” example. It has become like a tradition. So, to be traditional, we’ll start with a VisualWorks “Hello, World!” example.

For some purposes it might be sufficient to enter into a workspace the following expression:

```
Transcript cr; show:'Hello World!'; cr
```

and evaluate that with Do it (in the menus, pick **Smalltalk → Do it**). This executes the one-line “program” shown above and displays the result in the Transcript window.

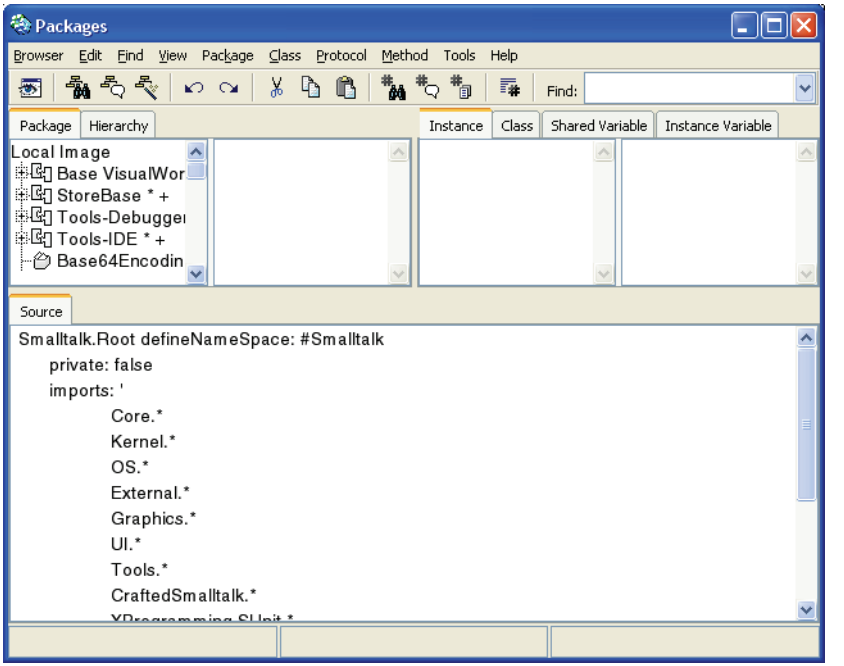


Most new Smalltalk users, however, want to see this done in a stand-alone application, rather than within the IDE as the above example does. This requires a little more work, but not all that much more.

The program will consist of one class and one method. We'll then have to generate the image file to run stand-alone. That's about it, except for some optional packaging.

Writing the Program

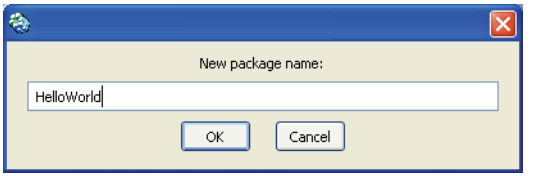
We will write the entire program using a code browser. In the VisualWorks Launcher, click on the balloon button. This opens a System Browser, which is where we'll start.



One thing to be aware of while is that in VisualWorks, as for most Smalltalk environments, you have the code for the whole current system, including the language, IDE (development tools), and any loaded libraries, right there in the browser available for browsing. This is useful, eventually, but can also be distracting, or confusing, or overwhelming. You need to learn how to focus on the parts of the system that you need, and ignore the rest. This comes with experience, but there are also techniques to help, such as how you organize your code, and the tools you use to view the code.

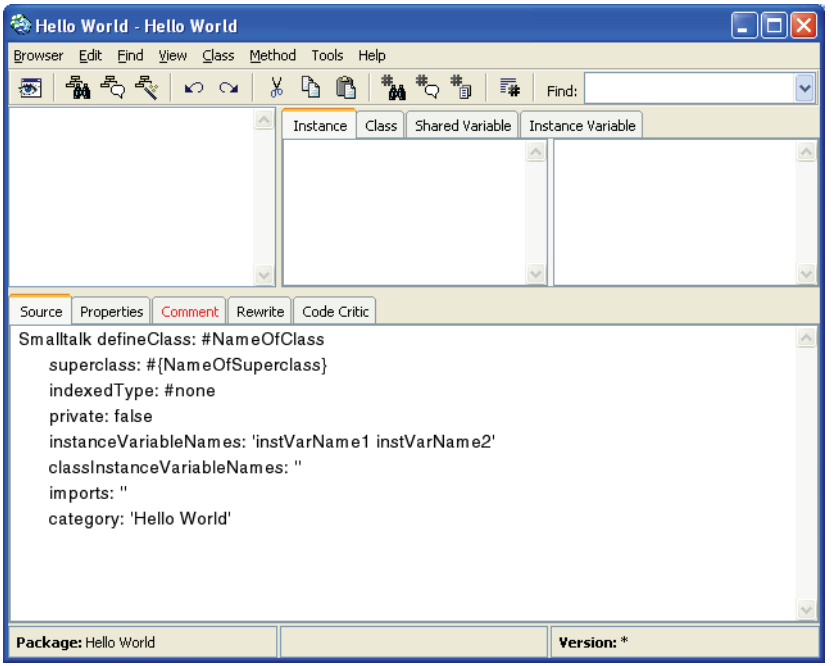
For now, look at the top left pane, which shows a tree view of components (packages and bundles) that contain the entire system. We don't want our program to be confused with all this stuff, so we will keep it separate by creating our own package.

To create a package, pick the **Package → New Package…** menu item. A dialog asks you for the package name. Let's call it, very imaginatively, "Hello World." Enter "Hello World" and click **OK**.

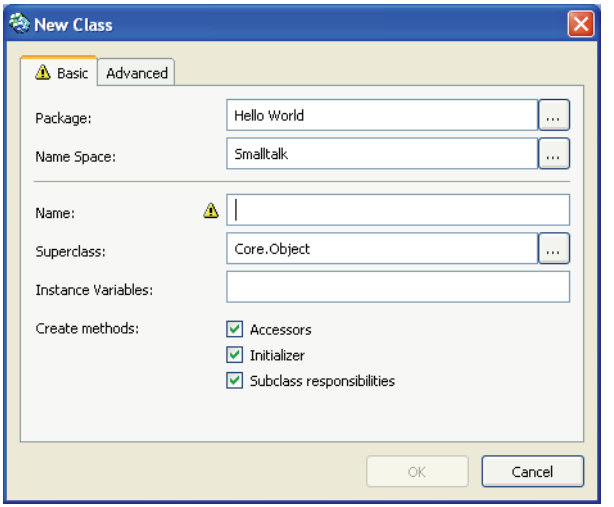


Now find the Hello World package in the top left list pane and select it. This is where we'll be working. You can ignore everything else.

To make it a bit easier to focus just on our program, we can open a new browser focused just on this package. With the Hello World package selected, pick the **Package → Spawn** menu item. The new browsers is empty, but is labeled as focusing on the Hello World package.



Now we need to create a class. In the Hello World browser, pick the **Class → New Class...** menu item, which opens the class creation dialog.



The yellow marker points out the required information, which in this case is the class name. Type “HelloWriter” in the **Name:** field, to specify the class name (unlike the package name, spaces are not allowed). The package is already specified as the package we’re browsing. (The rest of the items are all described in the *Application Developer’s Guide*. We will use the items created by the three checkboxes.) Then click **OK**. The class is then created, added to the package, and shown in the browser (in both the System Browser and the Hello World browser, if both are opened).

As a side note, you have just modified the system, by adding a class. Actually, you did when you created the package, as well, though that isn’t so interesting of a change. These changes are made immediately in the image. Unlike many other environments, there is no need to save a separate source file and compile it.

Unlike many environments, we do not need to import things like Dialog into our program; they’re already in the system image.

Now we need to create a method to do the work. The code is quite simple, and will simply open a dialog showing “Hello, World!” and then close when we click a button. We will use the class Dialog and the method, choose:lables:values:default:, to do this. Both are already defined in the system, in one of those system packages we are ignoring.

While it is not particularly good object-oriented code, it is quick and easy to put this in the initialize method that was created for us along with the class (remember those checkboxes?). In the Hello World browser, select

the **HelloWriter** class, then the **initialize-release** method category (also referred to as a “protocol”), and then the **initialize** method. Replace the space holder code there with:

```
initialize

    Dialog
        choose: 'Hello, World!'
        labels: (Array with: 'Hello')
        values: #(nil)
        default: nil
```

and save your changes (**Edit → Accept** or **Ctrl-S**).

That’s it. You can test this code in a workspace by typing in

```
HelloWriter new
```

and executing this expression with Do it (**Smalltalk → Do it** or **Ctrl-D**).

The new message is a class message that creates a new instance of the class. In the browser, click on the **Class** tab, select **instance creation** and **new**. The one executable line in that method invokes the instance creation method of HelloWriter’s superclass, then sends initialize to the new instance. The initialize message causes the dialog to open, as we wrote it to do.

Save the Image

You know how important it is to save your work. In VisualWorks, this is done by saving the image into an image file.

When you first started VisualWorks, you launched a pre-built image from a file, either **`visual.im`** or **`visualnc.im`**.. Now that we have changed the image by adding a package, a class, and a method, we want to save our work, but to a file with a new name.

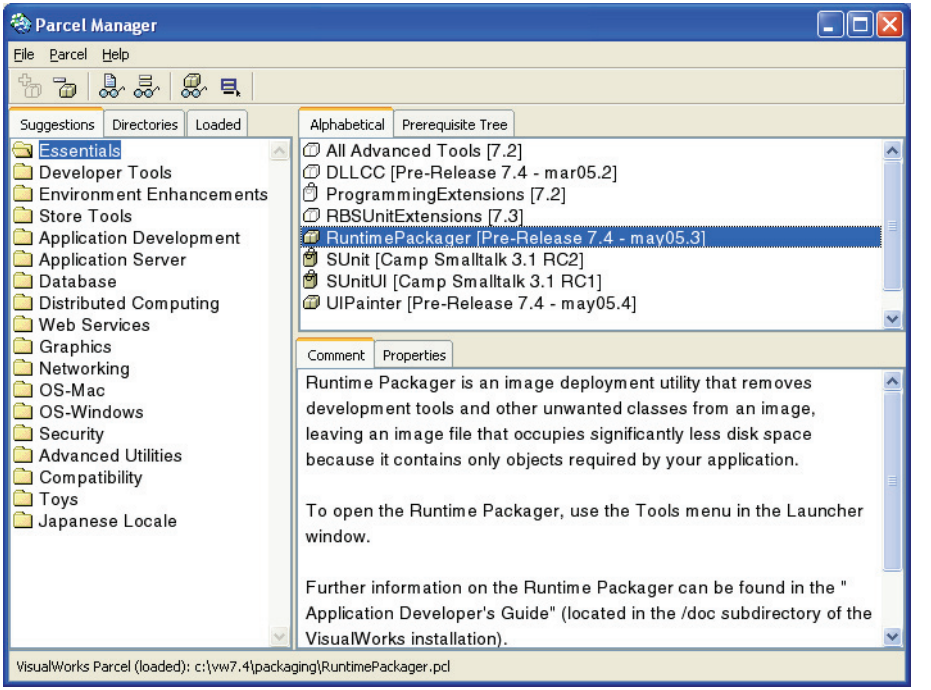
In the VisualWorks Launcher, pick **File → Save Image As…** . In the input dialog, type a name for the image, such as “HelloWorld,” and click **OK**. You don’t need to enter any path information, unless you want the image in a location other than the default directory. Also, you do not need to include the “.im” extension; it will be added for you.

The default location is typically the **`image/`** directory, but depends on your system’s startup configuration.

Packaging for Stand-alone Execution

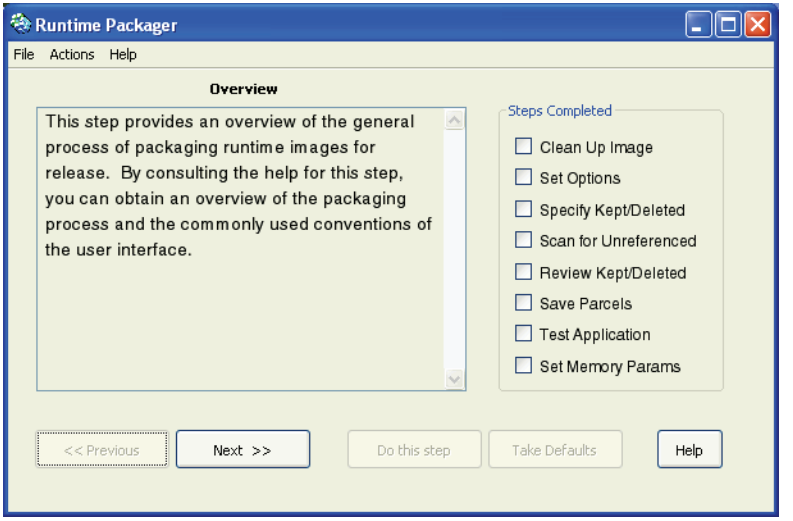
So far we have the Hello World program, but we can only run it within the VisualWorks development environment. We'd rather run it as a stand-alone program, without starting the IDE first. To do this we prepare the program using Runtime Packager.

In the VisualWorks Launcher, open the Parcel Manager (**System → Parcel Manager**). Parcels are external library files. We don't usually need all of the features provided with VisualWorks, so leave most of them unloaded until we need them. The Parcel Manager is the easiest way to load these libraries when we need them, as we do now with the Runtime Packager.



In the Parcel Manager, click on the **Essentials** folder in the left list pane. Then, in the top right list pane, double-click on **RuntimePackager** (or select the parcel and pick **Parcel → Load**). Answer **Yes** when asked if you want to load this package. Then close the Parcel Manager.

Now, in the Launcher, pick **Tools → Runtime Packager** to start the program.



There are a lot of options available in the Runtime Packager, and we're going to ignore nearly all of them. For the most part, the default values will work well for this example.

Click **Next>>** twice, until you get to the **Set common options** window. Then click **Do this step**. The new dialog has several pages. On the **Basics** page we need to enter the information needed to start our program. As we've already seen, running

```
HelloWriter new
```

runs the program. HelloWriter is the class and new is the method, so that's what we enter, plus a name for the final image:

- Startup Class: **HelloWriter**
- Startup Method: **new**
- Runtime Image Path Name: **hello**

While we're here, take a look at the **Details** page. There are a number of options here, but notice the **Action on last window close** section. The default is **Shutdown image**, which is what we want, so we'll leave it. The desired behavior of our program will be to launch, display "Hello World!" and then exit.

Also notice the **Suppress splash screen and herald sound** option. If checked, as it is by default, the VisualWorks splash screen and sound are not displayed and played when your image starts up. This is probably a good thing, so leave it checked. (The *Application Developer's Guide* describes other options.)

Might as well look at the **Platforms** page, too. VisualWorks images are fully portable between operating system platforms, meaning the same images can run on any of the supported platforms. But, if you remove some of the support for other platforms, it won't work as expected. On this page you can select the "look policy" and operating system support to include in your image, so it will work and look right on another platform. For example, if you are developing on Windows but know you will deploy on Linux as well, you want to check the **Motif** UI look and **Unix** operating system options on this page. By default, all of the options are selected, which is a good choice for now.

Click **OK** to save the options we've set and return to the main Runtime Packager window.

Click **Next>>** five times (but feel free to look at any of the pages by clicking **Do this step**) till you get to the **Test application** window. In the test window, click **Begin Test**. Our "Hello World!" dialog will be displayed again. Click **OK** to close it, then click **End Test** to close the test screen. Hopefully it all worked.

Click **Next>>** twice, to get to the **Strip and save image** screen. "Stripping" refers to what will be done to the image (not how you dress for the occasion); a number of classes used in the IDE but not needed in a runtime program are removed from the image. Once that is done, the image is saved to the name we specified in the "Set common options" step ("hello").

When you click **Do this step**, a dialog pops up saying that there are windows open referencing classes that will be removed. Those include any browsers we've left open. Click **Yes** to close all of those windows.

However, instances of the application and any workspace windows that we have left open will not be closed in this step. If there are any, click **No**, close the windows, then do the step again, answering **Yes**.

Read the messages in whatever dialogs are displayed, and respond appropriately. Mostly they are notices about what is about to be done, and asking for confirmation to proceed. Finally, changes are made to the image, and it is written to the file name specified (**`hello.im`**), and VisualWorks is shut down.

Test the Results

You should now have a working program that you can launch independently of the IDE. To check it out, find the image file, **`hello.im`**. Usually it is in the **`image/`** directory or folder of your VisualWorks installation.

Then launch the image. On Windows and Mac systems, you can generally just double-click on the image file. On other systems you may need to execute a command line. It is easiest to change the current directory to image/ and run from there. For instance, on Linux this might look like the following (though it varies with the command shell and configuration):

```
cd ~/vw7.4/image
../bin/linux86/visual hello.im
```

Polishing Things up a Bit

Renaming Visual Executable

End users on Windows like to launch the executable for their application, rather than hand the application data to another, differently named, executable. That is, they'd rather run a program called "hello.exe" than a more complex thing like "visual.exe hello.im." We can do this.

Using the tools provided by Windows, make a copy of the executable file (**`visual.exe`**). Then, rename the copy to **`hello.exe`**, so that the name is the same as for the image file. Copy or move both the executable and the image files in the same directory. It doesn't matter which directory. Now simply run the executable.

By default, if no image file is specified, the virtual machine (the executable) looks in its directory for an image file with the same name, minus the filename extension. If there is one, it loads that.

You do still need to provide two files, but this is then similar to delivering an executable with a DLL on Windows.

Note that this only works on Windows. For other platforms, there are other execution strategies, as described in the *Application Developer's Guide*.

Packaging as a Single Executable

Windows and MacOS developers sometimes want their programs to be deployed as a single file, an executable. This is usually the case for very small programs, like Hello World!, but can be useful for somewhat larger programs as well. This is seldom an issue for Linux and Unix users, however.

The approach on Windows and MacOS are different. Since I only have a Windows system, I'm going to settle for showing you how to do this, in a very simple form, on Windows. My apologies to Mac users.

Packaging on Windows

Windows allows an executable file to include certain resource files. VisualWorks includes a third-party shareware program, ResHacker, that helps you bundle an image, and possibly other resources, with the virtual machine for deployment as a single, stand-alone, executable.

First, you have to extract ResHacker. It is in a ZIP file in the **`packaging\win\`** directory of your VisualWorks installation. Find it, and extract it to the same directory.

It is easiest to build this file if all of our files are in the same place. So, copy the image file (the finished one, **`hello.im`**) and one of the virtual machine files (usually **`visual.exe`**) into **`packaging\win\`** as well.

Now, open a Windows command session, change to this directory, and execute the command:

```
reshacker -addoverwrite visual.exe, hello.exe,
  hello.im, 332, 322,
```

Note that the syntax is really very particular. Those commas, for instance, are necessary, even the last one.

Once successfully executed, ResHacker will create the **`hello.exe`** file, which you can run by itself.

You can add other resources, such as splash screen bitmaps, sound files, program icons, and command line options. Refer to the **`WindowsPackaging.txt`** file for a full description.

What's Next?

This has been a quick look at some basic features of VisualWorks. The next chapter introduces the GUI building tools, and a simple application design approach, as well as additional pointers for exploring VisualWorks.

2

Building GUI Application

What we're going to do…

There are a variety of ways to start building an application in VisualWorks. Frequently, the data model, or the kind of information and processes that the application controls, are very well defined, or already written, and a Graphical User Interface, or GUI, is simply put on top of it. In fact, that's pretty much what we'll do here. A random number generator already exists in VisualWorks, and we'll just put a GUI on it.

An alternative, though still common, approach for creating a prototype of an application begins with a GUI, for which there may not be a particularly well defined data model yet. The GUI helps identify what kind of information the underlying program will need to provide, and guides further development.

The two approaches are not all that distinct. In fact, both begin with the GUI, as we will here.

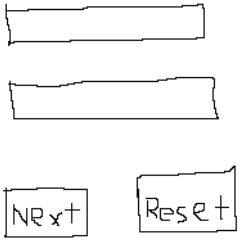
Program Structure

An application has a "model" and a "user interface." The model does the thinking. The user interface, which is usually graphical (hence, GUI), takes user input and displays results.

A GUI has two purposes: to accept user input, such as data and commands, and to display the results of the program's processing. The processing all goes on "behind the scenes." As a VisualWorks programmer you will be concerned with both. You have to start with one end or the other. We'll start with the GUI.

Here's the idea. We will create a GUI that, every time the user clicks a button labeled "Next" will display the next number in a random sequence, as produced by a random number generator. The user will also be

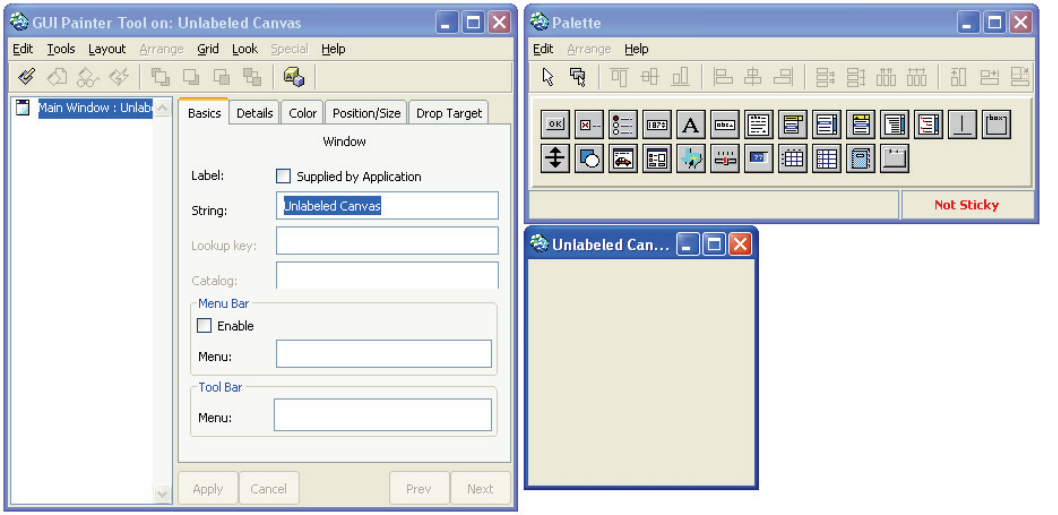
allowed to restart the sequence, or to enter a “seed” value, which just tells the sequence where to start. So, it will have two buttons and two display fields, something like this:



If you get stuck, especially later on, you can load the WalkThrough parcel and examine my code.

Build the application GUI

As I said, we’re going to start by building our application’s GUI. To do this, we need to open the UIPainter tool. Click on the easel looking button. (You could also select **Painter → New Canvas** in the Visual Launcher, but why work that hard?) Three windows are opened:



You may need to rearrange these windows for convenience.

UI Painter Tools

The Canvas, where you place and arrange “widgets.”

The Palette, which holds widgets for selection and placement on the canvas.

The GUI Painter Tool, which provides easy access to operations on the canvas.

The window with all the little buttons (top right) is called the Palette. This has all the pieces that you can (easily) put into your GUI.

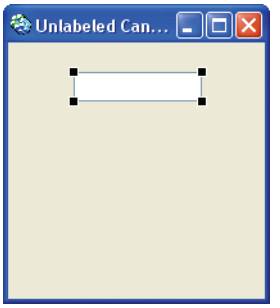
The big window on the left is called the GUI Painter Tool. It is really command central for configuring your application window. We’ll be using this a lot.

The really important one is what’s currently called “Unlabeled Canvas.” This is where you will build your GUI. You put pieces from the Palette onto it, arrange them, and so design the way your application will look to the user. Nothing to it, right? Right!

Look at the Palette and click on various of the buttons. The two buttons at the top left, the arrow and stack of cards, are for placing single or multiple copies of an element, respectively. There are also a bunch of “arrangement” buttons, all greyed out at the moment. The remaining buttons are the “widget” buttons.

When you click on one of the widget buttons, a brief description of the selected widget is shown at the bottom of the Palette window. When you drag the cursor over the widgets, a little fly-by help description is shown. Find the widget button that says **Input Field**.

When you find it, click it, then move your mouse over to the Unlabeled Canvas. To place it on the canvas, move it to a good location, like centered and pretty near the top, and click. The Input Field widget will “drop” there and stay.



If you had the arrow button selected, at the top of the Palette, then you’re done. If you’d selected the other button, you could drop more Input Fields by continuing to click on the canvas, dropping one each time.

Notice the little dark spots, or squares, at the corners of the Input Field widget. These are usually referred to as, appropriately, “corners,” or “handles.” Use them to change the size of the widget. Click and hold the

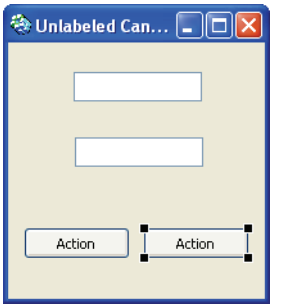
left mouse button (like a double-click, only don't let go on the second click), and drag the mouse. You'll push or pull the corner, changing its size.

To move the widget, click and hold somewhere on the widget other than a handle, and drag it to position. Then let go (drop).

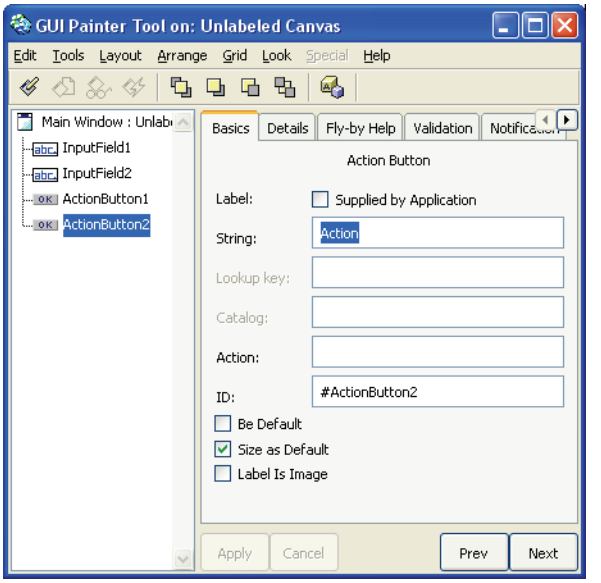
Add one more Input Field widget under the first one somewhere, around the middle of the canvas.

Now select the Action Button widget, and place two of them near the bottom of the canvas, side-by-side. Click on the button on the left, to select it (so its handles show).

The canvas should now look like this:



Now, look at the GUI Painter Tool.

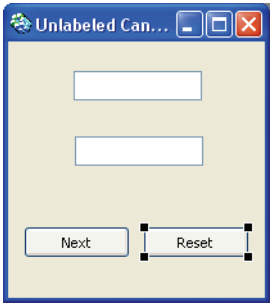


The list on the left shows all the widgets you've put on the canvas so far. The one that's highlighted is the widget that is currently selected on the canvas. You can change the selection either by clicking on another widget in the canvas or in this list. Try it, but then get back to the action button on the left.

The big area to the right holds the Properties pages. These pages set a bunch of, well, properties, for the selected widget, and for the canvas if no widget is selected. Each widget has a default name, or ID, which identifies it in the widget list. Currently the **Basics** page is showing.

For action buttons, the most important items are the **String** and the **Action:** fields (or properties). If you accidentally unselect the button, the Properties pages will change. Just reselect the left button on the canvas to get back to its properties.

The String field sets the button's label. Delete the text there now, and type in **Next**. Then click the **Apply** button at the bottom of the Properties page. Notice that the button's label changes. Select the other button, and change its label to **Reset** the same way.



The other important property for buttons is their action, in the **Action:** field. We've not talked about Smalltalk yet, but we have to now.

An extremely brief explanation of objects

Smalltalk is what's called an "object-oriented programming" language and environment. What that means is that programs are written by describing kinds of things (objects) and what they do. What objects do is respond to messages that are sent to them by other objects. So, really they talk to each other by sending messages.

Object Orientation

Smalltalk programs consist of individual things, or objects, in communication. Objects communicate by sending messages and receiving a response. Responses to messages are defined in methods. A general description of an object, and the methods that describe its response to message, are

Message Types

Unary messages are messages without arguments,

```
myBall color
```

Keyword messages take an argument for each keyword, marked by a colon (:):

```
myBall color: red
```

Binary messages use a special character (such as '+') and one argument:

```
2 + 2
```

A message has a name, called a *message selector*. It may also have one or more additional pieces of information, called *arguments* or *parameters*, which give more details about the request. For example, if you have a Ball object, called myBall, you might have a message called color that asks it for its color like this:

```
myBall color
```

Similarly, you might have a message called color: that sets its color. The colon indicates that the message must include an argument, in this case to set the ball's color:

```
myBall color: blue
```

When an object receives a *message*, it responds in some way. That response is defined by a *method*, which is a piece of Smalltalk code. The method defines the response to the message sent using the message selector. Note that a message *always* responds by returning an object; just what object is returned is determined by the method.

For example, an Action Button is an object. So, it communicates with other objects by sending messages and by responding to messages sent to it. The messages it responds to are fairly deep in the system, ultimately coming from the keyboard and mouse, in general, so you don't need to worry about them right now. We're really only interested in the message it sends when the user clicks on it.

We already know what we want to happen when we click on either of our buttons. The button labeled "Next" should get the next random number, and the button labeled "Reset" should start over, or reset the sequence. So, it makes sense for the first button to send a message like "next random" and the second button to send one called "reset sequence."

We will need to write methods to do this, but initially we only need the message identifier. Smalltalk conventions are that keywords like message identifiers are single words (no spaces), made up of intelligible (human understandable) words, with word separations indicated by an uppercase letter. The initial letter of a message identifier is always lower-case.

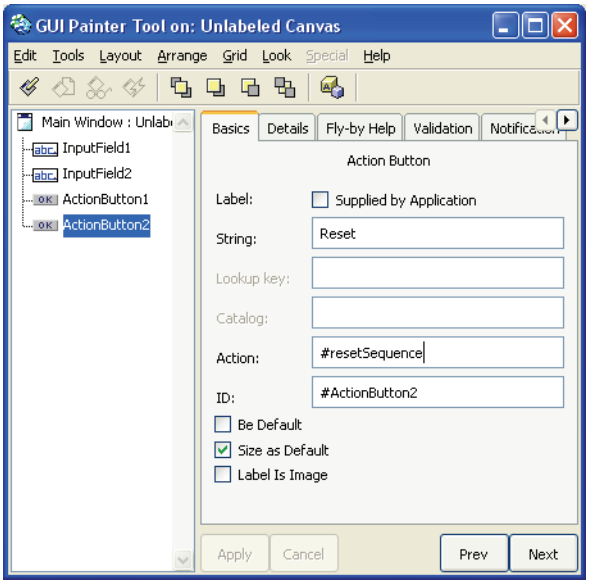
With this in mind, let's call our message for the **Next** button nextRandom, and for the **Reset** button resetSequence.

Finishing the GUI

On the **Basics** properties page, with the **Next** button selected, type **nextRandom** in the **Action:** field, and click **Apply**. When you accept the change, the message name is redisplayed as **#nextRandom**. The pound

sign (#) is a piece of Smalltalk syntax that indicates that the word will be passed as a symbol. Symbols are discussed in the *Application Developer's Guide*.

Now select the **Reset** button, type **resetSequence** in its **Action:** field, and click **Apply**.



Aspect Property

An Aspect stores a feature of an object, usually in an instance variable.

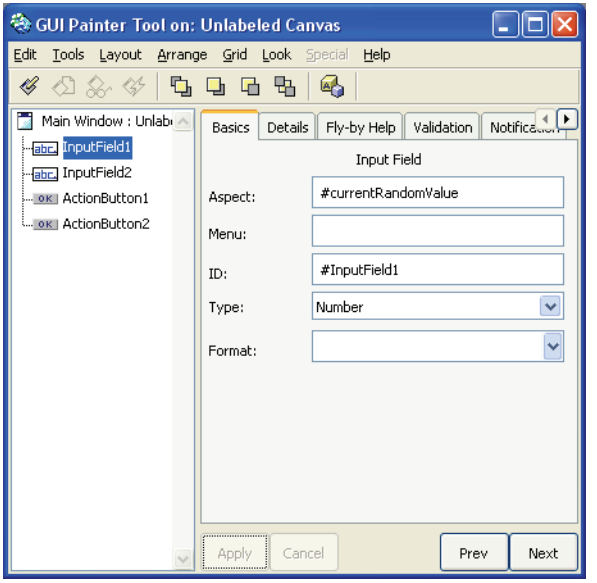
The aspect is usually stored as a ValueHolder, for easy use by the VisualWorks UI Framework.

We're done with the action buttons for now. Now we need to think about the input fields. So click on the top one and look at its properties page. Notice that the properties are different. There is no label string to be entered, and no action to specify. Instead there are fields called **Aspect:** and a **Type:**. Those are the most important fields for an Input Field widget.

An aspect is like a facet of a cut diamond; one part of its defining properties or characteristics. Programs "model" something; a human-machine interaction, perhaps, a manufacturing process or store transaction, or something more abstract.

For this example, our program needs to model a random number sequence (yes, mathematicians, it's only pseudo-random, because it's a predictable and repeatable sequence). There are two essential aspects of this model that we want to use: the current random value and the seed value. The current random value is obvious. The seed value is something used by computational (pseudo-) random number generators to provide a predictable starting point and repeatable sequence.

Our top input field is really only going to be a display field, to show the current random value. On its **Basics** properties page, we need to enter a name for that aspect. Let's call it **currentRandomValue**, and enter that in the **Aspect:** field of its properties. In its **Type:** field, select **Number** from the drop-down list. We'll not bother with the format for now. Click **Apply**.

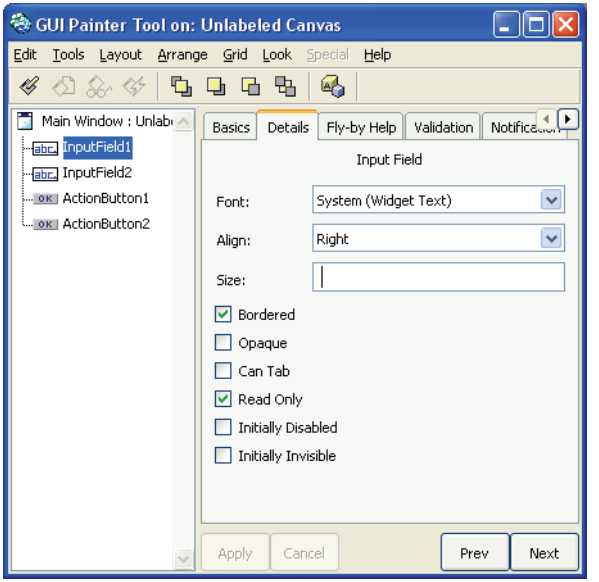


Notice that, since we made this a number, it's initial value is now shown in the canvas as 0. It's also left-justified, which looks funny. Click on the **Details** tab to change properties pages to see another page of properties.

In the **Align:** field, select **Right** from the drop-down list. Also, since we only want to read the current value, not set it, click on the **Read Only** check box, so a check mark shows in it. Since we won't enter anything here, we don't need to tab to it, so uncheck **Can Tab**. Now, click **Apply**.

Hey, the background went grey!

Yes, it did indeed. That is meant to indicate that the field is read-only. White background indicates read-write. This isn't always appropriate, but often is. You can change the background color on the Color property page, which you may explore on your own. Refer to the *GUI Developer's Guide* if you need help.



We do want to enter something into the other input field, namely a seed value. Click on it to show its properties, and click **Basics** to show that page. Let's call this field's aspect "seed," so enter **seed** into the **Aspect:** field. Seeds need to be numbers, so make the **Type:** field Number. Click **Apply**.

Tab Control

Tabbing is an important feature in a good GUI. It allows the user to move between widgets without the mouse.

Only widgets that take user input should allow tabbing, such as input fields, checkboxes, and buttons.

Again, we want this to be right justified, so fix that on the **Details** page. This time, however, we want to be able to enter a value in this field, so do not check **Read Only** or uncheck **Can Tab**. And, as always, click **Apply**.

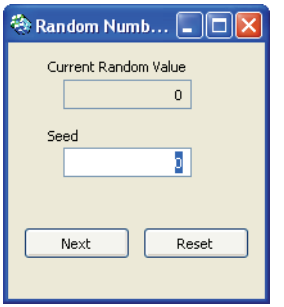
We've now done all the essentials of the GUI design. We can spruce it up a little, however. Notice that the input fields are not labeled, so it's not clear what they are. If necessary, move the fields a little so there's room to label them with a label just above and to the left of the field itself.

Now, find the Label widget, and put one above and to the left of each input field. Open the properties pages for each label and change their **String** field to **Current Random Value** for the top one, and **Seed** for the lower one. Remember to click **Apply**.

If the alignment of your widgets is a bit ragged, or the spacing is uneven, there are some aids. For example, select a label, then shift-click to select the other label, too. In the Palette, find the **Align Left** button and click it. The labels will line up with the first one selected. You can do the same for the entry fields and buttons, can even out the distribution, and so on. Explore the options until the widgets are arranged to your liking.

One more thing. We don't really want our canvas unlabeled. So, click on the background of the canvas, or click on the **Main Window** item in the widget list, so no widget is selected. Change the label string on the **Basics** properties page to something interesting, like **Random Number Picker**. Since we're done setting properties, click **Apply**.

Your final canvas should now look something like this:



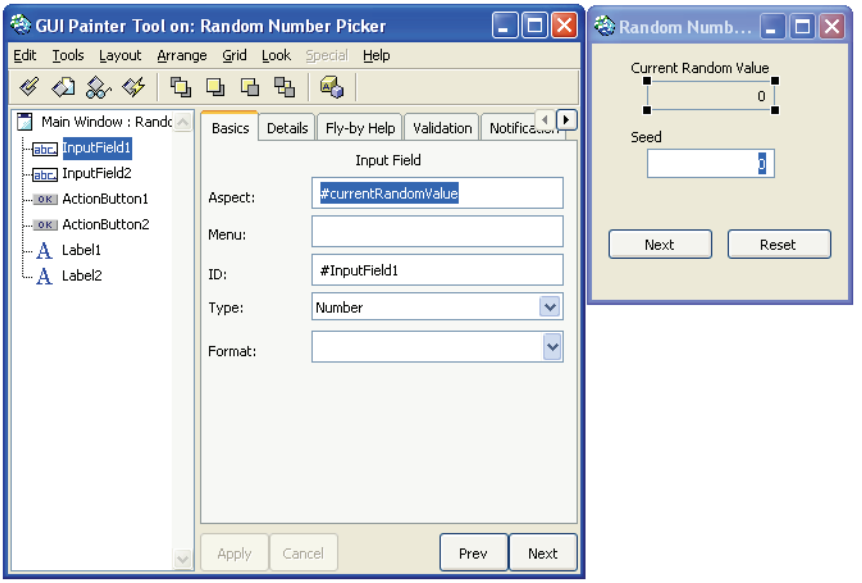
This is a good time to save the image again. It's not a general working image anymore, so you might give it a different name. Select **File → Save As...** and enter **WalkThru**. Remember not to include the ".im" suffix.

Generating initial Smalltalk code

So far we've laid out the GUI and specified names for a couple of methods that will need Smalltalk code. But, there is not yet any actual Smalltalk code written or created.

In addition to methods, which are Smalltalk code, there are class definitions, which are also Smalltalk code. Fortunately, taking the GUI-first approach allows us to do a lot of this automatically. The class will represent, or *model*, the application itself.

First, we will generate the class by “installing” the canvas. You need to have the canvas and the GUI Painter Tool open.



In the GUI Painter Tool, click the **Install** button (or select **Edit → Install**). The **Install On Class** dialog opens, asking you to specify the application class name.

Installing a Canvas

Installing a canvas is how the canvas design is stored in VisualWorks.

Every time you make a change to the canvas, you must install the canvas again. Use the same class and method for reinstalling a canvas, to update your application.

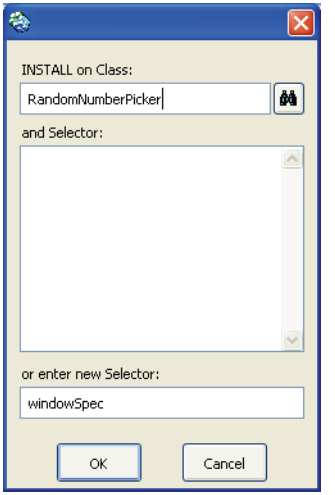
A little more about objects here. I've mentioned that action buttons are objects. What we really have on our canvas are two "instances" of the one "class" of action button. A class is like an abstract description of a whole collection of concrete individuals of that kind. Our two button instances are concrete, and differ from the prototype, or class, in having specific labels and actions associated with them.

This is true of application programs, too, like the one we're creating. All concrete objects in Smalltalk are instances of some class. Even if there is only one instance, it is defined by a class (it would be a singleton class, but a class nonetheless).

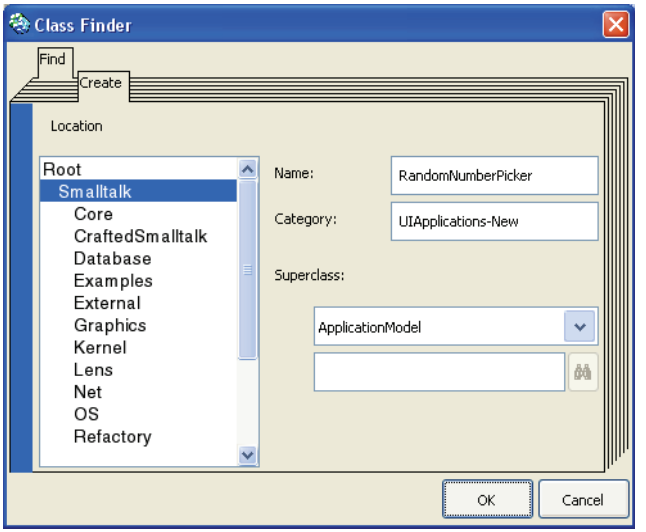
So, we need to name this new class we're about to create something. The convention for class names is similar to the convention for method names, except that they start with an uppercase letter. So, let's call our class RandomNumberPicker, taking our clue from what we labeled the canvas. In the dialog, enter **RandomNumberPicker** in the top entry field.

Notice down at the bottom that there is another word, **windowSpec**. This is actually a method name. You could change it, but don't. VisualWorks assumes that the initial GUI is defined in a method called windowSpec, and you have to work harder to launch an application if you change this name.

So, the dialog should now look like:



Click **OK**. Since this is a new class, another dialog opens up asking for some more information:



The list on the left is a list of *name spaces*, which are abstract and take a bit of explanation that we can skip for now. The Smalltalk name space is currently selected. In the long run, this is not the right place for our class, and we'll fix it later. For now it's just fine.

Subclasses

A class defines the kind of a thing. A subclass defines a more specific kind of a more general thing.

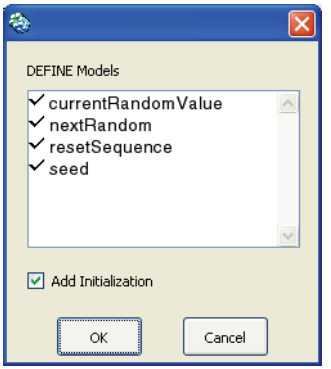
So, if a bird is defined as a class, a penguin could be defined as a subclass, a more specific kind of a bird.

Classes are also subclasses of other classes. Ultimately, all classes are subclasses of the big class Object (it's actually a longer story than that, but this is a good first approximation). Applications built using the UIPainter are typically defined as subclasses of ApplicationModel, as shown in the dialog. There are exceptions, but this isn't one of them, so that's ok.

There's also a **Category:** field. This is just an organizational aid. You can leave it as it is or change it to something like "My Applications". Might as well leave it with the default **UIApplications-New**.

Click **OK**. That's it, almost. The class name dialog is still open. Click OK again. This time it knows the rest of the information it needs. Now the dialogs close and you're back with the canvas and the Canvas Tool. The class RandomNumberPicker is now created and the windowSpec method is defined in it. We'll look at those shortly.

One more thing to do before moving to the code itself. Make sure no widgets are selected in the widget list by selecting **Main Window**. Then, in the UI Painter Tool, click the **Define** button. A **Define Models** dialog opens:



Look at the names in the list. Do they look familiar? They should. Those are the names we gave to the aspects of our entry fields and to the actions of our action buttons.

Each of those needs some Smalltalk code behind them. This dialog is offering to create “stub” methods; little, essentially empty, place-holder methods that we can then go in and modify. All the methods with check marks will be generated. The initialization check box indicates that a little bit of specific code, called “initialization” code, will be included in the stub when appropriate.

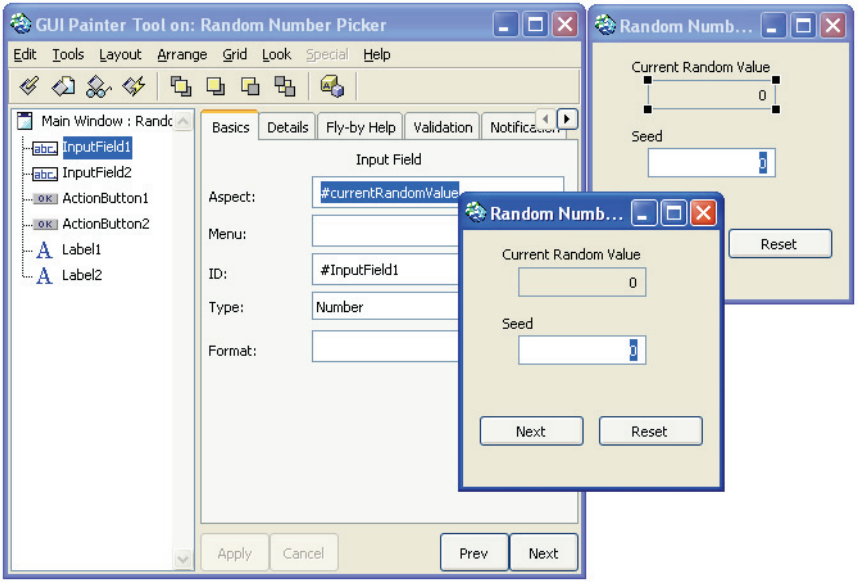
Make sure all the methods are checked, and the **Add Initialization** check box is checked. Then click **OK**.

Save the image again before we move on (**File → Save Image As…** in the Visual Launcher).

Try it out

Before moving on, let's test what we have. Don't expect much yet, but we really do have a working version of our GUI.

With the canvas still open, click **Open** on the UI Painter Tool. This runs the application, such as it is, right from the canvas.

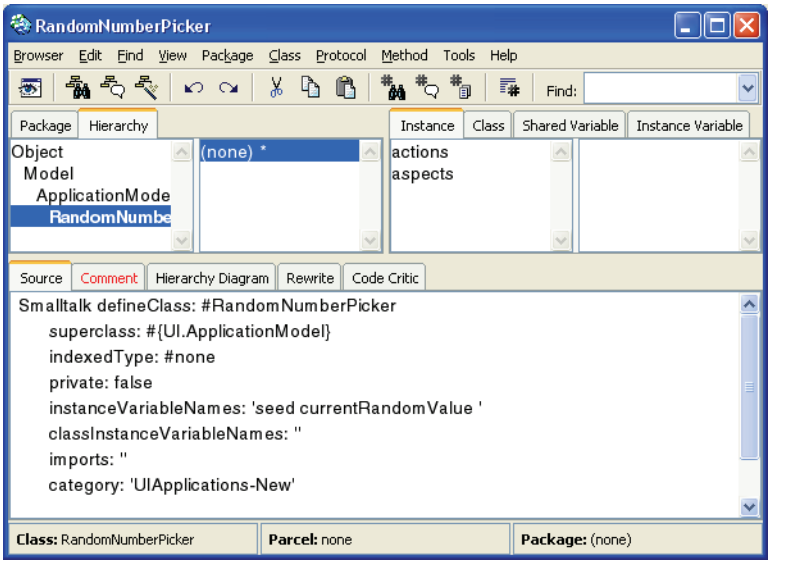


The application UI opens, and is ready to go. Well, sort of. Try clicking its buttons. Nothing happens. That's because we haven't told it what to do when its buttons are pushed. That's next.

But, so far so good. You're making progress! Now, to make it work.

Smalltalk Code: it's time

Let's keep this simple for now. With Main Window selected in the UI Painter widget list, click the **Browse** button. You open what's called, generically, a code browser. This one is a *hierarchy* browser, showing the class you just created, RandomNumberPicker, and all of its *superclasses*, all the way up to Object.



The top-left window pane shows the hierarchy of classes, starting at the top of the hierarchy (Object), then each of its *subclasses*, all the way down to RandomNumberPicker. The bottom pane shows the definition for whatever is currently selected. Initially, it is our class itself, so it is the class definition that is shown.

Without explaining this definition in detail, look at a few of the items we're already familiar with. When installing our canvas, we called its class RandomNumberPicker, and decided to leave it in the Smalltalk name space. That's what the first line says. The second line says that it is a subclass of ApplicationModel, or that ApplicationModel is its superclass, which is the same thing. The fifth line identifies instance variables, that is, variables whose values are determined separately for each instance of the class. You should recognize the two variable names as the aspects of our input fields. The last line is the category that we identified for the class when defining it. You might have changed it. I'll say more about categories shortly.

The other lines aren't important now, but you can learn about them in the *Application Developer's Guide*.

The second pane shows packages that contain definitions either of this class or methods in it. I haven't mentioned packages yet, but they are closely related to categories, which I've also not described. Let's come back to that. So far, our class isn't in a package, so this pane shows **(none)**.

The third pane shows method categories, or *protocols*, (I don't think much of the latter term, so will avoid it, but it's traditional and you *will* hear it). In this case, the categories are for methods that define messages that can be sent to instances of the selected class. Notice that the tabs above that pane indicate that instance-side definitions are being shown. These are methods that are sent to instances of a class. Class-side methods are sent to the class itself.

Class vs. Instance Methods

Class side methods define messages that are sent to the class itself, asking the class to do something. For example, new is a class message that tells the class to make an instance of itself.

Instance side methods define messages that are sent to instances, asking that instance to do something. For example, if an instance has a color, it can be asked for that color.

Select the **class** tab for a moment, and see what's there. There's just one category here, called interface specs. Select it (click on it so it's highlighted). There's just one method, windowSpec. This method stores all the data that sets the look of the canvas. You hardly ever have to edit this method directly, but it's nice to know it's there. Click on it to see what it looks like. Don't worry, you're not supposed to understand it.

Click the **instance** tab to get back to the instance side definitions. There are two categories for methods here, actions and aspects. That should give you a clue about what you'll find there.

Click on actions. Here are the stub method definitions for our action buttons. Click on them. Except for their names, they say the same things right now:

```
nextRandom
    "This stub method was generated by UIDefiner"
    ^self
```

The line in quotation marks is a comment, and isn't executed. The last line, ^self, just returns the object itself, in this case the application. That's not what we want, so we'll change it.

A method always returns a value (which is *always* an object) to whatever sent the message invoking the method (remember, their names are the same). The default return value is the message receiver, self. To specify a different return value, precede the expression with the caret (^), as in this method. Of course, the explicit value here specified is the same as the default value, but we're going to change that. It's just a place holder for now.

Before we change this method and the next one, we'll have to look at the VisualWorks random number generator. Right now we're just touring our class.

Click on the aspects method category. These two methods are supposed to return the value of the indicated aspect, which are typically values of instance variables. They're the same at the moment, except for the names of their variables:

```
seed
    "This method was generated by UIDefiner.  Any edits made here
    may be lost whenever methods are automatically defined.  The
    initialization provided below may have been preempted by an
    initialize method."

    ^seed isNil
        ifTrue:
            [seed := 0 asValue]
        ifFalse:
            [seed]
```

There's more code here, which is written in "lazy initialization" style. That refers to how, or when, the variable gets its initial value. In this case, not until the message is sent the first time, rather than in an initialization method that would set the value when the instance is created.

When a new instance of an object is created, that object's instance variables are also created, and have a initial value of nil, no value. Hardly ever is nil an appropriate value, as it is not here, and will frequently cause programs to crash. So, before the variable is actually used, it must be assigned a value.

We could, in another method called initialize, provide a value for seed and currentRandomValue as soon as the instance is created. Sometimes that's necessary, but here it's not. So, we will use the default style, lazy initialization, and just modify it as we need to.

Note the caret, specifying that the value of seed will be returned, rather than self. But, what is seed? Well, it depends on the rest of the expression. But, the conditions are evaluated first, determining the value of seed, and that value is returned.

What the seed and currentRandomValue messages are supposed to do is return the current value of the aspect of the model they represent, when asked. If they don't have a value when asked, that is if their value is still nil, they make it up and hand back a default value, currently 0.

ValueHolders

asValue creates a ValueHolder and assigns a value to it.

value: assigns a new value to an existing Value-Holder

value returns the value held by a ValueHolder

The asValue message places the value 0 in a *value holder*, a special kind of object, an instance of the class ValueHolder, which much of the GUI framework assumes to be holding the values it has to display. The really neat feature of a value holder is that it automatically updates the GUI when its value changes, saving us some work. The value holder is itself what is stored in the seed variable in the above code.

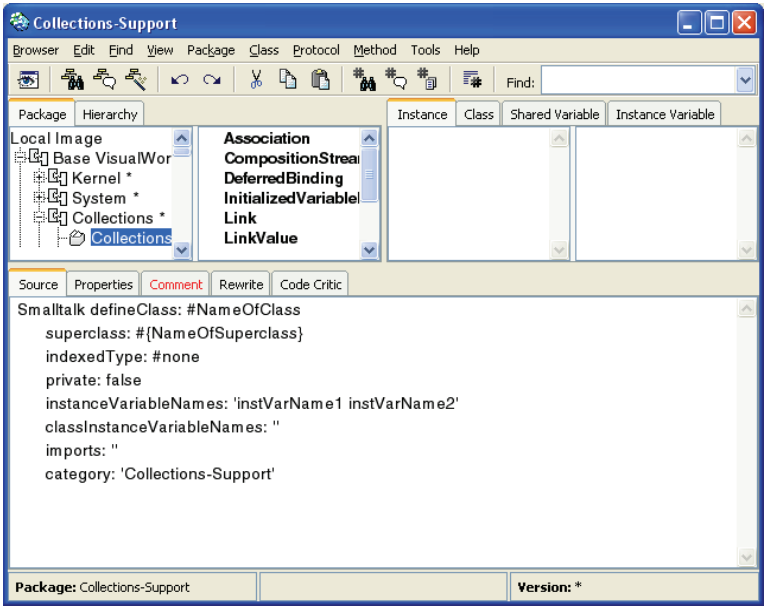
When we put a new random value into this variable, we will put it in the value holder, too, using the value: message. The GUI framework retrieves the value itself by sending another message, value, to the value holder. This is an GUI framework architectural thing, but you need to understand this much of it or you will be constantly confused and frustrated later.

More Smalltalk Code - Package Browser

We need to look at another bit of Smalltalk code, the Random class, because this is the class that will provide us the data to display. An instance of this class will give us new random numbers. It also gives us an excuse to look at another essential VisualWorks tool.

Click on the Visual Launcher to bring it to the front of your display. Find the fourth button, with the small, multi-colored balloon, reminiscent of the early Smalltalk logo that was featured on the cover of *Byte m*agazine (August 1981). This button opens a new System Browser, which gives you a view of the whole system.

Click on the balloon browser button; you might as well see the whole thing. The System Browser opens:



You'll notice that this is very similar to the hierarchy browser, but the top-left pane now shows a list of packages and bundles. These are groupings of classes related by some common functionality. Bundles contain packages, and possibly other bundles. Packages are what actually contain the code, but viewing a bundle shows all the code defined in its packages.

This is a good time to say something about categories. It hasn't always been the case, but currently categories and packages amount to the same thing. If you explore a few packages and the classes they contain, you'll see that the category and package names (not the bundle names) are the same, almost always. Categories are a traditional way of grouping classes that were related in some way. Packages do the same, but provide more organizational features, and are the foundation of the database code storage facilities available in VisualWorks if you load Store. Store is described in the *Source Code Management Guide*.

The next pane over shows a list of all classes currently defined in the selected category or categories. Several items are marked with icons noting something special about them, such as that they are a name

space, an exception class, a collection class, and so on. This list also shows name spaces and shared variables, which we'll have to explain a bit later.

You can select all packages and bundles to see all of the classes in the system. Or, you can see the entire class hierarchy, starting with object, by clicking on the **Hierarchy** tab. Or, select a class in a package and then click the **Hierarchy** tab, to display just the hierarchy for that class. There are other views for browsing the system as well, as described in the *Application Developer's Guide*.

The Random Class - Domain Models

Reminder: Model and UI

We said the model (or domain model) does the thinking, or the processing, of the program. Random does this for our application.

The UI, our RandomNumber-Picker, provides the user interface to Random.

Often when you build an application like we're doing, there is already a program that does some work, such as recording business transactions and performing calculations. Such a program "models," or represents in the program, a "problem domain," whether it is a business process or a representation of a scientific theory.

In setting up this example, we've chosen to build a GUI that provides input to and accepts output from a simple model that already exists in VisualWorks, namely a model of random numbers. This model is defined in the class Random. Let's take a look at it.

You can either use the System Browser you already have open or open a new one. It is common, while working in Smalltalk, to have several browsers open. The only limitations are your confusion threshold, the size of your screen, and, eventually, your computer's memory. I'm going to use a new browser so I can use the old one to look at RandomNumberPicker whenever I want.

<Operate> Menu

In most tools, you can do a right-click to pop-up a menu of operations. The menu changes depending on where the mouse is when clicked.

Most of the time, the same menu options are available on a normal menu, also.

Since we don't know what package to look in, but do know the class we want (because I just told you), we'll use the find-a-class command. In the package list, right-click and select **Find Class**…. In the prompter, enter **Random** and click **OK**. The browser finds Random and selects it, and selects its package, **Magnitude-Numbers**.

The Find command can be useful, also, if you know only part of the class name. You noticed as you typed that is showed a list, first of all classes starting with R, then only those with Ra, and so on until the list was quite short.

The right-click, or <Operate>, menu, by the way, is different depending on where the mouse is. Try it in the other panes. The same menu is available (at least usually) from the menu bar at the top of the browser. The code pane <Operate> menu is the same as the browser **Edit** menu.

Now that we've found Random, let's take a look at it. Looking at its class definition, we see:

```
Smalltalk.Core defineClass: #Random
    superclass: #{Core.Stream}
    indexedType: #none
    private: false
    instanceVariableNames: 'seed '
    classInstanceVariableNames: ''
    imports: ''
    category: 'Magnitude-Numbers'
```

You can see here that it is in the Core name space (Smalltalk.Core). It also has one instance variable, seed, which I've already mentioned in connection with our GUI. Here's the connection.

You can also see where Random is in the class hierarchy. Click on the **Hierarchy** tab in the System Browser's menus, and the category list is replaced by a pane that shows:

```
Object
    Stream
        Random
            FastRandom
            MinimumStandardRandom
```

You can see that it's not very deep in the hierarchy, just one class away from Object, the root class. Stream is an interesting class, essentially a superclass for classes that deliver a data series, or "stream." Random does that, delivering the next random number upon request.

Random also has two subclasses, which are the actual generators. The default generator is MinimumStandardRandom, so we'll look at it a little later. Random is what is called an "abstract superclass" for the other two.

There are a number of tabs on the code view, which are all described in the *Tool Guide*. One that is particularly useful while exploring the system is the **Comment** tab. Click on it to display the class comment. When written properly, the comment explains the purpose of the class, possibly how it should be used, and explains the important variables. While trying to understand the VisualWorks classes, don't neglect these comments. (And, as a programmer, you will write your own comments when you create a class or write a method, won't you? Make sure you do.)

Now let's look at the code. Click on the **Source** tab.

First, let's look at the class side. Click the **Class** tab. There are two method categories here, both of which occur frequently on the class side of class definitions. The class initialization category contains methods, in this case

a single method called initialize, that set up values governing the class itself and all instances of the class. (This requires a lot of explanation that I will not give here. Refer to the *Application Developer's Guide* and *Smalltalk-80: The Language* for more information.)

The instance creation category is an important one, since it tells you the protocol for creating instances from the class. Select this category and look at these.

Class side messages are sent to the class itself, as we'll see in a minute. Many classes have a new message, which is the simplest form of instance creation. A version of new is implemented in Object, and so is inherited by every class, though for some it's useless. When it is useful, it is generally reimplemented, as it is here:

```
new
    "Answer a new random number generator."

    ^DefaultRandomGenerator new
```

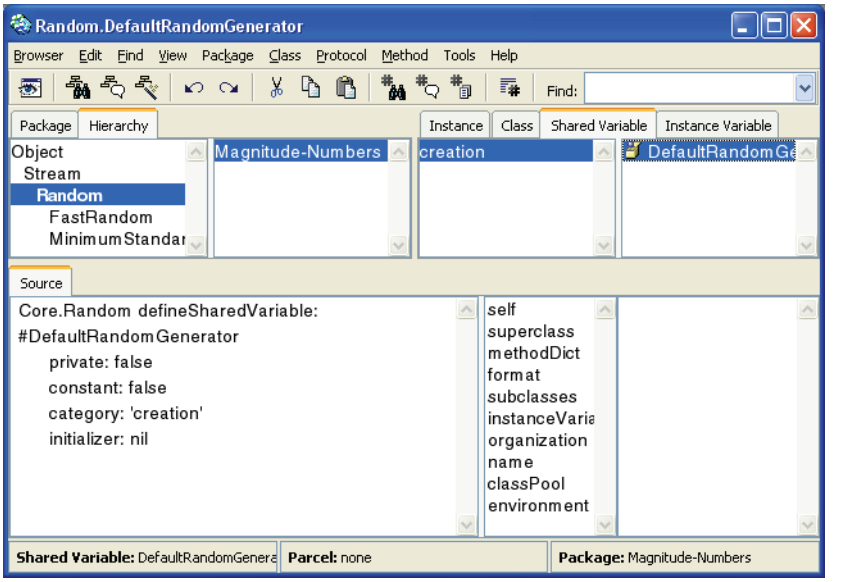
This method, like all methods, is defined by a selector name on the first line, new, and a few lines of code. Lines between double-quotation marks are comments, and are there for explanatory purposes. The rest consists of lines that send messages to objects, either the current object itself, or other objects.

There is only one message sent in this method. The message begins with the receiver object, in this case DefaultRandomGenerator. It looks like a class name, but it's not. The message sent to the generator is simply new, which seems rather uninformative. At least it does until you know what DefaultRandomGenerator is. Click on the S**hared Variable** tab and select the **creation** category. There's DefaultRandomGenerator in the far right pane.

A word about shared variables. Most variables have values relative to a single object. These are the instance variables. They are created when an object instance is created, and assigned variable somewhere along the line, and then deleted when the instance is destroyed (objects come, objects go).

Shared variables are defined for values that are of more general interest, and have to live longer than objects that refer to them. They're like global variables, and have in fact replaced what were called globals in earlier versions of VisualWorks. Such is the case here, when the default generator class remains the same independently of instances of any class.

It's been a while since we've had a screen shot, so here's one:



By the way, all those panes are resizable, so you can make your browser look more like this. Just drag a border.

DefaultRandomGenerator is also called a "class variable," which is a shared variable defined in the scope of a class. Class variables store values that are inherited by the class's subclasses and all of their instances.

Often, as in this case, a class variable's value is set in the class's initialize method, since it only needs to be set once when the class is created, and remains the same nearly forever. Click on the **Class** tab again, select the class initialization category, and then select the initialize method:

```
initialize
    "Random initialize"

    DefaultRandomGenerator := MinimumStandardRandom
```

This method sets the variable's value to a class, MinimumStandardRandom, which we've already seen is a subclass of Random. If you want to change the default generator, you can simply implement it, then assign it here, and reinitialize the class. The default generator is what actually does the work for us.

Now we can see what happens back there in Random's new message; it simply sends new to the actual generator, MinimumStandardRandom. To dig a bit deeper, find and select MinimumStandardRandom in the browser, and look at its new method, which looks like this:

```
new
    ^self basicNew initialize
```

This may look odd, with three words but none of them having a colon, so let's talk about it a little.

The first word, self, is the initial message receiver. This is a class method, so here it refers to the class itself. basicNew is the really primitive instance creator method, but we won't chase it further here. So, the result of self basicNew is an instance, and it becomes the receiver of the message initialize, which is an instance method.

Message Parsing

Unary messages take precedence over binary messages, and are parsed from left to right.

Binary messages take precedence over keyword messages, and are parsed from left to right.

Keyword messages are evaluated last.

Messages in parentheses take precedence over unary messages.

In Smalltalk, a series of message sends like this are evaluated from left to right, according to a set of rules of precedence. Sometimes parentheses are helpful to make clear what's going on. So, we could have written that message series:

```
^(self basicNew) initialize
```

Sometimes parentheses are even necessary, but they aren't here.

Refer to the *Application Developer's Guide* for a fuller description of how Smalltalk expressions are parsed and evaluated. It describes the "precedence rules" for various operations and the use of parentheses.

Click on the **Instance** tab, select the **initialize-release** category, and select initialize. Here, finally, is where the generator really gets set up:

```
initialize

    " Set a reasonable Park-Miller starting seed."
    seed := Time millisecondClockValue.

    a := 16r000041A7 asDouble." magic constant = 16807 "
    m := 16r7FFFFFFF asDouble " magic constant = 2147483647 "
    q := (m quo: a) asDouble.
    r  := (m \\ a) asDouble.
```

Understanding how this random number generator actually works will be left as an exercise for the reader (that's you). But, what this method does, as do most instance initialization methods, is assign values to instance variables. These values are used only by this instance of the object, unlike class variables which share their values rather more widely, as mentioned.

In summary, when we send new to Random, it in turn sends new to the default generator class. What that class does with the message is up to it, but in this case it sends basicNew, to create an instance, then sends initialize to set the instance variables, so it's ready to generate random numbers. Make sense? It might take a little pondering. But, let's move on.

Select Random again and click on the **Instance** tab. There are two categories here.

The testing category typically contains methods that report important conditions of the instance. Here, atEnd reports whether the random number stream is finished, which it never is, and so it always returns false. Similarly, an object should not be able to push a value into a stream, so isWritable also returns false. However, the point of a random number generator is to provide values, so the stream returns true to isReadable.

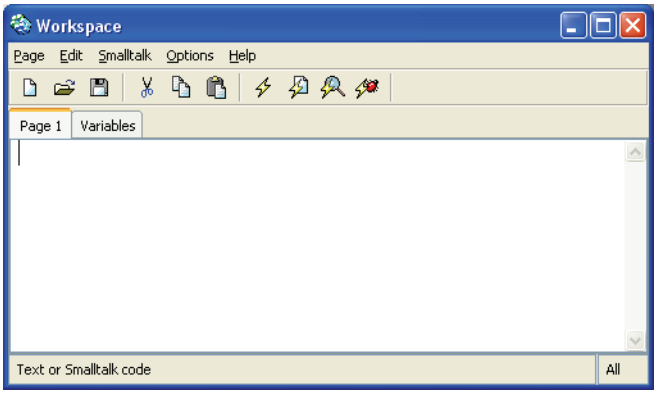
The accessing category is an important category, containing "accessor methods," methods that set and retrieve values in the object's instance variables. Here, only the seed: method is important to us, and not for a little while.

We need to look back at MinimumStandardRandom to find one more important piece of behavior, so find it in the browser. Among its instance methods, find next in the accessor methods. This method returns a value based on the seed value, and updates the seed. The real work of calculating the value is done in nextValue, which you can try to figure out in your spare time, but it's not important to understand it for our purposes. That's the stuff we refer to as "implementation details."

Thinking back on what we've seen, and thinking in terms of what we need for the UI, the methods that we potentially need from Random are:

- Class methods
  - new - to get a random number generator object.
- Instance methods
  - next - to get the next value from the generator.
  - seed: - to set the seed value for the generator.

Let's quickly look at how the messages work, and what they return, before continuing to work on our application itself. To do this, we use the VisualWorks Workspace, a tool we haven't explored yet. Open a workspace by clicking on the icon in the Visual Launcher that looks like a pad of paper, or by selecting **Tools → Workspace**. The workspace opens looking like a blank window. You can drag its corners to a size more to your liking. You can resize it whenever necessary.



Workspace

The <Operate> menu for a workspace has normal editor commands, plus:

Do it, to evaluate an expression silently.

Print it, to evaluate an express and print the return value.

Inspect, to open an inspector on the return value of the expression.

The workspace is where you can do free-form evaluation of Smalltalk expressions. It's a good place for testing, to make sure you know how a message works and what it returns.

Try this. In the workspace, type:

```
Random new next
```

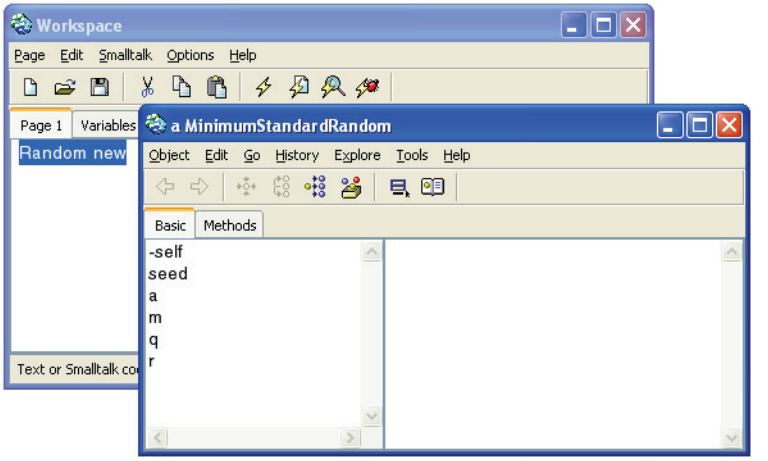
Click on the expression, so the cursor is somewhere on it. Right-click in the workspace to open its <Operate> menu, and select **Print it** (there's also a button for this). A floating point number (a Double, or double-precision real, to be doubly precise) is displayed immediately following the expression. This is the first random number in the sequence generated by the default generator. For comparison, select just the Random new part, and do **Print it**. All it says this time is "a MinimumStandardRandom." Remember, that's the default generator.

Sometimes you just need to perform an action, without seeing the result in this window. Select the whole expression again, and select **Do it** from the <Operate> menu (or the corresponding button). Nothing is displayed, but it does the same thing. Now try this, type into the workspace:

```
Transcript show: (Random new next) printString
```

and evaluate it with **Do it**. There's no response in the workspace, but a number is shown in the Transcript, the text window part of the Visual Launcher.

Here's another useful trick for learning your way around objects. If you can get an object, you can inspect it. Select Random new and select **Inspect it** on the <Operate> menu. The window that opens is an inspector on the instance of Random:



Selecting self just shows a MinimumStandardRandom, like you saw in the workspace. The other items are its instance variables. While an object is alive, you can watch these values change. There is no instance variable for the current, or next, value, since it is calculated from the seed based on an algorithm embedded in the code. You can study the code sometime to tease it out, but it is an “implementation detail” and so will seldom, if ever, be discussed.

We can return now to our application itself, and finish this up.

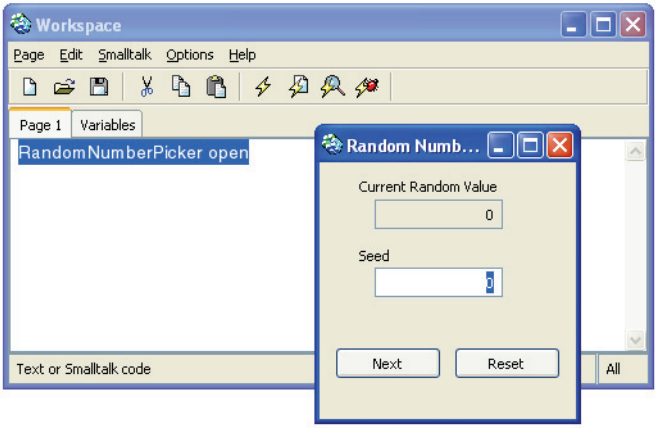
Putting the GUI and the Model Together

We’ve built our GUI and explored the model that will be used to provide values to the GUI upon request. Now we just need to put them together to finish our application.

We’ve already seen that we can already open our application; it just doesn’t do anything. Because it’s a subclass of ApplicationModel, it responds to the open class method. So, you can enter this in a workspace and evaluate it with **Do it**:

```
RandomNumberPicker open
```

The application opens looking like this:



This does exactly the same thing as clicking the **Open** button in the GUI Painter Tool.

As we've already seen, its buttons don't do anything. We have to fix that now. Close the application, because we'll have to reopen it after a couple of changes.

The first thing we need is a Random instance from which to get values. We know how to do that in a workspace. In an application, though, we want to make one and hold onto it. We do this by putting it in an instance variable, which we must add. So, find RandomNumberPicker in a System Browser (you may still have one open on it) and get the class definition itself in the code pane. To the list of instance variable names, between the single-quotes, add a variable, which I'll call myRandom. Then select **Accept** on the <Operate> menu. Your class definition should now be (with the change highlighted):

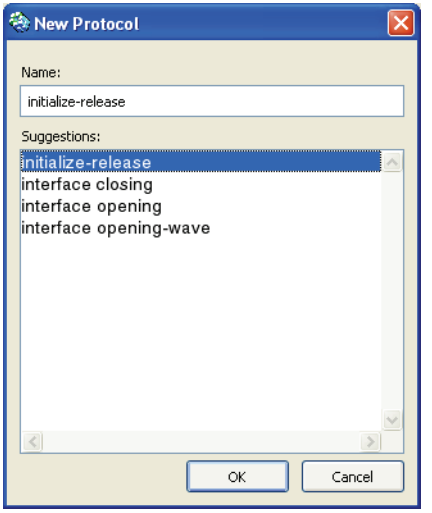
```
Smalltalk.Tutorial defineClass: #RandomNumberPicker
    superclass: #{UI.ApplicationModel}
    indexedType: #none
    private: false
    instanceVariableNames: 'currentRandomValue seed myRandom '
    classInstanceVariableNames: ''
    imports: ''
    category: 'UIApplications-New'
```

The VisualWorks application framework gives us an easy way to initialize myRandom when the application opens. In the early stages, right after creating the instance, it invokes the object's initialize method, if one exists. This is where you typically set such variables.

initialize Method

As soon as an object is created, its **initialize** instance method is evaluated. This is the method used to set instance variable values early. You also use it to set up dependencies between widgets, if necessary (see the *Application Developer's Guide* for information).

In the System Browser focused on RandomNumberPicker, make sure you're looking at the instance side (click on the **Instance** tab). In the method category pane, open its <Operate> menu and select **New...** to add a new category:



The traditional category for the initialize method is initialize-release. No point in breaking tradition now, so enter **initialize-release** in the prompter and click **OK**. This is another one of those helpful dialogs that makes recommendations once you start typing.

Select the new method category, and a method definition template is shown. Replace the method definition template with this:

```
initialize
    "Create the initial random number generator for this application"

    myRandom := Random new.
```

No surprises here, I hope. Smalltalk uses := to assign a value to a variable. As soon as the application opens, it grabs a new instance of Random and holds it captive as myRandom. Select **Accept** on the <Operate> menu to save the code.

Now select the actions category and look at the nextRandom method. We need to make the button do something. This is deceptively easy, because the application framework does so much for us.

You can guess that when the user clicks the **Next** button we will want to send the message myRandom next. But, what shall we do with it? Display the new value, of course. To do so we need to put the value in currentRandomValue and make it display. We could do the value assignment this way:

```
currentRandomValue := myRandom next
```

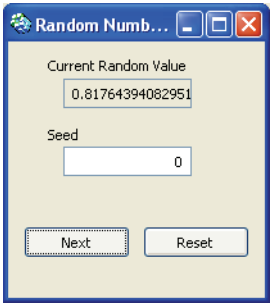
We'd need a way to update the display, then. That can be done, but instead we'll use the cool feature of value holders mentioned on page 39, and both set the value and update the display with a single message, value:. So, we shall write the next method like this:

```
nextRandom
    "Update the current random display when the Next button is clicked"

    currentRandomValue value: myRandom next
```

Select **Accept** on the <Operate> menu to save the code.

Now, launch the application again and see if anything has changed. (If you still have the canvas open, click **Open** on the Canvas Tool; otherwise, use the workspace expression RandomNumberPicker open.) Try clicking the **Next** button. Anything happen? It should now show a new number. Click it a bunch of times and watch it change.



Don't close the application this time, because we're going to see the dynamic update feature of Smalltalk. Click the **Reset** button to verify that it does nothing at this point. We're going to fix that right now.

The **Reset** button is similarly straightforward. Select the resetSequence method, and replace its stub code with:

```
resetSequence
    "Start a new Random"

    myRandom := Random new.
    currentRandomValue value: 0.
```

and **Accept** the change. Now click the **Reset** button. Everything goes back to the start. Click the buttons, just to make sure everything's working.

You know enough to understand what's going on in this method. Reset just creates a new instance of Random, starting a new sequence, and resets currentRandomValue to 0, using the value: message so the display is updated.

Pretty slick, huh? And we didn't even have to restart the application. This is a feature of Smalltalk that developers love. No need to write code, recompile the code, and relaunch the application for testing, in a seemingly unending cycle. The exception earlier, when we had to relaunch, was because we added that instance variable.

Save your image, and take a deep breath.

We're almost done. We aren't doing anything with the seed yet, but now we will.

Using the seed value

Go back to the System Browser and look again at the new method in Random. Remember, it looked like:

```
new
    "Answer a new random number generator."

    ^DefaultRandomGenerator new
```

Now, look more carefully at the last line. If you select it and select **Print it** on the <Operate> menu, it prints a MinimumStandardRandom. This shows that the result is an instance of the default generator. There are lots of ways to generate pseudo-random numbers. The default one is specified in Random's initialize method.

Random also provides a method for assigning a new seed to an instance, called seed:. The colon indicate that an *argument* is expected, a value that the receiving object needs in order to provide a response to the message. We will get the desired effect of setting the seed by simply sending this message, with an appropriate argument, to our new instance.

Back in our UI, you can't see any response yet, but you can click in the **Seed** field and enter a number. When you then hit **Enter** or click one of the buttons, the seed variable is updated with this new value, automatically. We want to use this changed value to set the seed in our random number generator.

What the seed value does is provide a known starting point for the pseudo-random sequence, allowing us to repeat a given sequence of values. The only time we want to do this is when a new Random is created. The first time may be too early, but when the **Reset** button is clicked we can use the seed value to select the sequence.

But, we don't always want to use the seed value, because sometimes we really want the sequence to be more arbitrary. If in the initial case it were set to 0, we would always start with the same sequence, which we don't want. We want the initial series to be arbitrary, more random.

We can do this by writing the program so that if seed is 0, then the instance of Random is created without a specified seed, but if seed is anything else, it is created with the seed specified. Make sense? Here's what we'll do.

Display the resetSequence method definition. There are a lot of ways to do this, but replace the method's definition with this:

```
resetSequence
    "Start a new Random, with a specified seed if seed is not 0"

    | seedValue |
    seedValue := self seed value.
    seedValue = 0
        ifTrue: [myRandom := Random new]
        ifFalse: [myRandom := Random new seed: seedValue].
    currentRandomValue value: 0
```

You can probably figure out what's going on in most of this based on explanations gone before, but some deserve further comment.

Remember that seed is the variable holding the contents of the **Seed** input field. While this is an instance variable, and so can be accessed directly by the instance, instead we access it by sending the seed accessor message to self. This can be important, especially since we used lazy initialization, to make sure the value has been properly set, and isn't nil. In this case it's not particularly important, because the seed message is sent when the application opens, but that is not always the case. We could have written the line:

```
seedValue := seed value.
```

While it looks like seed is holding a number, it's really not. It's holding a ValueHolder. But, Random needs to perform arithmetic operations, so needs a numeric value, not a ValueHolder. Extracting this value from a ValueHolder is done with the value message. In order to do this only once

rather than twice in this method, I've added a temporary variable, seedValue, and set it to the value of seed. That's the first two lines of the code section, following the comment. (See, I commented my code!)

Then, as described above, we want to split the cases where seedValue is 0 and where it is not. This is done with a conditional branch. There are a few messages for doing this in VisualWorks. Since we need to do something different for each case, I've used the ifTrue:ifFalse: message. (You can see other such messages by browsing the Boolean class, and they're described in the *Application Developer's Guide*.)

Control Methods

ifTrue:ifFalse, and similar messages, set conditions for performing certain operations.

Other messages, such as while:do:, iterate an action as long as the condition obtains.

We start the *branch* by testing whether seedValue is equal to 0. That's the seedValue = 0 part. Pretty clear, I hope. The result of that test is either true or false (which are instances of Boolean subclasses). If it is true, the ifTrue: branch is followed, and myRandom gets set to Random new as before. However, if it is false, then the ifFalse: branch is followed, and we create the instance and send seed: to it.

By the way, the arguments to the ifTrue: and ifFalse: keywords, the expressions enclosed in square brackets, those are called *block closures*, or simply *blocks*. These are another powerful feature of VisualWorks, representing a deferred sequence of actions. They are themselves objects, instances of class BlockClosure. Blocks are required as the arguments for some messages, such as ifTrue:ifFalse:, but have uses in a lot of contexts. Blocks are covered in detail in the *Application Developer's Guide*.

That's it! Once you've entered the method code, test the application again. Enter a value other than 0 into the **Seed** field, and click **Reset** and **Next** a few times to see that it always starts generating the sequence at the same value. Change **Seed** back to 0, and click **Reset** and **Next** a few times to see that it always starts with a different value. That's what we wanted.

Note that, because the seed value is only used deeply within the calculation of the new random sequence, there is no obvious relation between the seed and any of the resulting random numbers. For instance, it does not specify the smallest random number. All it does is force a repeatable sequence of numbers.

The application works! We're done (almost). Save your image!

Move to its own package and name space

We've mentioned name spaces earlier, but have tried to skirt the issue, because it can be complicated. But, they are important and powerful, something Smalltalk needed for a long time, and were finally introduced to Smalltalk in VisualWorks 5i. The reason is that without them, shared variable and class names can only occur once in the whole image.

If two programmers decided to create a class called Customer for their applications, for example, and both applications were loaded into the system, the second one loaded would stomp on the first one. This isn't funny, and it has happened. The work-arounds have been creative, but name spaces are the right solution.

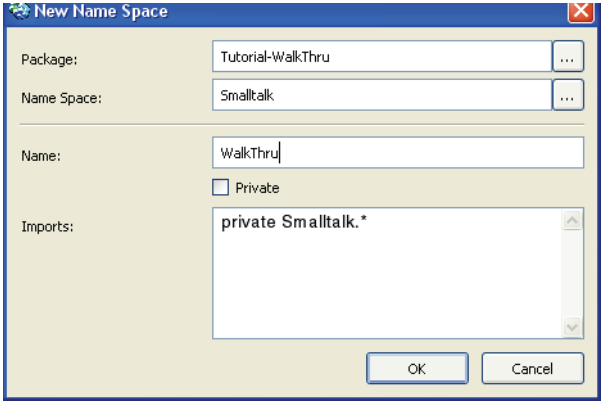
Name spaces form a hierarchy, starting with Root at the top, then followed by Smalltalk, then a whole bunch of other name spaces. All Smalltalk code should be in sub-name spaces of the Smalltalk name space. But, remember, we didn't do that. We just let our class and its code be created in Smalltalk. So, let's move it.

If you still have a browser open on RandomNumberPicker, you can use that. Click on the **Package** tab to show the list of packages and bundles. If you don't have the browser open, open a new System Browser. RandomNumberPicker is in the **(none)** pseudo-package, since we haven't created one for it, so make sure it is selected. Only RandomNumberPicker is in that package right now.

Let's put it in its own package, say, Tutorial–WalkThru. Make sure you don't have a bundle selected (selecting **(none)** will ensure that), then pick **Package → New Package…**. In the prompter, which should look familiar by now, enter **Tutorial-WalkThru**, and click **OK**. The package is added to the package list and selected. If **(none)** was selected, it still is, so it looks like RandomNumberPicker class definition is already in it. But, it's not. We have to move it.

With (none) selected, select RandomNumberPicker in the class list. Then, select **Class → Move All to Package…**. In the dialog, another one of those helpful selection dialogs, start typing **Tutorial-WalkThru**. Select it and click **OK**. You can now verify that the class and its methods are in the **Tutorial-WalkThru** package, and not in **(none)**.

Creating and moving our class to its own name space is similar. Select **Tutorial-WalkThru** (the package) again, and select **Class → New → Name Space…**. The name space creation dialog opens.

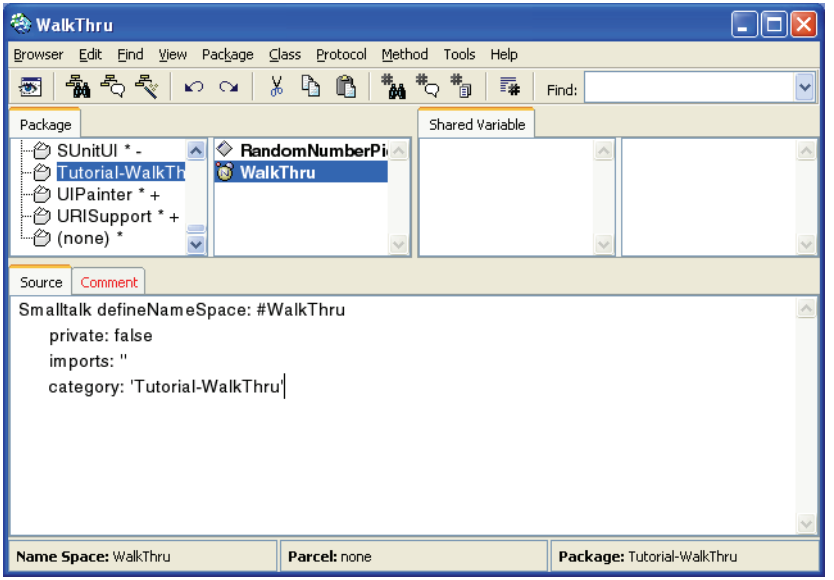


The marker indicates that we need to enter a name, so enter **WalkThru**. Notice that is already has our package name. The name space will be created in the package (it's a real object, so its definition has to go somewhere). It also shows that our name space will be in the Smalltalk namespace, so WalkThru will be a sub-name space of Smalltalk.

The **Private** checkbox indicates whether other name spaces will have access to your definitions. You want them too, usually, so leave this unchecked.

The **Imports** field specifies classes, other name spaces, and shared variables) that are defined in other name spaces and that you want to refer to without identifying their name space explicitly every time. Initially it includes **private Smalltalk.***. Let's remove this for now, so I can show you something interesting in a moment. Select the text and delete it.

Click **OK** to save this definition. The dialog closes, and you are returned to the browser. The name space has been added to the package and selected, so you can see its actual definition in the code pane:



Now, we just need to move our RandomNumberPicker class to our name space. Select RandomNumberPicker in the class/name space list. Then, select the **Class ⟶ Move ⟶ to Name Space…** menu command (or **Move ⟶ to Name Space…** in the <Operate> menu). A dialog opens listing the available name space.

Select our name space, **WalkThru**, and click **OK**. The dialog closes, and the deed is done. See in the class definition, the first line now says that it is in Smalltalk.WalkThru.

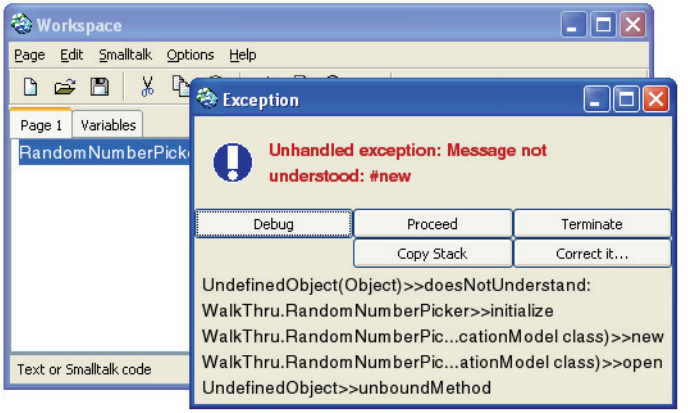
A quick introduction to debugging

If you try to run the application now, you'll get various kinds of errors. That's because it is now looking for things in the wrong name space. We need to make a fix, but first, let's look at the first error.

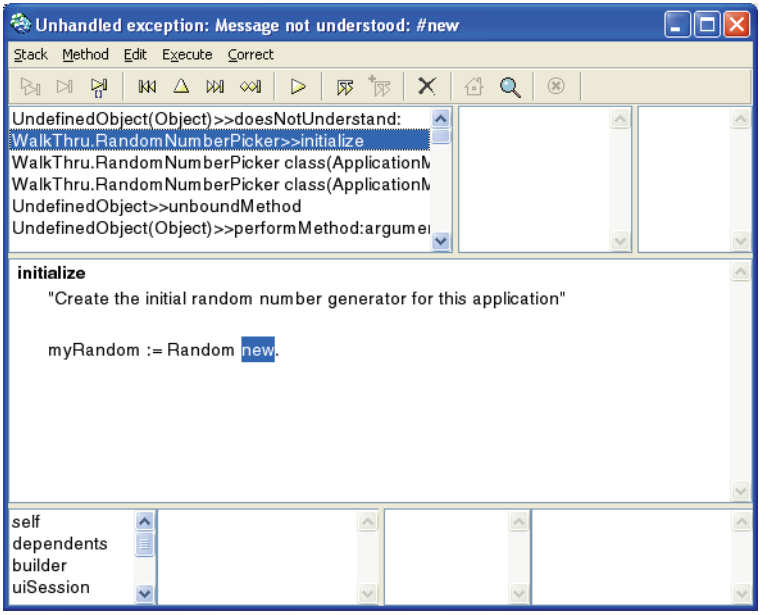
So, again in the Workspace, type:

```
RandomNumberPicker open
```

and execute it using **Do It**. You get an **Unhandled exception** dialog, affectionately known as a "walkback window":



Don't panic! These are normal, and a very useful part of the VisualWorks programming environment. When you see one, avoid the temptation to simply close it or click **Terminate**. Instead, click **Debug** and learn something about your code and the environment. Go ahead, click **Debug** now. You get the VisualWorks debug window:



At the top of this window is a pane listing the most recent "message sends," messages sent to objects, with the most recent at the top of the list. This list is also referred to as the message "stack," and is useful for

diagnosing problems in your code. The top one or two usually just have to do with displaying the error message itself, and can be ignored, but look at them to make sure.

The title bar says exactly what went wrong. In this case it says “Message not understood: #new.” This means that some object was sent the message new, but didn’t know how to handle it. We need to see which object that was, and try to figure out why it didn’t understand.

We don’t have to look far. Select the second line in the stack, as shown above, and you will recognize our initialize message. It shows that the message new was sent to Random, and that’s what failed. But, it worked before! What went wrong?

Select Random new and try to evaluate it with **Do it** again. You get a little dialog with several buttons asking you to declare Random as a variable of some sort. But, Random already exists. The problem, as I mentioned a few paragraphs above, is that now our application is in a different name space, and so Random can no longer be found. We need to fix that.

Here’s a useful trick. We can fix our code directly in the debugger. In the code pane, change the definition to:

```
initialize
    "Create the initial random number generator for this application"

    myRandom := Core.Random new.
```

and **Accept** the change, just like we did in the browser. Adding “Core.” in front of Random tells the system what name space Random is in. Now if you select Core.Random new and use **Do it**, there’s no error.

What we’ve done is changed our code in the debugger; fixed a bug on the fly, as it were. You can look at the message in a regular browser now, and see that it has been changed.

Now select **Execute → Run**, and see what happens. The application opens, and we’re running again.

Test the application a bit. Click **Next** a few times. Now click **Reset**. Bang! Another walkback. What now? Someone else doesn’t understand new.

Click **Debug** again and let’s take a look. Select the second item in the list, and you’ll recognize our resetSequence method. Again, new is being sent to Random.

We can fix this the same way, by prefixing "Core." to Random, and we'll have fixed the problem for a little while. But, notice there's another Random new on the next line. That will also cause a problem. We could go along, fixing these one at a time and hoping we catch them all, but that's not the best solution.

Importing a name space

The better solution is to fix the general problem. RandomNumberPicker doesn't know where to find Random, so let's tell it. We do this by *importing* Random into RandomNumberPicker's name space, which is the WalkThru name space.

Go back to the System Browser, and find and select the WalkThru name space. Remember, the definition looks like this:

```
Smalltalk defineNameSpace: #WalkThru
    private: false
    imports: ''
    category: 'Tutorial-WalkThru'
```

The imports: line corresponds to the **Imports** field in the creation dialog, which I told you to leave empty. That's where we're going to tell RandomNumberPicker where to find Random.

It would be enough to change the line to:

```
imports: 'Core.Random'
```

You can add that, save, and run the application to make sure. But, instead, we're going to put back line we removed. Change the definition so it reads:

```
Smalltalk defineNameSpace: #WalkThru
    private: false
    imports: 'private Smalltalk.*'
    category: 'Tutorial-WalkThru'
```

and accept the change (Ctrl-S). Make sure you include the period and the asterisk, because they are essential. By a little bit of magic, which happens to be fully explained in the *Application Developer's Guide*, this imports all of the classes in the Smalltalk system, including Random.

Now go back and open the application again. It should open and run just like before. One more time, save your image.

As a little bit of clean up, you can go find that "Core." we put in and delete it, but it won't hurt anything.

This time we're done, for sure! Go have a beer.

Comment your code!

We've been ignoring this little detail. Everyone does. No one should.

But, you've probably noticed that bright red label on a tab above the code pane that says Comment. Sure you have, don't deny it. That's a reminder that we haven't written a comment for our class or our namespace. This is easy to fix.

Select the class and click the Comment tab. There's a dummy message there saying the class hasn't been commented. But, we knew that.

Replace the text with something descriptive, like:

```
RandomNumberPicker is a UI for Random, which allows specifying a seed
value, and then displays successive random values.

Instance Variables:
    currentRandomValue <ValueModel> the current random number
    myRandom <Stream> an instance of Random
    seed <ValueModel> a seed value
```

Accept the changes as usual, and the tab label turns black.

Do the same for the name space. Just something simple like "Name space for RandomNumberPicker of the WalkThrough."

There! Guilt assuaged.

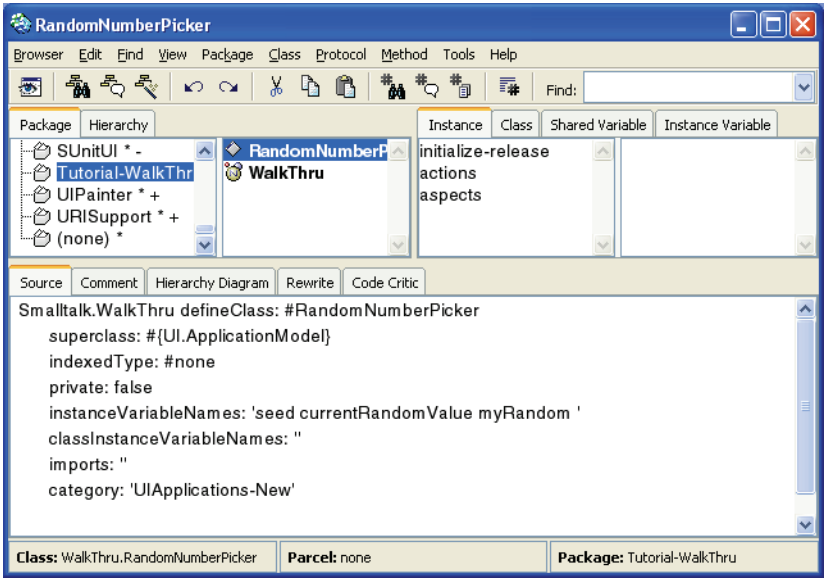
Packaging it up

OK, now you have this absolutely wonderful application that you want to share with all your friends, or sell for the big bucks. How do you do that? It can be quite a long story, but here's a short version of it.

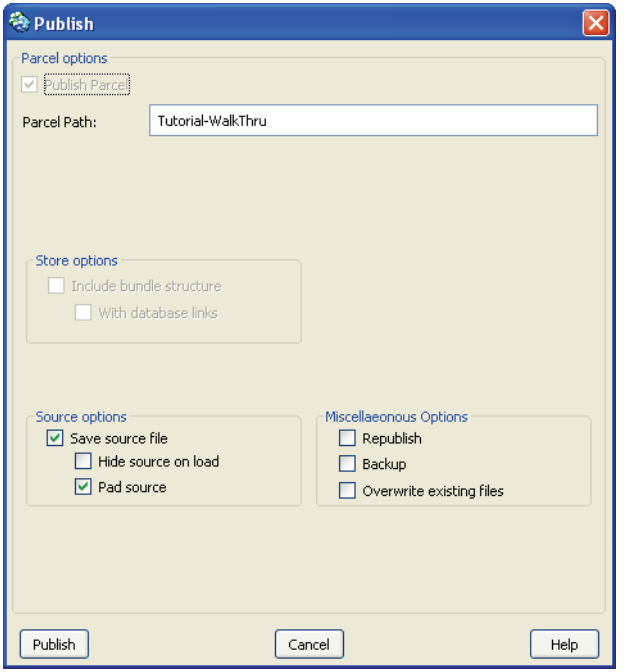
Remember that at the beginning of all this we loaded a parcel to get the UI Painter into the system. At that time I mentioned that a parcel is an external program module. It is useful for storing our program for loading into another image, for archiving, and for distributing to friends or customers. (When such a module contains a well-defined set of functionality, it is often called a *component*.)

We can now make our own parcel. We won't need to keep our WalkThru image, which is big, but just the parcel. We can then load our application when we want to use it or change it. Or, email it to friends to load into their VisualWorks image.

This is pretty easy. Open a System Browser, or use one that is already open, and select our **Tutorial-WalkThru** package. The browser looks like this:



Select **Package → Publish as Parcel** (also on the package <Operate> menu). The publishing dialog opens.



There's really not much for us to do here. The parcel name is already entered in the **Parcel Path:** field. (A parcel path can include directory information, but the name is enough for now.) There's no need to change any of the checkbox items, which are described on the dialog's Help screen (click Help if you want to read about them).

So, just click **Publish**. The system does its thing and closes the dialog.

Now find the image directory, which is usually the default parcel path directory. If you started VisualWorks with a different default directory, you might have to look around a bit. There should be two files: **`Tutorial-WalkThru.pcl`** and **`Tutorial-WalkThru.pst`**. Copy these to a safe place.

One more thing. The package is uncommented. Give it a comment, like "This package contains RandomNumberPicker, the application model developed in the VisualWorks Walk Through, and the WalkThru name space required by the final example."

That's it. We're done with this application. For help loading this parcel in another image, refer to the *Application Developer's Guide*. You can also package things up as an executable, as we did for the Hello World! program, though things are a bit different with a parcel.

But, you're only starting with VisualWorks and Smalltalk. Read the documentation. Browse the class library. Build an application of your own. In a word, keep playing with VisualWorks. There's a lot more to discover.

Where from here?

You are only limited by your imagination. This walk-through has only given you a taste of VisualWorks, and given you some ideas about how to work with it. It's time to dream.

The best way to move on is to experiment. Browse the VisualWorks classes, and think of a way to use them. Refer to the documentation for hints and suggestions when you can't figure them out.

Contact other Smalltalkers. For example, subscribe to the internet newsgroup **`comp.lang.smalltalk`**.

Read. There are lots of books on Smalltalk and Object Oriented programming.

And, play! Life's short. Enjoy yourself.