GDI+ Custom Controls with Visual C# 2005

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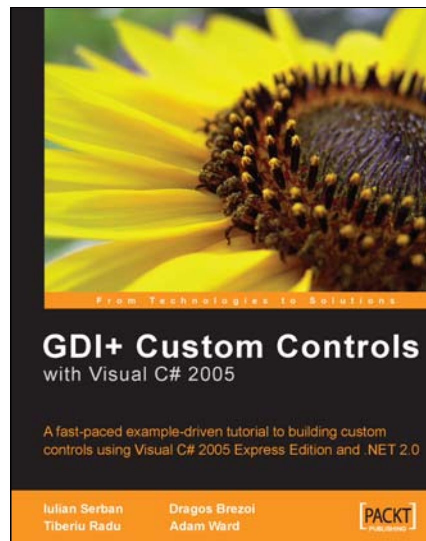

Chapter 6

"Working with Images"

In this package, you will find:

A Biography of the authors of the book

A preview chapter from the book, Chapter 6 "Working with Images"

A synopsis of the book's content

Information on where to buy this book

About the Authors

Iulian Serban is a software architect who started programming at a very young age. He evolved through a lot of programming languages including Pascal, Delphi, C++ Builder, Visual C++ with MFC. and finally .NET and C #. By the age of 17 he started working for Syncfusion, one of the largest .NET control builders in the US, writing professional custom controls code. Nowadays he devotes most of his spare time to his own IT business, which is set to release significant software projects soon.

I'm using this opportunity to thank the Syncfusion team for their continued support, and for their professionalism.

Dragos Brezoi started programming looking to create an application for processing and adding extra effects to his guitar's sound. Several years after, he got a Masters Degree in Computer Science from the Politehnica University of Bucharest, and is now researching for a Ph.D. program in Advanced Automatics. Dragos currently works as a programmer for Mikon Systems, developing industrial software. His skills cover a wide area of specialization from PLC and DSP programming to SCADA, OPC and DCS solutions. At this moment he is creating professional human-machine interfaces, with a focus on developing advanced custom controls with C#.

My big thanks go to my son, Matei, who was a wonderful and cooperative baby and let me work on this book.

Adam Ward works for a communications technology company in Derby, England. Adam excels in experimental programming techniques and has a particular interest in high-speed algorithms and graphical methods. His professional in a varied Research and Development environment and he thrives on tasks requiring innovation, skill and fine-tuning. He has also been involved in experimental coding collaborations showcasing the power of C#. Away from work, Adam is turning his attentions to Linux systems and especially cross-platform programming under .NET-compatible systems.

6

Working with Images

Ever since **Graphical User Interfaces** (**GUIs**) were invented, developers have been keen to use images to make their programs easier to use, and more attractive and intuitive to their users. Images brighten up an otherwise boring and clinical computer screen, and make the general computing experience more enjoyable.

Visual support facilitates the information absorption and presentation of up-to-date information. Any user can more easily understand information just by looking at a picture. Images are the most intuitive memories because the human mind in most cases has a visual memory. This means that when you recall a memory it is frequently a visual one. Think briefly of a tree. What comes to your mind first? Is it the roughness of bark, the taste of fruit or nuts, the smell of tree, the rustle of leaves—or is it a picture of a tree?

Have you ever wondered what it was like before the GUI? There were just text-mode applications. The GUI tried and succeeded in emulating different features of reality. Today, computers can easily reproduce the image and the sound of a tree and in the years to come they will become increasingly better at it.

As regards to the custom controls, these can be user-friendly, if you do the job the right way. It is up to you to develop a custom control that has a good-looking interface. The rendering can be done using drawing lines and curves, using brushes and text; but sometimes it can be improved using images. For example, the Save button in a common application has a floppy disk picture associated, loaded from an image file.

In this chapter, we will discuss how .NET deals with images, and how it can be used to improve your software. We'll visit the `Image`, `Bitmap`, and `Graphics` objects and create a powerful component that you can include in your own programs. You'll learn how to create a picture from scratch without any user intervention, and you'll see some of the cool capabilities of GDI+ in action. Most of the examples take the form of short code snippets, although we will look at creating a small but powerful component that will fast-track you towards some of the more detailed image effects that .NET has to offer.

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For the rest of this chapter, you will:

- Learn about the basic .NET classes that deal with images: Image and Bitmap
- Display images
- Apply various effects on images
- Use images to build better-looking custom controls

As usual, at the end of the chapter you'll build a full custom control where you'll apply the new theory. Let's get started.

Drawing Images

All of the examples in this chapter will require the use of a few namespaces. Make sure each C# file has the following using clauses:

```
using System;
using System.Drawing;
using System.Drawing.Imaging;
using System.Drawing.Drawing2D;
```

This will make sure that C# knows where to find each of the classes we will be using.

Using the Image Class

The Image class is usually your first port of call when using images in .NET programming. It enables you to store a picture in memory so that it can be manipulated, and it exposes many pieces of information about that picture, including its size and how many colors are used. Image is the base class from which another class, Bitmap, is derived. We'll be looking at Bitmap in a while, but we should look at Image's capabilities first.

The Image class comes packed with lots of useful functionality, such as:

- Loading an image from a file and exposing information about it.
- Saving a picture to a file in a specified format such as JPEG or GIF.
- Rotating or flipping a picture.
- Enabling detailed manipulation of the picture by using other classes in conjunction with the Image object. For example, you can draw lines on the picture by using an associated Graphics object.

There are of course many other properties and methods of the Image class but the ones outlined above are by far the most commonly used. To introduce the Image class we'll use three of the above features in one go!

Besides being a programmer, I am also an amateur photographer, and I like to take personal portraits. I often take several dozen photographs on my digital camera over the course of a day. One problem I face is that I hold my camera at 90 degrees to the horizontal; so that I can fit the chosen subject in the viewfinder properly.

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This is annoying because all the saved pictures on my camera are stored sideways and my camera doesn't have an auto-rotate feature. So every day I have to open all the new photographs on my computer, rotate them by 90 degrees to make them appear the right way up and then save them again. I like to save them as JPEG files to save space.

How could I use C# to make my life easier? Simple, just by creating a method that will rotate the image 90 degrees.

```
private void RotateAndSaveImage(String input, String output)
{
  //create an object that we can use to examine an image file
  Image img = Image.FromFile(input);
  //rotate the picture by 90 degrees
  img.RotateFlip(RotateFlipType.Rotate90FlipNone);
  //re-save the picture as a Jpeg
  img.Save(output, System.Drawing.Imaging.ImageFormat.Jpeg);
  //tidy up after we've finished
  img.Dispose();
}
```

That's an outline of the whole process of loading, rotating, and saving a picture, all wrapped in a short method; exception handling and parameter validation were omitted for clarity. Let us look at it in detail.

Firstly, the `RotateAndSaveImage()` method takes two string parameters: `input` and `output`. The `input` parameter is the path of the picture file we want to use. The `output` parameter is the name of the new file that will be created when the `Image.Save()` method is called.

Further I could use a `for` loop to iterate through all the files within a folder on my computer. I can even try this on my camera's memory card directly and pass each filename to this `RotateAndSaveImage()` method. So in doing this, I can save valuable time, being free to travel further from home in pursuit of my hobby.

Using the Bitmap Class

We used the `Image` class to load an existing picture, and in earlier chapters we saw how graphical effects could be drawn onto controls. These two processes can be combined to enable the creation of brand new images purely by writing code.

So let's do exactly that, create a usable picture from scratch. Since the `Image` class is abstract, it does not have a constructor that would allow creating an image that doesn't already exist; but we still need a blank `canvas` to paint onto. This is where the `Bitmap` class comes in. `Bitmap` does have a constructor that lets us immediately create a blank picture in memory. The following code helps us understand the concept better:

```
private Image CreatePicture()
{
  // Create a new Bitmap object, 50 x 50 pixels in size
  Image canvas = new Bitmap(50, 50);
  // create an object that will do the drawing operations
  Graphics artist = Graphics.FromImage(canvas);
  // draw a few shapes on the canvas picture
  artist.Clear(Color.Lime);
  artist.FillEllipse(Brushes.Red, 3, 30, 30, 30);
  artist.DrawBezier(new Pen(Color.Blue, 3), 0, 0, 40, 15, 10, 35, 50, 50);
```


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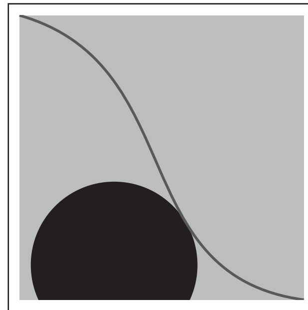
```
    // now the drawing is done, we can discard the artist object
    artist.Dispose();
    // return the picture
    return canvas;
}
```

`CreatePicture()` is a function that returns an `Image` object. As you can see, it takes no parameters. The first thing that happens is the declaration of an `Image` object called `canvas`. The `canvas` variable is initialized by a call to one of `Bitmap`'s several constructors, the one that enables us to define the dimensions of the new picture. This line of code also demonstrates the "is a" OOP concept, because "`Bitmap` is an `Image`". `Image` is the base class of the `Bitmap` class and so we can happily assign a `Bitmap` object to an `Image` variable.

So, now that we literally have a blank canvas to paint on, we need to have a way to get the paint onto it; to achieve this we create a `Graphics` object called `artist`. For anything to appear on our `canvas`, the `Graphics` object must be associated with the image. So we use one of the `Graphics` class's static methods, `FromImage()`, to create a new `Graphics` object that is bound to our `canvas`. So from this point onwards, anything that we ask `artist` to draw will appear on our `canvas`.



The next three lines of code are dedicated to drawing the picture itself. The image you see above is drawn (in memory) by this code.

We discussed simple drawing operations in the first chapters so these lines of code should be recognizable. The `background`, the `ellipse`, and the `Bezier` curve are all drawn by calls on the `artist` object, and they are all drawn onto our `canvas` object.

The last two lines finish the job. First we `dispose` of the `artist` object because it is no longer of any use to us. Note that even though we have destroyed the `Graphics` object, the drawing that it created remains unharmed inside the `Bitmap` object. The last line returns our freshly created picture back to the calling method.

We'll use the `CreatePicture()` method throughout the examples in this chapter to demonstrate some interesting graphical techniques, saving us the time to select and load images each time.

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Displaying Images

So now we have designed a function to draw a nice image for us, how are we going to appreciate its magnificence if we can't even see it?

It's a fair point and one we can easily address. Fire up a new Windows Application project in C# and add a `PictureBox` control to your form. Add the `CreatePicture()` function code (above) to the form's code. Finally, go to the form's `Load` event handler and insert the following code:

```
pictureBox1.Image = CreatePicture();
```

Now run the program. In the top left of your `PictureBox` you can see the image that was created by the `CreatePicture()` function. Setting a `Picturebox`'s `Image` property is the simplest way to use a `PictureBox` to display an image but it doesn't allow you to control exactly where the image is drawn on the `PictureBox`'s visible area. You can use the `SizeMode` property to do things like force the image to expand or shrink to fill the control. Still, this isn't very useful if we want to draw an image at specific coordinates.

Luckily, the `Graphics` object has the tool for the job. We'll add a private member variable to hold our picture so we don't have to keep calling the `CreatePicture()` method all the time. We'll assign the image to this variable in the form's `Load` event.

Time for Action—Displaying Images

1. Create a Windows Application and name it `DisplayImage`.
2. Add the following member variable to the code in the `Form1.cs` file:
   ```
   private Image myPicture = null;
   ```
3. While in the designer, double-click the Form; this will bring you to the following method:
   ```
   private void Form1_Load(object sender, EventArgs e)
   {
   ...
   }
   ```
4. Add the following code in the `Form1_Load()` method:
   ```
   private void Form1_Load(object sender, EventArgs e)
   {
     myPicture = CreatePicture(); //create and store
   }
   ```
5. Switch the Form to Design View mode, and drag a `PictureBox` control from the Toolbox to the form.
6. Right-click your newly added `PictureBox`, and open its Properties window. In the Properties window select the Events tab, and double-click the `Paint` event to have Visual C# Express generate the event handler for you.
7. Add the following code to the `pictureBox1_Paint()` method:
   ```
   private void pictureBox1_Paint(object sender, PaintEventArgs e)
   {
     // draw the image onto the picturebox using the supplied
                         graphics object
     e.Graphics.DrawImage(myPicture, 30, 50); //draw the image
   }
   ```


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8. Add the `CreatePicture()` method as shown below to the `Form1.cs` file.

```
private Image CreatePicture()
{
  // Create a new Bitmap object, 50 x 50 pixels in size
  Image canvas = new Bitmap(50, 50);
  // create an object that will do the drawing operations
  Graphics artist = Graphics.FromImage(canvas);
  // draw a few shapes on the canvas picture
  artist.Clear(Color.Lime);
  artist.FillEllipse(Brushes.Red, 3, 30, 30, 30);
  artist.DrawBezier(new Pen(Color.Blue, 3), 0, 0, 40, 15, 10,
                                            35, 50, 50);
  // now the drawing is done, we can discard the artist object
  artist.Dispose();
  // return the picture
  return canvas;
 }
```

9. Change the BackColor of the `picturebox` to ControlLightLight (Window color) and the BorderStyle to Fixed3D border.
10. Build and then execute the project.

What Just Happened?

In the sequence that the program runs, the member variable `myPicture` is declared and initialized to `null`. Then the form's `Load` event handler calls `CreatePicture()` and passes the resultant image to the `myPicture` variable. From this point onwards, every time the `Paint` event of the `PictureBox` fires, it uses the `Graphics` object supplied by the `PaintEventArgs` parameter to draw the image onto the `PictureBox`. Its position is 30 pixels to the right and 50 pixels below the top left corner of the `PictureBox`. We should end up with a form that looks something like the one that follows:

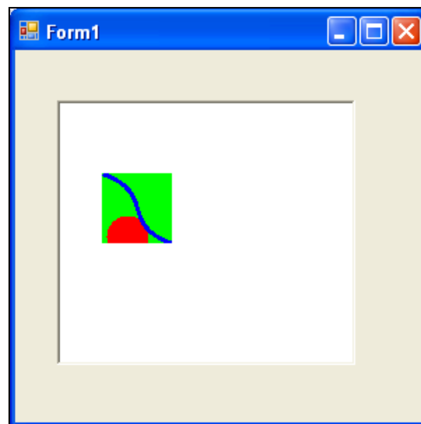

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Image Effects

GDI+ provides a host of exciting tools to let you draw your images in complex ways. Skewing, rotating, and even tiling are all possible. We'll have a go at tiling first because it's quick and easy to set up.

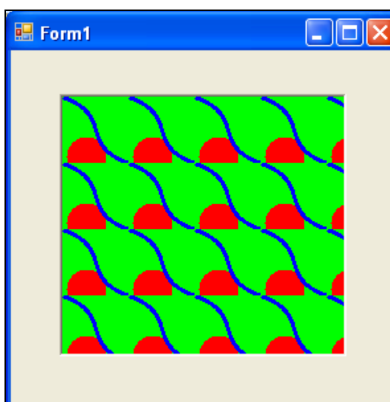
You'll need to have the `CreatePicture()` function ready again, and also have a `PictureBox` set up on your form. We'll use the `Paint` event of the `PictureBox` to demonstrate this effect.

```
// declare a member variable to cache the image
private Image myPicture = null;
// use form load to create and store our image
private void Form1_Load(object sender, EventArgs e)
{
  myPicture = CreatePicture(); //create and store
}
private void pictureBox1_Paint(object sender, PaintEventArgs e)
{
  // create a texturebrush that will do the tiling for us
  TextureBrush tex = new TextureBrush(myPicture, WrapMode.Tile);
  // draw the effect onto the picturebox using the supplied graphics object
  e.Graphics.FillRectangle(tex, e.ClipRectangle);
  tex.Dispose();
}
```

You will no doubt have noticed a new class, `TextureBrush`. As you can imagine, given its name, it is derived from the `Brush` class that we looked at earlier in the book. Brushes are used to fill areas rather than to draw outlines of shapes. This means we can use `TextureBrush` to fill rectangles, ellipses, `GraphicsPath` objects, or anything else. We supply an `Image` object to initialize the `TextureBrush` instead of initializing it with a color as we do with other normal brushes. This image will become the 'paint' that this brush applies to our drawing surfaces.

The second parameter of the `TextureBrush`'s constructor lets us specify what kind of behavior the brush will exhibit. There are a few different **WrapMode** styles to play with; so feel free to experiment with different ones and look at their effects. For the time being, we just want to `Tile` the background of our `PictureBox` with our now familiar picture. Enter the previous code into your program and run it.

You will get a result that looks similar to the following screenshot:



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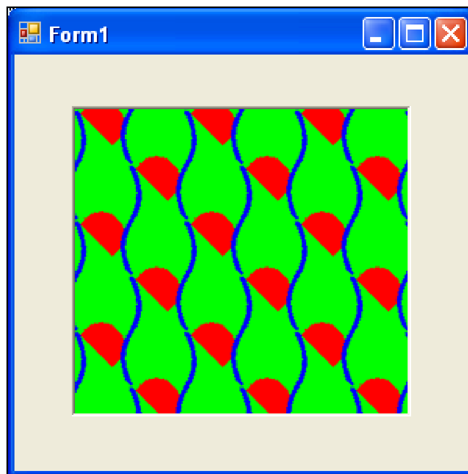
You may also have noticed that this is identical to the effect that the `PictureBox` uses when its `BackgroundImageLayout` property is set to `Tile`. So why bother using all those lines of code when we can just set a property? Good question, and if you only wanted to tile the image horizontally and vertically then you probably would just pass an image to the `pictureBox1.BackgroundImage` and set its `BackgroundImageLayout` to `Tile` and forget about it. But that's just not good enough for us, is it? No, it's not.

What if we want to choose the angle at which the tiles are displayed? We stay with our `TextureBrush` and modify our `Paint` event handler a little. By adding a transformation to the `TextureBrush` we can alter the way it paints our tiles.

Take this example:

```
private void pictureBox1_Paint(object sender, PaintEventArgs e)
{
  //create a texturebrush that will do the tiling for us
  TextureBrush tex = new TextureBrush(myPicture, WrapMode.Tile);
  //Rotate the brush by 45 degrees clockwise
  tex.RotateTransform(45);
  //draw the effect onto the picturebox using the supplied graphics object
  e.Graphics.FillRectangle(tex, e.ClipRectangle);
  tex.Dispose();
}
```



Run the program again. By adding a single line we have radically altered the tile effect; basically instead of tiling horizontally from left to right, it is now striping the image from top left to bottom right. This is due to our specified angle of 45 degrees, that we have passed to the `RotateTransform()` method of the `TextureBrush`.

Other kinds of transformation are also available to the `TextureBrush`, such as `TranslateTransform`, which slides the tiles left, right, up, or down. Finally, `ScaleTransform` enables us to change the size of the image before it is tiled onto the screen. Experiment with them and you will be able to see the effects of each.

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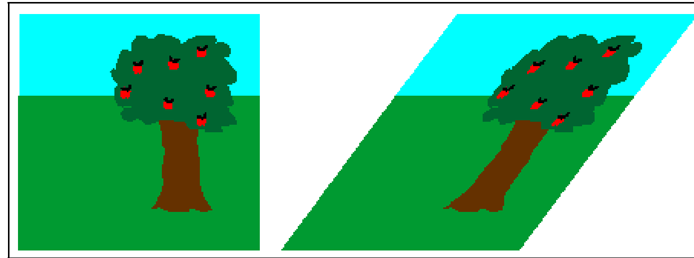
Skewing, Rotation, and Scaling

We are going to build a class to help us apply these effects on images. Skewing, rotating, and scaling images (if handled separately) can seem daunting, but if you take the right approach, they are closely related to each other. It is convenient to design a control (or a helper class) for this task because it's quite possible that you may want to include these features in several of your programs. This kind of code re-use is a central tenet of Object Orientated Programming and we shall once again see its benefits here.

First we should understand what each of these three terms means.

Skewing is the act of making a rectangular image slanted. That is to make it fit into a parallelogram instead of a rectangle.

This figure shows an image before (left) and after skewing:



The image shown here has been skewed along the X-axis by approximately two thirds of its width. Skewing can also be done along the Y-axis in the same fashion, or even both X and Y axes at once. This effect is often used in animation and 2D computer games: imagine a character running quickly from left to right; the sprites can be skewed slightly to the right to give the impression of acceleration. It can be quite an effective way to enhance graphics without sacrificing speed or writing lots of additional code.

Rotation is pretty much what you'd imagine. An image turns through a known angle but remains rectangular and maintains its dimensions throughout. It should be made clear at this point that when we rotated the pictures earlier in the chapter we were only able to rotate in multiples of 90 degrees, which is fine for photographic work but a little too restrictive for anything more elaborate such as animation or computer games. It would be cool if we could say exactly how much we wanted to rotate our picture, 30, 45, 90 or even 132.677 degrees!

Scaling is simply making an image larger or smaller. To scale an image, the user is normally asked to supply a single value. The width and height values are then both multiplied by this number to alter the size of the image. Scaling preserves the height:width ratio of the picture. For example, if we have an image that we want to double in both width and height then we would specify a scaling factor of 2.0. If we wanted to reduce the image down to one third of its width and height then our scaling factor would be 0.33333. The scaling factor must be greater than zero.

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Building the ImageWarper Class

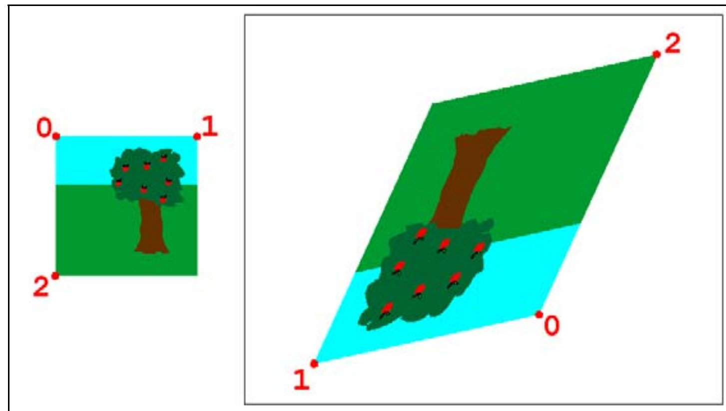
So you've learned how to create, draw, and apply different effects on image objects. These skills are important for custom control builders, since the appearance of a control is very important for its success with end users.

We'll build a simple but powerful control to help us with drawing images and adding graphical effects to your custom controls. This control will take advantage of the `Graphics.DrawImage()` method to unify skewing, rotation, and scaling into a single operation. You may have noticed that this method has about thirty different overload implementations! Do not fear, we will be using only one of them.

In order to unify skewing, rotation, and scaling into a single operation we need to identify some common ground that all three things share. What these operations have in common is that they all work with the coordinates system. A normal image can be drawn anywhere if you supply the right coordinates, but we will do something a little more complicated than that. The particular overload of `DrawImage()` that we will use is given below:

```
Graphics.DrawImage(Image, PointF[])
```

This method accepts an image object (the one that we want to draw) and also an array of three `PointF` objects. This array defines the parallelogram that the image is to be drawn inside. We only need to define three of these points because the GDI+ is able to extrapolate the fourth corner from the first three; this saves us having to work it out ourselves. The array should contain the top-left, top-right, and bottom-left points in that order. This may sound like advanced mathematics but it really looks quite simple when illustrated:



In the above illustration, you can see the original image on the left, where the points of the array are shown numbered at the three corners of the image. Now look at the image on the right. The rectangle box represents the control onto which we are drawing, be it a control, or a form, or whatever. You can see the same numbered points but in a different formation.

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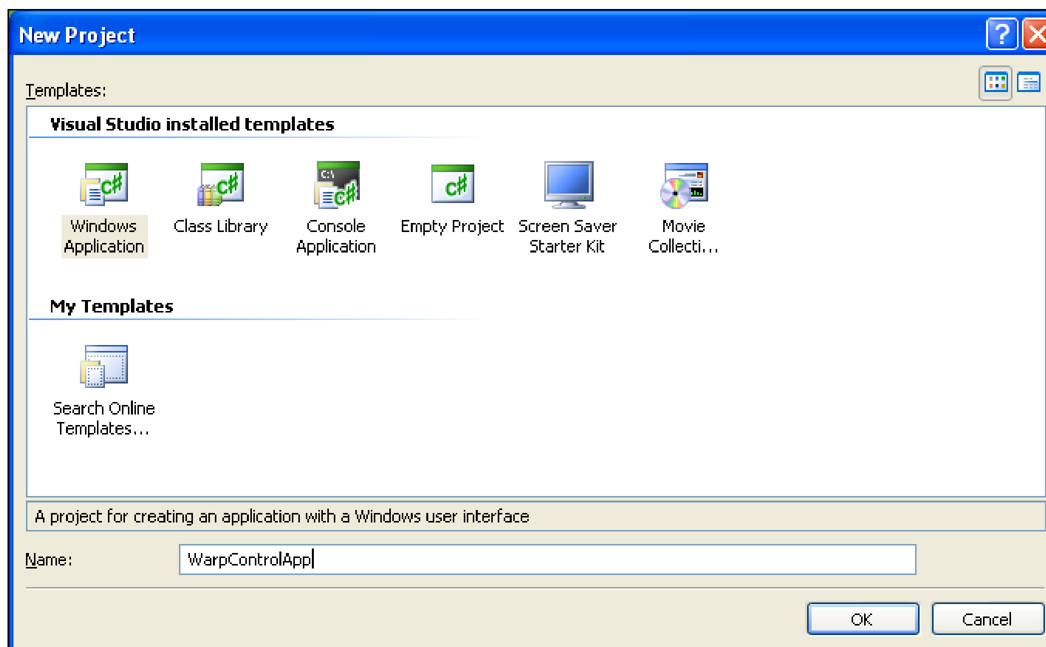
The picture on the right has had all three effects applied to it. We can see that it is skewed because it is no longer square. We know it has been rotated because it is upside down. And because it is much larger than the image on the left, we can deduce that it has been scaled. We can do all of this simply by manipulating three points on a two dimensional plane. That is pretty amazing isn't it?

Let's just write this control and examine how it works.

Time for Action—Creating the ImageWarper Class

1. In Visual C# Express, go to File | New Project, select Visual C# project types, and the Windows Application project type.
2. Write WarpControlApp as the project's name, as shown in the following screenshot, and click OK:



3. Add the `CreatePicture()` method to your form's code:

```
namespace ImageWarperTest
{
  public partial class Form1 : Form
  {
    public Form1()
    {
      InitializeComponent();
    }
    private Image CreatePicture()
    {
      // Create a new Bitmap object, 50 x 50 pixels in size
      Image canvas = new Bitmap(50, 50);
      // create an object that will do the drawing operations
      Graphics artist = Graphics.FromImage(canvas);
      // draw a few shapes on the canvas picture
      artist.Clear(Color.Lime);
```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```
            artist.FillEllipse(Brushes.Red, 3, 30, 30, 30);
            artist.DrawBezier(new Pen(Color.Blue, 3), 0, 0, 40, 15, 10,
                                                    35, 50, 50);
            // now the drawing is done, we can discard the artist object
            artist.Dispose();
            //return the picture
            return canvas;
          }
        }
      }
```

4. Right-click the project name in Solution Explorer, and select Add | New Item. Choose the Class template, change its name to `ImageWarper.cs`, and press Add.
5. Change the default generated code to:

```
using System;
using System.Drawing;
using System.Drawing.Drawing2D;
using System.ComponentModel;
public class ImageWarper : Component
{
  public void DrawWarpedPicture(
  Graphics surface,  // the surface to draw on
  Image img,         // the image to draw
  PointF sourceAxle, // pivot point passing through image.
  PointF destAxle,   // pivot point's position on destination surface
  double degrees,    // degrees through which the image is rotated
                        clockwise
  double scale,      // size multiplier
  SizeF skew         // the slanting effect size, applies BEFORE
                        scaling or rotation
)
{
 // give this array temporary coords that will be overwritten in the
    loop below
 // the skewing is done here orthogonally, before any trigonometry is
    applied
 PointF[] temp = new PointF[3] {  new
                PointF(skew.Width, -skew.Height),
 new PointF((img.Width - 1) + skew.Width, skew.Height),
 new PointF(-skew.Width,(img.Height - 1) - skew.Height) };
 double ang, dist;
 double radians = degrees * (Math.PI / 180);
 // convert the images corner points into scaled, rotated, skewed and
    translated points
 for (int i = 0; i < 3; i++)
 {
   // measure the angle to the image's corner and then add the
      rotation value to it
   ang = GetBearingRadians(sourceAxle, temp[i], out dist) + radians;
   dist *= scale; // scale
   temp[i] = new PointF((Single)((Math.Cos(ang) * dist) + destAxle.X),
   (Single)((Math.Sin(ang) * dist) + destAxle.Y));
 }
 surface.DrawImage(img, temp);
}

private double GetBearingRadians(PointF reference, PointF target, out
                                double distance)
{
  double dx = target.X - reference.X;
  double dy = target.Y - reference.Y;
  double result = Math.Atan2(dy, dx);
  distance = Math.Sqrt((dx * dx) + (dy * dy));
  if (result < 0)
```


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```
            result += (Math.PI * 2);  // add the negative number to 360 degrees
                                      // to correct the atan2 value
        return result;
    }
}
```

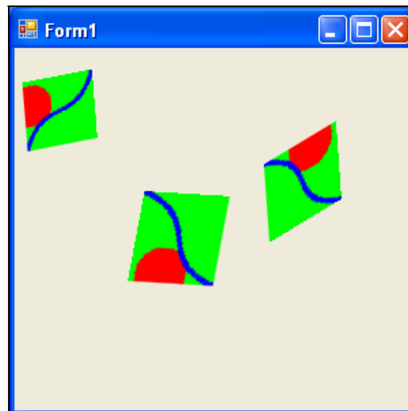
6. To demonstrate the usefulness of the `ImageWarper` class, we will use a random object to randomly select rotation, skewing, and scaling values, so that we can see a wide range of different combinations without having to keep recompiling or manually choosing values—plus it's a quick bit of code to write anyway. First, while in the designer, double-click the form to have the `Form1_Load` event handler generated for you, and then complete it with the code given below:

```
public partial class Form1 : Form
{
  Image img = null;
  private void Form1_Load(object sender, EventArgs e)
  {
    img = CreatePicture();
  }
```

7. Use the Properties window in the Visual C# Express designer to have the `Form1_MouseUp()` event handler generated for you, then complete its code like this:

```
private void Form1_MouseUp(object sender, MouseEventArgs e)
{
  Random rand = new Random(); // randomizes our drawing parameters
  // set up all our parameters first before calling DrawWarpedPicture.
  Graphics target = this.CreateGraphics(); // draw onto the form's
                                           // surface
  PointF pivotOnImage = new PointF(img.Width / 2, img.Height / 2);
  PointF pivotOnTarget = new PointF((Single)e.X, (Single)e.Y);
  double rotate = rand.NextDouble() * 360;
  double scaleFactor = 0.2 + (rand.NextDouble() * 2);
  SizeF skewing = new SizeF(rand.Next(-20, 21), rand.Next(-20, 21));
// draw it!
  ImageWarper warper = new ImageWarper();
   warper.DrawWarpedPicture(target, img, pivotOnImage, pivotOnTarget,
                            rotate, scaleFactor, skewing);
}
```

8. Fire up the program and click on the centre of the form. Every time you click, a randomly warped version of the picture appears at your mouse coordinates. Notice that each one's centre is aligned to the mouse pointer.



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What Just Happened?

The main focus of this exercise is the `ImageWarper` class, so we'll discuss it first. The `ImageWarper` class serves to skew, rotate, scale, and draw an image using a `Graphics` object. It has only two methods, of which only one is public (and consequently, available to our program). Before demonstrating its use, we should briefly discuss its working.

Let's look at the parameters of the `DrawWarpedPicture()` method:

Parameters	Description
`Graphics surface`	This can be any `Graphics` object that you want to draw to.
`Image img`	This is the image object that you want to warp and draw. The actual image is unaffected but it is drawn warped; this allows for repeated draw operations to be done without damaging the original.
`PointF sourceAxle`	The point around which the image is rotated. Coordinates are relative to the top left corner of the image. This enables us to pick a feature on the image and make that point stationary while the image rotates around it.
`PointF destAxle`	This is the point on the target surface where the `sourceAxle` is snapped to. Imagine you pin the image to the screen with a needle; the image can only spin around the needle. The needle passes through both `sourceAxle` and `destAxle`.
`double degrees`	The angle that you want to rotate the image by. The method could be easily modified to change this to radians if needed. The degrees are converted to radians internally anyway before any processing is done. Degrees are easier to visualize though.
`double scale`	The scaling factor. Numbers between 0 and 1 will shrink the image, numbers greater than 1 will enlarge it.
`SizeF skew`	The number of pixels to skew each side of the image by. A size of (10,3) will cause the top side to move 10 pixels to the right, the bottom side moves 10 to the left. Then the left side moves up by 3 pixels and the right side down by 3.

The `GetBearingRadians()` method is not accessible to our programs but it is used by the component's `DrawWarpedPicture()` method; this is in accordance with the OOP's 'black box' principle. `GetBearingRadians()` calculates a 'compass bearing' from one point to another, returning this bearing as the angle expressed in radians.

The warping operations are applied in a specific sequence in `DrawWarpedPicture()`. First an array of `PointF` objects called `temp` is defined and this is where the skewing operation takes place. It is little more than adjusting the corners of the image to reflect the skew and storing these points in an array. Once that is done, a loop is used to iterate through the array and do the following things:

- Calculate the angle from the `sourceAxle` point to each point in the array.
- Calculate the distance between the same points and multiply that distance by the scale factor.
- Finally, convert this angle and distance back into a rotated and scaled point relative to the `destAxle`.

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Once the array has been converted from the three image corners to skewed, rotated, and scaled points, the `Graphics.DrawImage()` method is called. Here we simply supply the image and the array of `PointF` objects. Then the GDI+ engine springs into action and does the hard work of drawing our image in its new position. All of this appears complex but it is very efficient and executes very quickly at run time.

When you execute the project, each picture's centre is aligned to the mouse pointer. This is because of the `pivotOnImage` variable, which is set to half the width and half the height of the original image. The `pivotOnTarget` point is simply set to the mouse coordinates, so the pivoted image appears aligned to the mouse. This coordinate doesn't even have to be within the image's area; you can supply any coordinates to it and the image will appear offset by the correct amount. Keep clicking on the form to see more and more warped images appear

Why go to all this trouble to draw images in such a strange way? Well let's say you wanted to design a control that looks like a volume control dial from your car stereo. Maybe you want to have your company logo on the dial control that rotates along with the turning of the dial. Using conventional methods this might mean capturing dozens of images of the logo at varying angles and drawing the appropriate image at the right time, or writing a complicated way to draw the logo manually, which would involve storing lots of coordinates, and colors. Both of these methods are far from ideal because of the time and effort it would take to implement them. With this method all you need to do is store a single image and just rotate it with a given angle. It's a great solution to a difficult problem.

One notable aspect of the GDI+ drawing methods is that they support transparencies and images that can provide transparent pixel data. You could use a partially transparent GIF image instead of our `CreatePicture()` method and the image would display properly. To use the dial analogy, you could make a circular logo to fit inside your dial area but make all the pixels outside the circle transparent so we cannot see the actual rectangular outline of the whole image. We'd only see the opaque logo inside the dial.

The ImageWarperControl

Based on the example above, let's now create a control named `ImageWarperControl`. This control will create an image and it will be able to scale, rotate, and skew this image. First, we will create an application that will be a typical Windows form and then we will create the `ImageWarperControl` that will create and draw a picture at certain scaling, rotating, and skewing factors provided by the application through control properties.

Time for Action—Creating the ImageWarperApp and the Image WarperControl

1. The first step is to create a new **Windows Application** project in Visual C# Express 2005 named `ImageWarperApp`.
2. Then add a control to the project. In the **Solution Explorer**, right-click on the project name and select **Add | User Control** and name the control `ImageWarperControl`.

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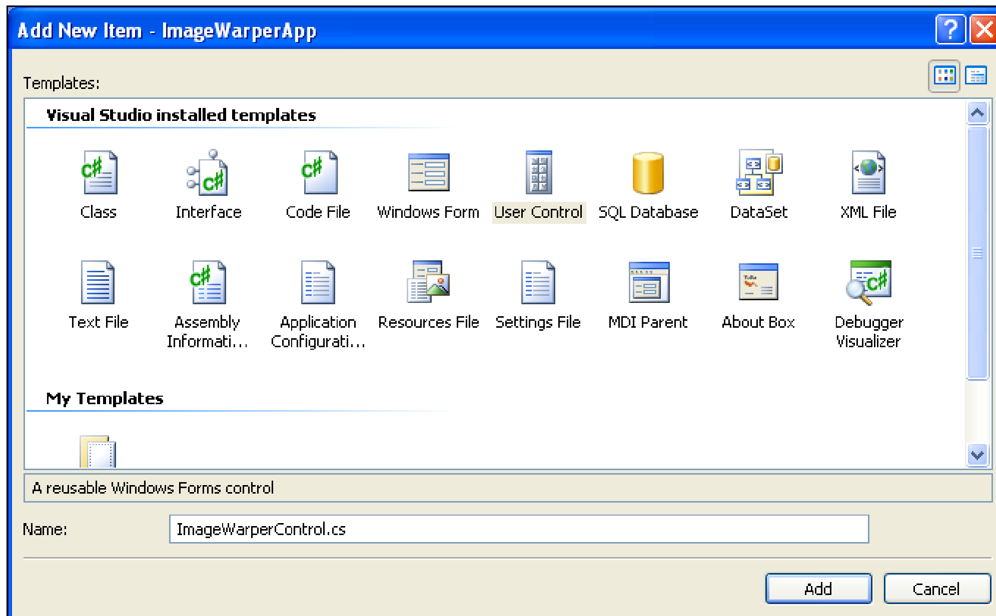
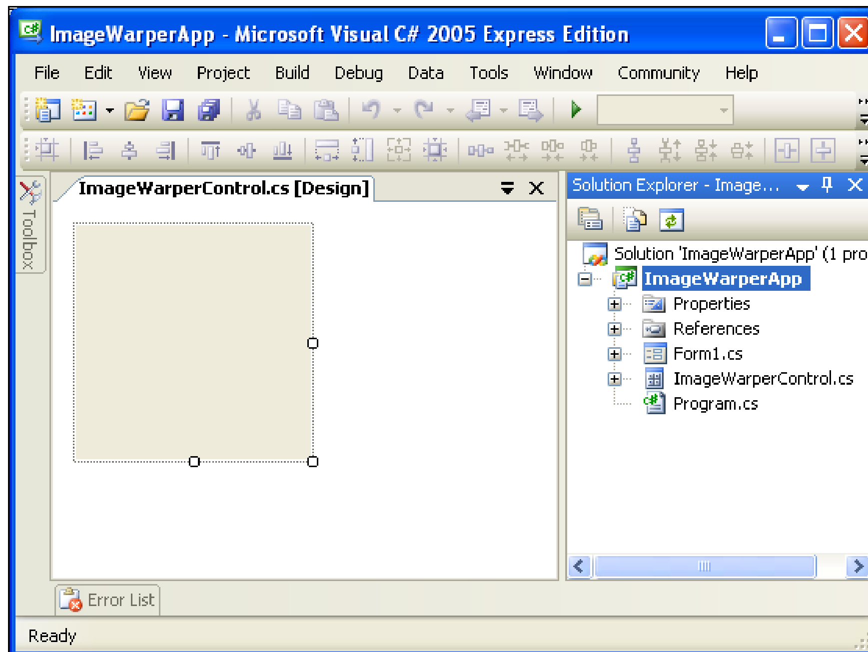


3. You have created a new control that looks like the following:



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4. Right-click the control and choose **Properties**. Go to the **Events** tab.
5. Double-click the `Load` event. The resulting method will be `ImageWarperControl_Load`. Here we will create a picture and store it in `img` variable.

```
Image img,      // the image to draw
private void ImageWarperControl_Load(object sender, EventArgs e)
{
  img = CreatePicture();
}
```

6. Click on the **Form** and press *F4* to view the **Properties** window. Click on the **Events** tab and then double-click the `Paint` event. The result will be the `ImageWarperControl_Paint()` method. The picture will be rendered in this method.

```
private void ImageWarperControl_Paint(object sender, PaintEventArgs e)
{
  // set up all our parameters first before calling DrawWarpedPicture.
  Graphics target = this.CreateGraphics(); //draw onto the form's surface
  PointF pivotOnImage = new PointF(img.Width / 2, img.Height / 2);
  PointF pivotOnTarget = new PointF(this.Width / 2, this.Height / 2);
  double rotate = imageAngle;
  double scaleFactor = imageScale;
  SizeF skewing = imageSkew;
  DrawWarpedPicture(target, img, pivotOnImage, pivotOnTarget, rotate,
                    scaleFactor, skewing);
}
```

7. Add the `CreatePicture()` function to the class:

```
private Image CreatePicture()
{
  // Create a new Bitmap object, 50 x 50 pixels in size
  Image canvas = new Bitmap(50, 50);
  // create an object that will do the drawing operations
  Graphics artist = Graphics.FromImage(canvas);
  // draw a few shapes on the canvas picture
  artist.Clear(Color.Lime);
  artist.FillEllipse(Brushes.Red, 3, 30, 30, 30);
  artist.DrawBezier(new Pen(Color.Blue, 3), 0, 0, 40, 15, 10, 35,
  50, 50);
  // now the drawing is done, we can discard the artist object
  artist.Dispose();
  // return the picture
  return canvas;
}
```

8. Add the `DrawWarpedPicture()` method:

```
  public void DrawWarpedPicture(
  Graphics surface,    //the surface to draw on
  Image img,     //the image to draw
  PointF sourceAxle,   //pivot point passing through image.
  PointF destAxle,   //pivot point's position on destination surface
  double degrees,   //degrees through which the image is rotated clockwise
  double scale,      //size multiplier
  SizeF skew       //the slanting effect size, applies BEFORE scaling or
                   // rotation
)
  {
    //give this array temporary coords that will be overwritten in the
    // loop below
```


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```
    //the skewing is done here orthogonally, before any trigonometry is
    // applied
    PointF[] temp = new PointF[3] {  new PointF(skew.Width, -skew.Height),
                  new PointF((img.Width - 1) + skew.Width, skew.Height),
                  new PointF(-skew.Width,(img.Height - 1) - skew.Height) };
    double ang, dist;
    //convert the images corner points into scaled, rotated, skewed and
    // translated points
    for (int i = 0; i < 3; i++)
    {
      //measure the angle to the image's corner and then add the rotation
      // value to it
      ang = GetBearingRadians(sourceAxle, temp[i], out dist) + degrees;
      dist *= scale; //scale
      temp[i] = new PointF((Single)((Math.Cos(ang) * dist) + destAxle.X),
               (Single)((Math.Sin(ang) * dist) + destAxle.Y));
    }
    surface.DrawImage(img, temp);
  }
```

9. Also insert the following method:

```
  private static double GetBearingRadians(PointF reference, PointF target,
                                        out double distance)
  {
    double dx = target.X - reference.X;
    double dy = target.Y - reference.Y;
    double result = Math.Atan2(dy, dx);
    distance = Math.Sqrt((dx * dx) + (dy * dy));
    if (result < 0)
      result += (Math.PI * 2); //add  the negative number to 360 degrees to
                               // correct the atan2 value
    return result;
  }
```

10. Declare the following member variables in `ImagewarperControl.cs`:

```
  private double imageAngle;
  private double imageScale;
  private SizeF imageSkew;
  private Image img = null;
```

11. These members are accessed through properties. Add the following properties code in `ImagewarperControl.cs`:

```
  public double ImageAngle
  {
    get
    {
      return imageAngle;
    }
    set
    {
      if (imageAngle != value)
      {
        imageAngle = value;
        Invalidate();
      }
    }
  }
  public double ImageScale
  {
    get
    {
      return imageScale;
```


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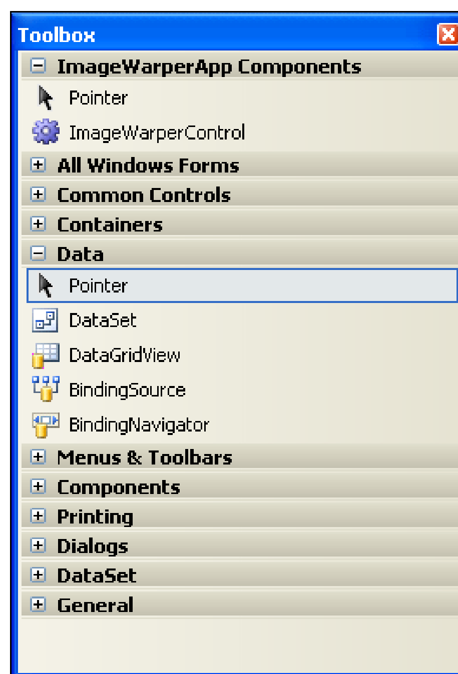
```
        }
        set
        {
            if (imageScale != value)
            {
                imageScale = value;
                Invalidate();
            }
        }
    }
    public SizeF ImageSkew
    {
        get
        {
            return imageSkew;
        }
        set
        {
            if (imageSkew != value)
            {
                imageSkew = value;
                Invalidate();
            }
        }
    }
```

12. Build the project by clicking Build | Build Solution. Now, when opening `Form1` in the designer, you should see the new `ImageWarperControl` in the toolbox:



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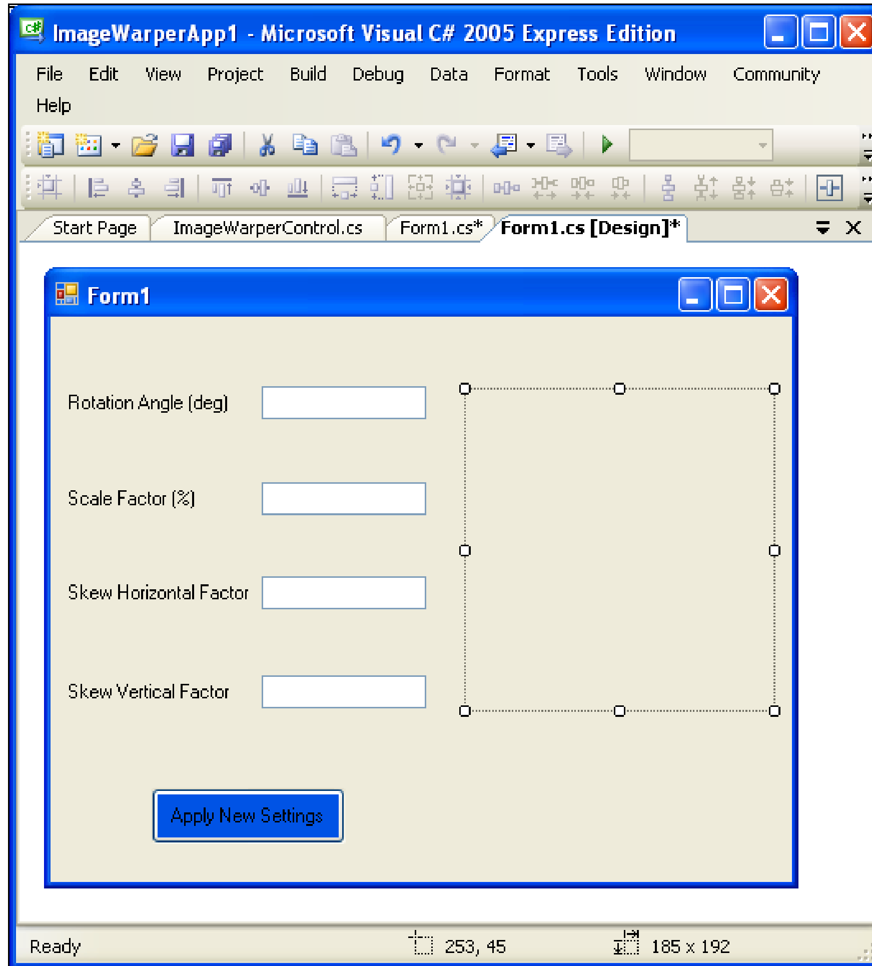
13. Drag an `ImageWarperControl` control to the form.
14. Drag four `TextBox` controls to the form and name them angleBox, scaleBox, skewHorizontalBox, skewVerticalBox.
15. Drag a button to the form and name it applyButton and set the text to Apply new settings. After resizing the controls and inserting some label text controls for each edit control, your form should look as in the following screenshot:



16. Double-click the button. This will generate the `applyButton_Click()` method. Here the values for rotate, scale, and skew are set through control properties.

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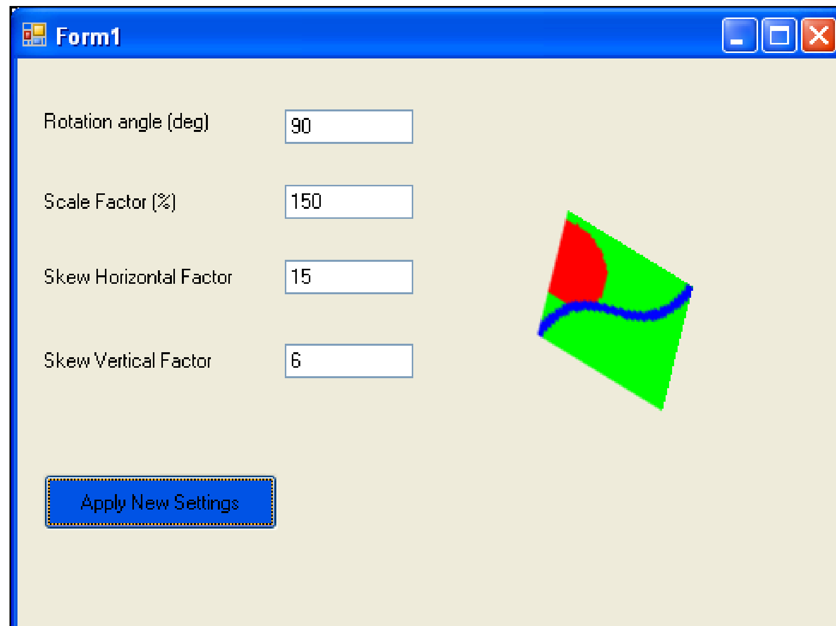
```
private void applyButton_Click(object sender, EventArgs e)
{
  imageWarperControl1.ImageAngle = Double.Parse(angleBox.Text) *
                                   System.Math.PI / 180;
  imageWarperControl1.ImageScale = Double.Parse(scaleBox.Text) / 100;
  imageWarperControl1.ImageSkew =
  new SizeF(float.Parse(skewHorizontalBox. Text),
  float.Parse(skewVerticalBox.Text));
}
```

17. Now build your application and enjoy working with the `ImageWarperControl`.



What Just Happened?

You have successfully written and used the `ImageWarperControl`. This control creates an image and exposes it to image's processing functions. You have used in this example the three most important functions that you can apply on an image: rotation, scaling, and skewing.

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Summary

In this chapter you explored the area of the GDI+ that deals with various kinds of images. The `Image` and `Bitmap` classes were used to load, and save an image and create a brand new image from scratch through code. With our `ImageWarper` component we looked at the GDI+ coordinate system in great detail, and learned how to combine skewing, rotation, and scaling in high resolution. That component is invisible to the user but can enable us to create some impressive graphical effects that have negligible effect upon our program's performance. We also briefly visited the quality control features of the `Graphics` class. Graphics under .NET is a massive subject and we have only skimmed the surface here, but now we have a sound basis upon which to build deeper knowledge later on.

Finally, you have created a custom control named `ImageWarperControl` that can apply different functions to an image. This can be the start for you to create image handling custom controls.

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GDI+ Custom Controls with Visual C# 2005

The amount of built-in functionality included in the .NET Framework is amazing. One could create complex applications with lots of functionality by simply assembling the pieces you're offered for free. Among those pieces you'll find lots of powerful, flexible, and configurable controls. Who would ever need to build their own controls, right?

While some can get away without ever needing to build a custom control, many don't, or don't want to. Sometimes building a custom control is a necessity, because what you want to achieve doesn't exist, or is too expensive to buy. This is particularly true for controls with customized shapes, which need to be drawn instead of reusing other existing controls.

In some other cases, developers build custom controls as part of their architecture, allowing them to reuse more efficiently common functionality (and code) that they trust and like. There are many circumstances where building a custom control can make a programmer's life easier.

Unfortunately, programmers frequently avoided learning how to build custom controls because learning all the complexities consume lots of time and energy. Comprehensive and advanced books on the subject well exceed 1,000 pages, and the excessive amount of information can indeed be intimidating.

This book takes a lighter approach, guiding you step by step into building your first custom controls, and writing quality code. You'll build a new example in each chapter, and in the end you'll build a completely functional custom control where you'll apply most of what you've learned in the book.

What This Book Covers

Chapter 1: Introduction to Custom Controls will be your introduction to the world of .NET custom controls. You'll learn what controls are, why they are useful, what they are made of, and towards the end of the chapter you'll also create a simple yet functional custom control called TinyNoiseMaker.

Chapter 2: Introduction to GDI+ introduces you to the basics of drawing with GDI+. You will meet a few namespaces, classes, and events that form the foundations of drawing with .NET, and you'll see how to paint the surface of a custom control.

Chapter 3: Basic Drawing teaches you more about the coordinate system of GDI+, drawing lines and polygons using pens, brushes, and colors, and guides you to build a control named GradientLabel**.**

Chapter 4: Drawing Complex Shapes and Using Transformations teaches you how to use graphics paths, regions, and transformations to build complex shapes. You'll then use the theory to build a Clock control.

Chapter 5: Drawing Control Parts, Borders, and Adornments explores using the ControlPaint class to implement common functionality and adds finishing touches to your control. To demonstrate the theory you'll build a simple custom control named GradientButton.

Chapter 6: Working with Images covers common techniques for manipulating images. You'll build a control called ImageWarper that scales, skews, and rotates an image.

Chapter 7: Printing introduces this very important area of GDI+. In many circumstances you'll want to add printing support to your controls, and you'll see exactly how to do so by creating the PrintableRichTextBox control**.**

Chapter 8: Collections teaches more details about .NET collections, including the new .NET 2.0 generics. Collections are very useful when building custom controls, and as an example you'll build a Font Picker control.

Chapter 9: Double Buffering introduces this advanced technique that can make a big difference in improving the speed and responsiveness of your control. Scrolling is one such area where double buffering could make a difference, and you'll end the chapter by implementing a control that displays a scrolling text.

Chapter 10: Handling Mouse Events deals with a very important topic for any desktop application you'll ever write. Luckily enough, all controls that ship with .NET have integrated mouse support, but at times you'll need to customize the features. In this chapter, you'll implement two applications: one will allow you to drag an image inside a delimited area, and the second lets you drag pictures from your Windows system into your form.

Chapter 11: Implementing Design-Time Support shows you how to make your user controls designer friendly. This way, your control will be friendly not only to the end users working with it but also to developers as well.

Chapter 12: Designing Intuitive Interfaces is a high-level overview of some human interface aspects that, handled correctly, can help you build controls and applications that are easier and more fun to use.

Chapter 13: The PieChart Control is a comprehensive case study, showing you how to develop a complete custom control in several stages, each time adding features, fixing bugs, and improving functionality.

Appendix A: Distributing Custom Controls shows you how to compile a custom control into a separate DLL file, which can be reused later in other projects. You'll be shown how to do this with both Visual Studio 2005 and Visual C# 2005 Express Edition, which offers different built-in features.

For More Information: www.packtpub.com/Csharpcontrols/book

Where to buy this book

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