CHAPTER 1

Introduction to Perspective and Space Coordinates

Our first perspective activity involves using masking or drafting tape[1] to make a perspective picture of a building on a window (Figure 1.1). It's tricky! One person (the Art Director) must stand rooted to the spot, with one eye closed. Using the one open eye, the Art Director directs one or more people (the Artists), telling them where to place masking tape in order to outline architectural features as seen from the Director's unique viewpoint. In Figure 1.1, this process resulted in a simple but fairly respectable perspective drawing of the University Library at Indiana University–Purdue University Indianapolis.

[1] Actually, half-inch drafting tape from an office supply store is better. It's less sticky and easier to find in a narrow width. Nevertheless, we'll use the more common term "masking tape."

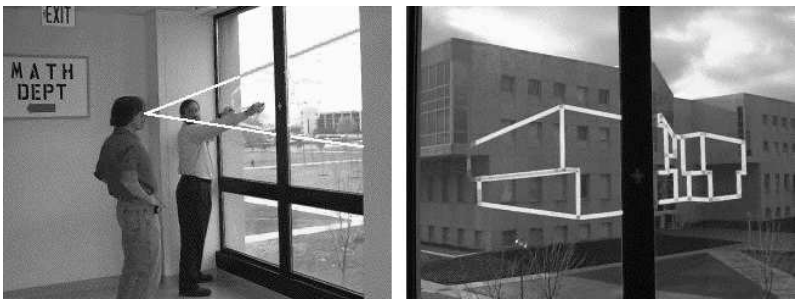


Figure 1.1. Making a masking tape drawing on a window.

If no windows with views of architecture are available, then a portable "window" made of Plexiglas will do just as well. In Figure 1.2, workshop participants at the Indianapolis Museum of Art are making masking tape pictures of interior architectural details in a hallway.

Figure 1.2. Plexiglas will do the job indoors.

Figure 1.3. Using a display case.

Finally, if a sheet of Plexiglas is not available, the window of a display case will also work. In this case, the Art Director directs the Artists in making a picture of the interior of the case (Figure 1.3).

If the masking tape picture from Figure 1.1 is put in digital form (either by photographing and scanning, or by photographing with a digital camera) it can be drawn on in a computer program, and some interesting patterns emerge. (Figure 1.4).

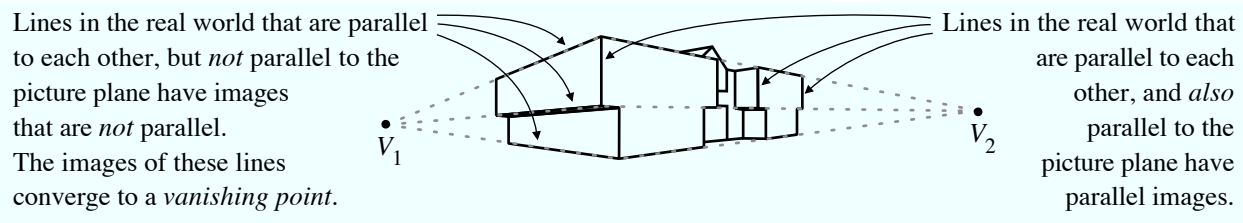


Figure 1.4. Two observations of the library drawing.

[2]A line (extended infinitely in both directions) is parallel to a plane if the line does not intersect the plane.

Observation 1. Lines in the real world that are parallel to each other, and *also* parallel[2] to the picture plane (the window) have parallel (masking tape) images.

Observation 2. Lines in the real world that are parallel to each other, but *not* parallel to the picture plane, have images that converge to a common point called a *vanishing point*.

Two such vanishing points, V_1 and V_2, are indicated in Figure 1.4. The correct use of vanishing points and other geometric devices can greatly enhance not only one's ability to draw realistically, but also one's ability to appreciate and enjoy art. To properly understand such things, we need a geometric interpretation of our perspective experiment (Figure 1.5). As you can see from Figure 1.5, we're going to be using some mathematical objects called *points*, *planes*, and *lines*. To begin describing these objects, let's start with points.

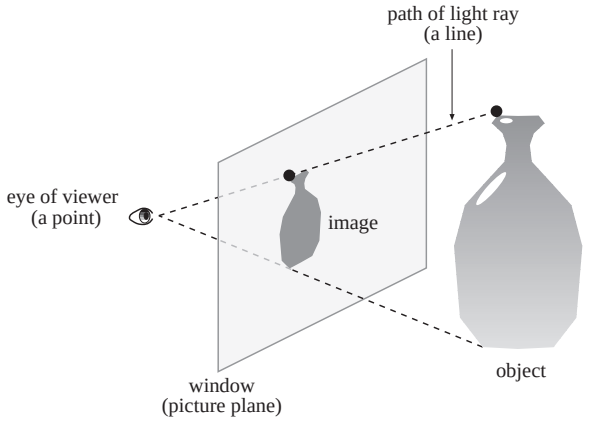


Figure 1.5. Mathematical description of the window-taping experiment.

It's assumed that you're familiar with the idea of locating points in a plane using the standard xy-coordinate system. To locate points in 3-dimensional space (3-space), we need to introduce a third coordinate called a z-coordinate. The standard arrangement of the xyz-coordinate axes looks like Figure 1.6; the positive x-axis points toward you.

For a point $P(x, y, z)$ in 3-space, we can think of the x, y, and z-coordinates as "out," "over," and "up," respectively. For instance, in Figure 1.6, the point $P(4, 5, 6)$ can be located by starting at the origin $(0, 0, 0)$ and going out toward you 4 units along the x-axis (you'd go *back* if the x-coordinate were negative), then over 5 units to the right (you'd go to the *left* if the y-coordinate were negative), and finally 6 units up (you'd go *down* if the z-coordinate were negative).

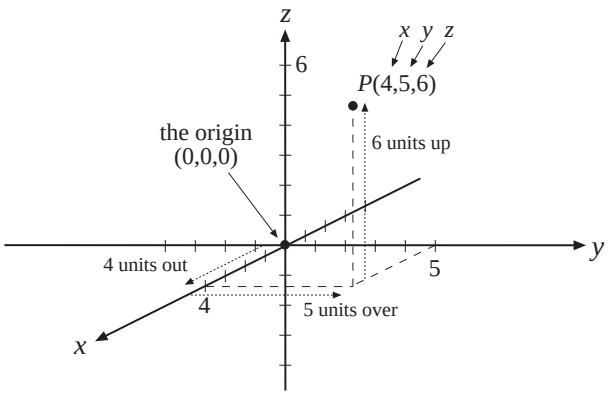
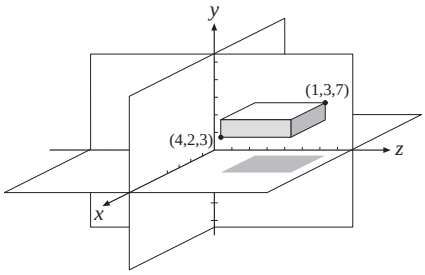


Figure 1.6. The standard xyz-coordinate system.

We took a look at the standard xyz-system in Figure 1.6 simply because it *is* the standard system, and you may see it again in another course. However, it will be convenient for our purposes to use the



Margin Exercise 1.1. What are the missing vertex coordinates of this block whose faces are parallel to the coordinate planes?

slightly different xyz-coordinate system in Figure 1.7—it's the one we'll be using from now on. In Figure 1.7 we have included sketches of three special planes called the *coordinate planes*. In this case, we have to think of the x, y, and z-coordinates as "out," "up," and "over," respectively, as indicated in the figure.

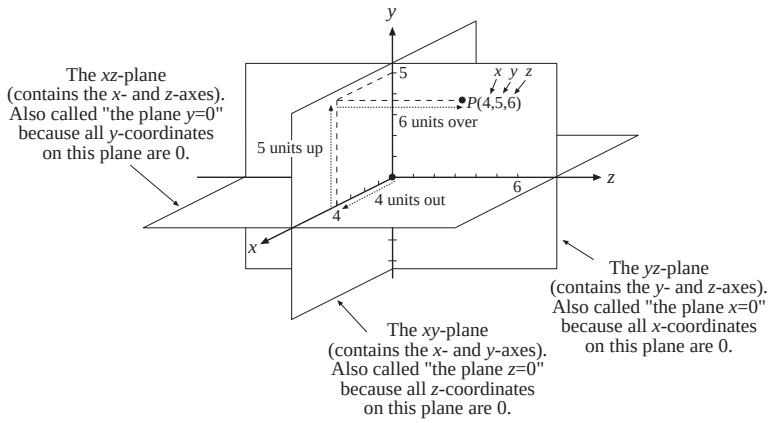


Figure 1.7. The coordinate system we will use.

A first look at how this coordinate system will be used to study perspective is presented in Figure 1.8. A light ray from a point $P(x, y, z)$ on an object travels in a straight line to the viewer's eye located at $E(0, 0, -d)$, piercing the picture plane $z = 0$ at the point $P'(x', y', 0)$ and (in our imagination) leaves behind an appropriately colored dot. The set of all such colored dots forms the perspective image of the object and hopefully fools the eye into seeing the real thing.

Margin Exercise 1.2. Suppose we are given two points $A(3, 3, 2)$ and $B(4, 2, 7)$ in the coordinate system of Figure 1.8.

Which is higher?

Which is closer to the viewer?

Which is further to the viewer's left?

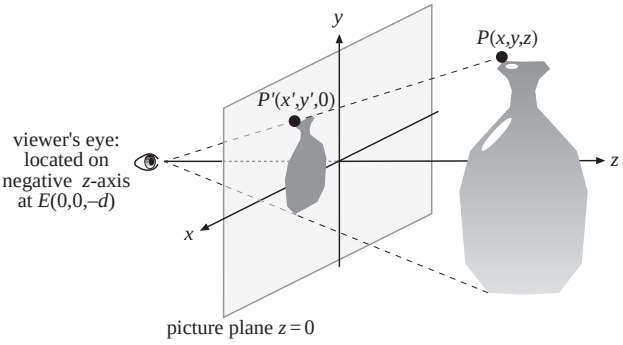


Figure 1.8. Perspective as a problem in coordinates.

In the next chapter we will see how to use this coordinate method to make pictures in perspective, much like special effects artists do

in the movies. We close this chapter by taking a look at how even the most basic mathematics can help us make better drawings.

A Brief Look at Human Proportions

Most untrained artists will draw the human figure with the head too large and the hands and feet too small (Figure 1.9). To prevent these common mistakes, artists have made measurements and observations, and come up with some approximate rules, some of which may surprise you:

- The adult human body, including the head, is approximately 7 to $7\frac{1}{2}$ heads tall.
- Your open hand is as big as your whole face.
- Your foot is as long as your forearm (from elbow to wrist).

That last one really is pretty surprising—we have big feet! To see that these principles result in good proportions, take a look at the two versions of the painting by Diego Velazquez in Figure 1.10.

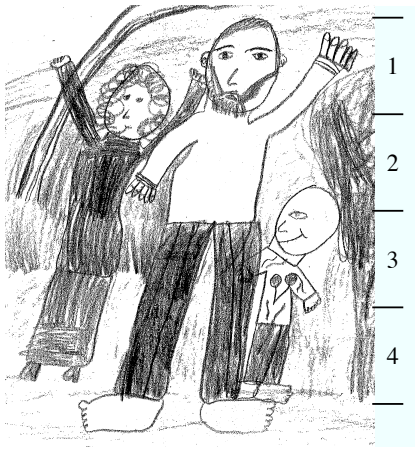


Figure 1.9. Detail of a family portrait by Lauren Auster-Gussman at 8 years old. Note the height of the father in heads marked on the right, and the small hands and feet of the mother.

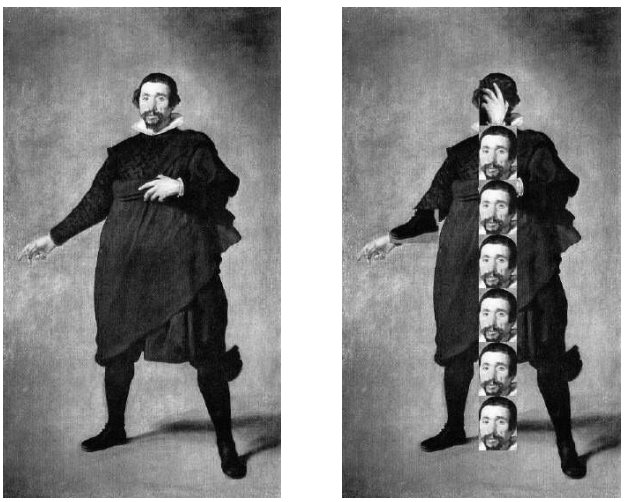


Figure 1.10. Diego Velazquez, *Pablo de Vallodolid*, c. 1635 oil on canvas 82.5 × 48.5 in.

In the digitally altered version on the right, we see that the figure is about 7 heads tall, the left hand (superimposed) is as big as the face, and the man's right foot, when superimposed on his right forearm, just about covers it from elbow to wrist.

Artists who understand human proportions also know how to bend the rules to achieve the effects they want. Comic artists are a good example of this (Figure 1.11).

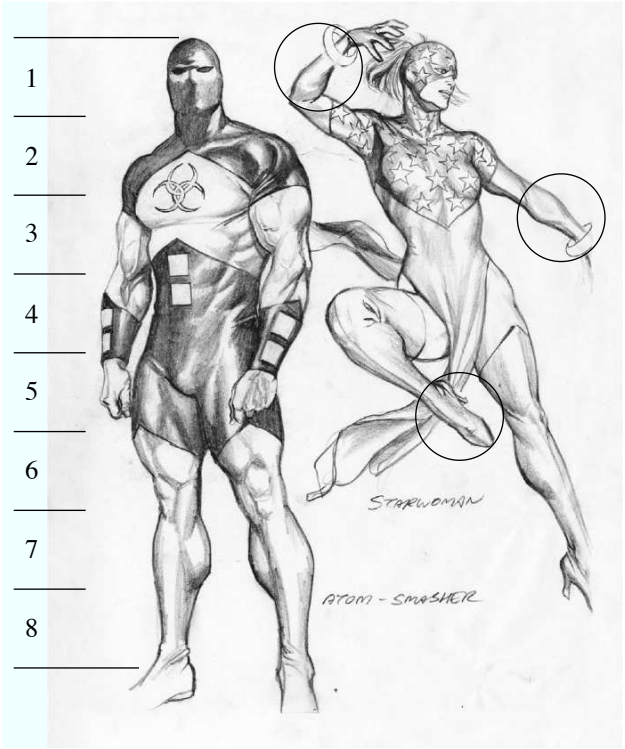


Figure 1.11. In this sketch by popular comic artist Alex Ross, the DC Comics superhero Atom-Smasher is more than eight heads tall. Superimposed circles of the same diameter show that Starwoman's foot is roughly as long as her forearms. (From *Rough Justice: The DC Comics Sketches of Alex Ross*, Pantheon, New York, 2010. ATOM-SMASHER and STARWOMAN are ™ and © DC Comics. All Rights Reserved.)

In their book *How to Draw Comics the Marvel Way* (Simon & Schuster, New York, 1978) Marvel Comics editor Stan Lee and artist John Buscema reveal that Marvel artists generally draw superheroes eight and three-quarters heads tall, for heroic proportions. Popular comic artist Alex Ross, who has drawn for both Marvel and DC Comics, uses these proportions for the DC Comics superhero Atom-Smasher in Figure 1.11, taken from Ross's book *Rough Justice: The DC Comics Sketches of Alex Ross* (Pantheon, New York, 2010).

Having rules like this helps comic artists to visually distinguish superheroes from ordinary characters. It also helps the artists to draw the same character again and again in a consistent way. Thus we see that although artists are not bound by any one set of mathematical rules, *understanding* the rules can be very helpful. That's a theme we will see repeatedly throughout this book.

Exercises for Chapter 1

1. Divide your height in inches by the height of your head in inches (you'll have to measure). According to the artists' rule, the answer should be about 7 to 7.5.

(a) What is your actual answer?

(b) For a child, should the answer be greater or smaller than 7–7.5?

2. In each of Parts (a), (b), and (c), we consider a rectangular box with its faces parallel to the coordinate planes in Figure 1.7. Some of the coordinates of the eight corners (A, B, C, D, E, F, G, H) of the box are given; your job is to fill in the rest.

(a) $A = (1, 1, 1)$,
$B = (1, 1, 5)$,
$C = (4, 1, 1)$,
$D = (4, 1, 5)$,
$E = (4, 7, 1)$,
$F = (4, 7, 5)$,
$G = (1, 7, 1)$,
$H = (\_\_, \_\_, \_\_)$.

(b) $A = (1, 2, 3)$,
$B = (2, 3, 4)$,
$C = (\_\_, \_\_, \_\_)$,
$D = (\_\_, \_\_, \_\_)$,
$E = (\_\_, \_\_, \_\_)$,
$F = (\_\_, \_\_, \_\_)$,
$G = (\_\_, \_\_, \_\_)$,
$H = (\_\_, \_\_, \_\_)$.

(c) $A = (1, 1, 1)$,
$B = (3, 4, 5)$,
$C = (\_\_, \_\_, \_\_)$,
$D = (\_\_, \_\_, \_\_)$,
$E = (\_\_, \_\_, \_\_)$,
$F = (\_\_, \_\_, \_\_)$,
$G = (\_\_, \_\_, \_\_)$,
$H = (\_\_, \_\_, \_\_)$.

(d) Which of the boxes in Parts (a), (b), and (c) is a cube? How big is it?

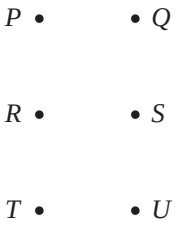


Figure 1.12.

3. This exercise involves drawing sequences of straight line segments without lifting your pencil.

(a) Without lifting your pencil, connect the dots in Figure 1.12 in the following order: $QPRSRTU$. That is, go from Q to P, from P to R, from R to S, from S back to R, etc. Notice that some vertices (dots) get visited more than once, and some edges (such as RS) get drawn more than once. What letter did you draw?

(b) Referring to Figure 1.12, write down a sequence of vertices that draws the letter H. If your straight line path takes you through a vertex, then list it. For example, don't write PT, write PRT instead.

(c) On the left of Figure 1.13 is a simple drawing of a house, and on the right are the vertices of the drawing. List the vertices in an order that duplicates the drawing. Can you do it so that only one edge is drawn twice?

(d) Refer to the box in Problem 2(a). List the vertices of the box (with occasional repetitions) in an order so that if we connect the dots in the same order, we trace every edge of the box at least once. Your path should stay on the edges and not cut diagonally from one corner to another.

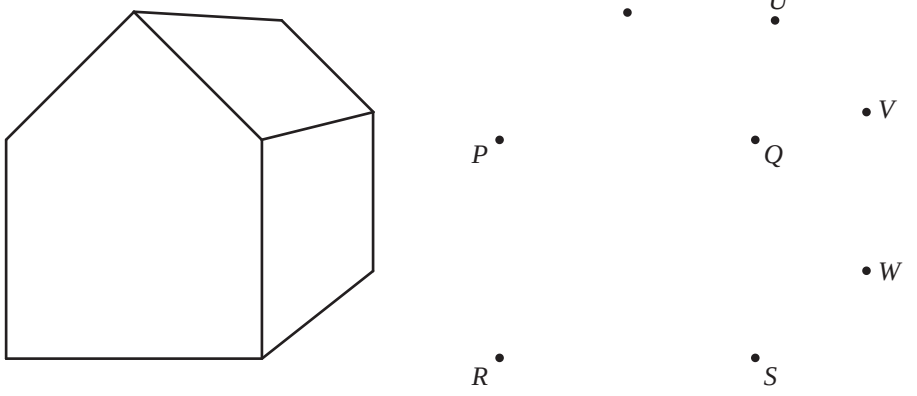


Figure 1.13.

Artist Vignette: Sherry Stone

SHERRY STONE is a lecturer in Foundation Studies at Herron School of Art and Design, IUPUI, with a special interest in teaching first-year art students. Degreed in printmaking, she has become a painter and printmaker who has exhibited in the Midwest and on both coasts. She writes on the topic of the education of artists—and anything else that strikes a whim—and if she hadn't decided to study art, she says she would have become either a writer or a very bad ballet dancer.

If you were to ask my freshman art students what they liked to draw when they were younger, many of them would answer Manga comics. They aren't very different from many other generations of young artists who started off by copying comics. The first comic I tried to copy was "Nancy." The drawings were simple and I was really fascinated with her hair; it looked like a helmet with spikes sticking out of it! When I was older, I liked to copy Wonder Woman, who was a much better role model—if a comic book character can be a role model—and I enjoyed her connection to mythology.

My father was a draftsman: the old-fashioned kind, one of those guys who learned to draw with rulers and mechanical instruments like compasses and protractors, not CADs and computers. My first drawing utensils were his turquoise 2H pencils. That's "h" for "hard," which means they could make the sharp, light, accurate lines that draftsmen needed for architectural drawings. I learned not to like them very well. The marks they made were too light no matter how hard you pressed and they had no erasers on the ends.

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When I was growing up, he worked for a company that constructed water towers like the ones you see from the interstate that announce

the presence of small towns like "Sellersburg" or "Speed" to everyone passing by. Sometimes his company built water towers shaped as unusual objects like ketchup bottles or Dixie cups. They acted as signposts for companies that were so big that they needed their own water tower. I thought those towers were very cool. That was before Claus Oldenberg began making his monumental Pop Art sculptures of everyday objects like baseball bats. Years later, after my dad left, the company built the giant baseball bat that leans against the front wall of the Louisville Slugger company. It's interesting to consider how an object is regarded as art in one context and not in another.

When I was in sixth grade, my dad started moonlighting as a draftsman for the developer who was building houses in our subdivision. That was the year I almost decided to become an architect rather than an artist. I learned linear perspective and I used it to design dozens of dream homes. My interest in being an architect eventually waned: my heart was set on being an artist, and my interests were too broad to be limited to houses. I have a long history of writing poetry and stories and making drawings and paintings. I love to read. Art is a great profession for someone who has a lot of interests. It's an area where the entire realm of your experiences can come together. That is why artists really need to be well educated. It's hard to make art when you have nothing to say.

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My interest in architecture was, however, a valuable detour. I learned linear perspective at a time when many kids decide they can't draw. Upper elementary school children want their drawings to look realistic. They are embarrassed by drawings that look childish because they are growing up and they want their drawings to look as mature as they feel. Linear perspective was one tool I could use to make my drawings look like reality.

Consequently, linear perspective has never been much of a mystery to me. Today, I teach linear perspective to wary students in first-year drawing courses. Some really enjoy it and take to it very quickly, while others treat it like a bad math test. That saddens me because it is so useful in understanding the three-dimensional nature of objects you are drawing, even when you are not specifically using it. Art students are an interesting lot, though. Some are little Da Vincis, very analytical and seem more like scientists and philosophers. Many, though, are intuitive souls and are content to feel their way through problems and don't take well to the structure and rules of perspective.

I find that very puzzling. I once taught a drawing workshop for 8- to 10-year-olds in which the coordinator had written perspective into the course description. I had great reservations about it. I decided to teach it by playing a game of "Follow the Leader": they were to draw what I drew, line for line, and guess what we were drawing. They were very excited and followed me perfectly as we

drew a house in two-point perspective with inclined planes, auxiliary vanishing points, and doors and windows centered on the walls. And they happily duplicated it with very little help from me! I think about that every time I am faced with an impossibly confused college art student.

My artwork now has very little to do with linear perspective, but I am always aware of it, even if I am drawing from the human form. Any form that can be simplified into a configuration of geometric shapes can be drawn in linear perspective. By considering the body as a series of boxes and cylinders situated on a plane, it is easier to draw the human form as though it is part of a space.

"My artwork now has very little to do with linear perspective, but I am always aware of it, even if I am drawing from the human form."

In my recent work, I have utilized photography and computer programs like Photoshop to do preparatory work for my paintings. I have found the distortions of planes and lines caused by viewing the subject through a lens to be very interesting and sometimes quite a departure from the invented environments one would create with linear perspective—although I have been known to purposely distort the rules of perspective for expressive reasons.

Like perspective environments, photography captures environments that appear very real, yet they both walk a line between illusion of reality and abstraction. They both are two-dimensional, striving to create an illusion of three dimensions, but if artists aren't aware of the inherent limitations of the individual processes, they can create very strange illusions. Some artists find this aspect intriguing and freely manipulate these conventions for their own purposes.

For example, the Photorealist painters of the sixties were very interested in the effect of photography on painting. Richard Estes painted many images of store windows. If you were actually standing in front of one of the stores he painted, you would be able to see the merchandise inside because of our eyes' ability to focus on various planes of space and to ignore some visual information in favor of other information. Estes, however, painted the store window as the camera saw it, with many reflections dancing across the glass and very little of the merchandise visible. Even though painters had been using photographs as resource material since the advent of photography, most artists painted from them as though they were working from life, and often would not admit they had used a photograph. Painting an image as the camera saw it—and not only admitting it but also making the work about it—was new.

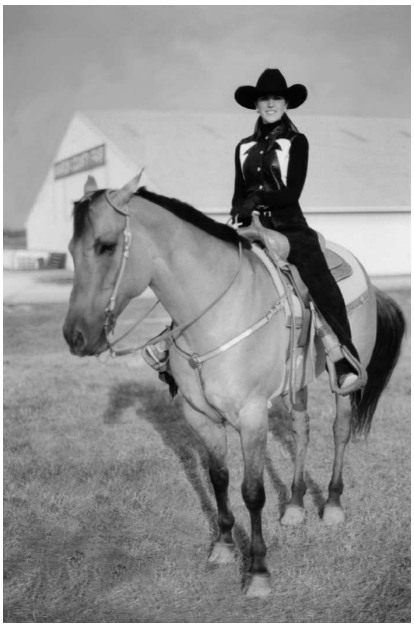
Sherry Stone
Vampires, 2001
acrylic on canvas 11 × 17 in.

One question I face is how far removed from the original subject I can progress while still maintaining the essence of the original. Through how many material, developmental, and aesthetic filters can an image pass and still be considered a documentary work? The truth is that there is no truly objective work, no matter whether it's art or journalism or law or management or anything else, because

everything we do is colored by our experiences and our own points of view. Influences such as education, upbringing, societal attitudes, for example, go into effect even as a person anticipates beginning the project.

"The subjects of my work are young women and girls at a time in their lives when they are making decisions that will affect their destinies."

I suppose decision making is really at the core of most aspects of my work. The subjects of my work are young women and girls at a time in their lives when they are making decisions that will affect their destinies. The work, in essence, is about portraiture, but I would rather consider it to be about capturing a moment in time in these young people's lives. Art is a process-oriented activity at its best, but I am constantly questioning how far I should go in processing the image, given the immediacy of the content of my work. I do not consider myself a photographer, yet maybe the photograph is the most appropriate final form? Once I photograph, process the image in the computer, make rough sketches, and paint the image, I have to ask myself whether I am taking the image too far from its source.



Sherry Stone
Western Rider, 2002
ink-jet print 8 × 12 in.

In answer to that, I often leave the image as an ink-jet print, but still, unable to resist tinkering, I can be found painting on them occasionally. My answer, for now, is that my objective in photographing is to capture information, not create a finished piece of photography. The process of creating something beyond the photograph is more important for now.

For more of the artist's work, see the Plates section.