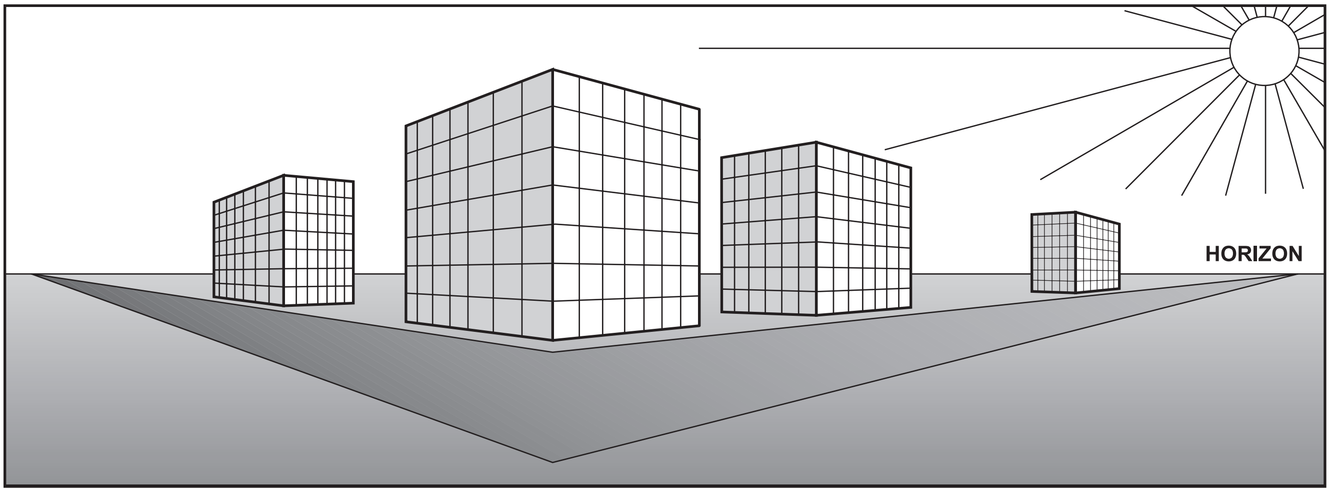


**Figure 1.4.1. Visual perspective affects everything you see in three dimensions and causes objects to appear distorted..**

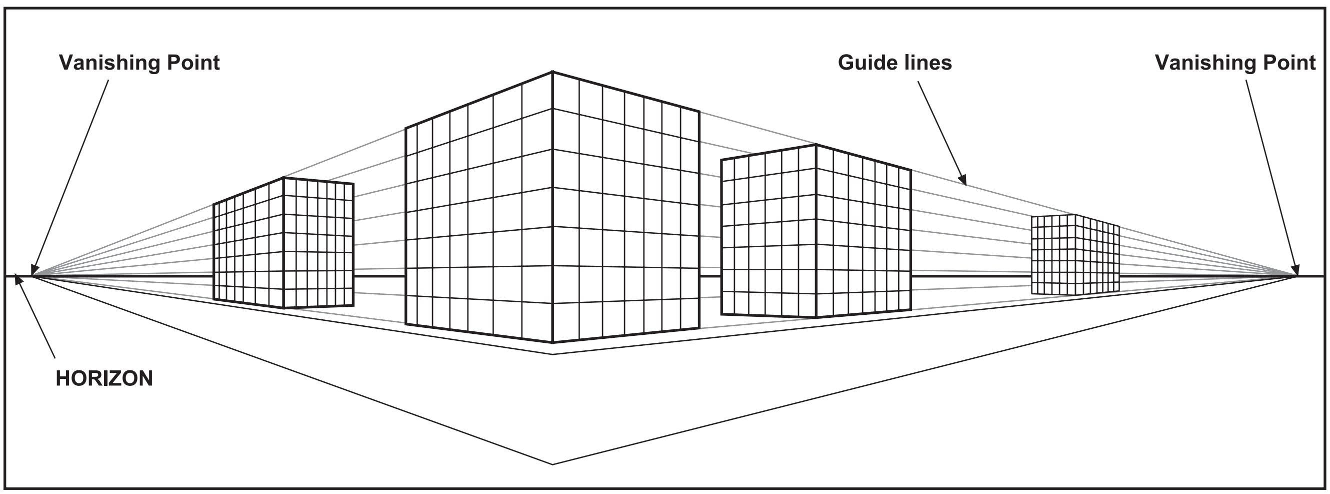


**Figure 1.4.2. Simulate visual perspective in a 2D drawing by creating a horizon line with two "vanishing points."**

Visual perspective plays havoc when trying to use perspective views as a guide for drawing blueprints. This side view is distorted because the outboard "engine pod" is closer to the camera and thus appears enlarged. The front view is badly distorted because the nose of the ship is so much closer to the camera than everything else.

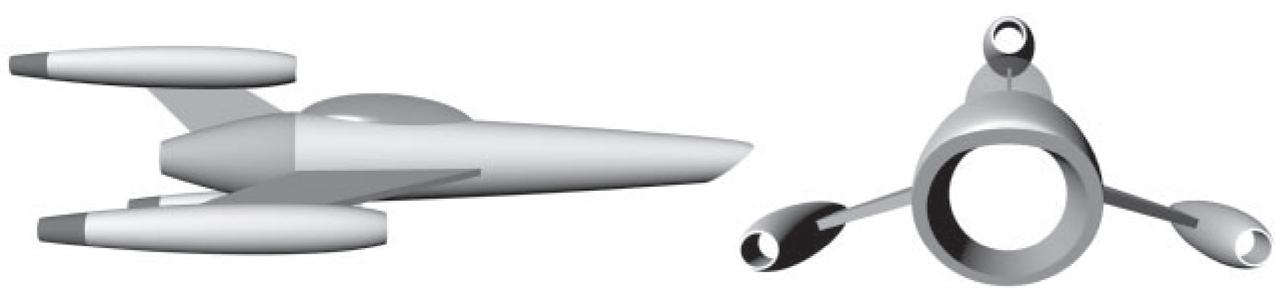

**Figure 1.4.3. Visual perspective plays tricks on the eye by causing significant distortion in reference photos.**

2D drawing or painting by using *converging* reference lines as shown. To appear realistic, all such lines must converge to two different points on the same horizon.

Because they do not include any visual perspective, blueprints are dramatically different from just about all other types of illustrations. When all perspective has been eliminated, the drawings are said to be "flattened." This is why you can extract useful measurements from them.

The idea of a "flattened" illustration, however, can sometimes cause confusion. As it turns out, orthographic views can look dramatically different from perspective views! As a result, you may find the projected plan view does not look quite "right" to your eye simply because you are accustomed to seeing the subject in perspective.

This also points the way to another common problem. You may need to rely on *photographs* as reference in order to make your blueprints. Unfortunately, like your eye, the camera also "sees" visual perspective. As a result, using photographs as the basis for your blueprints can cause significant problems. As it turns out, it's very difficult to take a photograph that successfully approximates or "emulates" a true orthographic plan view.

Visual perspective is always present whenever you take a photograph. This can cause numerous problems if you are relying on photos as reference when making your blueprints.

The main reasons for this shortcoming are inherent distortion caused by the lens of the camera along with poor alignment of the subject. In fact, lenses can add a tremendous amount of distortion to an image. In addition, it is rarely possible to perfectly align the camera with the centerline of a subject without going to a great deal of trouble. Despite your best efforts, the resulting photographs will inevitably be distorted in one way or another. As a consequence of all this, subtle differences will nearly always exist between "flattened" orthographic views and the perspective views seen by a camera.

To illustrate this phenomenon, a series of examples are presented in **Figure 1.4.3** though **Figure 1.4.5**. Although it may not be apparent at first glance, this fictional spacecraft (created specially for the purposes of this example) has a shape that is somewhat troublesome to draw accurately in plan view form. If you imagine having a model of this craft in front of you, you could rotate the model in order to view it from the side, top, front, and back. You could also photograph the model and use the photographs as a reference to begin drawing blueprints of the craft.

Unfortunately, if you simply trace a side view photo of this subject, you will start running into problems right away. Drawing the fuselage of this model in the side view is fairly straightforward. But, what about the engines? Note how the outboard engine is placed on the tip of the "wing" so that it is located quite far away from the centerline of the ship. As a result, when looking at the model from the side, the engine nearest your eye will appear quite a bit

Note the drastic difference between a front perspective view using a 50 mm lens (left) versus the same angle using with a 150 mm lens. A “longer” lens reduces perspective distortion considerably, making the resultant image far more useful.


**Figure 1.4.4. Perspective distortion can be drastically affected by distance to the camera and focal length of the lens.**

Example orthographic plan view drawings superimposed on both a side and a front perspective view.
Note the dramatic differences even though the images were photographed with a “proper” lens.

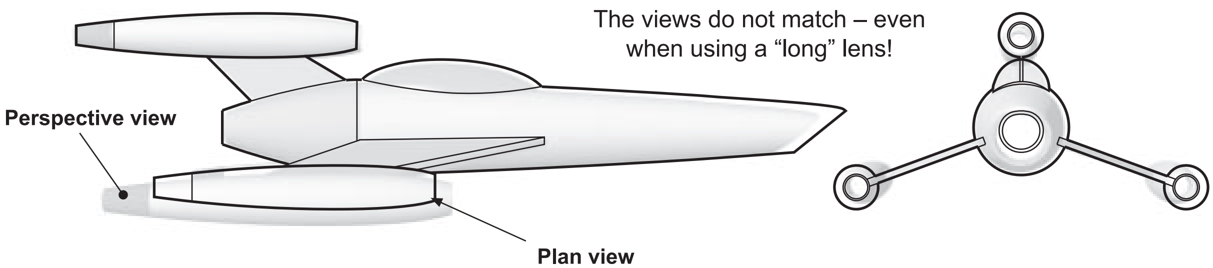


**Figure 1.4.5. Photographs contain some perspective distortion even when using a “telephoto” lens.**

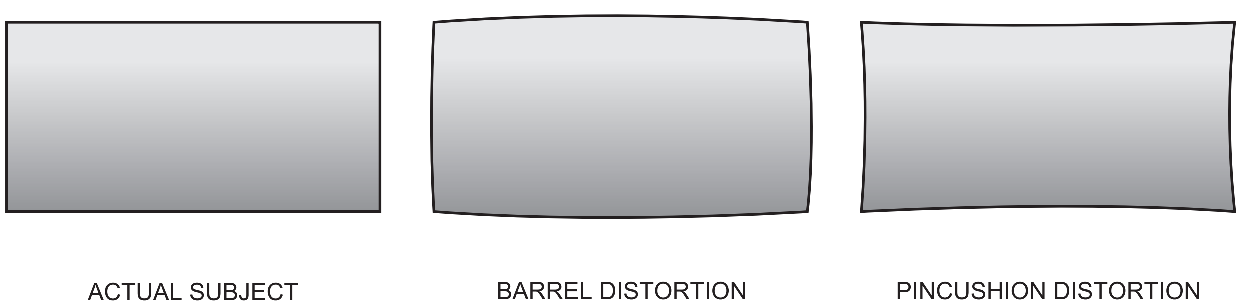


**Figure 1.4.6. Cheap or defective camera lenses can cause either *barrel distortion* or *pincushion distortion*.**

larger than it really is! At the same time, the engine on the opposite side will appear much smaller than it really is. Then there is a *third* engine in the middle of the craft. Which one do you trace?

The answer in this case is to use the *center engine* for reference in the side view while ignoring the other two. Since the center engine and fuselage both share the same centerline, you can accurately gauge the size of each in relation to the other. In contrast, the outboard engines are so distorted they should not be used for reference in this view.

Other problems appear as you continue trying to draw the craft. For example, when viewed from the front, the long "nose" will be much closer to the camera than the rest of the ship. This causes *severe* perspective distortion as illustrated in **Figure 1.4.3**. The amount of distortion will depend both on the distance between the model and the camera and also on the focal length of the lens used to take the photograph.

According to basic principles of photography, it is generally believed your eye sees objects the same way a 35 mm camera would when fitted with a 50 mm lens. As a result, an object appearing in a photograph taken with such a setup should appear about the same as it would if you were viewing it in person. *Decreasing* the focal length of the lens *increases* the perspective and, therefore, the distortion. This is known as "wide angle" photography. Because the distortion in such photos can be severe, you should avoid using wide angle photos for reference whenever you are drawing blueprints.

When studying photographs, beware of perspective distortion based on the shape of the subject, the type of lens used, and the distance from the camera. Whenever possible, choose photographs taken with a *telephoto lens* where the camera was aimed directly at one side of the subject.

Increasing the focal length reduces the apparent perspective distortion. This can be very valuable if you need to use photos as an aid when drawing blueprints. For example, in **Figure 1.4.4** you can see an illustration of how drastically different the front view of our example spacecraft will appear when photographed with a 50 mm lens as opposed to a 150 mm lens. The first image is approximately how you would see the model if it were in front of you. It is obvious that such a view would not be very useful for reference! As you can see, using a "telephoto" lens (i.e. one longer than about 100 mm) aimed directly at the side, top, bottom, front or rear of a subject will generally provide better reference images.

Perspective distortion is not the only potential problem when using photographs for reference. The lens used to take the photograph can cause other types of visual distortion as well. One common example is called <u>barrel distortion</u> and is illustrated in **Figure 1.4.5**. Barrel distortion causes the middle of the image to be enlarged relative to the outside edges. This problem is quite common when using an inexpensive lens such as that typically found on a consumer-grade, auto-focus type of camera. A related problem is known as <u>pincushion distortion</u> and this is also demonstrated in **Figure 1.4.5**.