Plans From Photos Clinic
Article written by Gary Robinson

INTRODUCTION

How many times have you seen a railroad car, or a structure, that you'd like to model, but you just haven't been able to take accurate measurements. Perhaps it's too big to measure adequately, particularly if you're alone when you see it. What if you have a picture of a building that was torn down, or a car or locomotive that was scrapped, years ago?

Here's a method you might be able to use to estimate the measurements you need to create plans for that coaling tower you couldn't measure. Best of all, it's easy, relatively quick and inexpensive, and takes advantage of things most modelers already have in their toolbox.

First we'll talk about how to prepare to take pictures of a new subject. This will familiarize you with the techniques we'll use. Then we'll talk about how to create plans, including some ways we can "guesstimate" measurements from existing photos or slides. Along the way we'll see some examples that will help you visualize the process.

The basic process for preparing an image from which you'll create your plan is to place a "calibration stick" on or near the subject, photograph it using a camera loaded with color transparency (slide) film, then project the image onto a piece of paper. By adjusting the size of the image until the size of the calibration stick matches a scale rule for the scale you're working with, you get an image of the subject in the appropriate size for your scale. You can now take measurements from the image, or simply trace the major features onto the paper, creating a basic plan.

Sounds easy, doesn't it? It really is, but there are a few things we should know to get the best possible results. Let's explore some of these in more detail.

MATERIALS

You'll need one or more "calibration sticks," which we'll talk more about later, a fairly good quality 35mm camera with a flash attachment and slide (color transparency) film, a slide projector, and something with which to take notes in the field. You'll also want a scale rule appropriate for your scale. Optional items may include a draftsman's divider, a measuring tape, a tripod, a cable release, a light meter, and a tape recorder.

First, the camera you use should be capable of some range of adjustment for distance from the subject, and amount of light gathered onto the film. This allows you greater opportunity to get shots of darker areas, and particularly back-lit subjects (subjects between you and the light source, usually the sun).

Unfortunately, we're not always able to achieve the optimum positioning of our subject to have the light source behind the camera (You can't move a building!). The flash may help in this regard, but the ability to change the shutter speed and F-stop (size of the lens opening) will prove invaluable. Most model railroaders already have a 35mm camera that will be adequate for this work. A snapshot camera or a single-use camera may not provide satisfying results, but if that's what you have available, try it! In my opinion, it's always better to have a less-than-perfect picture of a subject than no picture of the subject.

Let's talk about digital cameras for a minute. I don't want to get into a clinic on digital photography, but there are a couple of important items to mention. A good quality digital camera may provide images good enough to allow you to create plans that will be adequate for modeling purposes.

Two critical factors are the number of pixels (the more, the better) and the number of images that can be stored (ditto). Expect to see a price increase for the camera as these numbers go up. The key with the digital camera will be that you must be able to scale the image so the calibration stick matches the scale rule. This may be possible with your software, or you could print out the image and photocopy it on a machine that scales the reproduction. (This service is available from places such as Kinko's.) Of course, you could also calculate the measurements using ratios, as we'll discuss later, but this is more complex. It really depends on your need for accuracy. Your notes can come in handy here.

An attachment that would disperse the flash output across a wider angle may be helpful if wide-angle photography is necessary because of clearance problems. However, use care when relying on wide-angle shots. While they can be valuable to document the overall look of a building, for measurement purposes a shot taken with the "normal" lens is best. This is usually a 45-55mm lens for most 35mm cameras.

The reason for this is that wide-angle shots rely on the optics (lens elements) of the lens to compress the rays of light striking the film, thereby allowing more of a scene to be recorded on the image. Unfortunately, this also tends the change the perspective of the shot, particularly at the edges. As a general rule, the smaller the lens is (in other words, the wider the angle), the more distortion will be introduced to the image.

The next thing you'll need is at least one "calibration stick." This is simply a straight piece of wood or other material that has been marked off in known increments. The increments have been painted or otherwise marked so as to be easily seen in the photographs. The stick I use is a five foot length of 1x2 that I salvaged from an old hammock. First I cut the stick off to be exactly five feet. Then I divided it into five one-foot sections. I next painted the entire stick white, then painted the second and fourth feet International Orange. (It's always best to paint the darker color over the lighter color.) You may find it handy to have a

smaller stick, marked off in inches, that you can use when taking close-ups of small details. Alternatively, you could mark a section of the main stick into inches using a different color.
Your slide projector should allow you to project the image as flat as possible. By this I mean, the size of the projected image should be the same at the top and bottom, and at both sides.

If you've followed the directions below for taking the photos, this will provide the most accurate plans. You should be able to adjust the image so you can calibrate the stick using the scale rule. This may be with a zoom lens, or it may mean simply moving the projector closer or farther away. You'll also want to consider where you'll be projecting the images. We'll discuss this more later, when we talk about creating the plans. For now you'll want to think about how you support the slide projector. Will it be on a table, or a special stand?

Remember, the location of the projected image should allow you to work between the projector and the image without obscuring (much of) the image. The work height should also be considered. I like to set my projector up so the image is projected over my right shoulder (since I'm right-handed), allowing me to reach in and draw without obscuring too much of the image.

A pad and a pencil may be all you'll need to take notes. I find it convenient to carry a pocket tape recorder and one or two extra tapes. I simply talk into the recorder, then transcribe the data later. This seems to be faster, and takes up less space. It's also a one-handed operation and that comes in handy from time to time. I use this to record measurements I may take instead of photographing something, or when a photo won't show the subject well (as in the depth of an indentation, for instance). I also mention things I don't want to forget about the setting.

A scale rule calibrated for your scale is required. This is how you will determine when the image is the proper size. If you don't have a commercial scale rule, borrow a buddy's and mark off the measurements on an index card. But a scale rule is comparatively inexpensive, and will also be useful as a straightedge when drawing plans directly from the image, not to mention other modeling applications.

Optional items may make the project easier. A draftsman's divider (looks like a compass, only with two points) will allow you to set the points equal to a measurement you know, and measure something you don't know. For instance, say the subject is a two story building, but your calibration stick is only five feet long. Set the divider points at five feet, and "walk" it up the dimension to be determined. Mark the number of complete five foot sections, reset the points for the left over amount, and place them on the scale rule to obtain the leftover dimension.

A measuring tape may be useful for taking those measurements you can reach, or something you want to be especially careful with. Also, there are some things, such as depth, that can't be easily determined from a picture. This will allow you to supplement your photos with lots of useful information, and provide a more complete plan.

A tripod and cable release (and maybe a time release shutter on your camera) may allow you to get pictures you couldn't otherwise get. You can place yourself in the picture, and be your own calibration stick. (You know how tall you are, don't you?) You can use natural light in low-light situations where hand-holding the camera may introduce shake and result in a photo that isn't useable. This is particularly important when shooting buildings, where you have to be so far away your flash is less effective. Your tripod may also double as your projector stand, as mine does.

The light meter will allow you to take an accurate reading (don't trust your camera's built-in meter - the type of metering and the sensitivity are generally too variable) of a back-lit subject and determine the correct exposure settings.
You may discover other things that prove useful as you try these techniques. Now that we've assembled our equipment, let's take a look at how we use it all.

TAKING THE PHOTOS

The first thing to do is compose the image. The orientation of the camera to the subject is critical for this work. To achieve the best results, the camera should be positioned perpendicular to the main plane of the subject. The film plane of the camera should be parallel to the subject. Also, the camera should not be tipped up or down, but the lens should be parallel, or nearly parallel, to the ground. The camera should be as near the vertical center of the subject as possible.

Composing the picture in this way reduces distortion and the perspective effect. This is not always possible because of clearances at the photo location. In such cases, it is usually better to take one overall picture of the subject, to establish the relationship of the details to each other. Then take single shots of smaller details that will be assembled into the larger subject.

These single shots can usually be taken at an angle more nearly perpendicular to the subject, and the overall size of the subject can be extrapolated (estimated) from the known size of the details and the overall view of the subject. This is usually close enough for modeling most buildings, because we will probably "selectively compress" our model anyway. Be sure to overlap sections in your shots, so you don't miss anything. This will also help to align longer subjects properly.

If you're lucky enough to own a Nikon camera, you may be able to find an "architectural" or "shift" lens. This special purpose (read "expensive") lens is designed to allow the photographer to compensate for perspective. Unfortunately, this type of lens is not available for all makes of cameras.

You then place the calibration stick in the scene, somewhere that it doesn't obscure important details. I like to try to get it close to something I know I'll want to measure, such as a door or window frame. Also try to get it as close to the center of the image as possible. This reduces the effect of any distortion that may be introduced into the image by the lens.

CREATING THE PLAN

Once you have your slides processed, set your projector to project the image on a piece of paper that you can draw on. If you have smooth walls at home, you can simply tape a piece of paper to the wall.

Be sure to use the easy-release (blue) masking tape so it doesn't pull the finish off the walls. If you have textured walls as I do, first tape a large piece of foamcore or Strathmore board to the wall, then tape the paper to this. Now you will have a smooth surface on which to draw. Note: black foamcore makes it easy to see the edges of the paper.

Adjust the position of the projector so the image is flat (see discussion above). Don't try to compensate for any perspective (converging lines) that may appear in the image, we'll try to do that with our calculations. When you view the slide, you'll want to adjust the size of the image until the marks on the calibration stick are each the same length as a scale foot in the scale you're working with. Make sure the slide projector remains perpendicular to the surface onto which you're projecting.

If you're projecting onto the paper against a wall, you'll want to be sure the projected image is high enough to allow you to stand between the projector and the image and work comfortably, without obscuring the image (casting a shadow over the part you're working with). I find about shoulder height seems to work best for me.

If you have the time, space, and inclination, you could suspend the projector from the ceiling so it projects straight down onto a desk or counter top, or over your shoulder onto a drafting table. This would make it easier to trace the lines of the image on the paper, and I highly recommend this if you plan to use this technique a lot. The time spent in designing and building the set up will pay for itself in avoided frustration and reduced time to completion. Whatever method you use, be sure the projector is stable. You don't want it moving around in the middle of your drawing session.

I strongly recommend you install a mechanism to move the projector smoothly toward and away from the screen in small increments. This will be invaluable in adjusting the calibration of the image. This doesn't mean you have to spend a lot of money for an Incra-jig. A simple plywood platform and a fine threaded bolt to move it will work. Use a wrench to turn the bolt. Adjust the image toward or away from the screen by moving the entire projector until the size is close, then use the threaded bolt to make the final adjustment. The closer the calibration stick is to the scale size, the more accurate your plans will be.

Once the image is projected to the correct size, you have two options. If perspective problems are not apparent in your image, you could simply trace the lines of the image onto the paper. The scale rule will come in handy for keeping the lines straight. This will give you a workable plan, if scale tolerances aren't a significant issue.

If you want a more accurate plan, I suggest transferring measurements from the image onto a separate sheet of paper using a draftsman's divider, square and straightedge, and a sharp pencil. This second method allows you to compensate for any perspective you may have in the photo. If you have CAD software, you could transfer the measurements into a CAD drawing.

If your image does exhibit perspective, you can correct for it. By referring to a known dimension in the narrowing section, such as a standard window or door, you can extrapolate the measurements of the wall or other structural component. The same method could be used to calculate the height of a tall structure, such as a coaling tower. It won't be 100% accurate, but again, it will be close enough for our modeling purposes.

Another way to compensate for perspective is to draw the plans for a section at a time, then assemble the sections to make the final plan. This may be the only way you can get an accurate plan for some long structures. You may be able to save time by only drawing plans for one section and using those plans to create multiple sections, depending on the structure of your subject.

For tall buildings, you'll have to extrapolate the correct measurements for the upper stories. There may be several keys to use in determining a starting point. Consider such things as

" Are the walls straight up from the bottom to the top of the building?

" Are the windows the same on the upper floors as they are on the lower floors?

" Is there any other detail that can be seen in a lower section where less perspective is evident?

You want to find something in the upper (narrower) part of the structure that is represented in the lower part, where it can be measured. Once you've identified the key you will use, the following process will allow you to solve for the measurement you need.

Even though the higher element appears smaller in the image, the two elements are proportional. Since you know the measurement in inches for the key item in the image, you can measure the subject (unknown) item in inches, then set this up as a ratio (fraction). Next you measure the key item using the scale rule, and place this number in the second fraction in the same position (numerator or denominator) as that item's measurement in the first fraction, then solve for the unknown element.

For example,
2/4 = X/2, can also be expressed as
(the subject item in inches) = (the subject item in scale feet)
(the key item in inches) (the key item in scale feet)

Solving the example, we first multiply both sides of the equation by 2. This give us 4/4 on the left and X alone on the right. Reducing 4/4 gives us 1, so X=1. The same process is used to solve for the unknown dimension, the subject item in scale feet. Once you have this new ratio, you can apply the same process to any item on the same level in the image.

For example, suppose you have a multi-story warehouse you want draw. You have an excellent overall photo that shows a wall with windows on all stories, and loading doors on the second and third story. You can tell that all the windows are the same size, but perspective in the image makes them appear smaller in the upper stories. You want to know the dimensions of the doors, which do not appear on the first story. Fill in the above formula for the windows in scale feet. You can now use a similar process to determine the measurements of the doors.

The ratio of measured inches to scale feet for each subject in the same story will be equal. Therefore, the following formula will be true:
(the subject item in inches) = (the unknown item in inches)
(the subject item in scale feet) (the unknown item in scale feet)

Fill in the formula and solve for the unknown item in scale feet. Alternatively, you could solve the subject item fraction for a decimal equivalent, then multiply the unknown item in inches by the decimal equivalent to get the unknown item in scale feet. This is really what you're doing when you solve the formula above. Remember that if the second and third story doors were to be different, you would have to do this calculation separately for each story.

PROBLEMS

What if you have an old photograph that was taken with a calibration stick, or an image that was taken without a calibration stick, but you still want to draw up plans? You can come reasonably close with the one of following methods.

For a photograph that was taken with a calibration stick, you have an image of fixed size. You can't adjust the size of the image so the calibrations match the scale rule. However, you can use the ratio method described above. You know the length of the graduations on the calibration stick, so just use them to extrapolate measurements in the rest of the image.

It is more difficult when you have an image that has no calibration stick. Here you'll have to make some assumptions and use some logic to estimate measurements. The good news is, you can come very close, probably close enough for modeling purposes. Start by reviewing the image closely. Look at the doorways. Most single doorways are about three feet wide by about seven feet tall. Is there a doorway you can use as a reference point?

What about people? Today the average American Caucasian male is about 5 feet, 9 inches tall. This height has increased about 10 cm (about four inches) in the past hundred years. This is about 1 cm every ten years. What is the era of your image? Can you use any people in the picture to establish a baseline measurement? Perhaps there's a briefcase or suitcase that can be used to establish a baseline. Advertising signs, movie posters, anything you can think of that hasn't changed much in size over the years.

Wheels on standard gauge freight cars, except the behemoths of recent years, are generally 33 inches. Passenger cars are 36 inches. Standard-sized automobiles are about the same size from year to year, but watch out for the variety in "compact cars." Car wheels (not including the tire, just the steel center) for standard autos have been either 14 or 15 inches in diameter for years; compact cars, mostly 13 inches; some sports cars and luxury models 16 or 17 inches.

Truck wheels are another story. There was far greater variety in sizes. Locomotive driver size can usually be determined from old guides or an historical society. NMRA members can take advantage of the Kalmbach Library research function at reduced rates to get information about a specific piece or rolling stock or a locomotive.

Bricks and concrete blocks were generally common sizes, although we have to be careful to consider the locality here. Common sizes were not necessarily universal, but were generally fairly consistent in major population centers (cities).

So you see, even if you don't have the opportunity to include a calibration stick in your image, you may still be able to develop useable plans. Remember, model railroading is not necessarily about museum quality scale models, it is more a representation of an interesting building, locomotive, or freight or passenger car that will fit in the space available on our railroad.

Model railroading is the art of creating an illusion that we have a huge transportation system in our railroad room. Many of us attempt to re-create specific scenes that evoke a particular place or time in our memory. We can't always do this with commercial kits. Using this method you can create fairly accurate representations of anything you want. So go out and collect those images, and start planning!