How to scan a Lego instruction sheet

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Scanners used to be expensive pieces of equipment, operated by skilled professionals with a trained eye for image quality. Nowadays, low cost scanners are available for home computers, and can be operated by anyone. Sadly, the lack of training and experience shows very clearly in many scans posted on the Internet.

Scanning is not rocket science, and you can achieve excellent results even with very inexpensive hardware, but there are a few things you simply *must* consider if you want the result to be good. What is said below is valid for any full color printed matter, including Lego instruction sheets. Follow the four simple steps presented here and you can achieve a quality increase like the one below. This involves almost no extra work, just some knowledge and planning!

| Incorrectly scanned instruction sheet | The very same sheet, scanned correctly |
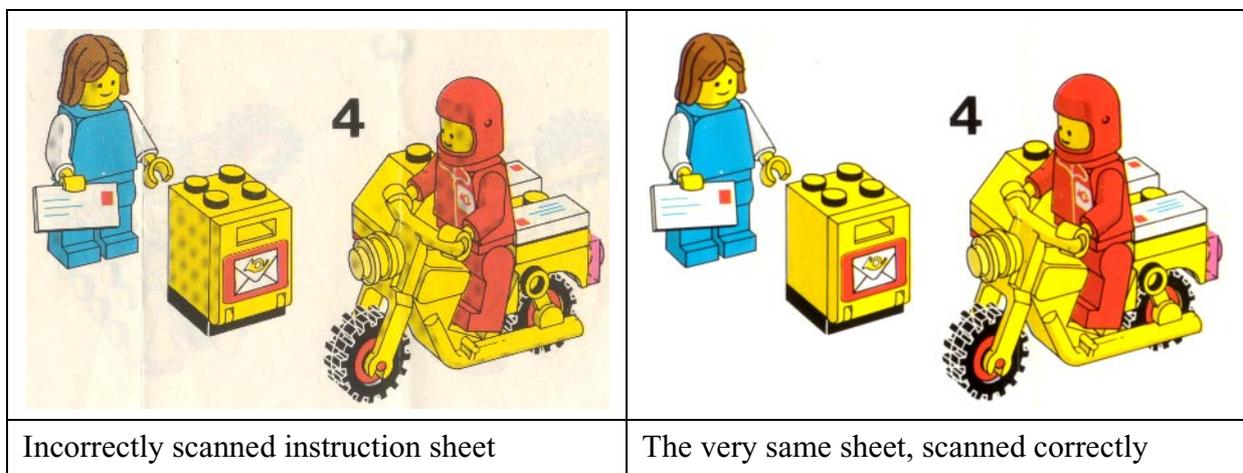
Step 1. Work around the halftone pattern to avoid Moiré

In short: use the descreening option in your scanning software, or scan at a high resolution and resize the image afterwards in a good image editing program.

Unlike a photograph, all printed matter has a halftone screen pattern. The printed colors are reproduced by a pattern of small dots. In a high quality print, the halftone pattern is more or less invisible to the naked eye, but you can see it clearly if you use a simple magnifying glass.

A typical halftone pattern, scanned at 1200 dpi and magnified 8 times.
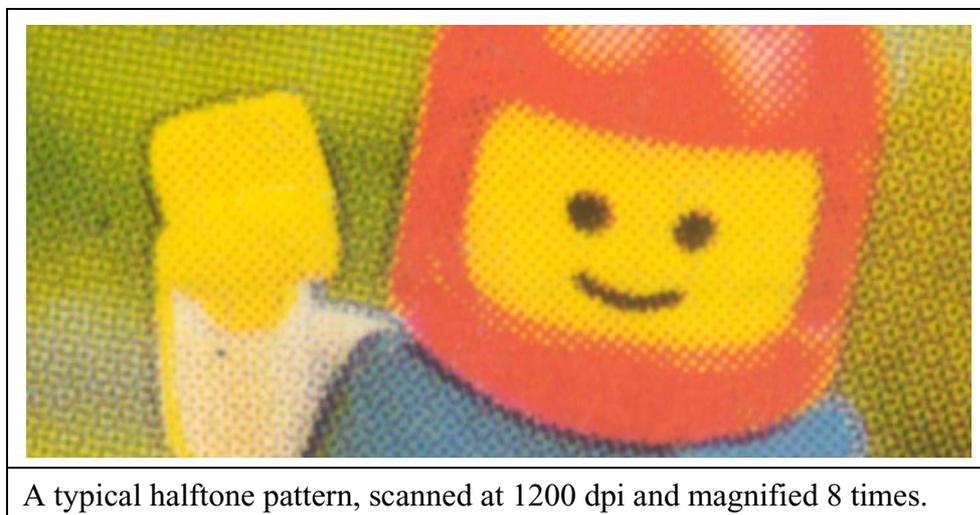
The problem here is that compared to the human eye, a scanner has very sharp vision. The halftone pattern is clearly visible to the scanner and will come into play when the image is scanned. The measured pixel value at a certain scanned point depends on whether that point is inside or outside a halftone dot. The pixels you are scanning form a regular grid, which almost certainly is not coincident with the grid of the halftone pattern. As a result, interference will occur between the halftone pattern and the pixel grid. This is called *Moiré*. It manifests itself as ugly blotches or stripes in the image, and it can completely ruin a scan. Moiré is almost impossible to remove in digital post-processing, so the problem must be addressed when scanning.

| Scanned image and close-up with Moiré | The same image scanned without Moiré |
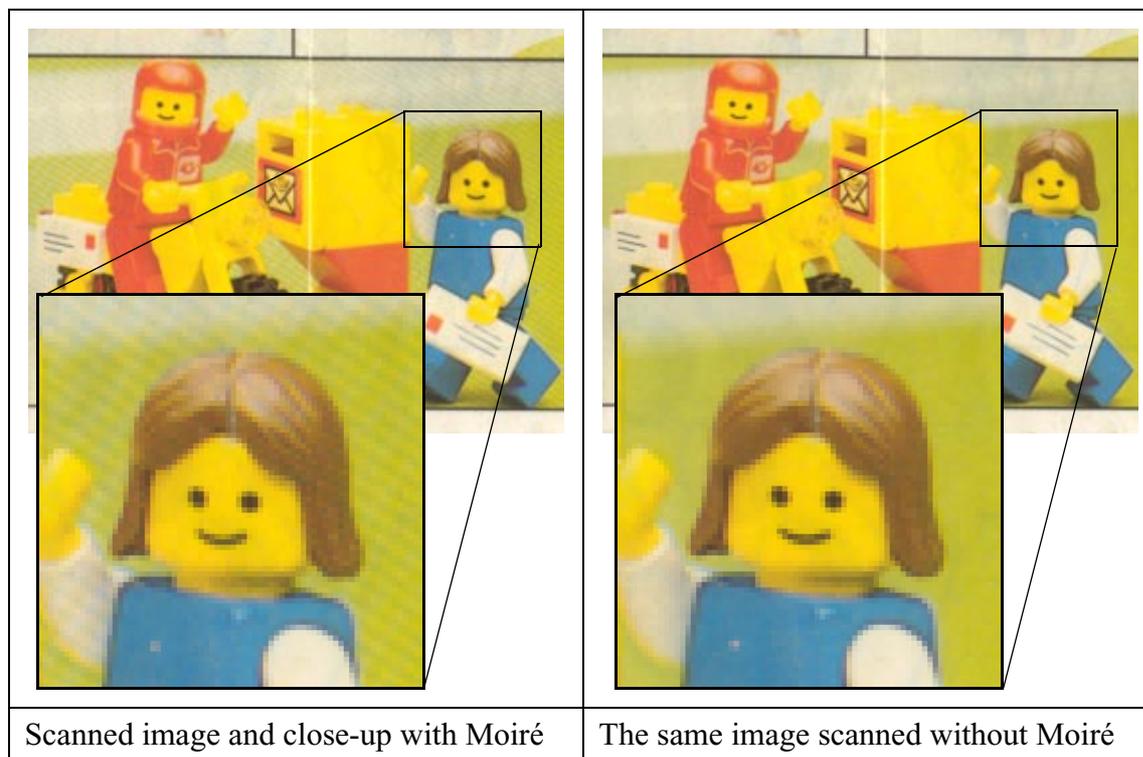
There are two remedies for Moiré. The quick and easy solution is to find a checkbox in your scanner software that says "descreen", or "magazine scan", or something to that effect, click it and hope for the best. It certainly helps, although the results vary considerably between manufacturers. If you do not have that option, if it performs badly, or if you simply want complete control, you need to scan at a very high resolution, if possible the full optical resolution of your scanner. This is not as bad as it sounds, you certainly don't need to scan at 2400 or 4800 dpi. Most low cost desktop scanners have an actual optical resolution of around 600-1200 dpi, although manufacturers mostly claim significantly more. The *optical* resolution is determined by the quality of the optics in the scanner. The *physical* resolution of the image sensor is often higher, and the maximum *output* resolution of the scanner software might be higher still, for no good reason other than marketing. Beyond the optical resolution of your scanner, you will get more pixels out of the scanner, the image will require huge amounts of memory and the scan will take a lot longer to finish, but the image will be blurry and the extra data will not be useful.

To measure the optical resolution of your scanner, scan a small area of a crisp, high quality printed text (not a halftoned image) at some high resolution like 1200 or 2400 dpi, and zoom in on the image to see if it is blurry. Then scan at successively lower resolutions until the image is sharp, or at higher resolutions until it gets blurry. The maximum setting where you still have a sharp and crisp image is the optical resolution of your scanner. If you are uncertain or wish to avoid this measurement, just scan at 1200 dpi, or 600 dpi if your computer is low on memory.

When you have scanned the image at a high resolution, resize it in a good image editing program, and if your software gives you a choice, always favor quality over speed in the resizing operation. If you reduce the size a lot, you might have to perform a careful digital blurring operation first, so that the halftone pattern is no longer visible. It might also help if you do the resizing in smaller steps, 50% at a time. It all depends on your image editing program. Look at what you get and see to it that you do not introduce Moiré in the resizing operation.

A good final size for a Lego instruction scan is around 100 dpi. Scanning at 1200 dpi and saving at 100 dpi might seem silly, because you are throwing away more than 99% of your scanned data. Trust me, though, it's not silly at all, it really helps. But, as stated earlier: if you have a good descreening option in your scanner software, it's easier to use that instead.

Step 2. Avoid see-through
In short: put something black behind the sheet you are scanning.

Paper is a translucent material. Light that shines on one side will leak through to the other side. A scanned image of a thin paper like the one used for most color prints will show some of the pattern on the other side as well. This is particularly noticeable in large unprinted areas. Plain white areas can be manually retouched fairly easily, but the problem can and should be attacked at the source instead.

Just put a sheet of black paper behind the sheet you are scanning. This will not remove the see-through altogether, but it will make the situation a lot better. It's not magic, it's basic optics. The black backing will simply reduce the amount of light that is reflected back through the paper. Cut out a piece of black paper or cardboard the size of the scanner platen and keep it near your scanner. You will find it very useful for scanning any printed matter, not only Lego instructions. When you scan a booklet with multiple pages, put the black backing directly behind the page you are scanning. It takes some extra flipping of the pages, but it's clearly worth the trouble.

| Image scanned with the default white backing | Image scanned with black backing instead |
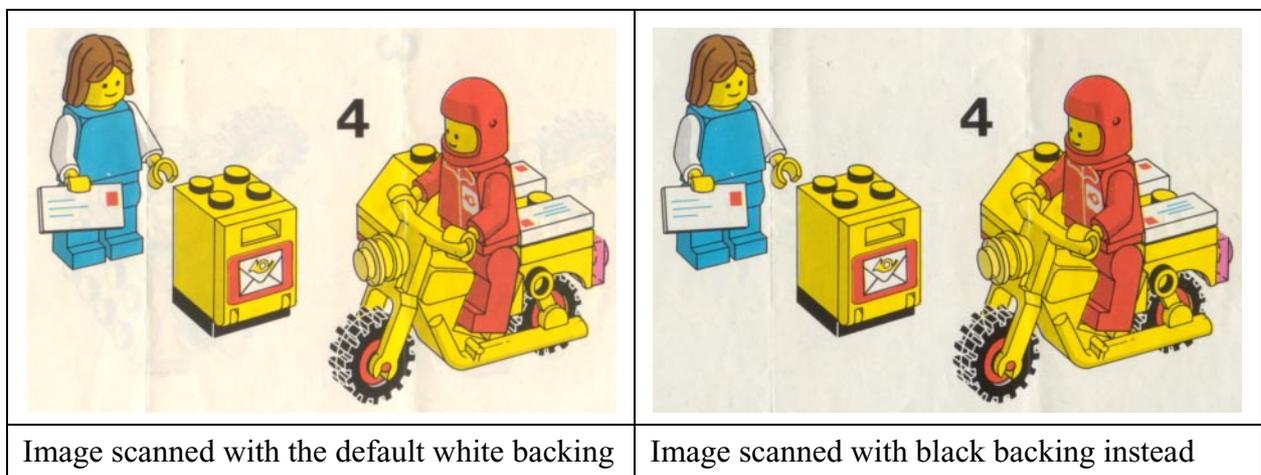
Step 3. Adjust the white point and the black point
In short: Adjust the digital levels in the image to make sure the color of the unprinted paper comes out as bright white, and the darkest printed black comes out as deep black.

Most color prints are made on paper that is actually quite yellowish compared to office paper. Old Lego instructions will be even more yellow with age, even if they are well preserved. Before saving the scan, you should adjust it so that the color of the paper is true, bright white in the digital image, and the darkest printed black is true, deep black. This will make the instructions display and print nicely, and printouts will not use a lot of yellow ink or toner just to tint

large areas of your white printer paper to a yellowish tone. If you leave the white as a slightly yellowish and very light gray it will also be halftoned in printouts, which might look ugly.

| Image with default black and white levels | Image with adjusted black and white levels |
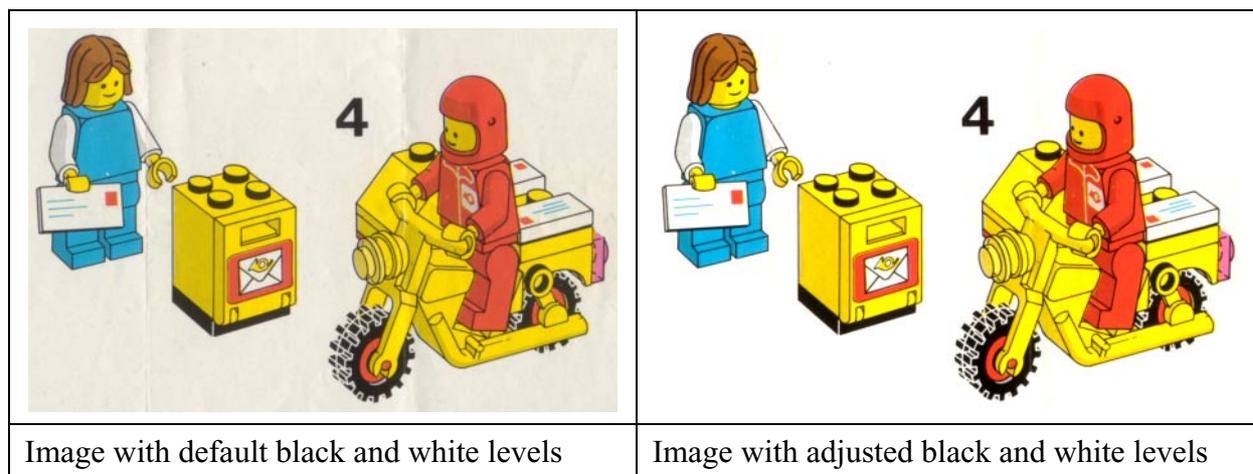
Adjusting the white point is performed differently depending on your image editing software, but there is almost always some kind of magic "auto level" or "auto adjust" feature that finds the brightest pixel and the darkest pixel in the image and makes those colors appear white and black, respectively. Most Lego instruction sheets show at least some pure black and some unprinted white paper, so that should work. Note that you first need to crop out any visible parts of the white or black backing around the edges of the scan, otherwise that might be the darkest or lightest part of the image.

If you want more control, you should perform this step manually, and use exactly the same adjustment parameters for each scanned image within the same instruction sheet. Otherwise, the color of your scan might vary between pages. If you do this step manually, you can also go slightly beyond the white point and make even some less bright spots appear pure white. This can sometimes completely remove slight stains, light folds and creases or remaining seethrough. Most scans of instructions that are not in mint condition will require some retouching of the unprinted areas to appear spotless, but if those unprinted areas are bright white instead of a light yellowish gray, it is a lot easier to paint them over without the retouching being visible.

Note! If you are making a scan to show the condition of an instruction sheet you are planning to sell, do not perform this last step. If you adjust the digital levels, the image will no longer be representative of the paperware as such. But if you are aiming for a nice presentation, do adjust the levels. It makes a huge difference. Print this page and compare the two images above.

Step 4: Do not throw away all your hard work

In short: save your image with a high enough quality setting.

The final step is simple but very important: do not destroy your work by saving it as a JPEG with a low quality setting! That is a *very* common mistake. For scans of Lego instructions that are intended to replace printed matter that was lost, it is much more important to have a high image quality than a small file size. You don't have to use a bulky lossless format like PNG, JPEG works fine, but save your file with a high quality, and when you have saved it, *open it and look at it* to make sure that it looks OK. If you are uncertain, try a higher quality setting and see if the difference is clearly visible. If you save the image with a too low quality, it is irreversibly damaged and the lost data cannot be restored.

That's it: four steps to successful scanning. Now go ahead and make some good looking scans!