Making the **Easy 35**

A Complete Guide

Design

Clint O'Connor, creator of the 2013 "Pinhole Printed" Kickstarter project, is back again with a new 3D printed pinhole camera that anyone with access to a 3D printer can make. Clint has designed a number of 3D printed pinhole cameras, including the very popular Flyer 6x6 and Clipper 6x18 cameras.

The Easy 35 camera satisfies Clint's goals of fast, cheap, and easy to make. Such a camera would appeal both to pinhole photographers and to educators wanting to teach principles of photography to youths. Based on 35mm film, the Easy 35 can be printed in 2/3 the time of a Flyer 6x6 and needs just a pinhole to assemble (at a bare minimum). A rubber band secures the top and black tape is used as the shutter.

The Easy 35 camera is released as open source, using the Creative Commons CC-BY-SA 4.0 license, meaning anyone is free to make them or even sell them, as long as attribution is given to the designer and any remixes or derivations are shared alike.

Details on the Easy 35 camera can be found on www.pinholeprinted.com.

Easy 35 Specifications

- Film - 35mm format
- Image Size - 24mm x 48mm
- Field of View - 88 degrees horizontally
- Focal Length - 25mm
- Pinhole Diameter - 0.20mm (20mm disc)
- f/Stop - 125
- Size - 115mm x 35mm x 55mm (WxDxH)
- Easily printable even on smaller 150 x 150 mm bed 3D Printers
- Print in ABS (recommended) or PLA
- **3D Printed - body, top, winder knob, rewind knob, 2 winder shafts**
- **Requires only a 0.20mm pinhole, rubber band, and black tape to complete**
- Optional - 2 screws, o-ring, and tripod nut

New world technology meets old school photography!

Printing the Easy 35

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Files

There are six printed parts to the Easy 35. There are multiple sets of STL files to allow you to print the parts individually or in combination. The winder shafts (2) should be printed separately with 60% infill (see **Printer / Slicer Settings**, and **Troubleshooting**) while other parts should be printed with 30% infill.

Recommended - print these two separately to get a full camera kit:

- Easy 35 B2 all but Winders (1 copy at 30% infill)
- Easy 35 B2 Winder (2 copies at 60% infill)

Material

You can print the camera in any color as long as it is solid black, if you want to use it as a camera. Any color other than black will allow light to come through the body and ruin the film.

I recommend using ABS if you have a printer with a heated bed. PLA will soften and deform in sunlight or on a car dash so you will need to take extra care with a PLA printed camera. There are hybrid filaments as well that have the characteristics of ABS with less warp - if your printer can handle them, they're worth a try.

In either case, I recommend you keep the Easy 35 in a small camera case when not using it - this will help keep the tape from coming off between shots and keep the camera (and film) cool.

Printer / Slicer Settings

Printer and slicer settings are too complex to cover in detail. Your printer should successfully print various torture tests, including overhangs (at least 60 degrees) and bridges. Thingiverse has many such test prints available. You should also calibrate your extruder so your solid layers are solid and do not have gaps between the extrusion lines.

If you have little experience and need something to start off with, I'd recommend starting with printing at 50mm/s, using ABS at 235-250C on a heated bed at 90-110C. However, you should use the settings you have found to work if you already have experience with your printer.

All the parts except the winder shaft should be printed with 30% infill. The winder shafts, because they have a smaller cross-section and are under more strain than any other part, should be printed with 60% infill. I have printed this camera with a 0.4mm nozzle at 0.3mm layer height and also 0.25mm. I recommend 0.3mm for faster printing and use thinner layers only if you have a smaller nozzle or want a finer finish.

The walls should be sufficiently solid to keep light out. I recommend a minimum of 3 solid top and bottom layers and perimeters, or 1.1mm depending on whether your slicer uses layers or thickness.

Check the **Troubleshooting** section for more information before you try to print your first camera.

Printing

It will take about 3 hours to print all the parts without the winder shafts and about 30 minutes to print the two winder shafts, depending on your printer settings.

You will need less than 30,000mm of filament, or 1/10 of a 1kg roll. It should be just possible to print 10 cameras per roll.

After printing, check your camera. Put black tape over the pinhole opening, place each body end close to your eye (carefully!), cover the other end, and look toward a bright table lamp (NOT the Sun). If there are voids in the bottom or sides, you should be able to see some light.

Looks dark? Good! Next, read **Assembling your Easy 35**. Among other things, you will need to remove the film window support as explained there.

Troubleshooting

BED ADHESION ISSUES (CURVED BOTTOM)

This is the #1 issue with printing cameras. Because the camera is tall, there is more warping force as the ABS cools. I use a glass bed with hairspray and heated to as close to 100C as I can get (generally 96C on my printer). For your particular bed substrate, you may need to google for "3D bed adhesion solutions". If you have a Kapton bed, try a print first and use hairspray next if you have leveled your bed and still can't get adhesion. If the top fits on with film in the camera, you can still use it as there is a little leeway for warp. Technology progresses and there may be better solutions than hairspray in the near future.

Leveling your bed and getting the first layer squashed down is critically important. I adjust my bed with a sheet of standard 20b paper so that I can just drag and barely push it under the nozzle all over the bed. I set my first layer height at 67% in the slicer so the first layer is squashed down with wide traces. As well, I reduce my first layer speed by 50% (25mm/s).

CRACKS IN THE BODY, BROKEN WINDERS

You may notice the body cracking in the middle between layers as you get up near the top. If this occurs, this is due to the layers not bonding together sufficiently, and it is a clear indication that you are not printing hot enough. Try increasing the extrusion temperature by 10C, or 5C if you are nearing your printer extrusion temperature limit.

The same applies to broken winder shafts. If they are breaking, the layer bonding is poor and they need to be printed at a hotter temperature.

Assembling the Easy 35

Parts

- 6 Printed parts
  - body, top, rewind knob, winder knob, 2 winder shafts
- Pinhole (20mm disc with 0.20mm hole)
- Wide rubber band
- Black photo tape (for shutter)
- Optional but recommended:
  - O-ring (018 Buna-N 3/4" ID, 7/8" OD)
  - 2 screws (M3-0.5 X x 8mm pan head, #4 can be substituted)
  - 1/4-20 nut

(Always check pinholeprinted/support/easy35 for the latest on sources)

Assembly

BODY PREPARATION

After printing, the Easy 35 body has an internal film window support that must be removed. The way to remove it is to use long-nose pliers to grab the supporting brace near the bottom and twist back and forth until it snaps off and then pull out the brace and window support. Check to make sure no filament strands or bits are present in the window.

PINHOLE INSTALLATION

The pinhole simply drops into the front recess if you have a 20mm (or 3/4") pinhole disc with a 0.20mm hole. These can be found on eBay, or you can make your own (google "making a pinhole").

If the disc is larger than 20mm, it will need to be trimmed to fit. If it is mounted in a thicker disc, the edges may need to be beveled for the o-ring to still fit.

The pinhole is held in with an o-ring, which is optional but highly recommended. If you don't use an o-ring, you'll need some rubber cement or craft glue to hold the pinhole in after installation. I do not recommend using epoxy or superglue or anything permanent, as you may wish to change the pinhole later.

TOP ASSEMBLY

There is a winder knob (the bigger one) and a rewind knob (the smaller one with an "R"). Each must be attached to a winder shaft with a screw (highly recommended as you may need to add friction material or replace a part) or glue. Orient the camera with the pinhole facing away from you as if you are going to take a photo. Fit the top to the camera. The rewind knob goes on your left and the winder knob goes on your right (see photo). Insert the winder shafts through the bottom of the top plate, fit the knobs on top, and screw in the two M3 screws until they just become tight enough to hold the knobs on without wobbling (remember, these are plastic and it's easy to strip the threads).

TRIPOD NUT

The tripod nut is optional. If used, clear any filament strands from the bottom hexagonal hole and make sure the nut fits in. Then use superglue or epoxy to cement the nut in (make sure you don't get it in the threads).

REWIND SPOOL

Cameras need a spool to take the film up while taking photos and then the film is rewound into the original film canister. To obtain a rewind spool, either find a discarded film canister from a photo store or buy the cheapest roll of film you can get (number of exposures does not matter) and take the canister apart with a bottle opener or pliers. Remove the film and tape from the spool and you are ready.

COMPLETION

Tear off some black photo tape to create a shutter. Depending on the width of the tape, you may need to overlap a strip or two. Fold over one end to create a handle. Simply pull the tape off to take a photo and replace it when done. Replace the tape periodically to ensure stickiness.

Operating the Easy 35

Operation

LOADING THE FILM

Get a fresh roll of 35mm film out, pull the leader out a couple of inches and use a piece of tape to secure the end of the leader to the empty spool as shown in the photo. Be sure not to wrap the tape all the way around - it needs to pull off during rewinding.

Next, pick up both spools and carefully drop them into the camera as shown.

Now pick up the top and carefully fit it in, turning the knobs slightly to engage the tabs in the film spools.

Make sure the top is fully seated, and then secure it with the rubber band.

USING THE CAMERA

1. Turn the winder knob (on your right as you hold the camera for a photograph) counter clockwise 3 full turns to start the roll.
2. Remove the tape to take a photo and replace the tape after the desired exposure time. Wind the film 2 turns.
3. Repeat until you feel significant resistance in winding. This marks the end of the roll - do not force it!
4. Using the smaller rewind knob, rewind the film back into the film canister. There will be some resistance when you reach the end where you taped the leader to the spool.
5. Open the camera, remove the tape, and manually wind the rest of the film into the canister. The film is now ready to be processed!

TIPS

The Easy 35 camera is a simple camera that depends entirely on the skill of the photographer. There are no fancy sprocket wheels to count exposures or to register the film, or keeping the knobs from going backwards. Here are some tips to help you get started. If you follow these, you will not have problems and you'll get great photographs!

1. For an easy way to tell if there is film in the camera, wrap the rubber band around the base of the body when there is no film in the camera. Otherwise wrap it around both to secure the top.
2. 35mm film has a strong curl. The effect of this is to cause the knobs to spring back after winding, making it difficult to advance the film correctly. An easy way to prevent this is to put the rubber band around the winder knob side and have the rubber band providing some tension against the knob so it won't spring back. An better alternative is to insert some springy material under the knob (one good reason to screw it on rather than glue it on) that will prevent spring back.
3. Use a tripod or mini-tripod for shake-free photos. I use Ultrapods all the time.
4. Use a phone app to meter your exposure times. These are pretty accurate. There are many to try but most don't permit high f/stops. Personally, I have used Pinhole Meter and Pinhole Assist (by Le bord de la piscine) on the iPhone and find both easy to use.
5. When having film processed at a photo lab, the key phrases to use are "**develop only**" and "**no cut**", since the spacing will be uneven and you don't want your images chopped into random bits.

Enjoy your **Easy 35** camera! This camera has the advantage of being quick to make on a 3D printer as well as cheap, consistent, durable, weatherproof, reliable, and versatile - and it is capable of taking great pinhole photographs!

If you'd like to use a larger film format for more resolution, the **Flyer 6x6** uses 120 film and has 3.4x the film area as the Easy 35. The **Clipper 6x18**, with its curved backplane and 10.8x the film area, can take astounding panoramic photos.

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