8 - make

> “The time for half-measures and talk is over.”
>
> – Maximus in *Gladiator*

intro

Just the ideas in this book can bring relief and hope. But 99% of their value lies in their application. This requires a darkroom. Since darkrooms are uncommon, these last four chapters explain how to build darkrooms, usually inside existing buildings.

This chapter provides basic information that applies to all components of a darkroom. The next three chapters provide blueprints and instructions for components related to three elements: air, darkness, water. They are vents, silencers, seals, blinds, and kitchen and bathroom fixtures. Designs are low-cost, low-tech, and work off-grid.

A darkroom is a real thing you see and touch, make, use, and offer others. It is not a metaphor. It takes a knowledge, imagination, design, measurement, plans, materials, craftsmanship, construction, testing, and improvement.

These are normal human activities. Everyone does them to some degree. and get help with the rest. If you can walk down stairs without falling, slice a loaf of bread, hit a plate when you aim food at it, hold a pencil, cognize sentences, tell light from dark, and feel a breeze, you are mechanically sufficient to begin. As Jack Nuckols, an engineer and my grand-elder, once told me when my time came, “Become a craftsman.” Perhaps your time has come. Become a craftsman. Become a maker.

I suggest that, your first time through these chapters, you read everything in this one. But just read the prose parts of the next three. Save the lists of instructions for the next time and again when it comes time to build. They make dense read-

ing. Eventually, they'll be replaced with graphical assembly instructions like IKEA's. For now, slog through with me.

All components rely on the basic instructions in the following sections: **metric**, **tools**, **plans**, and **fabrication**. Each component has special instructions and design constraints in its own section in later chapters:

After improvising darkness to sleep in *tonight*, the *instant sleeping mask* probably comes next. Thus initiated, you can begin your training as a darkroom-building ninja. You will become invisible to everyone for a while. And you won't be able to see anything, either. Haha.

If you need more specific advice for darkening your space, I provide *design consultation*. I guide people through text, voice, and image on a chat app toward a completed darkroom and successful retreat. Likewise, feel free to use these *open*-source designs and my consultation to darken other people's spaces as a service for money. See *license* for my liberal terms.

metric

I give all measurements in metric, mostly millimeters. Are you used to the inches, pounds, and gallons of the imperial system? Get a handle on the brain-descrambling metric system in a split-minute:

1. understand that, with metric, you will simply be counting to 10 and multiplying by 10 like normal. You will not be wrangling fractions and multiple conversion factors as in the imperial system.
    - basic metric conversions:
        - length: 1m=100cm=1000mm (meter, centimeter, millimeter)
        - volume: 1L=10dL=1000mL (liter, deciliter, milliliter)

    - mass: 1kg=10hg=1000g (kilogram, hectagram, gram. Mass is like weight. But it uses a balance, not a spring scale, so it does not depend on Earth's gravity. Build a darkroom in space!)
  - cool intra-conversions:
    - 1L=10cm x 10cm x 10cm ($1000cm^3$)
    - 1L water=1kg
    - thus, 1mL water=$1cm^3$=1g
    - brilliant! simple! humane!

2. use these imperial near-equivalents to practice the metric system, visualize my descriptions, and make estimations. Not for precise conversions or large quantities. (*My favorites):
   - length
     - *25mm = 1" (inch)
     - *100mm = 4"
     - 30cm = 1' (foot)
     - 1m = 1 yard & 4"
     - 3m = 10'
     - 1km = 0.6 mile
   - area
     - $1m^2$ = $11'^2$
     - 4' x 8' sheet = 120cm x 240cm ($\sim 3m^2$)
     - the genius A0-A8 paper size system. A sheet's $1:\sqrt{2}$ proportion remain the same when cut in half the short way. A0 = 841 x 1189 = $1m^2$. A1 = 595 x 841 = $0.5m^2$. A4, the metric counterpart to North American letter size paper, is 210 x 297 = $0.0625m^2$, $1/2^{(A)4}$ of a square meter
   - volume
     - *4L = 1 gallon
     - 1.7cmh = 1cfm (cubic meter per hour to cubic feet per minute; for airflow)
   - mass
     - 28g = 1 oz
     - *1kg = 2.2 lb

tools

Making components requires most or all of these tools:

1. table or desk
2. measure
    1. Note: before purchase, test tools for accuracy, which can vary between identical tools, even of good brands. Instructions below.
    2. metric ruler, 30cm, clear plastic. If reproducing plans by hand rather than printing them, then get an Incra ruler. For its effortless marking precision, I recommend it for making anything at all ever. It's the greatest hand tool I have ever used.
    3. meter stick, steel with engraved marks
        1. put marked edges of two sticks together so 40cm mark of one meets 60cm mark of other
        2. push ends of both against a wall and check how well marks line up
        3. repeat with other sticks till you find a match
        4. buy one of them
    4. metric measuring tape, 5m
        1. use a tape whose case length is easily and accurately added to the figure on the tape itself. Some measuring tapes are designed to give highly accurate internal measurements, eg, between sills
        2. hook tape on end of meter stick and compare marks for accuracy of external measurement
        3. push end of meter stick against a wall, put tape on top of meter stick, and compare marks for accuracy of internal measurement
3. mark
    1. 0.5mm mechanical pencil
    2. ballpoint pen, black or blue ink
    3. black marker
    4. straight pin with colored plastic head or masking tape handle

    5. magnifying glass (even a tiny plastic one works, like the one in a Swiss Army knife)

4. crease, score, cut

    1. straight edge 200mm longer than your longest piece will be. 1-2mm-thick steel is best. An aluminum door or window frame member also works well. A board less than 12mm thick with a perfectly straight edge (check it!) is fine.
    2. table knife: use back of tip for creasing
    3. razor knife with new blade: use for scoring and cutting. To score is to cut halfway through thickness of material with razor knife so it remains one piece and folds very easily
    4. scissors for both paper and fabric

5. join

    1. masking tape
    2. wood glue, unthickened, any grade
    3. glue syringe, 20-50mL for precise, efficient gluing
        - available at:
            - as kitchenware along with 2-3mm stainless needles
            - pharmacies. Also get a 2mm x 40–50mm needle. Perhaps cut off the tip. If unavailable, use a cartridge from ballpoint pen, the fat (4-5mm) tapering type. Clean it out and trim it down to point in taper that fits over nipple of syringe
            - woodworking shops, with needles
        - remove needle and plunger. Cover nipple with finger and fill from back, leaving 10mm unfilled. Replace plunger barely. Point nipple upward and uncover it. Wait for air bubble to rise to top. Then push plunger in till air is cleared from syringe. Replace needle and use.

6. for roller blind:

    1. drill
    2. screwdriver

3. gluing clamp (for roller blind)
    - 2 straight, flat 35 x 90 boards, non-rounded edges
    - 1.5x as long as long edge of paper sheets
    - every 300mm, 8mm holes, an 8x80mm bolt, 2 washers, and a wingnut holding boards together
4. hack saw (for roller blind), even just a hack saw blade is enough. Cover teeth at one end with tape as a handle so you can cut on the pull stroke

plans

I have drawn the plans on a computer for precision, clarity, and ease of modification. However, at first, they can be baffling to look at.

1. use the **key** to understand the symbols and marks
2. compare drawings to photos.
3. read the instructions through a couple times in the days before making begins.
4. then *follow the instructions*, one step at a time, and you ought to end up with the intended component.
5. dimensions are either H x W x L (height, width, length) or X x Y x Z (left-right, up-down, in-out or width, height, depth) with newer components: helix vents, silencer, fan mount, sleeping mask Understanding often comes through doing. If this does not work, write me and I'll try to sort out the confusion and maybe improve the instructions and drawings for others, too.

A drawing has one or two *views*, depending on the best way to communicate its information:

- *plan:* from above, two dimensional (2D). Default view if unlabeled.
- *elevation:* from the side (2D)
- *section:* a cutaway or slice of the object showing all parts when assembled (2D)

- *perspective:* from a non-right-angled point of view to capture more sides (3D)
- *exploded:* all parts separated but in correct order and linear relation (3D)

For example, the helix vent has plan views of its flat parts and one section view showing how parts are assembled. The toilet frame has both plan and elevation views, while the shower has an exploded view.

All plans can be reused except *sleeping mask* plan, which is destroyed as you make it. So make as many prints of it as masks you intend to make.

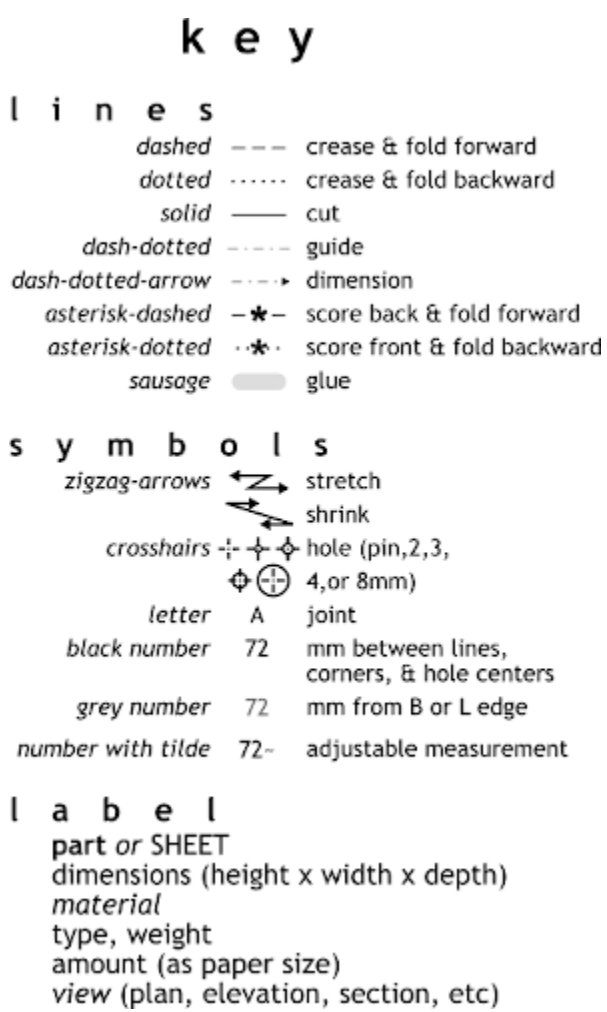
Images in this book are only for reference and hand-reproduction. They are reduced to fit book pages. Thus they are neither full-scale nor in proportion to each other. If reading on a screen while online, you can zoom in. Click each image to open the corresponding full-size plan as an individual PDF.

1. download all plans at once with the darkroom retreat zip file. Extract (decompress) the file. Contents:
    - plans: a complete set of PDF plans
    - all photos below plus extras from website
    - SVG source files of plans for modifying them, originally drawn in Inkscape.
    - I would love it if someone made
        - 3D versions of these drawings with Sketchup
        - assembly instructions for the components like IKEA
2. print
    1. large format
        1. large format printing is cheap, extremely accurate, and much faster and easier than desktop printing. Most print shops, including Staples and Office Depot, now offer large format printing.
        2. email your files to print shop or take them on a USB flash drive
        3. paper
            1. specify cheapest option

    2. if print shop has 300gsm acid-free black paper on a roll for large format printing, print the helix vent's channels and walls directly onto it. Yes, black ink on black paper is visible enough to work with.
  4. have files printed in actual size, with no scaling. Before paying, check measurements with ruler or measuring tape. Distortion should not exceed 1mm over a 250mm span.
     After resigning myself to 2mm distortion per 250mm (0.8%) with desktop printers, I was shocked to find almost no distortion with large format printing, maybe 0.5mm/500mm (0.1%). But then it made sense because architects, engineers, and builders depend on this service for their blueprints.
2. desktop
  1. only do this if you are absolutely broke or can't find a large format printing service on your desert island. Desktop printing of plans takes a lot of time and yields imperfect results.
  2. print
    1. open file with Adobe Reader (not Adobe Professional)
    2. in print dialogue, select: "Poster"; Tile Scale: 100%; Overlap: 1.0in; Cut marks: yes; Labels: yes
    3. use A4, letter, or legal size, possibly A3
    4. Distortion over 250mm span should not exceed 1mm.
    5. after printing one file, check measurements against ruler to 1mm tolerance.
  3. join sheets
    1. cut a small wedge out of overlapping cut mark to align it with matching cut mark on sheet below
    2. align cut marks at perimeter of plan first, then the one(s) in the middle.
    3. use masking tape to join sheets
3. by hand

1. ruler and magnifying glass
    1. get large white paper to make a reusable pattern with. Don't measure directly on materials.
    2. to keep drawing orthogonal, use some combination of graph paper, drafting table, and extra careful measurement and marking. An Incra ruler will help a lot with this.
    3. use magnifying glass to see small words and numbers in the book
    4. plans are as symmetrical and uniform as possible. If two similar-looking areas of a plan look the same size, they are. So from measurements given in plans, infer the rest. There is some redundancy so you don't have to figure out everything and can double-check essential measurements with arithmetic.
    5. use grey-numbered cumulative measurements in plan to quickly mark lines
2. trace
    1. trace directly from a flat screen monitor
    2. zoom image till stated measurements match a ruler both horizontally and vertically
    3. tape paper to the screen
    4. mark ends, corners, and intersections of lines precisely and lines just well enough to know what you are looking at later
    5. you will have to overlap multiple sheets of paper for most plans, as with a desktop printer. On each new piece of paper, repeat the last set of marks from the previous so you know where to overlap and tape the sheets together.
3. key

Here is a key to the computer-drafted plans. Find further explanation of symbols, especially dash-dotted lines, in **fabricate** section below.



plan: key get pdf

fabricate

These instructions apply to all components, or as indicated. Read special instructions for each component in its respective section afterward.

1. prepare plans
    1. for fabric parts (sleeping mask, roller blind seals)

1. using ruler and razor knife, cut out parts at outlines (except roller blind seals: cut around group of 8 seals)
2. cut out tape holes on dash-dotted lines
3. skip to step “3. make parts” (about two pages below)

2. customize roller blind plans
    1. cut out parts, leaving as much paper around them as possible
    2. measure variables (h, w, t) and derive measurements for parts. Measure sill where it meets wall or trim. Write measurements on parts next to variables.
    3. cut lines running through stretch arrows. Rejoin with a couple small pieces of tape to keep them together until transfering plans to material.
3. customize threshold vent
    1. using straight edge and razor knife, cut vertical lines running through shrink arrows in grey areas
    2. shrink left and right sections (push them inward, overlapping center section) until cut edges match center section’s top and bottom mm marks equal to h
    3. draw vertical lines through mm marks in corners of plan equal to h
    4. cut horizontal line running through center shrink arrow
    5. shrink top and bottom sections until cut edges match center section’s left and right mm marks equal to t
    6. adjust point C (at both left and right):
        - downwardly so its distance from point D equals $t/2$
        - horizontally so it lies on new vertical line
    7. cut vertical line running through center stretch arrow

2. transfer plans to material
    1. tape plans to materials
        1. helix vent shell: align plan roughly diagonally to corrugations (or edges or folds) of cardboard

    2. where necessary, cut out small wedges from outlines of plans to align them with edges of materials. With some roller blind frame parts, dash-dotted extensions of outlines aid in this step.
    3. parts with stretch arrows
        1. tape one half to edge of material
        2. using derived measurements and tape measure, mark material where opposite edge of part should be and tape it there
    4. lay out other plans on materials and tape opposite corners
2. put three layers of cardboard on work surface
3. transfer plan with straight pin
    - use magnifying glass for ease of marking and geeky precision thrills
    - poke straight pin through
        - all black lines close to ends (not grey glue sausages)
        - centers of holes
4. remove plan from material
5. label drawing, words oriented the same as in plan
    - dashed lines: circles
    - dotted lines: double circle
    - solid lines: squares
    - dash-dotted lines: triangle
    - holes: star
6. mark the marked holes again
    - draw short lines from circles, triangles, and squares in the same direction as lines in plan
    - circles/double circles: add asterisk where indicated
    - copy joint labels (A, B, C, etc)

3. make parts:

    1. keep scrap cardboard on work surface
    2. fabric parts (sleeping mask, roller blind seals)
        1. tape plans to fleece over tape holes
        2. roller blind locking seals: cut 8mm slits through plan with razor knife

3. cut parts exactly around plan outline with scissors
4. leave plans taped to sleeping mask side seals
5. remove plans from other parts
6. repeat steps 1-4 to make
    - 2 sleeping mask center seals
    - 4 sleeping mask covers. For the 4th cover, use optional cotton fabric, add 20mm on side for seam allowance, and leave plan taped to fabric.
    - 4 roller blind locking seals
7. skip remaining steps 2-4 and resume special instructions

3. cardboard shell of helix vent
    1. trim excess cardboard around pattern but don't cut its edges (between squared holes) yet
    2. lightly crease between circled holes with back of table knife tip, avoiding breaking the surface of cardboard
    3. press the straight edge into creases to deepen them
    4. turn cardboard over and repeat steps 2 & 3 with double-circled holes
    5. cut between squared holes
    6. fold cardboard at creases, bending it well past 90°
4. paper parts
    1. between holes with asterisks
        - circled pairs, score back, fold forward
        - double-circled pairs, score front, fold backward
    2. between circled and double-circled holes
        - crease front side with back of table knife tip
        - fold at creases forward
        - then, fold double-circled creases backward
    3. between squared holes: cut with razor knife
    4. between starred holes
        - expand to diameter indicated in plan
        - use a pointed dowel of appropriate diameter
        - spin it with your fingers or a power drill as you gently push it into hole

Voila. Now that we've covered the basics that apply to all darkroom components, let's look at those in the air, silence, and warmth department.

9 - air

The tricky part of making a darkroom is not darkening it but ventilating it. After all, now its windows and doors are sealed. Ventilation requires planning. We'll look at it first and darkness in the next chapter.

Silencing a room is even trickier. We can install filters against air pollution. But noise puts us at the mercy of our surroundings.

Ventilation most affects the silence of a darkroom. It also affects temperature. We will examine each condition and see how they work together in a mechanical system.

ventilation

Below, I will give design constraints and describe various systems of ventilation. But first, I will address its physiological importance.

breathe

Nature gives us a constant, abundant supply of fresh air. Our buildings should, too.

I have observed a shocking number of people who seem oblivious to their own need for fresh air. Everyone knows we die within minutes without air. Yet the importance of a continuous fresh supply of it has escaped many.

I can only attribute this negligence to mass psychosis. It is my stock explanation for the appalling features of civilized life. The need for fresh air is one of the most basic, most obvious facts of life. At the risk of insulting your intelligence, I am bound to address it.

Fresh air is always important. It is a normal condition of life. Along with warmth and safety, it is one of our most urgent necessities. Every second of our lives, quintillions of organic processes occur. Virtually all of them require oxygen. It is the

most important nutrient we consume. We can live days without water and weeks without food. Not so, air.

Just like food, air becomes a part of one's organism. It affects quality of life to a very great degree. It seems like nothing. But the amount of air you breathe masses twice as much as the food you eat. In a darkroom, you have little to do besides breathe. If you haven't paid attention to air quality, you will notice it in darkness.

Even if you don't, poor air quality cancels most benefits of a retreat. Intermittently airing the room out *does not work*. I mean opening the door a couple times a day with eyes covered. Put this approach out of your mind. This is darkness, not the dark ages. Whatever it takes, no matter where you are or what you are doing, always provide yourself with continuous fresh air.

For a darkroom retreat, this means:

1. following the instructions below
2. hiring an HVAC contractor to clean, repair, replace, or install ventilation in your home
3. moving somewhere the ventilation system just works (like the tropics or a new house in northern Europe)
4. using houseplants: high oxygen producers and air-purifiers
5. a combination of these

Somehow, it must be done. Forget darkness a moment. We have few more urgent concerns in life than arranging to breathe fresh air continuously and comfortably. Keeping it foremost in your thinking about darkroom design and construction will help ensure a successful retreat.

Not freezing to death and avoiding danger are more urgent than continuous fresh air. Building systems that meet these needs can all work in harmony. But unconsciously, fear and ignorance result in design conflicts between them. We have largely eliminated open fires in uninsulated buildings, which require massive inputs, labor, and maintenance. But we still often depend on windows for ventilation instead of a proper, separate system. The rest of this chapter will help you avoid such errors.

constraints

- system provides plenty of fresh air
- absolutely lightproof
- silent: absolutely no hum or harmonics from fan and exterior noises mostly extinguished
- comfortable temperature: no undesired cold drafts
- economical: ie, no wasted heat to the outdoors. This is more involved and a lower priority than retreating itself, so don't get stuck on it. It requires a heat recovery ventilator (HRV). Besides significantly lowering heating costs, an HRV improves air quality and comfort in nearly all climates. More about it below.

system

Somehow, fresh air has to get into the darkroom and stale air has to get out, without letting in noise or light.

In the terms of the HVAC industry (Heating, Ventilation, Air Conditioning), the fresh air vent is the *supply* and the stale air vent is the *return*.

Sometimes, supply and return vents exist in the same room. This is the fanciest version of *balanced* mechanical ventilation. If your place has it, thank your lucky stars. Just make sure it runs continuously. Unless your room is huge, intermittent is not good enough.

More commonly, balanced systems put supplies in bedrooms and living rooms, and returns in kitchens and bathrooms. This means air escapes a bedroom around the door. Unless the space outside the door is totally dark, this calls for a *threshold* lightproof vent (plans below).

Balanced systems are rare. More common are negative pressure systems: bedroom and living room windows act as passive supplies and bathroom and kitchen exhaust fans as active returns. In this case, a lightproof multi-purpose *helix* vent, built into a window blind, is the supply. Or a silencer if noise surrounds your dwelling. A threshold vent is the return, letting stale air escape the bedroom to the exhaust fan.

Rooms with totally passive ventilation rely on open windows, exterior vents, and infiltration through cracks. These

will get sealed against light. Such rooms will need helix vents in blinds at different heights to take advantage of convection. But they probably call for a fan and a silencer, maybe ducting.

By closely observing buildings I have discovered some simple ways to ventilate them. Sometimes rooms have lightproof and sound-dampened holes built into them in unexpected places:

- unused holes for pipes, wires, chimneys, and ventilation.
- behind a cupboard or inside a closet
- a removable panel or piece of trim that could be temporarily replaced with a panel with a hole in it.

For example, I once found a cosmetically damaged door in the garbage at a building supply store exactly the same size as my darkroom's door. So I stored the original door and cut holes in the damaged door for ventilation.

Another darkroom had no ventilation or suitable holes anywhere. Except it had no door. So we built a frame inside the doorway with a narrow door on one side and a narrower panel on the other. We cut holes in the panel for ventilation ducts. We fixed the frame in the existing doorway with metal straps screwed into old hinge holes. So we left no trace when dismantling the darkroom.

Similarly, we hung 7m of ducting that ran through three rooms; attached a silencer to it; made three window panels; and imperfectly covered five more windows with only one new screw hole in the entire rented house. And that hole was invisible behind a loose piece of trim. "Leave no trace" is a fun game that often improves design.

Sewage pipes drain downward but are ventilated upward. Once, friends and I replaced a flush toilet with a composting toilet. The exposed drain pipe, being oversize and in a single-story house, wasn't subject to backflow. So it proved a perfect exhaust duct for a case fan at floor level. Imagination conquers all obstacles (and renews itself in darkness).

If you are building a new house, separate ventilation from fenestration (windows). This improves many attributes of a shelter: security, economy, comfort, quietness, control, and darkenability.

lightproof

Here are further design constraints, photos, plans, and instructions for making and installing lightproof vents.

constraints

(helix / helix-z specifications in parentheses)
{threshold-vent-specifications-in-curly-braces}

- durable (protected by cardboard shell or silencer){subject-to-damage-by-kicking-but-easily rebuilt and can be made of sheet metal or shielded with cardboard or thin wooden boards}
- thin enough to fit between blind and window (80mm) or door and threshold {adjustable}
- cross-sectional area >75cm^2 (90cm^2){60–120cm^2}
- fully traps light, sending light around at least 5 corners (7 corners / 5 corners){6-corners}
- short airway (240mm / in-silencer version, 160){140mm}
- minimal size (87 x 220 x 216 / in-silencer version 87 x 148 x 260){fits-under-door,-sticks-out-20mm-each side and up 60mm}
- easy to make (so-so){yes}
- elegant (yes: simple compact form, uses common materials, zig-zag-shaped passage accommodates natural helical movement of air){yes}
- cheap ($4 in materials, 2-hour assembly time){$2-in-materials,-1-hour-assembly-time}

helix vent

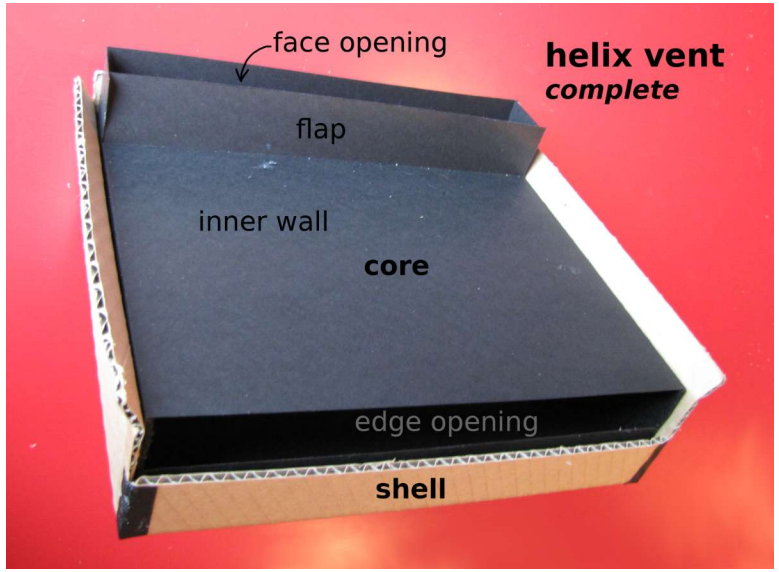


photo: helix vent, complete

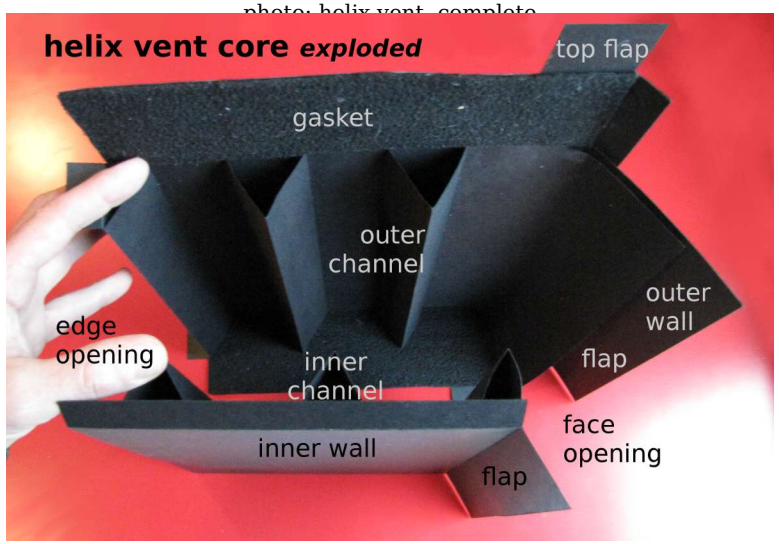
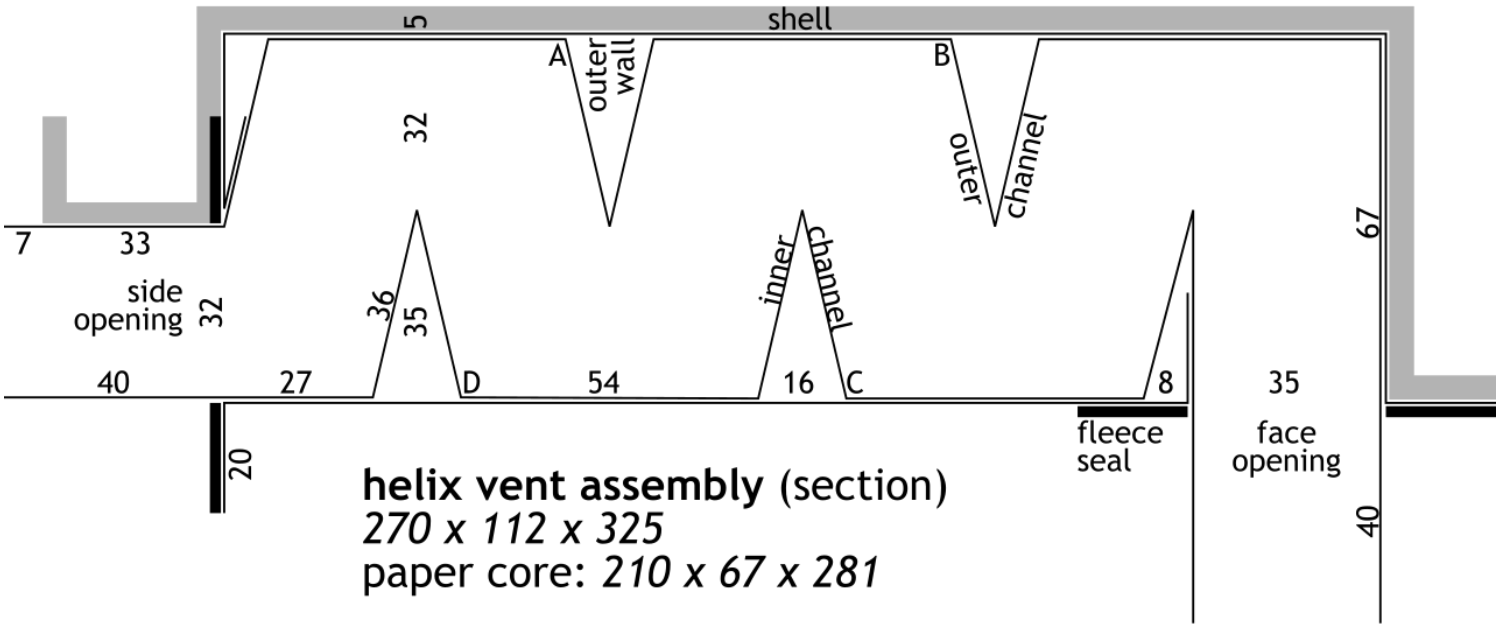


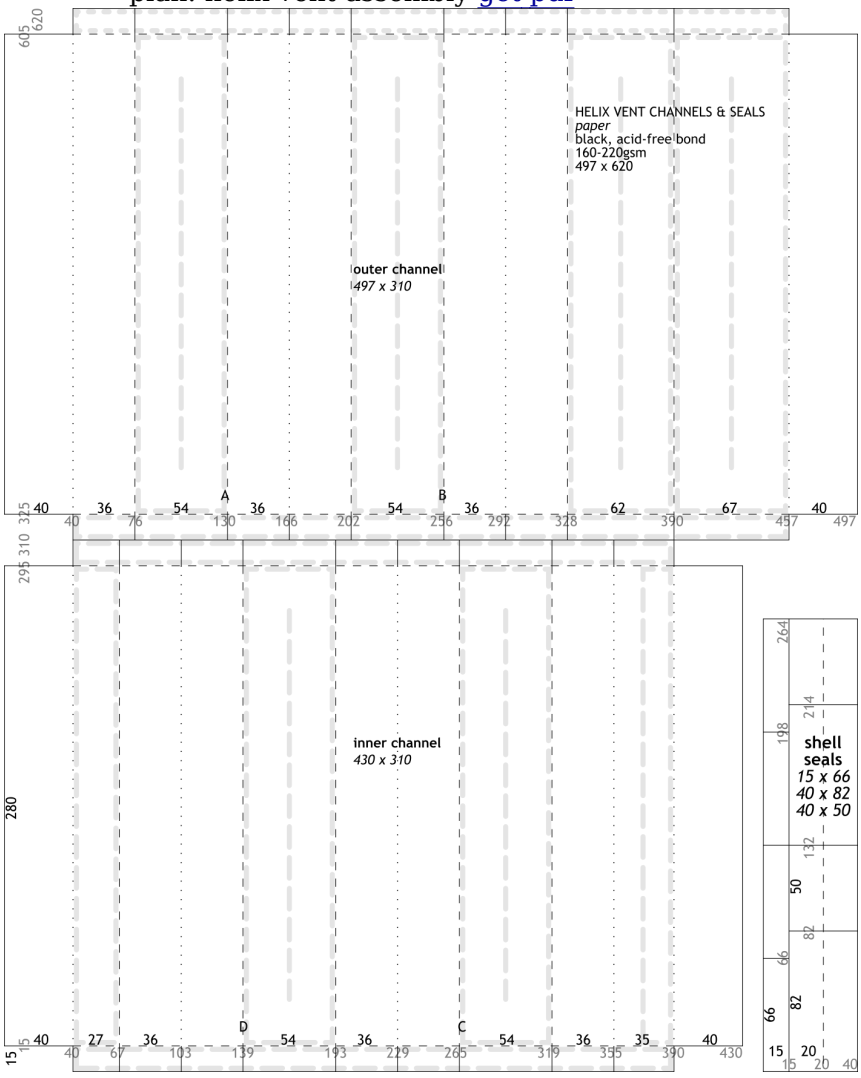
photo: helix vent, exploded core

This photo is of the old helix vent. The new one is similar but: a bit narrower; triangles inside are more pointy; their edges have flaps; there is no fabric; at the side opening, the cardboard has a lip and the core has flaps.

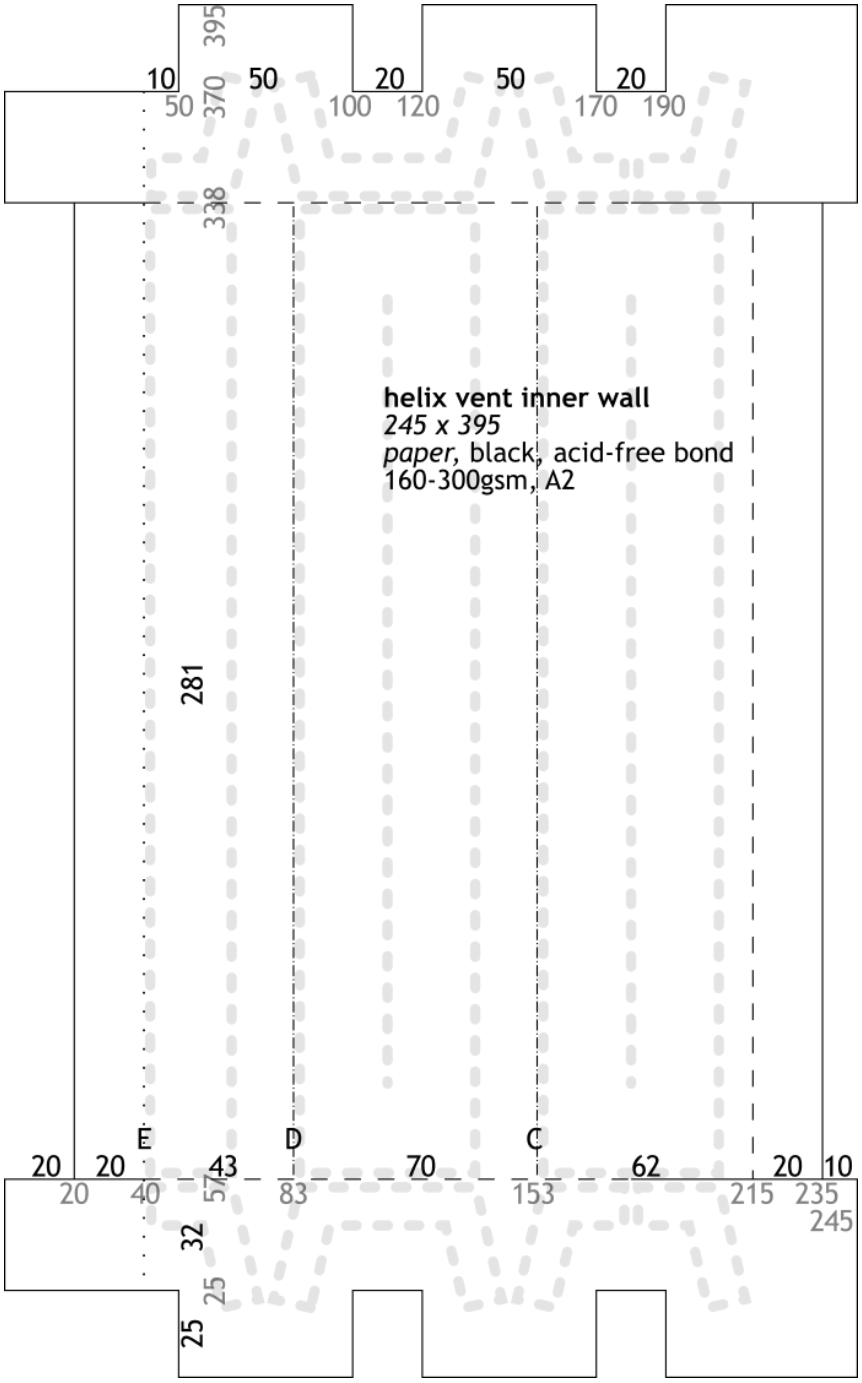


helix vent assembly (section)
270 x 112 x 325
paper core: *210 x 67 x 281*

plan: helix vent assembly get pdf



plan: helix vent channels get pdf


helix vent inner wall
245 x 395
paper, black, acid-free bond
160-300gsm, A2
10
50
20
50
20
50
370
395
100
120
170
190
338
281
E
D
C
20
20
43
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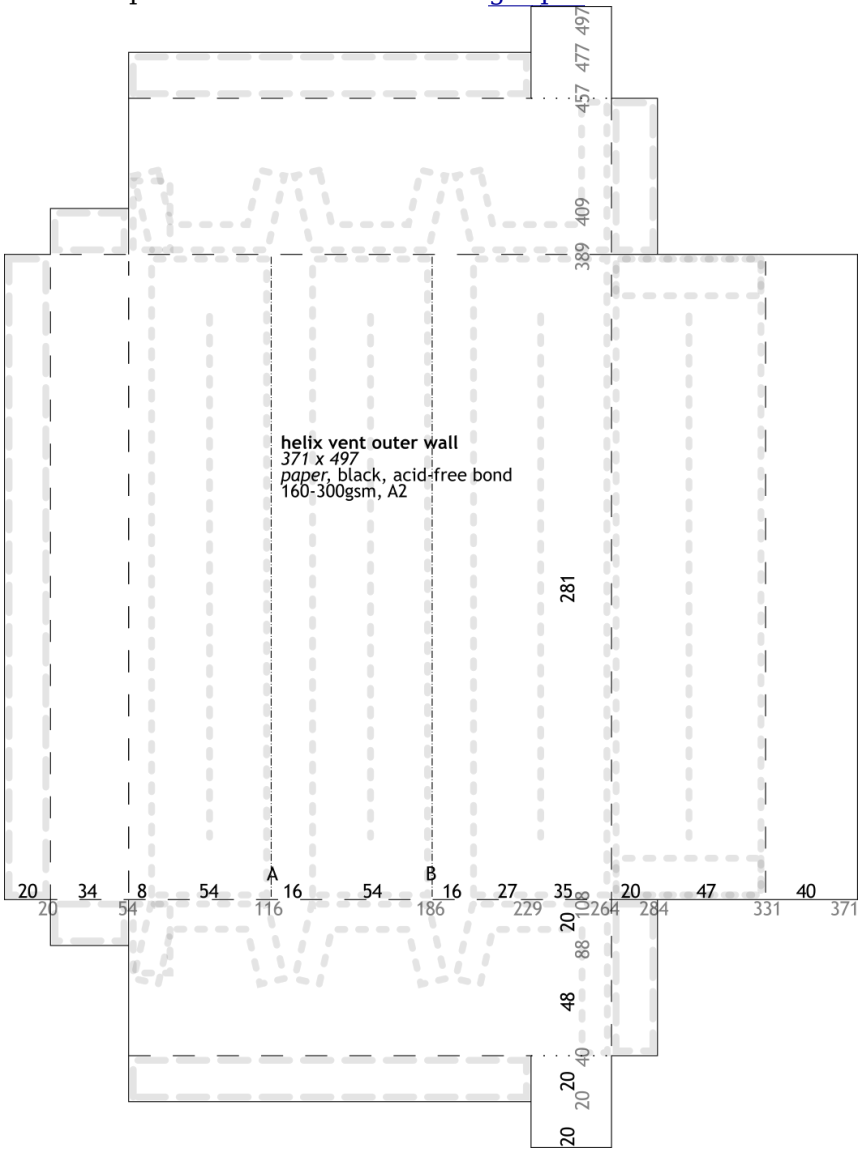
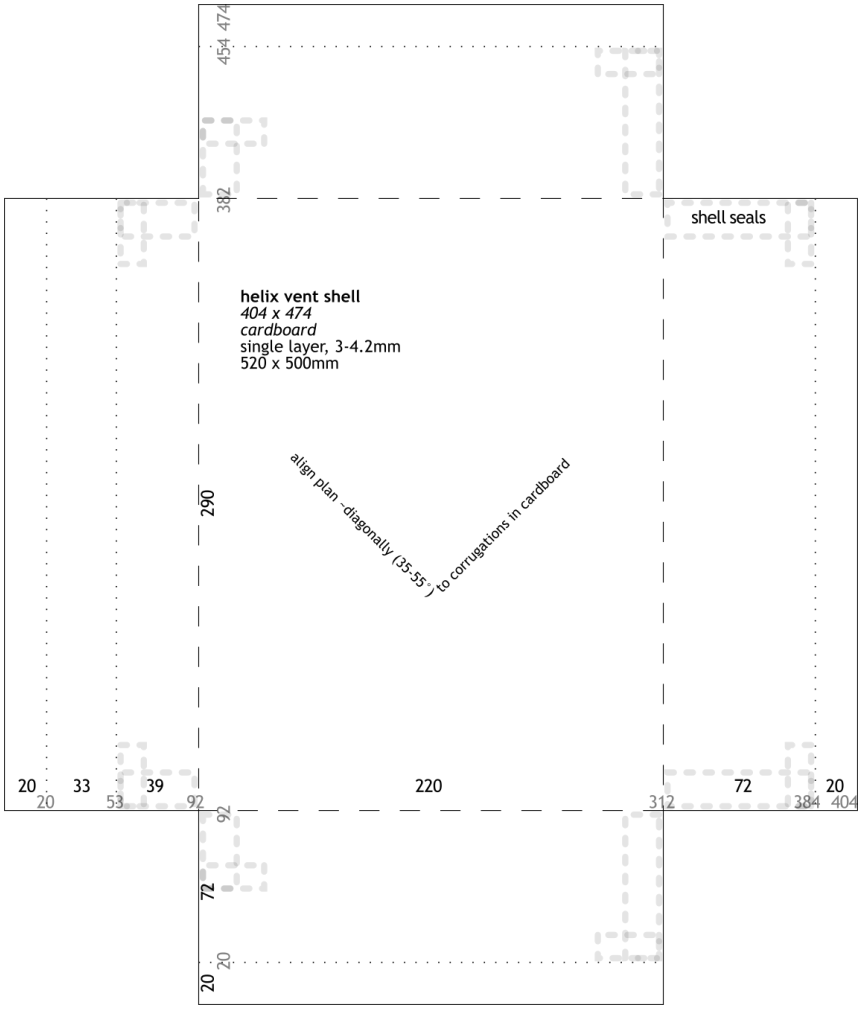
40
57
83
153
215
235
245
32
25
25

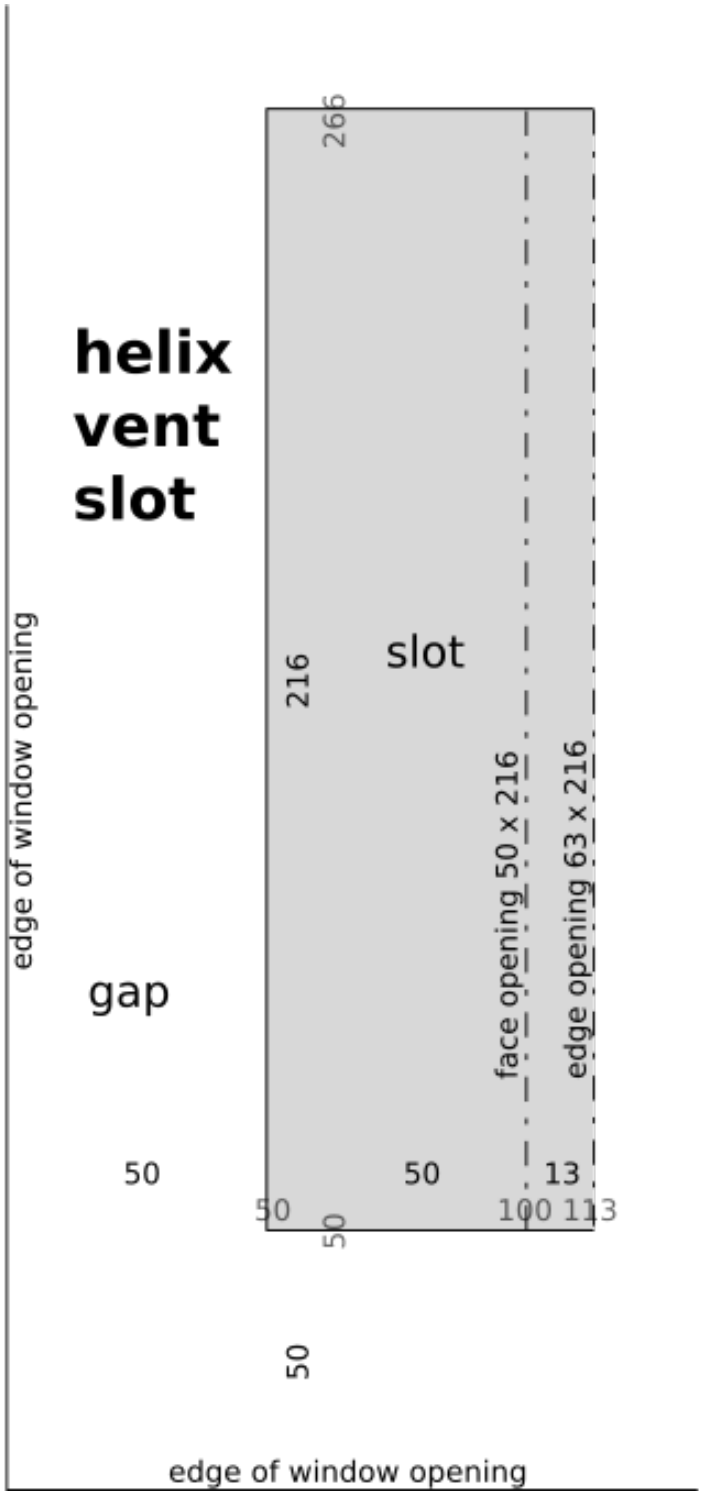
plan: helix vent inner wall get pdf



plan: helix vent outer wall get pdf



plan: helix vent shell get pdf


helix
vent
slot
edge of window opening
gap
slot
216
face opening 50 x 216
edge opening 63 x 216
266
50
50
50
50
100
113
13
50
edge of window opening

plan: helix vent slot get pdf

I call it a helix vent because of how air actually moves through it: like a corkscrew. It might look like air would zigzag through like light. But air is a fluid like water and takes the path of least resistance. Which is to maintain the same curved trajectory by *helixing* through. Because the helix is the natural form of fluids in motion under any circumstance, this minimizes friction within the airstream as well.

The helix vent can go anywhere. Flaps of either its edge or face opening poke through a slot and get taped or glued down to the other side.

- blind: attach it to the back of a blind and crack the window behind it.
- door: cut slot(s) in it and use helix vent instead of a threshold vent.
- wall (leading outside or to another room): attach vent to a flat cardboard box and attach box to the wall over the vent. Vent can be either supply or return
- silencer
  - outside: with shell, attached at face opening
  - inside: without shell, attached at face or edge.
  - Z version: simpler, more efficient, higher capacity version especially for the silencer. Attaches at the side opening. Short and straight, it has fewer light-stopping corners and no shell. It is only for installing inside the silencer or other enclosure with two or more corners for light to go around. See drawings in next section.

If your darkroom's ventilation is passive, put vents both low and high in room to enable convection. This works better the greater the inside and outside temperature difference; the greater the vertical distance between vents; and the more vents.

Do you need a more compact vent? I used the 3-4-5 triangle ratio in the channels, so it can be shrunk to make a narrower, shorter air passage. Do you wish to manufacture vents? A set of simple wooden or sheet metal templates and jigs can

speed production tremendously while keeping equipment and investment to a minimum. Start in your garage.

Materials are simple and non-toxic: heavy black acid-free paper, cardboard, fabric, and wood glue. Look in art or office supply shops for the paper. North Americans, use this paper weight and size conversion chart. If large sheets are unavailable, glue small sheets together between folds in plan. Wood glue has high tack and quick drying time, easing assembly. School glue will work, too.

Read through instructions once while studying plans.

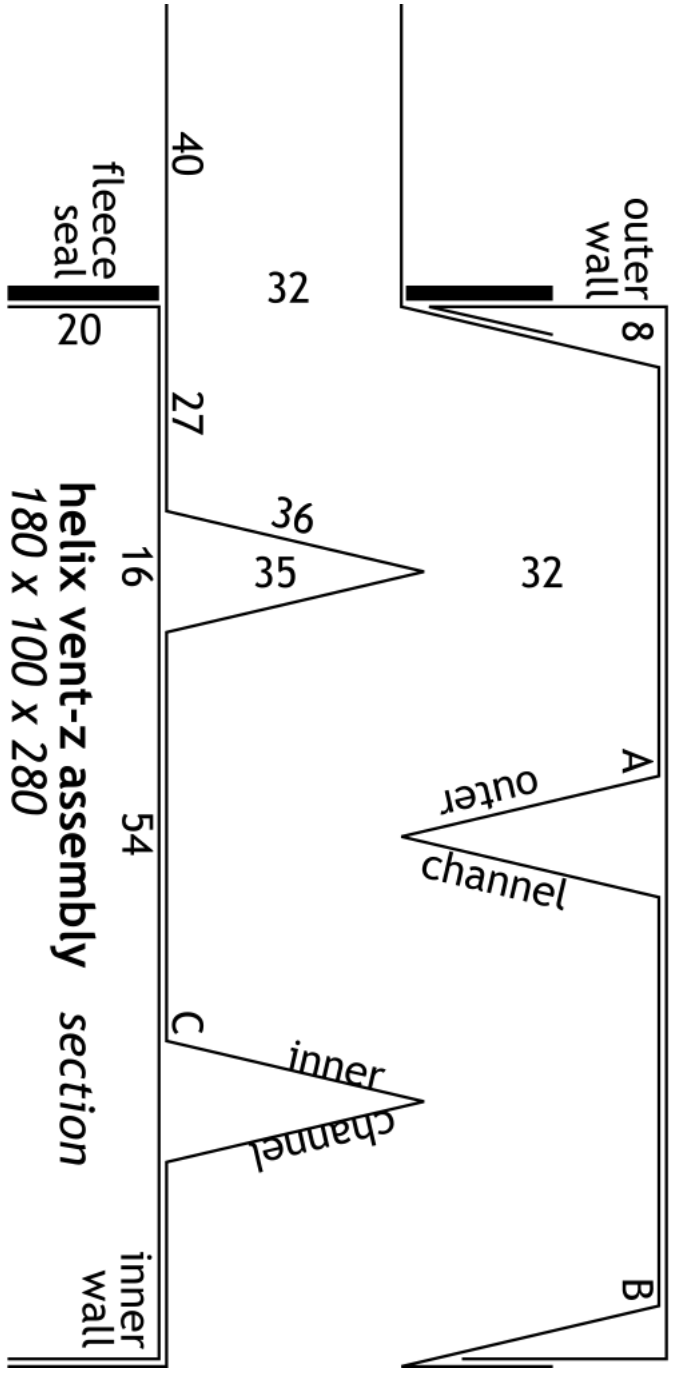
1. materials (see plans for quantities)
    1. paper (for channels and walls)
        - black, acid-free bond, coverstock
        - available at art supply, stationery, and book shops. In Europe, common posterboard is often acid-free.
        - two posterboard-size sheets (498 x 648 minimum) per vent
        - weights
            - channel: 120–300gsm (200 ideal)
            - wall: 180–400gsm (200 ideal)
            - total: 350–600gsm
    2. cardboard, single layer, 3–4.2mm thick (for shell, unnecessary inside silencer)
    3. fabric: polar fleece, black, medium weight (for seal. Quality check: 10 layers of it in a stack should measure 30-35mm high)
2. follow instructions in make > fabricate
3. glue channels to walls 1. refer to plans and key to get a clear idea of how parts go together. Keep plans right side up, marks visible, wall on bottom, channel on top. Test joints with masking tape till you've got everything right. 2. fat grey glue lines: long-dashed areas mate with short-dashed areas 3. glue joints - outer wall/channel: left to right in assembly plan - inner wall/channel: right to left - use as little glue as possible to minimize warping, ~2mm bead - match lettered lines 4. glue channel flaps to tops and bottoms of walls

4. assemble core
    1. orient sections
        1. stand them right side up, channels facing you, outer section behind inner section
        2. flip over inner one, so it is upside down and channels face each other
    2. test joints
        - work inner and outer sections together
        - note how cut-out areas of inner wall's top and bottom butt up against outer channel's triangles
        - curl middle flaps between cut-out areas outward so they will contact outer top and bottom when glued
        - note how flaps help align sections
        - practice using table knife to press tops together when glued
    3. separate sections then glue back together, one end at a time
        - use table knife
        - use flaps to align them
    4. glue down flaps of outer wall to outer and inner walls
5. shell
    - glue joints of shell together with shell seals
    - put core inside and attach fleece seal with glue. This is a 20mm wide double-layer strip of fleece that goes around the flaps of the face opening. Three sides of the seal attach to the shell flaps. The fourth side goes across the core. Double-layers overlap at corners.
    - when not in use, store core inside shell, taping up flap by side opening. Cover exposed part of core with scrap piece of cardboard to protect core from being crushed.
6. installation
    1. determine vent location
        - in blind, panel, or silencer
        - whether it will attach at edge or face opening
        - shell is unnecessary when installed inside silencer or other enclosure

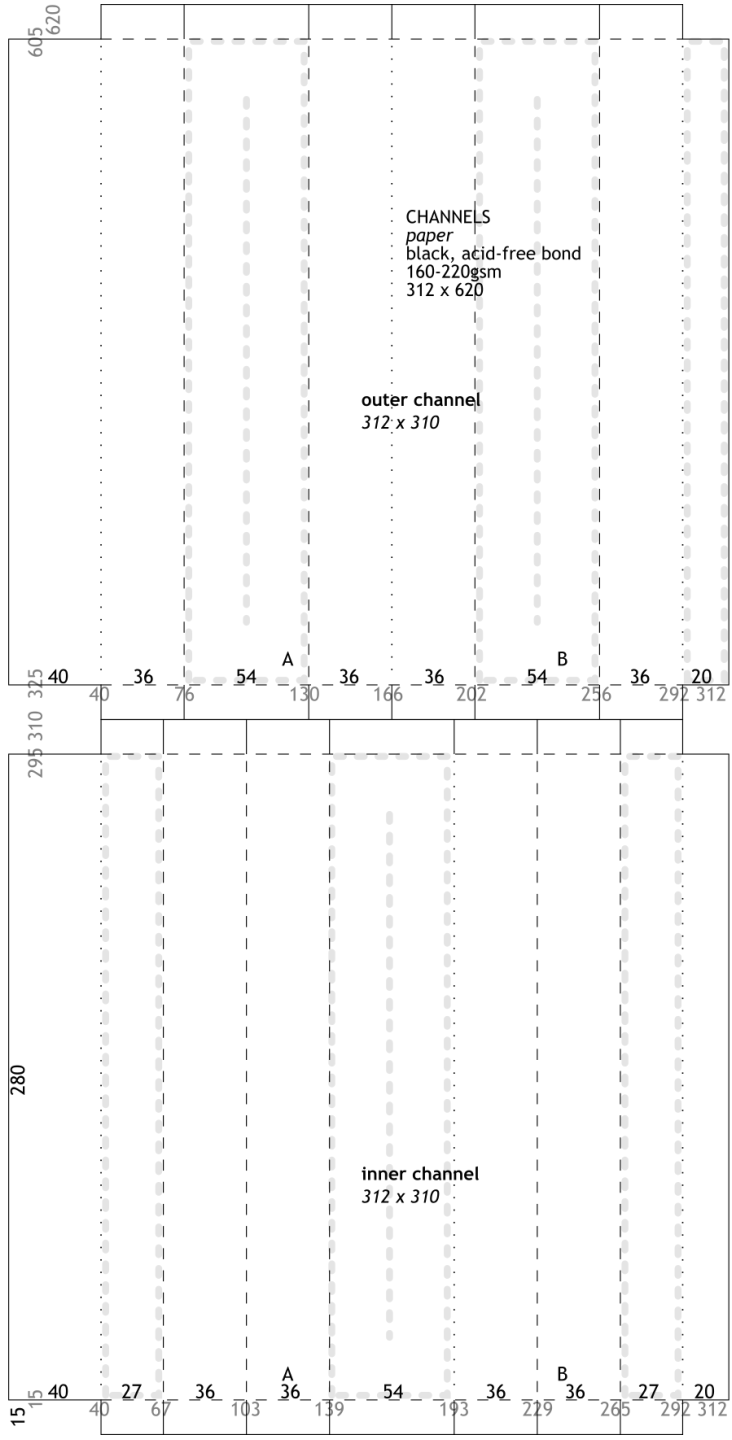
    - vent should not touch window handles, locks, or frame
2. mark slot with slot plan
    - the slot plan spaces slot correctly on most blinds and panels
    - face opening, 35 x 281, on blinds, panels, or outside silencer, with shell
    - side opening, 32 x 281, inside silencer or other enclosure, without shell
3. cut out slot
4. position vent over slot and fit vent flaps through it
5. when attaching to soft window covering like fabric, plastic sheeting, or cardboard, pull long flap snug, use back of table knife tip to crease the outside of it right where it passes through slot
6. fold flap at crease and tape it to cover. Tape is removable for vent reuse in another configuration later if you like. Only glue it in place if you are certain of not moving it for years.
7. repeat with other long flap, then with short flaps
8. attach shell to cover with tape, glue, or screws going through cover, into wooden braces if cover is soft
9. cover shell with foil and/or white paper to minimize warping by sun

helix vent-z

For inside silencer or other enclosure with two or more corners for light to go around. Follow helix vent instructions above, adapting as necessary.



plan: helix vent-z assembly get pdf


620
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CHANNELS
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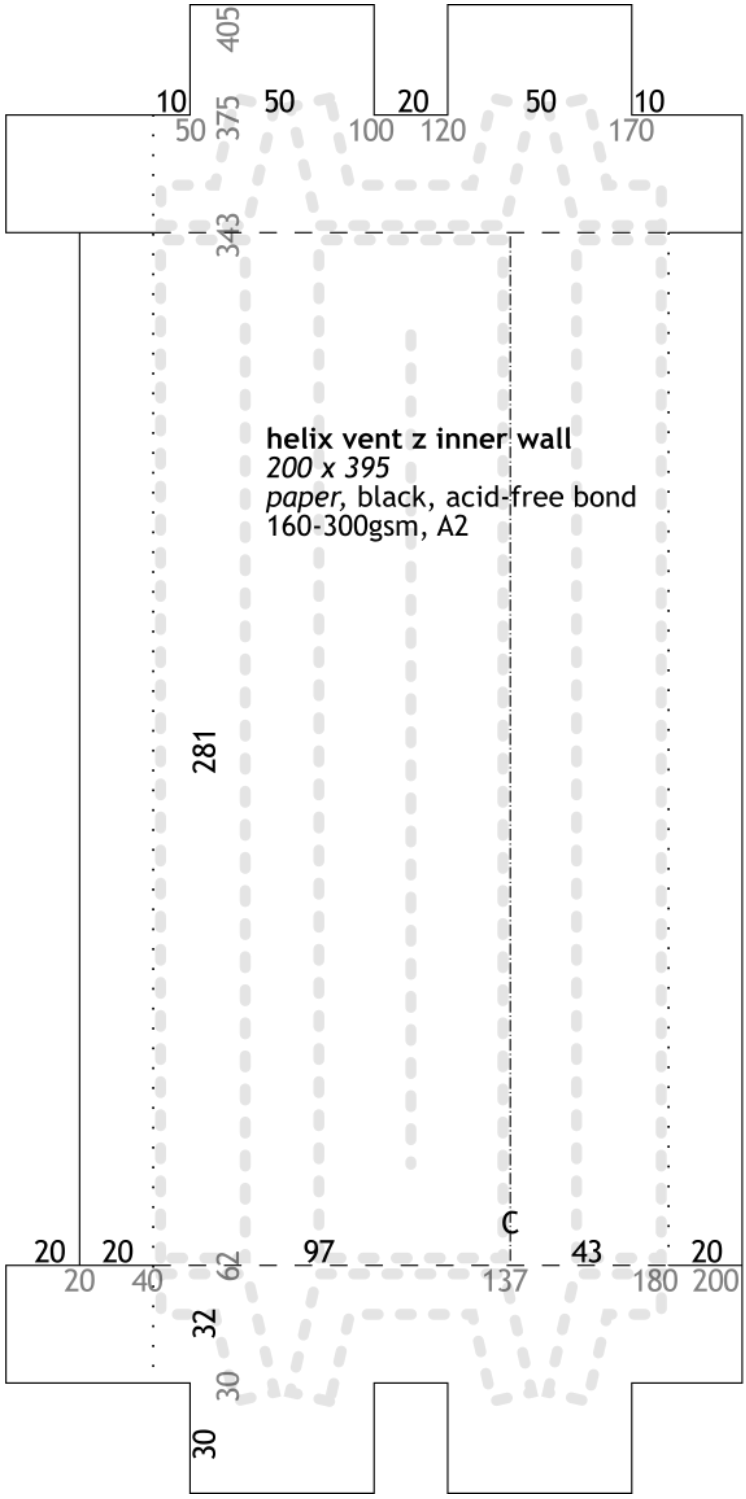
plan: helix vent-z channels get pdf


405
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50
375
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120
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170
343
helix vent z inner wall
200 x 395
paper, black, acid-free bond
160-300gsm, A2
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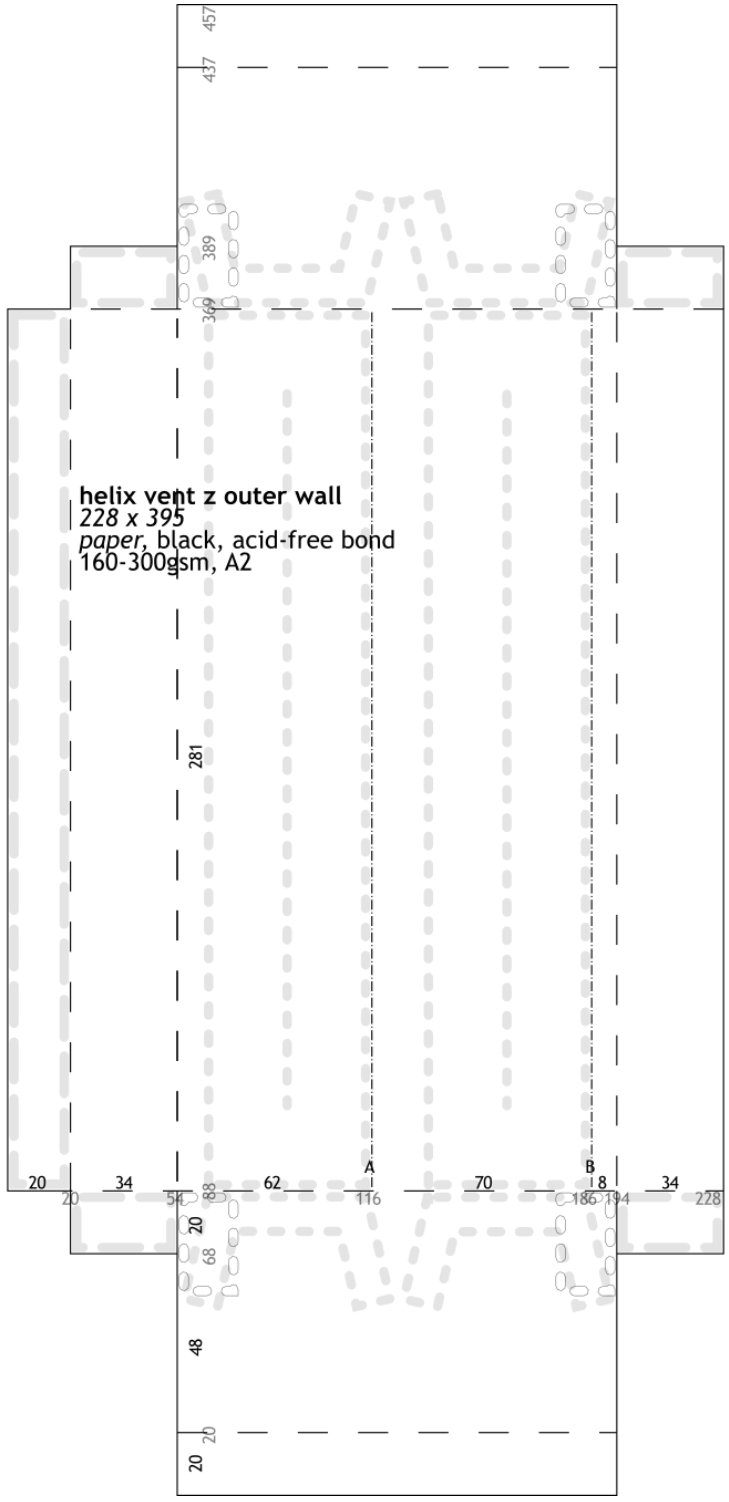
30

plan: helix vent-z inner wall get pdf


helix vent z outer wall
228 x 395
paper, black, acid-free bond
160-300gsm, A2
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437
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369
281
48
20
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88
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62
70
8
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20
54
116
186
194
228

door jam with masking tape or white school glue. When closing, door should catch middle of fabric, pulling and bending it around one edge of the door and fill the gap between the door and jam.

2. hinges: make perpendicular cuts in edges of fleece to accommodate these 3: latch: make a parallel cut over the strike plate to accommodate the bolts
3. bottom: where no threshold vent is necessary, make a fleece baffle the width of the door. See threshold vent perspective drawing for baffle design. It is a half-tube of black fleece fabric that hangs from the bottom of the door on each side and touches the threshold or floor underneath. Tape a 100mm wide strip of black fabric to the threshold or floor under the closed door. Black fabric against black fabric makes a good light seal. Partially darken space beyond door with curtains or partitions to ensure darkness in the darkroom.
4. if light still leaks in the sides or top, affix a second strip to door, as in drawing
5. to remove glued-on fabric, wet it. This will dissolve the glue and the strips will peel off easily after a few minutes. As this happens, use a wet rag to wipe off glue residue before it dries again.

If door has a window, use one of the methods below to cover it.

blinds

To darken windows, use one of the five methods I have come up with—foil, plastic, panel, velcro, and rollerblind. Custom manufactured blackout blinds are available with light-proof side rails for 10-100x the money. Or invent something of your own.

constraints

- perfectly darkening
- quickly and easily operated so it actually gets used

- good-looking
- discreet: looks like a blind or curtain from the outside (not a secret cannabis-growing operation)
- accommodates lightproof vent
- window or trickle vent can be open behind it
- holds its shape over time in different temperatures and humidities
- durable
- of common, cheap materials
- reasonably easy to make
- easily uninstalled
- leaves few marks or holes

intro

After darkening dozens of rooms to varying degrees, I like 2 methods the best: plastic sheeting for temporary situations and panels for long-term use.

Blackout blind fabric is plastic-coated to seal tiny holes in the weave. Like anything, fabric quality varies greatly. Light still leaks through the surface of some fabric.

Test any material using a high-power flashlight, like a big Mag-Lite or tactical flashlight. Get a sample of fabric big enough to cover the flashlight's lens twice. Test the flashlight to make sure it works. Tightly tape one layer of fabric over the lens with lightproof tape, then another. Put it by your bed. Darken your sleeping room as well as possible with blankets, cardboard, foil, etc, and go to sleep.

After waking, keep your eyes closed. Grab the flashlight and point it at your eyes. Open them and turn it on for a few seconds. You should see no light. If you see light, the fabric is unacceptable. Turn off flashlight to prevent burning. Remove one layer of fabric. Turn flashlight back on. If you now see light, then use two layers of that fabric. If you still see no light, you have found excellent blackout fabric you can use in one layer. Please let me know the brand. Blackout fabric that works perfectly in one layer is rare.

If buying a custom rollerblind, buy from an established local blind shop that cannot easily escape dissatisfied customers. Do not buy on the internet, regardless of price, guarantees, or reviews on (rigged) review sites. (Yes, I learned this the hard way). Buy only well-known, internationally distributed brands (which generally cause the least complaints). Get a guarantee of absolute lightproofness of the entire installation. Tell them you will be testing it with advanced sensors. That is, with eyes that have had days to adjust to darkness.

Look for acrylic coating. It is the industry standard. Some blackout fabric has toxic PVC (polyvinyl chloride) coatings. Get full disclosure of material content. The specifications of one product I looked at stretched to three pages. But still, under “coating”, the manufacturer divulged merely one word: “polymer”. This is another word for plastic. This could have meant PVC, so I did not buy it. It’s too bad. Later I found out they use acrylic.

Search for PVC-free blackout blinds and blackout fabric. A handful of companies make blinds for traveling (especially with children). Some sell the fabric they use by the meter.

Plastic sheeting can be reused and traveled with. It is the easiest and quickest method. Foil is for one-time use, easiest to get materials for, very cheap, quick, and only a little tricky to make. Its PVC tape is toxic. So only use if really pinched for time, money, or material availability.

The velcro blind is of medium difficulty to make. It is almost as easy to operate as the roller blind. It is good looking if unconventional. Take care when uninstalling it. Removing velcro may damage paint.

The rollerblind is hardest to make. For ease of fabrication and low cost, it has a frame of heavy paper instead of aluminum or wood. It operates easily and looks good. It works with or without a vent. Making it takes patience and precision.

If your room’s air supply comes through your window, attach a helix vent to the blind. Attach it to the back of the blind if the window is deep enough to allow it. Test position of vent before cutting a slot for it to make sure it clears the window frame and handles. If your supply and return air pass through your window, use two lightproof vents, one near the top and one near the bottom of a blind, maybe with fans and

silencers.

Some casement windows leave no space for a blind or vent because they are flush with the wall and open inwardly on hinges. In this case, either:

1. build a deep-set frame around window to attach blind to
2. sew a velcro blind into the shape of a box so it attaches to the wall but then sticks out enough to allow the window to open behind it and contain a *helix vent*.
3. remove the window temporarily and replace it with a solid panel of wood of the same size with a slot cut in it for vent. See hard panel section below.

lesson

Now for a quick lesson on window types and anatomy.

- types:
  - fixed
  - opening
    - sliding
      - horizontal
      - double-hung (vertical)
    - casement (hinged)
- anatomy, from center of window to wall:
  1. pane: the glass itself
  2. frame: holds pane, moving with it in opening windows
  3. sash: attached to wall, surrounds frame. In opening windows, the frame closes against the sash. With non-opening windows, sash is often the same as the frame.
  4. sill: holds sash; it's the surface where you put plants, candles, etc, but also corresponding sides and top
  5. recess: entire opening in wall where window is installed. Often same as sill.
  6. trim: decorative wood trim around window. It is on wall at edge of recess, where it meets sill. Joined to sill at a right angle. Not always present. 40-100 wide, 10-20 deep.
  7. wall

foil

disposable

This consists of foil taped over windows. It does not meet several of the criteria above. I put it first because most people have it now or can get it cheaply in minutes at the corner store. And use it for darkness tonight.

This only works on non-opening windows, where you don't need a vent. It helps if no light leaks through any joints of windows. Otherwise they can be sealed with tape or mitigated with dark curtain.

Foil only works one time. When it bends, it cracks and creates light leaks you can't see till the middle of a retreat. Bummer. But it works in a pinch if you are careful.

The trick is to unroll foil directly onto the glass and cut it in place. This prevents bending and cracking. Do not attempt to unroll and tear it from the box, away from the window, then apply it.

Do not tape foil to the frame, suspended in midair away from the window. It will rattle as air pressure changes near the window. Annoying.

1. materials:
    - aluminum foil, heavy duty, wide. Now available laminated to parchment paper laminate. Paper side facing out is a discreet look.)
    - electrical tape (19mm black vinyl), gaffer's tape, black masking tape
    - scissors
    - pizza cutter
2. assemble
    1. with scissors, cut several 2cm pieces of tape and hang them within reach of the window (keep scissors handy)
    2. starting 1cm from top left of window pane, unroll foil downward 10cm. Lightly tape foil at top with small piece of tape.
    3. unroll foil to bottom and cut 3cm longer than the pane with sharp scissors

4. unstick tape at top and reposition foil so edges extend 1cm past pane
5. tape right side of foil to glass with 2cm pieces of tape every 40-50cm
6. press foil into corners of pane, folding edges onto frame
7. tape top, bottom, and left sides of foil in place with 2cm pieces of tape
8. repeat steps 2–7 but on right side of pane, then in the middle of pane
9. tape full length of foil seams, where sheets overlap. As you pull out a length of tape, it will stretch. Let it relax before applying it.
10. tape foil to frame
11. tack dark blankets over window to catch any leaks

reusable

Use Reynolds brand paper-laminated foil for baking. Or, using white school glue (PVA glue, cola blanca), attach foil to dark posterboard. Once dry, wedge board in place over window, prop it up with a chair, or hang it with 1-2 pieces of tape. If the sun comes through really hot, face the foil outward toward it. Otherwise, face the dark side toward the sun.

Use this method to quickly reduce light where absolute lightproofness is not required or practical. For example, during travel. Or if you have an unsealed bedroom door which is almost dark enough for nightly sleep, except direct sunlight hits it from the outside in the morning through a small curtainless hallway window, cover the window this way.

plastic

This method consists of taping thick black plastic over windows. It is my main method for quickly and cheaply darkening rooms for temporary use. It is reusable, durable, cleanable.

This plastic is also great for traveling. Tape it up with masking tape in the corners. It cuts out 99% of light. The sleeping mask stops the rest.

1. materials (test whatever you use for absolute lightproofness)

- 1 layer: extra-thick (0.35) black polyethylene, construction sheeting, or EPDM rubber pond lining
- 2 layers
  - common construction sheeting, black polyethylene, 0.15-0.2mm thick, found at building supply houses in rolls or off a roll by the meter
  - white-black laminate agricultural plastic/"light deprivation" tarp used in greenhouses and for "pit tarps". I got the end of a roll for free, a huge amount. Amazing stuff. White looks really nice inside. Use one layer for traveling. Use two (white sides out) for perfect darkness. Fold back edge of outside layer to expose black surface to seal against wall.
- several layers: large black garbage bags

2. assembly

   1. **Important**: First, cover inside of windows with white material: paper, fabric, or plastic. Windows build up fierce heat when sealed with black plastic. It can damage paint, wooden frames, and trim. It can destroy the vacuum in dual or triple-pane windows, even causing them to explode! Black plastic also looks strange from the outside, attracting negative attention.
   2. measure and cut plastic to extend 100mm beyond window recess and any trim in case light and air leak between the window and wall. Or, if all joints and seals are perfect, and the window will not open during rest, cut plastic to almost cover frame.
   3. tape plastic to wall (or frame). Use 25mm black masking tape: Intertape PF3 or PB1, Shurtape T106. It is effective, cheap, sticks and conforms well to irregular wall surfaces, yet comes off easily without residue (unless you leave it up a long time). Not perfectly lightproof, it works with the plastic. Local art and professional lighting supply stores carry it. If it is not sticky enough on your surfaces, use photographic masking tape or black kraft paper tape.

These are thicker (more lightproof), stronger, stickier, and more expensive. Look for ProGaff (formerly Permacel) 743, Shurtape 724 or 743, and 3M 235.

4. avoid electrical tape and most duct and gaffer's tape. They are made of soft vinyl and especially obnoxious adhesives and are thus extremely toxic in their manufacture, handling, use, and disposal. One exception I know is Shurtape PC 657, a polyethylene coated gaffer's tape. Do research; the devil is in the details.
5. if the room gets too hot from direct sun, then before taping up the black plastic, cut a piece of cardboard the same size as the recess. Tape or glue aluminum foil to one side of it. Leave 15mm spaces between the strips of foil to allow moisture to pass through. Set the cardboard in recess, foil facing outward. In really hot areas, cover windows with foil from the outside or get exterior blinds, shutters, or awnings.
6. if it is a cold room, face the foil inwardly to reflect heat back in.

panel

I mentioned this at the end of the intro above regarding casement windows. I have been making these more and more because of their soundproofing and lightproofing qualities and the wide availability of discarded furniture for free material. Unlike glass, it allows you to cut a hole to easily attach a duct or vent. Use it just for retreats or make it permanent if you have extra opening windows.

Remove the window by its hinges. Carefully trace its outline onto the board you will use. Or trace onto paper or cardboard if handles or hinges make that awkward or to test fit. Tracing is better than measuring because it also accommodates non-square angles that windows tend to have over time.

Cut 2-3mm inside the line to allow for fleece seal. Make sure it fits in the frame with 2-3mm around it. Fold fleece the long way so it attaches to the panel's edge and face. Use glue. Then it will make contact with window frame on two surfaces all the way around and seal out light.

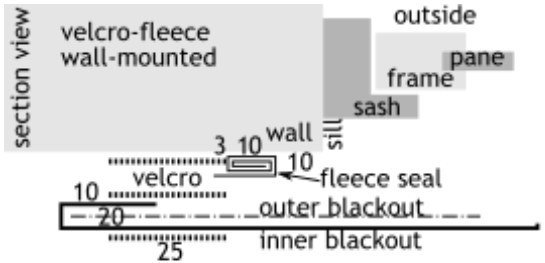
Determine where the vent or silencer will go so it clears the frame, the screen, and the window recess. Measure and mark a hole in the panel for the vent or silencer. Cut it out with a jig or coping saw. Or drill holes in the corners with a 4mm bit. For each hole, drill two more 8mm away. Then drill between them along the line at various angles until you cut a slot big enough for a coping, keyhole, or hack saw.

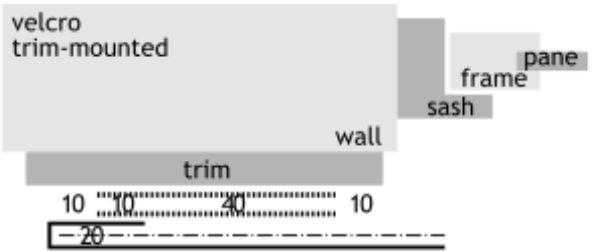
Attach a handle to the panel so you can lift it in and out. Just a 30 x 30 x 30 block of wood glued and screwed to the board is enough.

Stretch a cord or wire from one side of the frame to the other over the panel. Put a block of wood between cord and panel to keep panel pressed in place. But first,

velcro

Note: the plan view in this drawing shows just the top left corner of the blind and how the various materials come together.

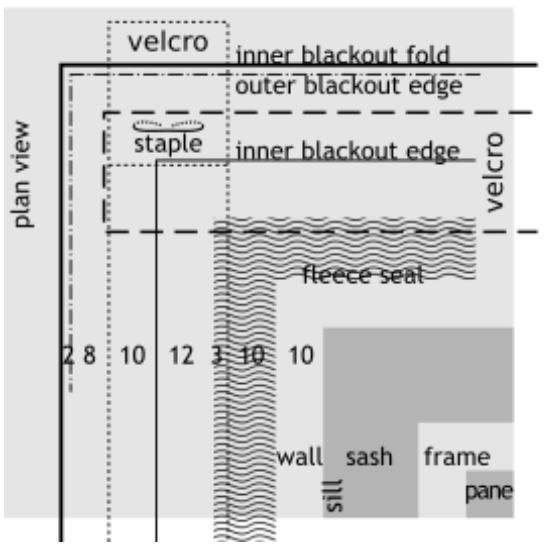


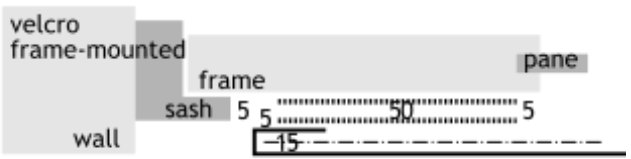


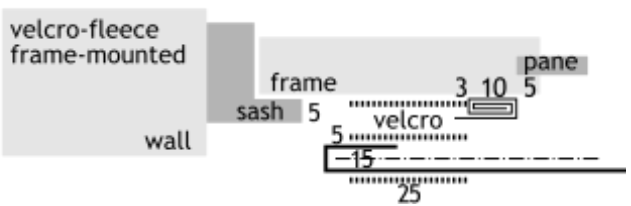
velcro blind

blackout fabric, velcro, fleece

velcro or velcro-fleece mounted on wall, trim, and frame







plan: velcro blind get pdf

I am still testing this design. At first, I cut the fabric from an IKEA Tupplar blackout blind and attached it to a window frame with adhesive velcro (hook & loop). This was the prototype. It only took an hour and it almost worked! Problems:

- light leaks sideways through the hook and loop of 25mm-wide black velcro!
- fabric is not perfectly lightproof in one layer
- plastic coating on fabric (especially black)
  - scratches easily, creating light leaks
  - peels off easily with adhesive of velcro or tape
- stress on ends of velcro cause it to lose adhesion, peeling off fabric or frame
- sealing black fabric over multi-pane windows destroys their vacuum seal with oven-level temperatures
- black fabric can overheat room

Thus, these (untested) improvements should make it work.

1. materials
   1. fabric
      - white IKEA Tupplar blackout blind
      - 2 layers, coated sides facing each other
   2. velcro
      - 25mm wide with a thick seal of black polar fleece just inside the velcro
      - 50mm wide (I have not tested this; I just know 25mm is almost enough to stop all light)
      - designs for both widths, each in two positions, are included in plan
2. extra tools:
   - wooden cooking spoon or other smooth, rounded piece of plastic or wood, at least 50mm long
   - board
     - 10-20mm thick, 10-40cm wide, 200–300cm long,
     - clean, smooth, straight, flat
3. choose position

1. window recess
    - attach blind here when:
        - attaching lightproof vent to blind and keeping window open
        - window frame is not big enough to hold velcro
        - light leaks around frame, sash, sill, or trim
    - cut first piece 55 wider and higher than recess for velcro-seal, 75mm wider for velcro-wide
2. window frame
    - attach blind here when window
        - opens but will never open during darkness
        - has a perfect light seal
        - has a frame at least 45mm wide
    - cut first piece of fabric 7mm narrower and shorter than exposed part of frame
    - cut second piece 40mm wider and 40mm higher than first piece

4. assembly
    1. affix hook (scratchy) side of velcro to frame or wall all the way around the window
        - outside of velcro is 60mm from edge of glass or recess
        - extend vertical strips 10-30mm beyond horizontal strips
        - affix one side, then top and bottom, then other side, ends of horizontal pieces jammed against edges of vertical pieces
        - cut four, 10mm strips of loop (fuzzy) side of velcro and mate them to ends of vertical hook
    2. mate the loop to the hook, sides first, leaving the paper adhesive cover on
        - horizontal strips should overlap vertical strips
        - vertical strips should extend 90mm past horizontal strips and 30mm past edge of fabric
        - go around velcro and press it hard into wall to improve seal of hook to frame/wall
    3. join mylar to blackout fabric
        - cut mylar or white fabric for style 1 the size of the glass pane; for style 2, the size of the recess

- glue mylar or white fabric on uncoated fabric side of blackout fabric with textile glue or spray adhesive, leaving 10mm gap between edge of mylar and where velcro will be

4. join decorative fabric to blackout fabric
   - wrap decorative fabric 20mm around the edge of the blackout fabric
   - attach it to the back with textile or hot glue or by sewing
5. join fabric to velcro
   - tape corners of fabric over the velcro so fabric extends 30mm past velcro
   - undo the masking tape at the bottom corners
   - get under fabric, lifting it away from velcro
   - remove paper adhesive cover from top horizontal velcro
   - carefully lower fabric onto it and press hard to make good seal between velcro and fabric
   - repeat with bottom horizontal velcro
   - remove paper from a side strip of velcro and seal fabric to it
   - fold ends of vertical velcro 40mm from end, 20mm from edge of fabric, sticking it back on itself and overlapping the fabric 20mm
   - staple the ends through the fabric twice
   - repeat on other side
6. secure velcro adhesive: press smooth plastic tool strongly into velcro all the way around the blind to ensure total adhesion
7. if using a black seal with 25mm velcro:
   1. grabbing a velcro tab at corner of blind, carefully remove it from wall
   2. study the section view of the seal in the plan. Make seal: a thick folded roll resembling the drawing, 10mm wide, 5mm thick. Hold roll together with a tiny amount of glue. Put it under board while it dries.
   3. to attach seal to wall, attach seal flap to hook of velcro or glue thick black fabric strip just inside the velcro all the way around. It must be twice as thick as both sides of velcro combined
   4. put blind back on wall
8. Voila!

roller blind

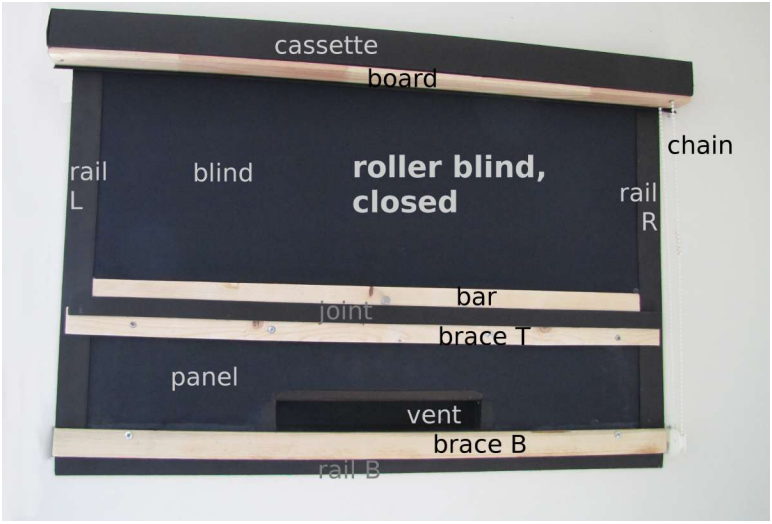


photo: roller blind, closed

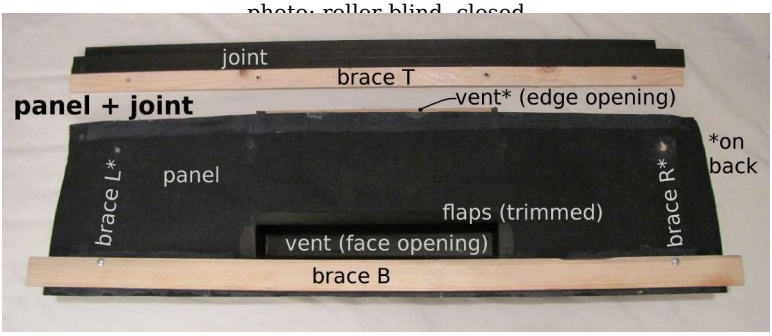


photo: roller blind, panel and joint

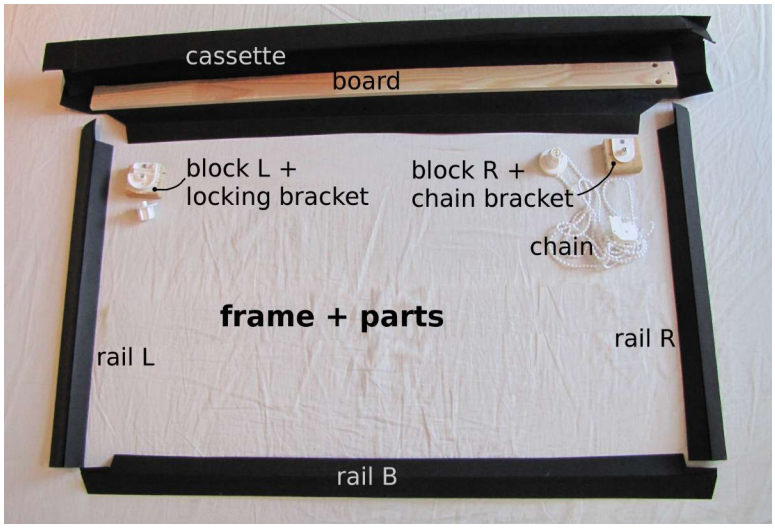


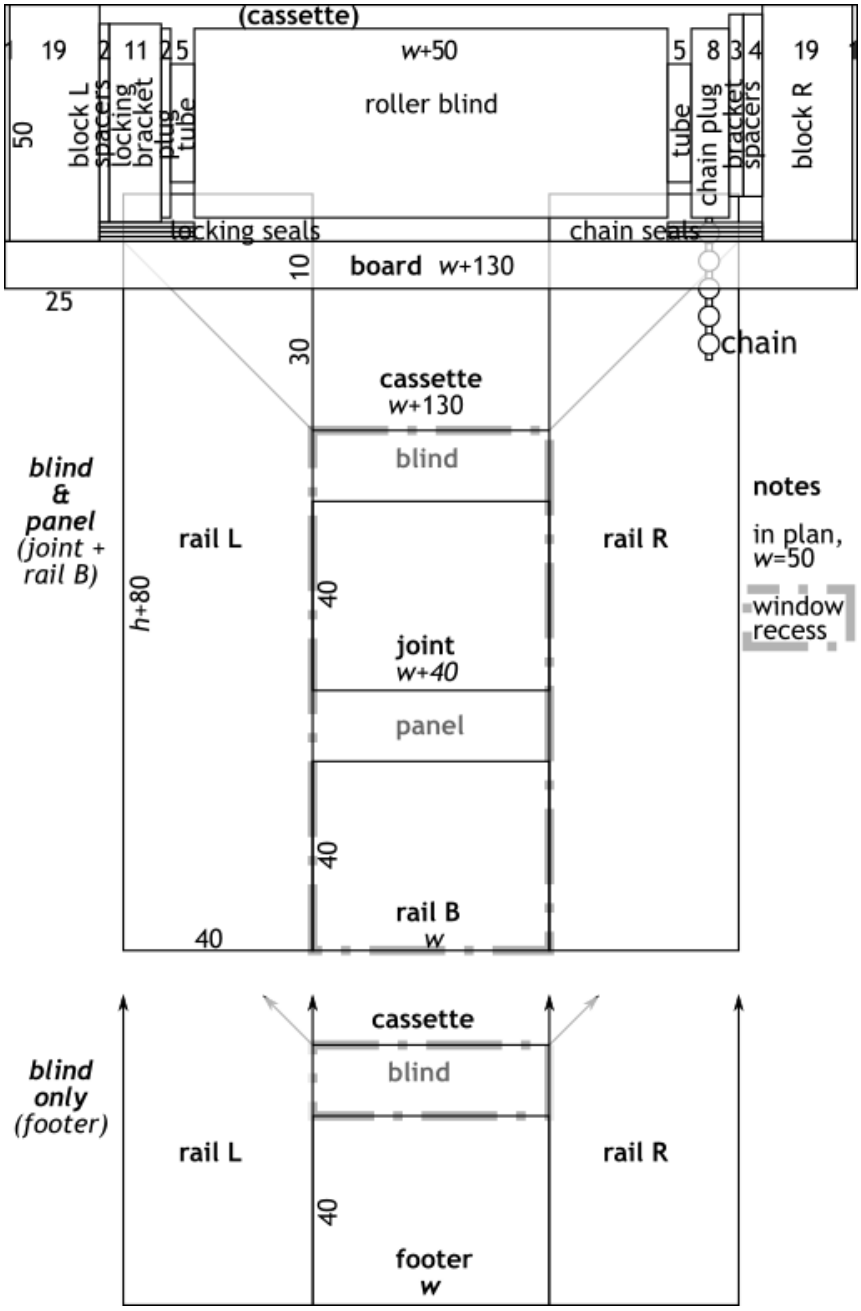
photo: roller blind, frame and parts

photo: roller blind, rail section

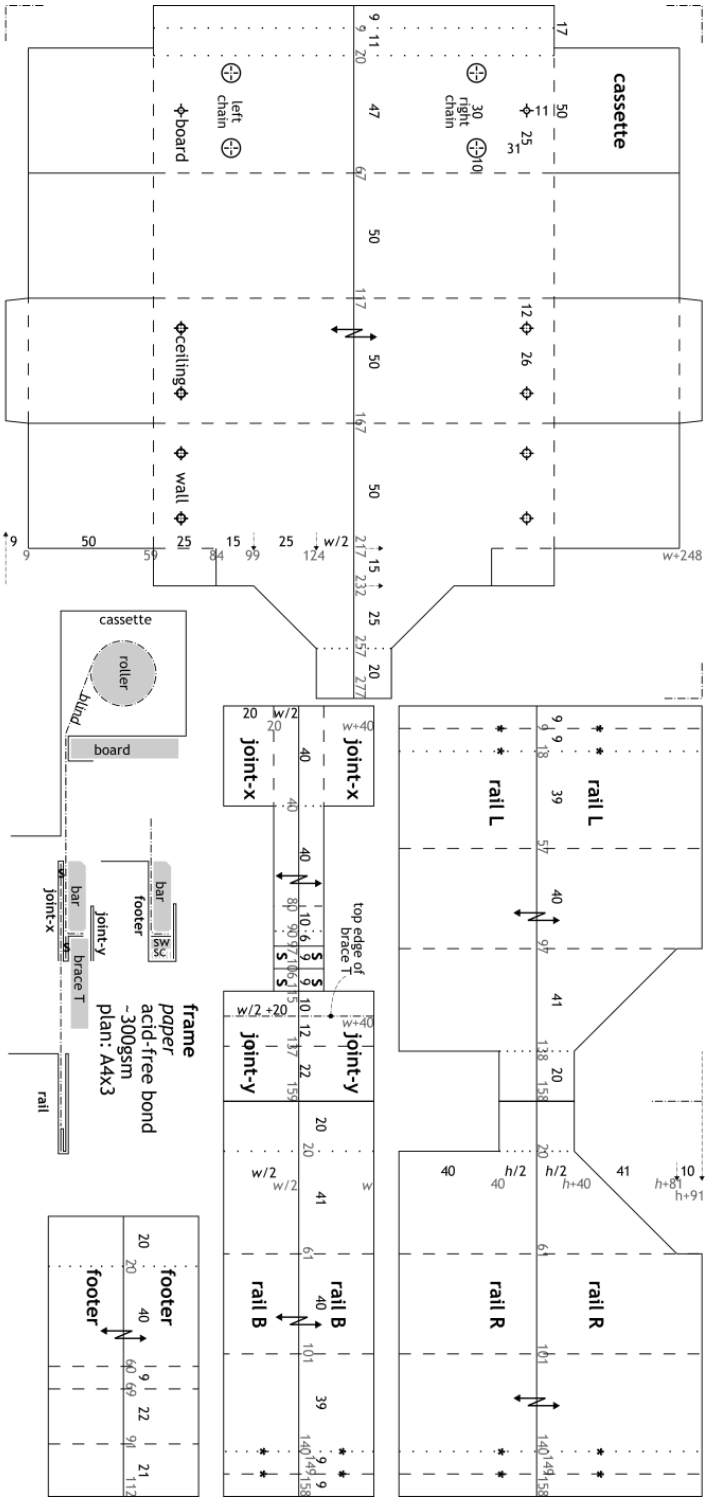
This design takes considerable time. I've built it only once. The price of manufactured fully sealed blackout roller blinds

annoyed me so much, I wanted to see if it could be done for a tenth the price.

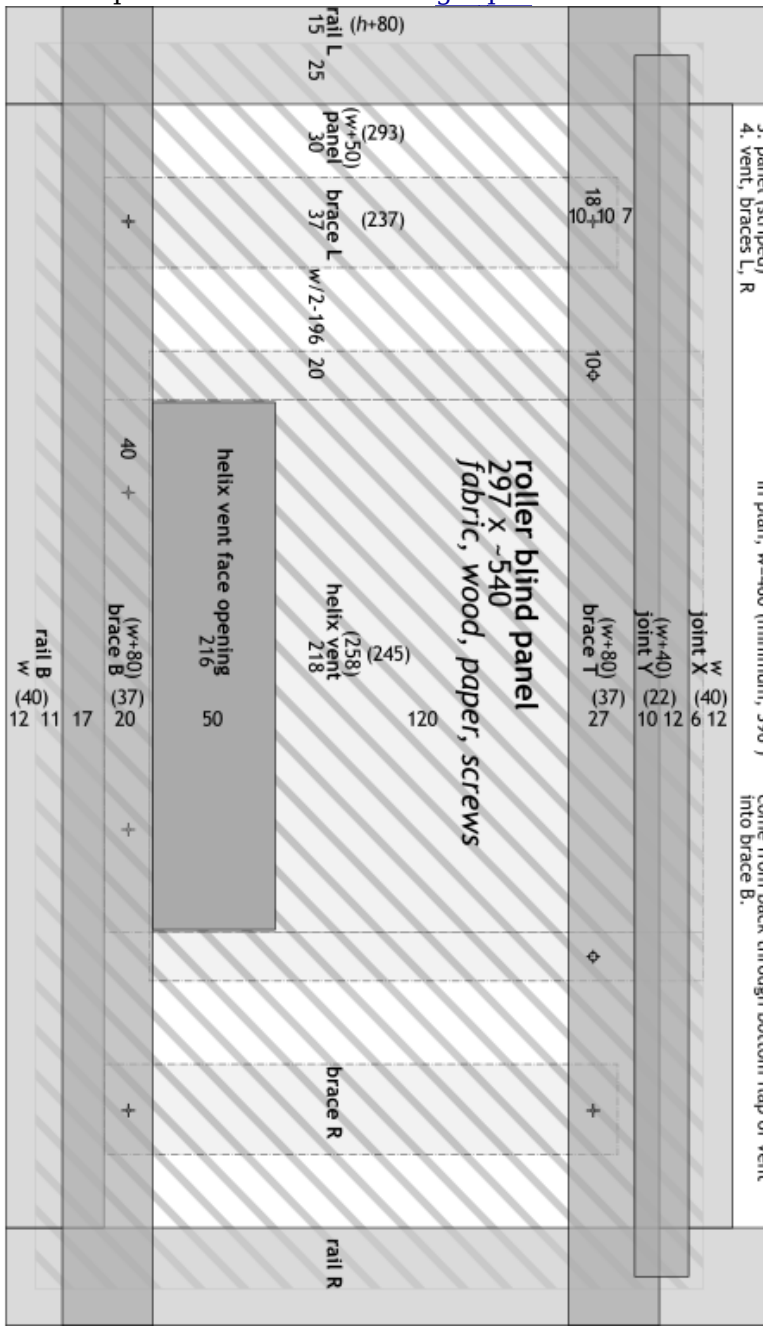
- the blind mounts on wall. The design can be adapted to mount on the ceiling or top-sill. If you need this, DIY or write me.
- use key to decipher plans
- measure window on all four sides. Windows are rarely identical or perfectly perpendicular
- *h* (italicized): height of recess, measured between T and B sills. Measure both sides.
- *w* (italicized): width of window recess, measured between the side sills. *w* changes slightly top to bottom. Measure top for cassette, bottom for rail B or footer, and 170mm up from bottom sill for joint. w of blind itself should be narrowest of 3 measurements.



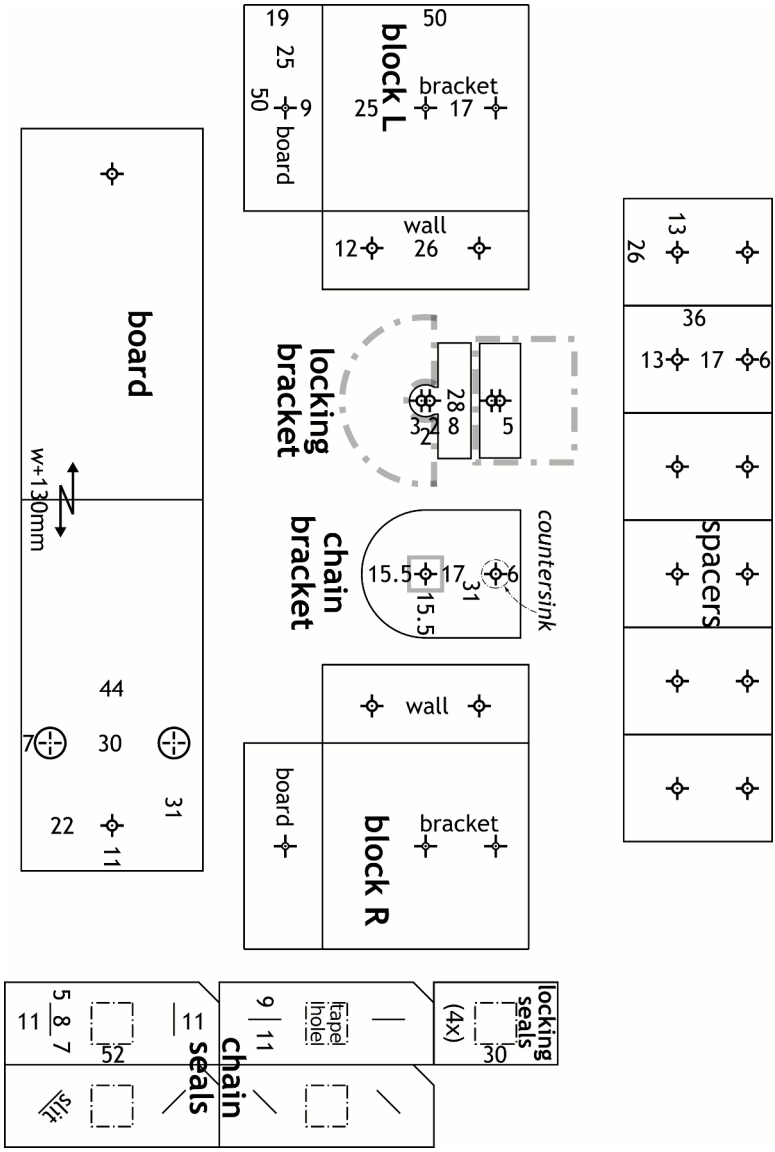
plan: roller blind layout [get pdf]


cassette
board
left chain
right chain
ceiling
wall
rail L
rail R
rail B
joint-x
joint-y
top edge of brace T
roller
bar
footer
brace T
rail
frame
paper
acid-free bond
-300gsm
plan: A4x3

plan: roller blind frame get pdf



plan: roller blind panel get pdf



plan: roller blind parts get pdf

- materials
  - white IKEA Tupplur blackout blind, enough for double layers (don't get black; the coating seems to be thinner and actually leaks more light)

  - black fleece (*locking seals* and *chain seals* may not be necessary. Try without them first.)
  - paper
    * acid-free
    * ~300gsm bond or coverstock
    * either black or any color with 100–120gsm black paper lining (lining not in design)
  - wood
    * braces: 35-50W x 6-12D (plans are for 37 x 7mm; adjust as necessary)
    * bar: w-10L x 30W x 6-10D
    * board: w+130L + 44H x 8-12D
  - cardboard, single layer, 4.2mm thick
  - caulk: cheap, semi-adhesive, and dark stuff that you can easily cut through and scrape off when removing blind without damaging it

- cassette
  - choose left or right chain
  - the *block* pattern on parts page lays on a block of wood, 50 x 37 x 19
  - spacers are made of credit cards or similar ~1mm thick material. Make more or less as necessary

- roller blind
  - to cut: roll it neatly, measure and mark where cut will be, wrap a piece of paper around so edge lines up with mark and tape in place, cut through layers of blind fabric with razor knife all the way around
  - chain: to get it through board
    * cut it and overlap and splice it back together with sewing thread (for blinds shorter than chain, where splice needn't pass through chain anchor. Chains can also be lengthened with cord; just position chain in gear of chain bracket so blind stops rolling up and down before cord enters gear.)
    * or cut board from each hole to edge of board
    * use bottom chain anchor as usual.
  - mount on wall with caulking and blocks

- frame
  - cut frame patterns in half horizontally through the zigzag arrow
  - stretch them apart to match window size as defined by *w* and *h*.
  - for frame pieces longer than paper
    1. butt pieces of heavy paper together (put edge to edge, not overlapped)
    2. join with 20mm wide strip of 120gsm paper and glue
    3. then mark/crease/score/cut
  - gluing
    * when gluing footer or joint, glue paper to brace/bar first, then glue other folds
    * glue one set of folds at a time, 2-3 sets in each rail/joint/footer
    * use smallest amount of glue possible (test to see how much is sufficient)
    * immediately clamp pieces
    * when you glue final fold of rails, you must put something non-stickable between the layers, against 9mm spacers, to prevent 40mm wide areas from sticking together.
  - joint
    * SW=spacer wood. Dimensions when installed (H x W x D) *w* x bar D+1 x ~4
    * SC=spacer cardboard: one layer or maybe two layers joined with tiny dots of glue
    * SW+SC=10
    * black line between SW and bar is layer of black paper glued to SW
  - mount rails with caulk on corner of sill and wall/trim
  - If face of trim has one shallow curve, concave or, more commonly, convex, bend roller blind rails to fit it. Or plan a larger blind and attach rails and cassette to wall outside the trim. But do not attach them to convoluted trim (with both convex and concave curves).
- panel

  - carefully transfer hole & slot marks from plan to fabric & braces
  - cut slot and attach vent to panel
  - glue braces L & R to back of panel
  - screw braces T & B to front of panel into holes of braces L & R with 5mm wood screws
  - drill 4mm middle holes through brace T and vent shell flaps
  - remove brace T
  - slip panel into rails. Shoehorn it in with 50mm wide paper strips
  - re-attach brace T, 4mm machine screws from front in middle holes with washers and nuts at the back

- panel alternative for short, wide windows

  - put vent in a tall narrow panel at one side of window. Put a 60-80mm wide vertical frame member into the window recess 305mm from the side closest to your bed. Make a 365W x h+60mm wood panel. Cut vertical slot in it for vent. Install vent. Point edge opening toward window recess. Screw panel to wall and frame piece with 20mm strip of black fleece as a gasket.

  Uncovered edge of vertical frame member holds rails for roller blind that covers remaining part of window. To keep blind in place when wind blows too strong, stick pushpins through rails and blind every 200-300mm. Always use same holes.

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That's darkness. Now for managing water and waste in a darkroom.