A Way to Make Panniers

Steven E. Pav*

May 22, 2004

Abstract

A means of producing rear panniers for the conveyance of goodies by bicycle is described. The panniers can be designed to fit many bicycle racks and have a carrying capacity of as much as 60 liters. Each pannier is a single bag without separate compartments; no zippers are required for bag construction. The panniers form a single unit (*i.e.*, are not separable), and attach to the rack by means of two locking wingnuts and rope ties. It is hoped this exposition is sufficiently detailed that the inexperienced seamster/seamstress/bikepunk may evaluate his/her/its carrying needs, create a pattern, cut fabric, and assemble the panniers with relative ease.

1 Document Release

This is Revision: 1.6 , updated on Date: 2004/04/20 20:51:57 . This document is in a state of flux; direct any commentary or suggestions for improvement to me at SPAV@ANDREW.CMU.EDU. The most recent version of this document is available on the web at
`http://www.andrew.cmu.edu/~spav/play`.

This document was prepared with the LaTeX text processing system.

2 How Many ℓ?

So you want to carry things around on your bicycle? You should first consider what kind of things you will be conveying about and how frequently. I manage to survive on a weekly grocery trip using only about 25 liters of capacity. Arkell's largest expedition bags have a 56ℓ capacity, likely enough to carry the requisite camping gear and such. You should think about the *weight* of what is to go in the bags; 50ℓ of water is around 50kg (depending on the temperature) which is probably more massive than (the artist formerly known as) Prince! Such a mass might break your rack, which is probably rated to no more than 25kg; if you need more carrying capacity, get a trailer. If you plan on using your panniers to convey marble countertops, or transfer your osmium paperweight collection to and fro, you may wish to make your bags small, to prevent you from overloading them. On the other hand if you are a travelling balsawood-airplane salesman, or are carrying relatively lightweight camping equipment you may opt for larger bags, taking care to note weight distribution.

*for purposes of design & manufacture of things of cloth, dba Maison Shabbychef.

Experiment 2.1. Here's a fun test for budding mad scientists: gather together two scales, a hard floor and your bicycle. Place the scales on the floor, one underneath each wheel of the bicycle. Record the weight on each scale. Climb on the bicycle (it may be necessary to lean against a wall), and assume your riding position. Record the weight distribution. Try the experiment again with 20kg of weight on your rack. Has all of the added weight gone to the rear wheel? Try to explain to yourself what physically is going on. Draw force diagrams if you are so inclined.

Now ask a bicycle-knowledgeable person about how much weight your wheels can handle (note this will also depend on tire pressure). Then determine the weight capacity of your rack. With this information, and a good estimate of load density, you could formulate a maximum allowable carrying capacity. Publish your results in a peer-reviewed journal. Send a preprint to SPAV@ANDREW.CMU.EDU.

3 Alternatives

In this document I present a means of making panniers from whole cloth; the weekend seamster should consider his/her alternatives before embarking on such a project. For example, the seamster *could* simply buy new panniers. There are a number of purveyors of these bags. For purposes of comparison, as many panniers are advertised in the despised Imperial unit system, recall that 1 cubic inch is about 16.4 cubic centimeters, so 1000 cubic inch bags are 16.4ℓ.

Arkell Corp (`www.panniers.com`) manufactures some fancy bags, with a number of separate pockets and zippers and such. I have no experience with these bags, they are presented for comparison purposes. A set of bags will run from around \$137 for 42ℓ capacity bags, to a whopping \$480 for 56ℓ capacity bags. These prices are approximate and reflect conversion from Canadian dollars at June 2003 rates.

Robert Beckman manufactures panniers which look serviceable; he seems to have the technology and skillz. You pay for quality, with entry prices starting at \$130. (March 2004 rates) See `http://www.coinet.com/~beckman/index.html`

One can purchase Nashbar panniers with 38ℓ capacity, apparently for around us \$40 on sale. These bags are less fancy, and it is not clear if the price is for one pannier or the set. Nashbar sells Cannondale panniers with 41ℓ capacity for around 130 bucks.

A fairly elegant alternative is to repurpose army surplus bags as panniers. This requires little sewing skill, is relatively quick and cheap and reduces landfill. The cost of such bags is determined by your local army surplus retailer, plus a few bucks for hardware. For more details, see the site `http://www.btinternet.com/~peteajones/bikes/pw_rack.htm`. This site also features some real tough-guy talk about making your own rack from metal bars. hot. shit.

If you were looking for something cheap, recycled and a bit wacky, you can repurpose 4 gallon kitty litter buckets. I find about one of these a month in the recycler in the alley (the city cannot actually recycle them). Add two bucks of hardware, and presto panniero. See
`http://members.rogers.com/bphuntley/BikeBucket.html`

Making your own panniers is probably a better bet if you: have some time on your hands; have access to a sewing machine; can get packcloth cheap; have your own ideas about how the world is to be arranged; want to match your panniers to your drapes; are a bit daft. Making your own panniers is probably a bad idea if you: are itching to blow a lot of cash on something fancy; are particular about waterproofing; do not trust me; are not technically inclined.

For alternative sources of information, see Ken Kifer's webpage on pannier construction:
`http://www.kenkifer.com/bikepages/touring/bags.htm`. Ken was killed in 2003 by a motorist, who was likely driving under the influence.

4 Designing a Pattern

First, look at your bike rack. The panniers herein discussed fit onto a rack by means of a machine screw and wingnut. So your bike rack should have a metal plate on the top with two holes in it, holes which will carry the screws; one hole should be towards the front of the rack, the other towards the back. If your rack has a plate but no holes, you could drill holes into the plate. If there is no plate, you should either get a different rack, or figure out how you are going to attach your panniers to the rack. I have no experience with other attachment styles.

Cut out a piece of paper in the shape given in Figure 1. Make sure to cut out the triangle in the lower left. Place the paper next to the rack on your bicycle, with the cutout triangle towards the lower front. The triangle cutout is there to prevent your foot from hitting the bags. Does it look big enough? My advice is that the paper (and thus the bags) should not cover the seat stays–those bars of your bicycle running from about the seat to the rear axle. Adjust measurements C_x, C_y as necessary.

Is the paper too wide or too narrow? It should be as wide (measurement W) as the rack; adjust as necessary. The piece of paper should probably not cover your rear axle. Note, however, some folks seem to think "low-rider" bags are the way to go, that is bags which ride even lower than the axle. (See Ken Kifer's webpage mentioned above) This strikes me as not such a good idea, but you might be ok with this. Adjust the measurement H as necessary.

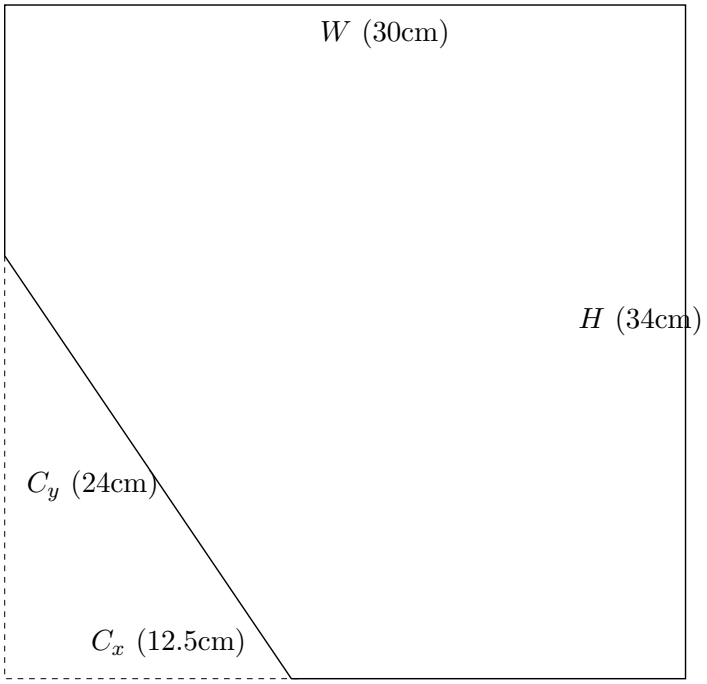

Figure 1: Pannier "footprint" against the rack. Cut one from paper to help construct pattern.

There is another measurement, the depth D, which needs to be determined. Hold a ruler outward from your racks, in the direction of your rear axle. Does 20cm look good to you? Select a depth measurement that is right for you, but 24cm is about the limit. Note that D must be greater than 12cm for this pattern, because there's some funny mathematical stuff going on; this should pose little problem, since 12cm is relatively small.

You should also determine the extension, measurement E. This is the height *above* your rack that the bags will extend. Determine a good extension–it should not extend too far, probably not

much farther than the height of your top bar. To avoid problems with weight distribution, it is probably a good idea to avoid packing denser items in the extension.

Once you have all these measurements, you can determine the approximate capacity per bag:

$$V_l = D \cdot \left[(W-4) \cdot (H-2) - 2 \left(\frac{C_z - C_y}{C_x} \right) \cdot \left(\frac{C_z - C_x}{C_y} \right) \right], \quad V_h = V_l + D \cdot E \cdot (W-4).$$

The capacity of your bags is about between V_l and V_h. The latter quantity takes into account the volume in the extension, which is $DE(W-4)$. Given that your measurements are in centimeters, these two quantities are in milliliters; divide by 1000 to get ℓ.

If these formulæ look funny to you, they should. The bags are not "cylinders," that is they do not come straight out from the racks, but come out at an angle, *i.e.*, they are more like truncated cones than cylinders. The formulæ are only approximate–they use a small angle approximation. The real formulæ substitute $\sqrt{D^2 - 16}$ for D. For $D = 20$cm, this is an error of merely 2%.

If the quantities V_l, V_h look too small or too big, adjust H, W, D, E, C_x, C_y as needed, but within those parameters outlined above. Write down the values of your design parameters in Table 1. The parameter C_z is computed as follows:

$$C_z = \sqrt{C_x^2 + C_y^2}.$$

Also measure the width of your rack (should be around 13cm or so), and enter as RW in Table 1.

parameter	sugg. val.	your val.
H	34cm	
W	30cm	
C_x	12.5cm	
C_y	24cm	
C_z	$\sqrt{C_x^2 + C_y^2}$	
D	20cm	
E	20cm	
RW		
SA	1cm-1.6cm	
WW	2.5cm?	

Table 1: Design Parameters. The parameter C_z is computed from C_x, C_y. The parameters SA and WW are defined below. For units compatibility, please use centimeters.

5 Sewing Notes

For those not in the know, seam allowance is the distance from your seam line to the edge of the fabric. Seam allowance errors are a major problem when designing and sewing; you are warned. I use a seam allowance of 1cm; patterns normally use $\frac{5}{8}$ inch (1.6cm) seam allowance. You should use at least 1cm. If you are using a sewing machine, look for lines on a plate next to the stitching area–these are you seam allowance guides. If they are numbered $4-8$, these are eigths of an inch; numbers $5-25$ are millimeters. Figure out your seam allowance and enter it as variable SA in Table 1.

The patterns given in this document have double lines; the bold line is the seam line, the thin line is the cutting line. The distance between the lines is your seam allowance.

Advice for the Novice: The most important skill to acquire in sewing is the ability to recover from mistakes. Luckily it is the skill that you will practice most. Get a seam ripper and learn to use it. Make sure you know what is under your fabric when you are stitching it–I have made this mistake countless times, accidentally sewing different parts of my project together because I was not paying attention to what was underneath the top layer of fabric. Remember that you are usually sewing with the outsides of the fabric facing each other; the seam ends up inside the bag, hidden from sight. You contrarians could sew it the other way, what do I care?

It is recommended that you use polyester monofilament (*i.e.*, fishing line) as thread. This stuff is UV- and rot-resistant, strong, and inherently waterproof. You can get it at your local fabric store. It is sometimes sold as 'invisible thread,' or for use in serging. You may find it in smaller spools, or you may find a few hundred meters wound on a cone, for about 10 bucks. Note you might have problems using a cone with your sewing machine–most home models are made for spools only. It might just make sense to get fishing line from a sports store–it may be cheaper there, though I am not sure what gauge you want. Take your sewing machine needle to the store and check out the gauge.

If you are going to hand-sew, note that monofilament tangles up pretty easily. One way to deal with this is pulling the thread through beeswax or the modern substitute, (www.threadheaven.com). Alternatively try dental floss (for sewing, not your teeth). I have tried sewing with dental floss; it is strong and durable, but I would not use it in my machine.

Use 9-13 stitches per inch (I just made those numbers up), or about 2-3mm stitch length (which is what I use). You should probably double stitch all your seams. Near corners you might want to triple stitch. Also, if there is any possibility the edges of your fabric will fray, you should check this either by serging the seam allowance (you would know if you had a serger), or sewing a zig-zag stitch over the allowance, or pinking. If you are working by hand, I guess you could blanket-stitch the edges.

You probably want to use some sort of waterproofing to seal the seams. Go to it.

6 Getting Your Fab On

You should probably use a durable water proof fabric, usually called packcloth. Canvas was the original and is still a good option; the nylon versions are popular with the tech-set. Nylon packcloth is usually measured in denier. According to the OED, denier is defined as "the weight in grammes of 9,000 metres of a filament or yarn. The denier system is used as the standard count for filament silk as well as for rayon, cellulose acetate, nylon and other man-made fibres." Higher denier is pricier, heavier, and more durable. Probably you want at least 500 denier. If you want fancy panniers, you can use two kinds of nylon, with the heavier stuff near where you think the bags will see more wear. You go, seamster!

For the basic panniers, you will need about 1 meter of webbing. The most common width is 1" (2.5cm), although $\frac{3}{4}$ inch is probably fine. Let WW be the width of your webbing–enter the value into Table 1.

An incomplete list of fabric sources follows. I do not mention the McFabric player in the fab-biz; use it only as a last resort.

- **Dumpstar** A friend dumpstered an awning factory in western New York, returning with rolls of good canvas, but at narrow widths–something like $60cm$. On a smaller scale, you probably have seen backpacks and cloth luggage in the trash. The incidence of such sightings

increases towards the end and beginning of the month in the summer. Note you may have to piece together small pieces of scavenged fabric from several sources to get enough for bags. Such finds are also an *excellent* source of zippers and webbing, which are otherwise pricey. Resourceful scavengers have also found some ripstop parachute nylon scraps for sale on the internet, probably sold by the pound. This stuff might work, but it is quite a bit lighter than packcloth. You are warned.

- **Okadaya** (http://www.sgj.co.jp/mall/okadaya/) Located in Tokyo, Okadaya is an excellent fabric store. Among its twelve floors, you will *probably* find a good variety of packcloth. They do have a wide selection of zippers, webbing, fasteners, reflective tapes, etc, and exotic and utilitarian fabrics of all kinds. Much recommended, but beware the high (but not for Japan) prices.

- **Michael Levine** in Los Angeles' garment district; they have had nylon packcloth at reasonable prices; not so sure about webbing, etc.

- **Outdoor Wilderness Fabrics** (http://www.owfinc.com/) I have not ordered from them yet, but am excited about them after poor experiences elsewhere. They carry a wide selection of fabrics and such for the manufacture of outdoor gear, and at excellent prices. I like their logo, and their webpage is well organized. They appear to be upfront about their pricing and shipping costs, and do sell wholesale as well. No online ordering–you have to send a fax or call it in.

- **Seattle Fabrics** (http://www.seattlefabrics.com/) For the grunge set, and the internet shopper, Seattle Fabrics provides some of what OWF does. However, their prices are inferior, their webpage is poorly organized, they charge hidden "handling costs," and do stupid things like fail to call you if there was a problem with your order, or call your answering machine with questions and then ship your order anyway without hearing from you. I'd rather rim a porcupine than order from them again.

- **Rockywoods Outdoor Fabrics** (http://www.rockywoods.com/) Much of the same stuff as Seattle at comparable prices, but they appear to have more pictures and descriptions on their webpage. Unfortunately they have no online ordering. (send a fax)

- **Sundrop** (http://www.sundroptextiles.com/) The Seattle Fabrics of Canada; beware weird Canada-US shipping rules and exchange rates.

- **Naraen's Outdoor Supply** On San Pablo in Berkeley, Naraen's has lots of outdoor fabrics and supplies, though the prices seem a bit high.

- **Local** Your local independent fabric shop may be able to help you. Probably they will not have nylon or webbing, though they should have canvas, and a workable grommet kit (hammer sold separately) made by Prym-Dritz, for about 8 bucks, including grommets.

7 Basic Panniers

The basic panniers consist of two single-compartment bags which are attached to each other. Bags close by means of rolling the top and 'locking' the roll with webbing and double rings. If you have ever used waterproof bags for kayaking and such, the closure method is the same idea; waterproof bags usually use plastic snap locks on the webbing. You may do the same, though rings are cheaper

item	OWF	Seattle	Rockywoods
500 denier cordura 60" widths, /yd	$8.37	$9.75	$11.99
1000 denier cordura 60" widths, /yd	$11.20	$13.25	$12.99
850 denier junior ballistics nylon 60" widths, /yd	$7.80	$11.95	n/a
1050 denier ballistics nylon 60" widths, /yd	$13.47	$15.25	$16.99
reflective coated ripstop nylon 60" widths, /yd	n/a	$9.50	n/a
nylon webbing, various widths, /yd	$.18 - $.88	$.55 - $.85	$.65 - $0.95
metal O rings, metal D rings, each	$.09 - $.45	$.30 - $.50	$.25-$.60
polyester monofilament thread 1000 yd cone	n/a	$12	n/a
polyester monofilament thread 2400 yd cone	$12	n/a	n/a
grommet setter kit	$14-$50	$40-$50	n/a
grommets (one gross)	n/a	$4-$15	n/a
grommets (1)	$.04 - $.23	n/a	n/a

Table 2: Fabric prices, OWF April 2004, Seattle Fabrics June 2003, and Rockywoods Fabrics January 2004. 60 inches is around 152cm.

and stronger. Note that these bags do not close very quickly, because rolling the top is a bit of a pain; probably snap locks can speed up the process. If you need quick access to the bags, you may wish to opt for more advanced designs.

The necessary materials are outlined in Table 3. The amount of required packcloth will be determined from the pattern. For backing I have used masonite in the past: my local art store had sheets big enough to make two backings for five bucks. Next time I am going to try 22 gauge steel sheeting; my hardware store has this in 1x2 foot sheets for 7 bucks. This is about enough for two backings. I have also tried posterboard, with no success. The parachute cord may be substituted with any fairly strong rope which is thin enough to get, doubled up, through your grommets.

If a total project cost of 33 bucks looks too pricey, you may be able to save here and there: it is easy to get webbing off of discarded backpacks; you could find a good backing sheet in a dumpster–even thin plywood or linoleum *might* work; the amount of packcloth required is probably an overestimate; canvas is cheaper than nylon, and found material is even cheaper. The marginal cost of grommets is pretty low–it's the grommet setter that adds cost. By keeping your eyes open, you can easily reduce the cost to ten bucks.

ingredient	approximate cost
packcloth; around 1.5 meter, 152cm wide	14.00
webbing; 1 meter	0.50
metal D rings; 4 cnt	1.00
grommets; 4 cnt, and setter	8.00
backing; $2W$ x H sheet	7.50
screw, washer, nut, wingnut; 2cnt	1.50
parachute cord; .5 meter	0.50
total	33.00

Table 3: Necessary ingredients for the basic pannier patters are given, along with approximate cost. The quantity of packcloth required is probably an overestimate. Here, metal sheeting was used for backing.

The basic pannier patterns are given in Figures 2-5, with the relevant measurements in Table 4. The measurements are calculated from the design variables (Table 1). Take the time to enter your measurements in Table 4. I usually draft patterns onto paper, then trace them onto tracing paper, and use the tracing paper for cutting. You may opt to avoid the middleman here. Note that your shears, which are for cutting fabric, should *not* be used on cutting paper–the thin tracing paper is probably fine. You can recycle pattern paper from other patterns–draw your pattern with a red sharpie to avoid confusion. You may find old patterns to recycle at the thrift store, or even your library.

Once you have drafted the patterns, you can mock up a cutting layout. This will help you determine how much fabric you will need. Note that you will need two each of pieces 1,2,3, and 4. Pieces 3 and 4 need not be constructed from waterproof material, but they should be durable and strong. Once you have the fabric and are on to cutting, I would recommend you do not double up cutting on nylon–when the stuff is on it's roll it gets stretched differently, so the two sides are not well aligned. Take the time to cut two of each piece, instead of doubling up. Of course, align the orthogonal parts of the patterns with the warp and weft of your fabric.

CAUTION! Most kinds of nylon packcloth have an inside and outside–the inside looks less sexy than the outside. The pattern pieces 1,2, and 3 are not symmetric and have a left and a right versions. IT WOULD SUCK if you cut TWO LEFTS or TWO RIGHTS of some piece instead of one left and one right, then realized that your packcloth has an inside and outside. Make sure you cut one left and one right of each. This is easiest done if you double up the fabric inside to inside and cut once instead of twice. Per the note above, however, this may not be a good idea. Your fabric might also have a nap, which would require more restrictions on cutting–however, this would only occur if you were making bags out of velvet or fake fur; this being the case, you are a total freaking nutjob, and I will give you no further advice, you goddamn freak.

There are line markings on pieces 1 and 2, and a circle marking on piece 3. Transfer these to the fabric; carbon paper works here usually. Put a grommet where the circle marking is on both pieces 3. These will be inside, facing your wheel so nobody will see if you are sloppy with the grommets. Here you will discover that the grommets look differently from each side when set; you may wish to put the prettier side out if you are vain like me.

Attach the two pieces 4 together by placing their 'out' sides together, then sewing on their 'in' sides along lines H and I. This gives you a cylinder of fabric. Turn the cylinder inside out (so now the piece is right side out). You may wish to lock your seam with an overstitch now. You may also wish to fray check the two raw edges, but this is probably not necessary. You now have a single piece 4. You will attach this to both pieces 1.

Place each raw edge of piece 4 along the lines J on pieces 1. Pin these on. Make sure that piece 4 is attached to the 'out' side of pieces 1. Attach the pieces by sewing parallel to line J. Sew many (at least three) parallel stitches between lines J and K. Make one of the stitches approximately along line K. These stitches will carry the weight of your bags–piece 4 will sit above your rack. You need to make sure that this weight is well-supported. Take the time to add another line of stitching just for safety's sake. It will be near impossible to restitch this later, so maybe you want to be paranoid and add another layer of stitching.

Fold the top of pieces 3 over. The top is the edge with measurement 3. Fold over twice from the outside to the in with 1cm or smaller rolls, then sew this fold in place. This is merely to finish the top edge, which is not strictly necessary. Now pin pieces 3 over the pieces 1. Where, you ask? Make that top edge run along line K. All those seams attaching 4 to the 1's will be covered. You are going to attach pieces 3 by sewing along all the edges of 3 *except* the top. This is how you get the backing in and out. It should look like a pocket. Fold over the edges about one seam allowance and pin them to pieces 1, then stitch them. Do not just leave the raw edges out.

measurement	value	shortcut	your val.
a	$W + D - 4$		
b	$H + E + 5WW - C_y$		
c	$H + E + 5WW$	$b + C_y$	
d	$W + \frac{D}{2} - 2$		
e	$W - C_x$		
f	C_z		
g	$\frac{D}{2} - 2$		
i	$H + E + 5WW - C_y - \left(2 - \frac{8}{D}\right) \left\lceil \frac{C_z - C_y}{C_x} \right\rceil$		
j	$C_z - \left(2 - \frac{8}{D}\right) \left\lceil \frac{C_z - C_x}{C_y} + \frac{C_z - C_y}{C_x} \right\rceil$		
k	$\left(2 - \frac{8}{D}\right) \left\lceil \frac{C_z - C_x}{C_y} \right\rceil$		
l	$W - C_x - \left(2 - \frac{8}{D}\right) \left\lceil 1 + \frac{C_z - C_x}{C_y} \right\rceil$	$e - k - m$	
m	$2 - \frac{8}{D}$		
n	$H + E + 5WW - 2 + \frac{8}{D}$	$c - m$	
p	$\frac{W}{4} + \frac{D}{4} - 1$	$a/4$	
q	$\frac{W}{2} + \frac{D}{2} - 2$	$a/2$	
r	$\frac{E}{2} + 5WW$		
s	$H - 6$		
t	6		
u	W		
v	$H + E + 5WW - C_y - 4 \left\lceil \frac{C_z - C_y}{C_x} \right\rceil$		
w	$C_z - 4 \left\lceil \frac{C_z - C_y}{C_x} + \frac{C_z - C_x}{C_y} \right\rceil$		
x	$W - C_x - 4 - 4 \left\lceil \frac{C_z - C_x}{C_y} \right\rceil$		
y	$H + E + 5WW - 4$	$c - 4$	
z	$W + \frac{D}{2} - 6$		
aa	$\frac{D}{2} + 2$		
bb	$\left(\frac{8}{D} + 2\right) \left\lceil \frac{C_z - C_x}{C_y} \right\rceil$		
cc	$\frac{8}{D} + 2$		
dd	$H - C_y$		
ee	H		
ff	2		
gg	$\frac{C_z}{2}$		
hh	$RW + 12$		

Table 4: Pattern measurements are given in terms of the design parameters. (see Table 1) All units are centimeters. This is important–do not use imperial units.

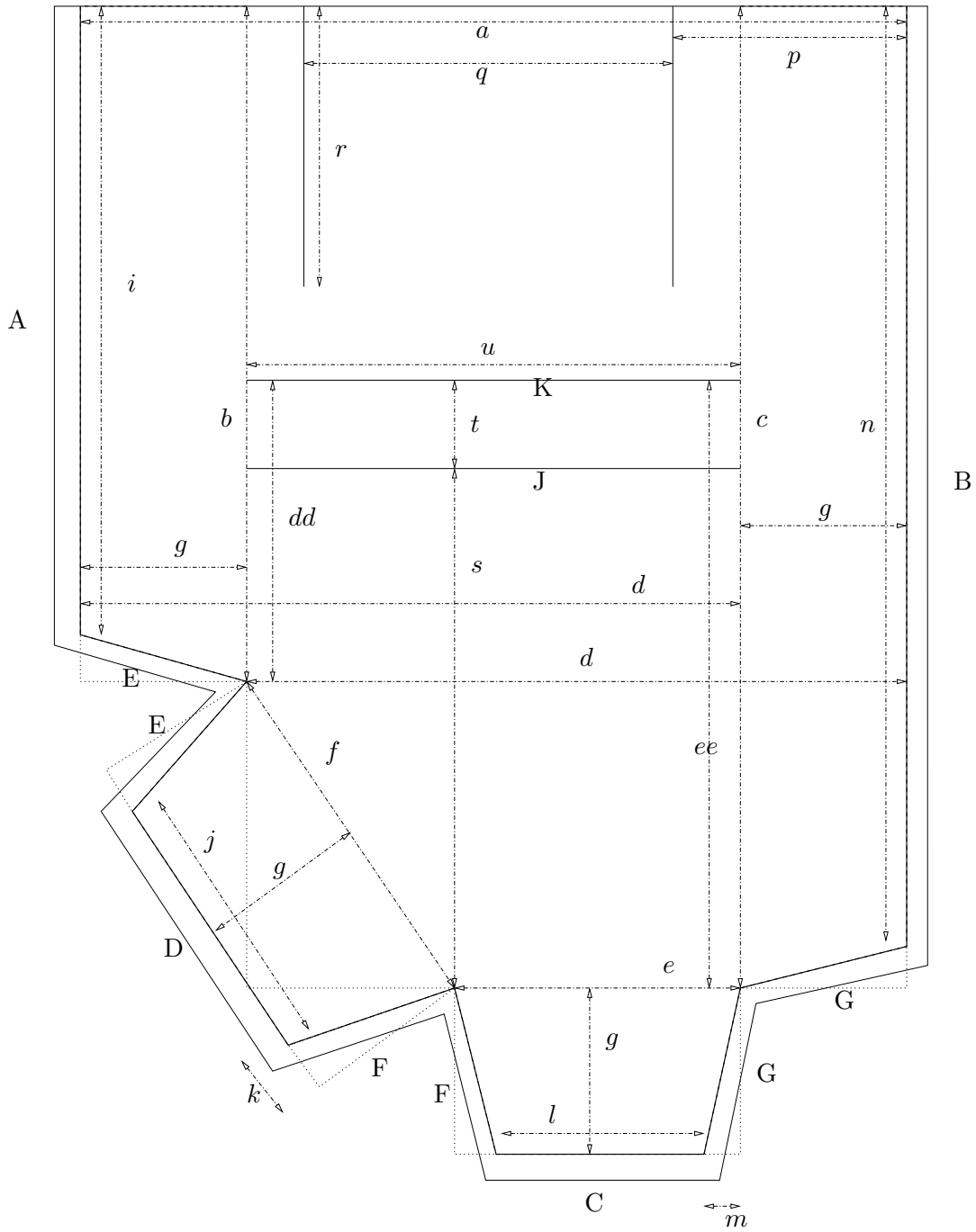

Figure 2: Piece 1. Cut two. Stitch lines are given in bold; cut lines are given as thinner lines one seam allowance (SA) away from stitch lines. Inner thin lines are to be marked. Measurements are given in Table 4. Drawing not to scale.

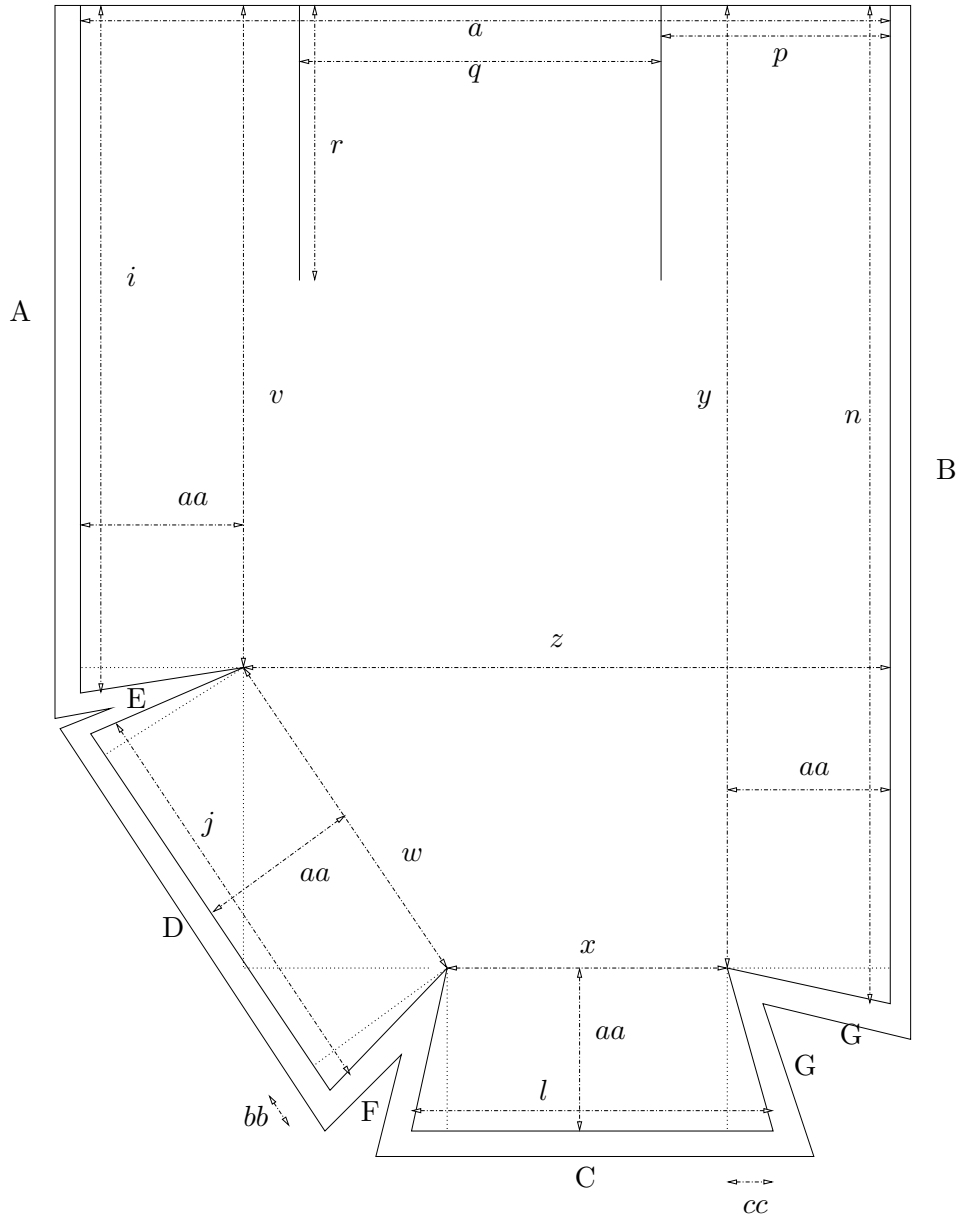

Figure 3: Piece 2. Cut two. Stitch lines are given in bold; cut lines are given as thinner lines one seam allowance (SA) away from stitch lines. Inner thin lines are to be marked. Measurements are given in Table 4. Drawing not to scale.

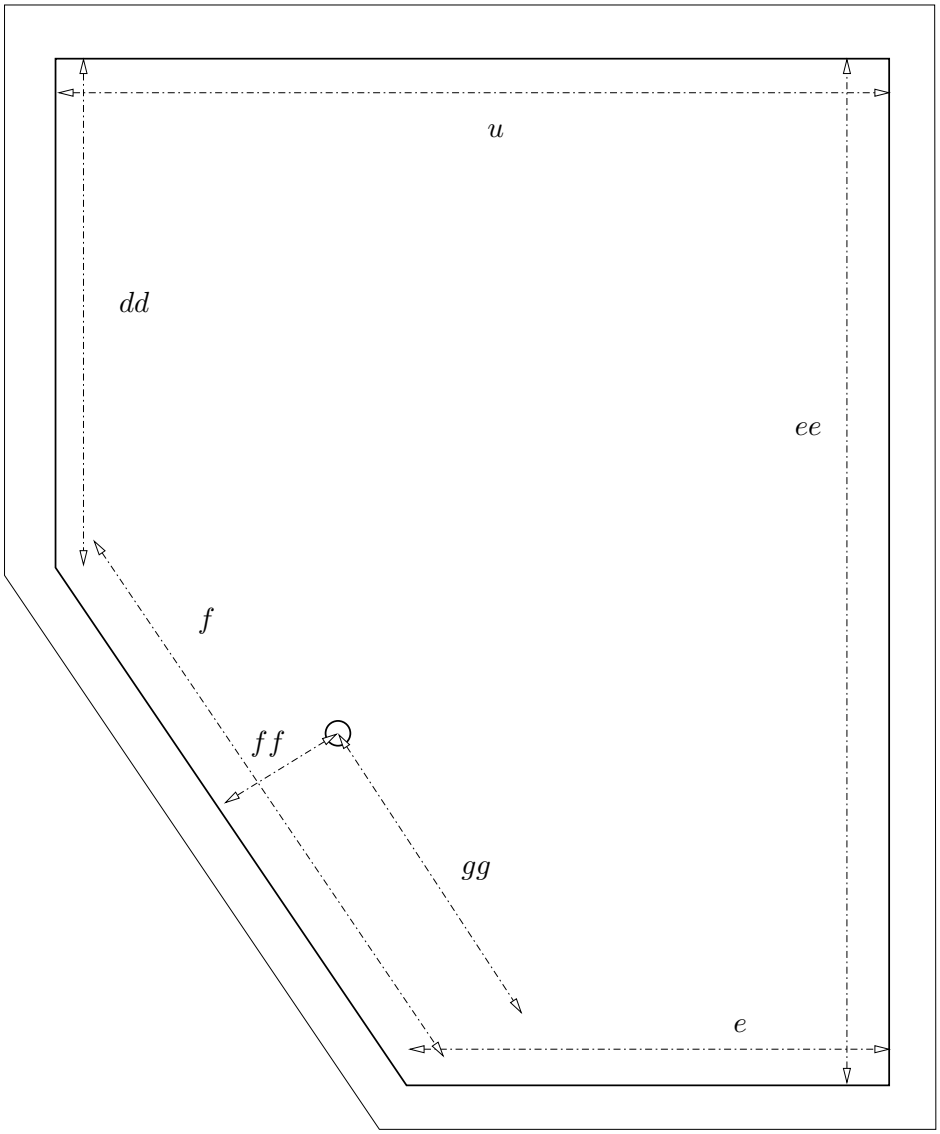

Figure 4: Piece 3. Cut two. Stitch lines are given in bold; cut lines are given as thinner lines one seam allowance (SA) away from stitch lines. Measurements are given in Table 4. Drawing not to scale.

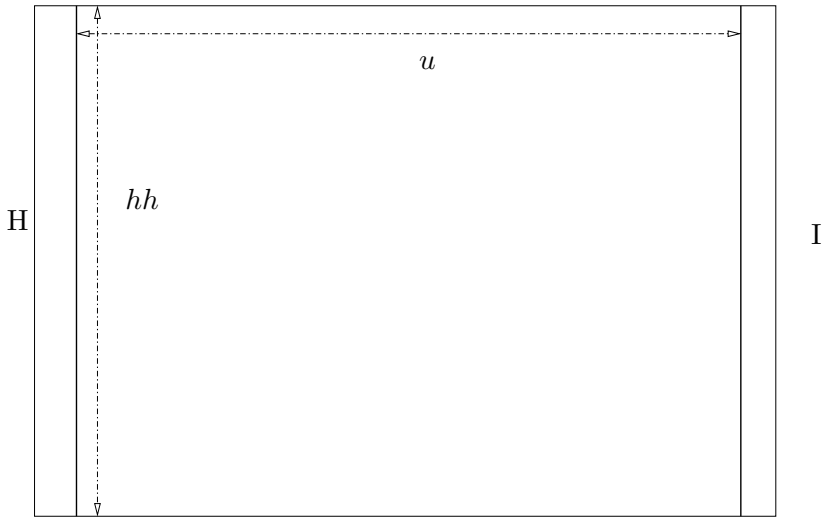

Figure 5: Piece 4. Cut two. Stitch lines are given in bold; cut lines are given as thinner lines one seam allowance (SA) away from stitch lines. Measurements are given in Table 4. Drawing not to scale.

Now attach the pieces 2 to the pieces 1. Pin edge A of a piece 1 to the appropriate edge A of a piece 2, making sure you are pinning the 'out' sides together. Then pin edge B,C,D. Repeat for the other bag. When everything looks ok, stitch together along the lines A,B,C,D. Reinforce the seam and check fraying.

You almost have a set of bags, but they look like they have slits in them, along lines E,F,G. Pin these closed in the obvious way, seam, reseam, fraycheck.

Now you should do something to check fraying along the top of the bags–this is the outside lip of your open bags. You could serge or zig-zag over the edge. Or you could fold the lip over and sew the fold in, though this would not work well with the folds (see next).

Now, what are those marked lines at the tops of the bags? Your bags will close by rolling, recall. To help close the bags before rolling, you will sew in fold lines. You've already sewn the inside folds–they coincide with the seams between pieces 1 and 2 along edges A and B. Now you will sew the outside folds along these marked lines. To do this fold the fabric along the lines, with inside to inside. Then sew on the outside along the line, approximately 1-3 mm from the edge.

Now add the webbing for closing the bags. When cutting webbing, the cut edges will fray. You can check fraying with heat. The science method of dealing with this is cutting the webbing with a hot kife. The homebrew version is running the cut edge over an open flame. Take care to do this with appropriate ventilation. Nylon parachute cord is fraychecked the same way.

On the outside of a bag, at the top, on the side facing away from the bicycle, sew approximately 25cm of webbing. On the other side, add a piece of webbing with two rings (or go for the snap closures, as mentioned above). It should look like Figure 6. Make sure you are sewing through only one layer of fabric, along the top of the bag, and between the outside fold lines. Probably there should be quite a bit of webbing attached to the top of the bags–this will help in the rolling.

You can now test closing the bags; fold the top of a bag along its fold lines. The inside folds (seams on edges A,B) should be touching. Then roll the top down, over the webbing; get about 5 rolls in there. Then lock the roll with the webbing through the rings (or use the snap closure). This should be fairly snug. I have constructed bags like this and used the rolled webbing as handles, but this does not seem to work so well for nylon packcloth–the surface is too smooth. For canvas,

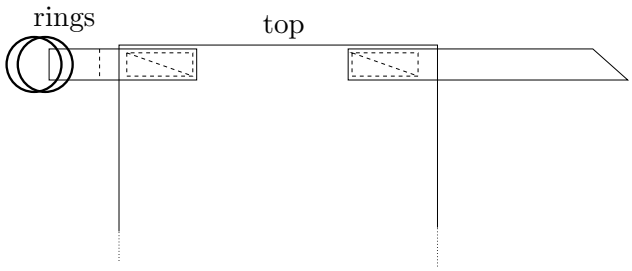

Figure 6: Detail for attaching webbing. Figure shown with bags folded along outside fold lines. Webbing shown in bold lines, back in thin lines. Sew seams like the dashed lines. You will have to fold the webbing over to get the rings (here shown as O-rings) to stay put. It is probably easier to thread rings if the opposite webbing is cut at an angle, as shown in this figure. Drawing not to scale.

it seemed to work just fine.

7.1 Making the Inserts

You now have to cut two inserts. They should be cut just like piece 3, but without the seam allowance. Moreover, you will probably have to trim the edges a bit to get them to fit into the insert pockets. You will want to cut a hole or two near or at the matching grommet holes of the pockets (the hole in piece 3). When your inserts are ready, run a doubled length of parachute cord or other rope through the hole in the insert and then through the grommet holes in your piece 3. The rope should be long enough to tie off a square knot around your seat stay or rack stay. Make sure the rope stays attached to your insert, either by using two holes in the insert, or a washer or a knot. This keeps your insert snug against your bags, snug against the seat stay.

7.2 Attaching the Bags

You are almost done. Place the bags, with inserts in, on your rack. Make sure you have them where you want them. Put a Sharpie marker through your rack holes from underneath to mark the locations of your grommets. You could do both holes at once, but it might be a better idea to mark one, add the grommet, attach that grommet through its post, then mark and add the other grommet.

When your grommets are in place, place the two screw posts in the holes in your rack. I attach these with a washer and nut, and they stay on even when the bags are not attached. I then attach the bags with a wing nut over the screws. The screws need to be long enough to accommodate this.

If you really want attachment, beyond the washer and ties, you can now hand sew on an elastic loop towards the bottom of your bags, and pull this loop over your rack hooks (most racks have some kind of catch at the bottom). I do not do this, and have not noticed any problems.

8 Gettin Fancy

There are a number of alterations and adjustments that can be made to the basic pannier design. In no particular order:

- **Weep Holes:** Very fancy. The theory is that if your bags become full of water, they will cry out of holes placed (a grommet or two will do) in the bottom of the bags; you'd cry too, if it happened to your bags. You might want to back these holes with something so that water does not splash up from the road, or small things do not fall out of the holes.

- **Reflective Tape:** Being seen might save your life. Add some reflective tape, available at most sewing supply shops, or cut large sheets of reflective backed nylon into crazy patterns and sew them on your bags. You probably want to figure out placement *before* the bags are constructed, *i.e.*, when all the fabric is layed out flat. Some reflective tape is adhesive-backed. If you sew this stuff, it will gum up your machine. If you do sew tape on, note that these seems are holes into which water may find its way. Seal the seams.

- **Zippers:** It is, admittedly, a bit of a hassle getting into and out of these bags–the rolling and unrolling of the tops can take a while. So you might like to also (or instead) add zipper access. You go ahead. Future versions of this document will include more detailed instructions on adding zippers.