

Clothing Materials:

A totally (or near-totally) subjective analysis of newer clothing materials for outdoor clothing

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Names and Fabrics: A Rose is a Rose, but Polyester isn't just Polyester!

There are zillions of fabric materials out there. For example, Malden Mills, which is the Polartec people, has only about 12-15 brand names. But each of these comes in slightly different flavors -- they actually make more than 150 different fabrics! Only some are suitable for the outdoors, and I've tried to limit the table to outdoor or travel clothing materials.

Here's just one example. Eastern Mountain Sports (EMS) sells a lot of outdoor clothing in the northeast. They had a brand name called *Bergelene* (though I haven't seen it in recent years). I'd seen mention that Bergelene was nylon, that Bergelene was polyester, that Bergelene was Malden PowerDry, and then I bought a pair of men's Bergelene briefs at the local EMS store, and the label says "CoolMax." What gives? Well, I talked with Patricia at EMS, and she told an interesting story. Back when Patagonia came out with *Capilene* treated polyester underwear (which has evolved over the years, but always continues to be a favorite), EMS came out with their own trade name for similar clothing, *Bergelene*. I'd heard it was bought from a Norwegian company that makes clothing with a somewhat similar name, but Patricia pooh-pooed this, saying it was named after a guy who worked for EMS named Berge. And, she told me, the fabric used in "Bergelene" products did indeed change over the years. The lightweight Bergelene I bought back about 2006 was indeed CoolMax. But of interest, the CoolMax that they used was knit in a way that makes it very, very stretchy, much more so than most CoolMax items. But the mid- and heavy-weight Bergelene was actually Malden's PowerDry. And, to make things more complicated still, EMS now uses the TechWick brand name, which includes something similar to silkweight Capilene: very silky, feeling somewhat like the Intera DryForce mentioned below.

Another problem is that the same material may appear under different brand names. For example, Malden Mills' favorite *Powerstretch* line of stretch fleece appears in a number of guises and brand names. The original Powerstretch is still one of my favorite fabrics -- I have a vest and sweater made of it that I wear all the time -- but Malden Mills has continued to develop the fabric in new directions. Over the years, they've made it more stretchy. They've also experimented with cutting away bits of the fleece on the inside, making the fabric lighter but still preserving the insulating and wicking properties. The early versions, some of which were called "high void grid" by Malden Mills, weren't as stretchy as the original, and a bit more itchy against the skin. Gradually they got more stretchy and less itchy. It seems as though Malden Mills and Patagonia cut a deal, because a few years ago (? 2001), Patagonia started offering this stuff, not with Malden Mills' *Powerstretch* brand name on it, but Patagonia's own *Regulator* brand name. Even though the material hadn't changed in any major way, in 2006 Patagonia decided to rebrand it as *Capilene 4*. Still great stuff, and my four zip mock turtlenecks of it are my favorite winter shirts. Note: the 2006/7 version of the Capilene 4 zip mock turtleneck was much better than previous years' versions. Not only was the material softer, less itchy and more stretchy, Patagonia has also added a "draft flap" behind the zipper; it doesn't really protect from drafts, but it *does* protect the thin skin over your sternal notch (at the base of the neck) from being abraded by the edge of the zipper pull, which was a bit of a problem with the previous versions. Still (2011) my favorite winter shirt, and I'm wearing one right now as I type this.

A further example: CoolMax. Originally made by Dupont Textiles, Dupont spun off and sold its textile business in 2003, so now CoolMax is made by the company [Invista](http://www.invista.com). Dupont said in 2002 that there were three different types of "CoolMax": "CoolMax Everyday" and "CoolMax Active" and "CoolMax Extreme." It seemed to me that the CoolMax variants "CoolMax Everyday" and "CoolMax Active" had less wicking, but better and longer-lasting appearance. I got a "CoolMax" polo shirt from [Tilley](http://www.tilley.com) (the maker of the famous hats), and, though relatively quick-drying, it certainly doesn't absorb sweat from my skin the way other CoolMax garments do. It's got a relatively hard finish, and is a bit stiff compared to other CoolMax garments I've got. So, don't depend on simple "CoolMax" labeling to ensure you are getting something suitable for the outdoors. When I revisited the [CoolMax website](http://www.coolmax.com) in 2011, Invista listed a grand total of NINE fabrics that bear the CoolMax moniker:

- COOLMAX EVERYDAY fabric
- COOLMAX EXTREME performance fabric
- COOLMAX EcoMade fiber and fabric
- COOLMAX freshFX fabric

- COOLMAX All Season fabric
- COOLMAX ACTIVE fabric
- COOLMAX UPF fabric
- COOLMAX XtraLife fabric for legwear
- COOLMAX fabric for wool

I guess the bottom line is to not take clothing material trademarks too seriously after they've been around a while. Just like cold medicines, (think Advil or Aleve) once a name becomes popular they get applied to all sorts of things that have only a sketchy relationship with the original.

One more note about words: the term "technical," as used by many manufacturers to describe their clothing, is meaningless noise: ignore it. Most marketing-speak is meaningless, but "technical" actually gets into the negative numbers. Originally it meant something that had good abrasion resistance for rock climbing, but marketing types used it for jackets with lots of pockets, patches and epaulettes and killed its original meaning.

A Pile of Fleece

Karl Ziegler and Giulio Natta were awarded the Nobel Prize for Chemistry in 1963 for the polymer process, resulting in textiles such as polypropylene and polyester. In the 1970s, [Helly-Hansen](#) invented (and still sells) pile: a knitted base with fibers sticking up, sort of an artificial fur, known by the trade name Lifa. The early versions matted down after a while, but this wasn't as much a problem with the later versions. I still have an early HH pile jacket in the basement that was one of my first artificial-fiber garments. Fuzzy jackets such as Patagonia sells ("Retro-X Fleece") are basically the same as that early Helly-Hansen Lifa pile, though with finer and denser fibers. Pile transports moisture quite well, but pile has basically no wind resistance at all. Helly-Hansen pile is still used widely in the maritime environment.

Fleece is like pile, but with two fuzzy faces, and has mostly replaced older styles of pile. Malden Mills makes most of this although it is marketed under a variety of names. Malden called their earliest efforts (~1981) Polarfleece, and Patagonia also sold it as Synchilla. In 1991, Malden Mills introduced the original Polartec 100 and 200 and 300, which were three increasing thicknesses of fleece, slightly stretchy, very soft and comfortable, and like pile, virtually no wind resistance. They are now known as "Polartec Classic." There was an early version with a wind-resistant layer between the two faces of the pile, called Polartec 1000, but I never even heard of it being made into a commercial garment; later versions became known as WindBloc, and then Wind Pro. I was initially skeptical of the idea: putting a wind-resistant layer in the middle, so that the outer layer of fleece is useless when the wind blows? And, the earlier versions didn't breathe that well. But my REI Wind Pro fleece has just the right balance of breathability (as good as regular fleece, perhaps due to the panels of Powerstretch incorporated into the jacket) and wind resistance (mild to moderate, but notably better than plain fleece).

In 1994, Malden came out with Powerstretch and Power Dry, two of my most favorite fabrics, which are discussed elsewhere.

Malden Mill claims to have started the softshell movement in 1998 with their PowerShield, but I think the prize goes to Schoeller of Switzerland for their Dryskin, that was featured in the original CloudVeil Serendipity Jacket. I have one of those that I have used for many years primarily as an outer shell in the winter, so much so that it's pretty worn out. More recently I've started using a windshell of Gossamera in the winter, but not sure how durable it'll be compared with that basically indestructible Schoeller material. On the other hand, my Gossamera windshell weighs and bulks a tenth as much...

In 1999, Malden started selling Polartec Thermal Pro, and then in 2000 die-cut versions marketed as Regulator ("R") by Patagonia. These were in a way a step back to pile: the material had a woven outer layer and a fuzzy inner layer. But the inner fuzz was shaved into a grid of little squares to lessen weight but still allow wicking and warmth. The early versions didn't work all that well and weren't very stretchy, but later versions improved quite a bit: softer, more stretchy, closer grids so less itchy. Along about this time, Malden also started using hollow fibers to lessen weight.

Polartec is Malden Mill's trademark, and almost every fabric they make is preceded with "Polartec" so it's not a very useful name, is it? Their website even says *Polartec manufactures over 300 different fabrics under the brand Polartec*. There are many, many types of Polartec; they do have a variety other trade names added to the Polartec moniker, but even within each of the sub-tradenames (e.g., Malden Polartec Thermal Pro) there are many different fabrics.

Pile, Fleece, Baselayer

Wicking baselayer and fleece polyester material have improved in recent years. If you read the manufacturer's fluff, there are hundreds of different kinds of treated polyester, each better than the others. But cutting through the marketese, you can see several major changes, which seem to apply regardless of brand name.

1. **Smell:** most fabrics now have a coating that discourages the bacterial growth that makes clothing smell bad. (Too bad we can't spray this on ourselves before we go out for a week in the mountains.)

2. **Wicking Persistence:** Used to be that polyester lost its wicking after a certain number of washings. The number of washings is now very much higher than it used to be. There are proprietary names for the different treatments (e.g., NanoTex, Acclimate) but they all basically do the same thing. Some are better than others, but there's very little hard data, so you're better off going with brand-name wicking material, specifically from major mountaineering clothing companies.
3. **Stretch:** Most polyester now is knit in a manner to allow it to be relatively stretchy, and sometimes Lycra or other stretch fibers are added to make the material even more stretchy. What is stretchy "enough"? Stretchy enough that you can push the sleeves of a long-sleeve top above your elbow, and it (A) won't compress your arm so much as to hurt after a long day of climbing, and (B) when you pull it back down, it'll recover enough to fit properly at your wrist. Malden PowerStretch meets this requirement, as does the thin 2004 Malden PowerDry used in the Patagonia R.5 fabric. (Doing a quick stretch-test, I found that PowerStretch stretches 1.5x its original length; by comparison, Malden WindPro only stretches 1.25x, and doesn't quite meet this test.) The 2001-2002 thicker Malden PowerDry isn't quite stretchy enough to meet this criteria, though the thinner PowerDry of this vintage does. With a skin-tight Powerstretch union suit (used under coveralls for caving) I can contort into any position and it doesn't bind.
4. **Bumps and Holes:** Many companies now offer fabrics of fleece, or sometimes very thin fleece that works as a thin baselayer, which allows the material to preserve much of its warmth but make it a lot lighter. Early examples of this include revisions of Aleutian fleece from Lowe, Polartec 100 Lattice, and the Patagonia R1 and R.5 ("Regulator"; though the R.5 is now known as Capilene 4, see above) fabrics. I think this is a mixed blessing – the lumpy-bumpy fabrics don't feel quite as nice against the skin as something smoother, and since there is less contact with your skin, I'd expected the material to be not quite as good at sucking sweat off your skin. Patagonia came out with R.5/Capilene 4 with smaller bumps (2003), and made it stretchier (2004), and so I got two Patagonia R.5 men's zipneck tops (2005 vintage) which are stretchy enough that I can wear a size small (usually I wear a medium) and they fit pretty well – stretchy enough that they don't bind. This material is very, very light, wicks very well, better than I expected, and is mildly itchy compared with, say, the original thin Malden Powerdry, which is as comfortable as a well-used cotton T-shirt (my Cloudveil Teewinot short-sleeve T-shirts of the original Powerdry circa 2000 are my favorite everyday three-season shirts). Capilene 4 wicks about as well or maybe a little bit better than the original Malden Powerdry, despite the lumps. And at the tail-end of 2006, I got two more of these – a bit stretchier, a bit less itchy, a bit softer on the inside, a bit better wicking, and now each has a tiny breast pocket. And stretchy enough to pass the "push up over your elbow" test. More recently, REI has started offering garments made of the same type of material; soft and stretchy, relatively cheap, though the tailoring isn't quite up to Patagonia standards. Recommended.

The old original PolyPro baselayer had disadvantages: it melted in the dryer or in front of a fire, smelled bad, and after a while was nothing but a mass of pills (those little wads of fuzz that form on the surface of some fabrics). Things have improved a lot since then, but there are still some companies marketing substandard baselayer materials. A few years ago, Cheng Hu emailed me that he tried Medalist Skinetics and didn't find it wicked very well. You're generally better off with a well-known brand name – you're more likely to get better pill-resistance, odor-resistance, and wicking.

Back in the days before modern high-tech fabrics, we used fishnet T-shirts. Originally, these were actual bits of old fishnets sewn into T-shirts, and they were worn under other clothing to provide some airspace for ventilation, to keep you less sweaty. In the summer you wore cotton fishnets, and in the winter, wool. I used to use these all the time. For a while you could get very thin fishnet CoolMax T-shirts (I got mine from [Brigade Quartermasters](#)), but they don't carry them anymore. Too bad – they were great when I responded with a disaster team to the Gulfcoast during and right after Hurricane Katrina in fall 2005. We were supposed to wear cotton T-shirts as part of our uniforms, and it was very, very hot and humid. Wearing a CoolMax fishnet under the T-shirt didn't make me significantly hotter, and wicked even better than the T-shirt, particularly as it had "DMAT PA-1" in big, waterproof and vapor impermeable letters on the back. I could then wash the CoolMax fishnet, wring it out, and put it back on under the same T-shirt, making me feel a lot cleaner. And, when I travel long distances, I always put on one of these CoolMax fishnets on under a nylon shirt. Even when stuck in an airplane for 12 hours, you can go to the head, wash the fishnet, wring it out, dry it a bit with a few paper towels, and put it back on – you feel a *lot* less greasy this way. Searching the Web for "CoolMax mesh t-shirt" I did find <http://www.pinnaclearmor.com/body-armor/accessories.php> which offers mesh (or fishnet to us oldtimers) CoolMax T-shirts. I also found some sales on Calvin Klein Lycra-CoolMax mesh T-shirts. Caveat emptor.

A similar concept is Coomax RVU (ribbed, ventilated underwear) designed for use under armor – you can get this for example at <http://www.rvuultracool.com/rvu.html>. But I've tried it, and it's a lot like wearing a flak vest in itself – the ribs don't really bend at all. I would only consider this as an alternative if you spend a lot of time in a bulletproof vest. However, that same website also lists what looks like my old CoolMax mesh t-shirts – only you can't buy them online, and there are only a few retailers across the country. When I searched the Web to try to find them online, I found a lot of technical (there's that word again) baby suits but no shirts.

Wicking vs. Bipolar Construction

There is no argument that, in cold/wet conditions, one wants something against the skin that is warm when wet. And one wants something that doesn't hold water against the skin. The traditional material was fine [wool](#) – reasonably warm when wet, doesn't hold much water against the skin, lasts a long time, and if made from high-quality wool (cashmere, north coast Australian wool like the old Sears wool underwear), not all *that* itchy. (Actually, I used to go caving in the Sears underwear all the time.)

But wool, unless you got the really good stuff, was itchy. And when wet you smelled like a wet sheep. And though it was much, much better than cotton, it still held a significant amount of water against the skin – wet wool is still heavy and cold when you put it on. But compared to cotton, the water would drain out the bottom of the wool underwear a lot quicker.

Well, next was [PolyPro](#) underwear. Polypropylene was used because it was very hydrophobic (“water-hating”) -- compared to wool, it wouldn’t hold hardly any water at all, and by staying drier it was warmer (and lighter) when wet. And, since it was made into a loose weave, it was pretty porous, so sweat could pass through fairly easily. But polypro absorbed body odor, “pilled” (developed lots of little fuzzy balls on its surface), and melted in the drier or near a fire, resulting in an ugly, smelly lump of melted plastic. So [polyester](#), with less pilling, and better heat resistance, replaced polypro.

But even polyester didn’t really feel all that comfortable against the skin in warm weather compared to dry cotton. Why? Well, cotton fibers, unlike polyester fibers, are made up of many, many smaller microfibers, which makes it softer against the skin, and allows it to drape a bit better. Cotton’s microfiber construction, along with its hydrophilic (“water-loving”), means that it *wicks* water away from the skin -- that is, until the cotton is soaked through and through. When soaked, cotton holds water near the skin, and allows it to circulate from the skin to the surface of the cotton and back again, making a pretty good heat pump. Good in warm weather, bad in cold weather.

So people thought “Can’t we find something that is as comfortable as cotton in warm weather AND in cold weather? And is comfortable even when soaked?” One way is to make polyester fibers made up of tiny microfibers, just like cotton -- this should make it more comfortable against the skin, drape better, and look better, but with polyester’s hydrophilic nature, it shouldn’t hold as much water or act like a heat pump. Indeed, as I type this, I’m wearing a pair of [polyester microfiber](#) dress pants at work, and they’re extremely comfortable against the skin. Nice stuff. You can also “brush” materials made out of microfibers so that they are all fuzzy on one side, and wear that against your skin. The older (pre 2004?) Malden Powerdry is a great example of this kind of construction (and the most comfortable stuff against the skin I’ve ever worn, it’s even better than cotton).

But there was still the problem of sweat. Even though polyester knits could pass sweat, they still weren’t as good as dry cotton at sucking up sweat. So what can we do? If we make material as hydrophilic as cotton, and with as small of a microfiber size, it’ll end up acting just like cotton. It turns out that you can coat polyester fibers with a variety of materials, you can make the surface hydrophilic enough to wick water -- but since the fibers aren’t as small or as hydrophilic as cotton, it still won’t hold much water.

But, compared with cotton, this wicking effect isn’t great, so what else can we do? Well, some clever people realized that if you combine two different types of fibers, in just the right yarn and with just the right construction, you can put a hydrophilic material on the outside and hydrophobic on the inside. The first such fabric I saw was called DriClime, and I was impressed. The outdoor store had a swatch, and the owner wadded it up, put it in a cup of water, and then wrung it out. He handed it to me, and I could feel that one side was wet and cold, and the other side felt warm and dry. I’ve had a Marmot Shelled DriClime windshirt since then and been very happy with it. Some prominent versions are Malden [Powerdry](#) and [Powerstretch](#), Paramo [Parameta-S](#) and Intera [DryForce](#).

Some companies insist that artificial fibers don’t wick at all, moisture just passes through them via vapor diffusion and bipolar fabrics are the only thing that seem to move moisture away from your skin. Well, we know that cotton wicks – you can demonstrate this by taking a cotton towel, and hanging it up so that one end is in a bucket of water. Half an hour later a lot of the water will be drawn up into the towel, and it will be soggy. You can do the same thing with artificial “wicking” fibers, too – there is little moisture in them after the bucket experiment, but enough to show that there is indeed wicking. Certainly polyester microfiber seems to do this more than other artificial fibers with which I’ve tried this, perhaps due to the enhanced wicking of the microfibers, and the best I’ve seen so far for wicking is Malden [Powerdry](#), although [Powerstretch](#) comes close, mostly because you can buy it small and wear it so it’s tight against your skin (improves wicking a lot). Powerdry seems best as a summer T-shirt or as a base layer in colder weather.

Two days before version 1.7 of this document, I was hiking fast on a warm day, relatively level trail, with a heavy pack (20 lbs. gear + 30 lbs. of 2-year-old) and was wearing a [Powerdry](#) shirt. Admittedly it was a fairly dry day for the Appalachians, but even though my entire shirt would get soaked in sweat going uphill – showing it spread out the sweat quite well – a 15’ rest stop would find it almost entirely dry at the end.

So don’t believe that artificial fibers don’t wick. As far as the relative contribution of wicking vs. bipolar construction for moving water away from your body, though, the jury is still out. One thing I’ve found is that wicking layers only work if they’re right up against your skin. So stretch materials are important, another reason to like Malden [Powerdry](#) or [Powerstretch](#). (No, I don’t own stock in Malden Mills or work for them!)

Malden WindPro is stretchy, too – but unlike Powerstretch, which stretches 1.5x, WindPro only stretches 1.25x. The difference is enough that REI, when making jackets out of WindPro, uses small inserts of Powerstretch under the armpits and on the shoulders to improve stretch.

I’ve gotten a top of Intera [DryForce](#) from Cloudveil (April 2003). Think “thin bicycle jersey” and you get an idea of what this material is like. It’s constructed like Powerstretch, in that it is fuzzy on the inside and less fuzzy on the outside. But DryForce is **very** slick on the outside, so clothing will go over it easily. However, it really doesn’t stretch as well as Powerstretch, so it’s not as comfortable. And the outside, while slick, doesn’t seem all that tough, certainly not shell-like. DryForce seems a bit like Schoeller Dynamic, and is about the same thickness, and is considerably more stretchy, but not nearly as tough on the outside. It wicks very well, about as good as I’ve ever

experienced, similar to DryClime. But overall, I think I like T-shirts of Malden PowerDry better as a base layer. Powerdry is more stretchy, more porous, and overall more comfortable.

One development along this line is the idea espoused by the European company [Paramo](#) in the Parameta-S fiber garments that they market. These are reversible bipolar garments, wear one way for hot weather and inside out for cold weather. Interesting idea! However, this material isn't really stretchy, so it loses out to Malden Mills' otherwise-similar [Powerstretch](#) fabric in my book.

In 2003, the big news was adding special coatings to fabrics to improve wicking and water resistance; for example, [Schoeller](#) added a "3xdry" coating to its Dryskin Extreme, found for example in the classic softshell [Cloudveil](#) Serendipity jacket, the first true softshell jacket.

One question that sometimes arises: if cotton wicks, and artificial fibers wick, what's the difference? Why is cotton so bad? Mountain Rescue Association teams are famous for teaching that "cotton kills."

Seems to me there are two parts to this. First, though cotton *wicks*, it's also *absorbent*. That means it sucks up lots of water and holds onto it. In a towel, at home where it will have plenty of time to dry, that's good. But if you're out in cold weather, and not interested in having a lot of cold water held right against your skin, then it's bad. Artificial fibers wick but don't hold much water. That's why those "pack towels" of polyester microfiber, no matter how good they are, will never beat a good cotton towel for sucking up water.

There is also another effect that makes cotton bad in cold, wet weather: loss of insulating value. Wet cotton allows water to circulate, and it's just like a little heat pump sucking the heat from your skin and sending it to the outside of the cotton garment to radiate away. Good in summer, bad in cold-wet conditions.

Fabric by the Yard, Fabric by the Number

Although you won't find it on the informational pages at www.polartec.com (Malden Mills' site), they have started numbering their fabrics. A phrase from their website (copied and pasted here) says *Polartec Thermal Pro is our most diverse family of fabrics*. So don't think that "Polartec Thermal Pro" means a specific fabric!

[Lowe Alpine](#) used to make garments using a variety of Malden Mills (and other) fabrics, though when I visited their website in 2011, they only seemed to be making packs, hats and gloves. Some of the fleece jointly designed by Malden Mills and Lowe was called Aleutian (some may be from other suppliers, Aleutian is just Lowe's trade name) and there were several varieties, mostly lumpy-bumpy type things that are similar to the R1 and R.5 fabrics used by Patagonia. Lowe's webmaster was nice enough to include the numbers of the fabrics on the [glossary page](#) of their website, which, if others did the same thing, would be a great way to make sure the fabric you're buying is (more or less) what you've bought in the past.

- **Polartec Special Edition with Power Dry Technology (7347)**
Technical inner layer insulation. Innovative 'pillar' interior traps warm air, improves breathability, reduces weight and increases packability. PowerDry wicking performance allows next-to-skin use or as an intermediate layer.
- **Polartec Special Edition with Thermal Pro Technology (4060)**
Versatile mid-layer insulation. The deep pile face is open-stitched to the interior velour, giving a high-loft fabric with low density. Maximum warmth with excellent airflow, low weight and packability. Top warmth-to-weight ratio.
- **Polartec Special Edition with Thermal Pro Technology (40810)**
The fleece that thinks it's down insulation. The deep pile face is open-stitched to the interior velour, giving a high-loft fabric with low density. Maximum warmth with excellent airflow, low weight and packability. Standard and marled versions.

There was also a "Special Edition" version of Powerstretch: **Special Edition Powerstretch (9400)**, see below. If you find this all very confusing, don't worry, the fact that you're confused is clear evidence that you know more than most people, who don't yet know enough to be confused!

Windproofness

One of the trends over the past few years is for new materials that have the warmth of fleece but with improved resistance to wind (traditional fleece has basically no wind resistance). Here are some figures that Katherine at Malden Mills emailed to me in February 2002 as far as wind resistance of newer Malden Mills Polartec fabrics. Wind resistance is cubic feet per square foot per minute (Ft³/ft²/min)

Polartec Windbloc	0
Polartec Power Shield	6.42
Polartec Windbloc ACT	15
Polartec Wind Pro	65
Polartec 200	325

I find this very useful information, because the marketing information really doesn't give you much quantitative information about wind resistance. The way I read the figures:

- **Windbloc** (and the Gore equivalent, WindStopper) basically stop all wind but don't ventilate moisture all that well; Windbloc isn't very stretchy.
- **Wind Pro** is about as stretchy as old-style fleece – i.e., it doesn't quite meet the “push above the elbow” test mentioned above. So Wind Pro is just fleece that's a bit better against wind, without losing too much vapor permeability or softness.
- **Power Shield** makes a pretty good (though heavy) wind shell. BTW, both North Face and [Mountain Equipment Coop](#) offer garments made of Power Shield.

I have a 2005-era [REL](#) jacket that's mostly WindPro, and with panels of Powerstretch here and there for better stretch. Although I always have reservations about garments made from two different materials, this jacket has become my favorite fleece – I wear it all the time.

Waterproof-Breathable: GoreTex et al.

The original Gore-Tex fabric was a true revolution in outdoor fabrics. By allowing water vapor to pass (at least when dry), yet preventing liquid water from penetrating, this fabric was a wonderful replacement for the other fabrics us outdoor people used prior to Gore-Tex. Before Gore-Tex, we had Ventile, which was a special, long-staple Egyptian cotton, the fibers all being very tightly wound. When wet, the fibers swelled, becoming (mostly) waterproof, although when wet and frozen, it was like cast iron (not great for climbing). 60/40 cloth, which mixed polyester fibers with the long-fiber cotton for better durability and flexibility when frozen, was “the thing” for a while – my wife and I still have our original “sixty-forties” – I use mine as a durable jacket for working on my truck. I think I threw my ventile anorak away years ago (it had holes in it, ventile wasn't that durable).

Gore-Tex is a tradename for something known generically as “expanded polytetrafluoroethylene” or PTFE for short – basically Teflon plastic that had been “expanded” in a proprietary manner to make zillions of tiny pores, small enough to prevent liquid water from penetrating, yet small enough for water vapor to get through. How so? Well, when water is liquid, it's not just individual molecules of H₂O, it's actually a clump of H₂O molecules bound together with hydrogen bonds, so the clumps are pretty big. But as water vapor, H₂O exists as individual molecules, i.e., much smaller.

Gore-Tex I (“one”) worked, mostly, but broke down quickly. I was lucky enough to have an early North Face pullover made from Gore-Tex I, which was nice, but the waterproofness only lasted about a year. However, Gore had a money-back lifetime guarantee, so I ended up with a free brand new pullover (which still hangs in my closet) made of Gore-Tex II, which was much more sturdy. Gore-Tex I and II, however, really didn't breathe all that well, and none of these fabrics breathe at all when they're wet. And so, especially for those like me who sweat a lot, pit zips (underarm zippers) are essential. I've even added pit zips to some of my old Gore-Tex jackets.

Today there are dozens of waterproof and breathable fabrics, including Pertex, Cloudveil Dermizax, Bibler ToddTex, Marmot MemBrain and PreCip, Patagonia H₂No, Mountain Hardwear Conduit, Sympatex, eVENT, Hydroflex, Ultrex, Omni-Tech, H₂No Storm HB, Nikwax Analogy, Cloudburst, HyVent, Triple Point Ceramic, Aquafoil, Hydro/dry P2 and Hydro/dry P3, Aqua Dry and Aqua Dry Pro, and Aqua Foil, just to mention a few. All of these (including current Gore-Tex) are better than Gore-Tex I, and as far as which is best, I doubt that anyone, anywhere, can really give you a good answer. Some are more breathable than the original Gore-Tex, some both more breathable and more waterproof, and all pretty much more durable. Sympatex is pretty much just for shoes, as it's very durable but not very flexible. Gore-Tex XCR (“extended comfort range”) is about as waterproof as Gore-Tex II but much more breathable – but I still say that Gore-Tex XCR jackets need pit zips. There is also a GoreTex PaCLite that is very thin, and used in ultralight equipment, but I have a Patagonia Specter Pullover (ultralight at 6.5 ounces) of their H₂No PTFE laminate which seems similar to PaCLite; the 2006 version of this ultralight waterproof jacket has an innovation, which is welded rather than sewn seams, decreasing weight even further and eliminating the ridges of sewn seams that are targets for rips and abrasion. I later got a NorthFace Triumph jacket that was similar, even to the welded seams, but even lighter – since Patagonia didn't make a similar jacket when I wanted a bigger one.

Pertex seems to be singled out as being very light and breathable. I have a couple of European style bivouac sacs made of Pertex. These sacs are basically a tiny tent without any provision for stakes or poles – you pull it over yourself and others when hit by a storm. Also handy to have a dry lunch in a downpour. I have one for two people, and one that fits four. The four-person is big enough for two people and packs eating lunch. The two-person was big enough for me and my five-year old daughter and our packs while eating lunch, but she was in my lap most of the time.

[Gore-Tex](#) (W.L. Gore) has Gore-Tex Windstopper N2S (“next to skin”) which is a wicking layer directly bonded to Gore-Tex XCR. This makes a nice pair of thin gloves, and I like the pair I have. However, I *hate* the feel of the original Windstopper (it is the feel-equivalent of the fingernails-on-a-blackboard sound).

Waterproofness can be measured precisely. The European standard for “waterproof” is that the material will not pass water if you pile 1,500 mm of water on top of it – a column of water 1.5 meters high. But this isn't quite waterproof enough if you figure you don't want water to seep through under your packstraps, where the pressure may easily exceed this. It's generally accepted that outdoor clothing needs to have a rating of 10,000 mm (10 meters). Classic GoreTex II has a rating of 28,000, though this decreases with age and with

contamination with body oils (which, however, can be counteracted with proper washing agents, such as those offered by [NikWax](#)). GoreTex XCR is rated at 45,000 mm.

Breathability can also be measured. A standard rating is grams of water vapor passed by a square metre of fabric in 24 hours ($\text{gm}/\text{m}^2/24\text{h}$); a standard minimum for outdoor clothing is $10,000\text{gm}/\text{m}^2/24\text{h}$, but this is clearly not enough for me, which is why I put pit zips in most of my parkas. W.L. Gore rates their fabrics in RET units, smaller being better. You can see how GoreTex has improved over the years:

- Classic GoreTex II: Waterproof 28,000 mm (>40 PSI), RET <90
- GoreTex XCR 2-layer: Waterproof 28,000 mm (>40 PSI), RET <45
- GoreTex XCR 3-layer: Waterproof 45,000 mm (>40 PSI), RET <60
- GoreTex PaLite: Waterproof ? mm (>40 PSI), RET <60 (<40 for most garments)

Unfortunately, it's hard if not impossible to get these numbers for competing fabrics. I do have some for Mountain Hardwear's Conduit line, and Marmot's MemBrain and PreCip:

- Conduit 3-layer: Waterproof 15,000 mm, RET <90
- Conduit 2-layer: Waterproof 12,000 mm, RET <95
- Conduit Silk: Waterproof 15,000 mm, RET <120
- MemBrain 2-layer: Waterproof ? mm (25,000 $\text{gr}/\text{m}/24$ hours), RET <50
- MemBrain 3-layer: Waterproof ? mm (20,000 $\text{gr}/\text{m}/24$ hours), RET <60
- PreCip: Waterproof 15,000 mm (~25 PSI), RET <70
- PreCip Plus: Waterproof 25,000 mm (~40 PSI), RET <60

You will likely see more and more of these figures as manufacturers start to compete on their numbers.

Of interest, the membrane used in Marmot MemBrain is the same as that used in Cloudveil and others' Dermizax clothing. This material is claimed to become more vapor-permeable as it gets warmer. However, after testing, the US Army concluded that *Shape Memory Polymer films show no special increase in permeability as compared to other waterproof breathable materials. The SMP [Shape Memory Polymers] laminates are comparable to standard Gore-Tex, so they are fairly functional in terms of being "breathable", but they don't have any unique behavior with regard to permeability at different temperatures.*

Phil Gibson, of the Materials Science Team at the U.S. Army Soldier Systems Center in Natick, MA has performed a number of tests on commercially available fabrics. A PDF with some of the results has been posted by Mark Verber at www.verber.com/mark/outdoors/gear/breathability.pdf.

Though the Army does a lot of testing of clothing materials, they often have to promise the companies not release the test results – so if you hear something unofficially from someone who knows someone in the Army test labs, what they say is probably true.

Some scholarly papers on the science of GoreTex and similar materials may be found at:

www.emeraldinsight.com/Insight/ViewContentServlet?Filename=Published/EmeraldFullTextArticle/Pdf/0580150306.pdf

jit.sagepub.com/cgi/content/abstract/32/3/165

jit.sagepub.com/cgi/content/abstract/34/4/223

Softshell

Of interest in the table referenced above is the great breathability of Schoeller Dryskin, which is probably why I like my Cloudveil Serendipity jacket and Symmetry pants so much (I basically live in the Symmetry pants all winter). I would add that you should use the NikWax SoftShellProof DWR treatment on a regular basis on Dryskin to keep it as water-resistant as possible. While Dryskin is not waterproof enough to be your sole rain jacket, you can carry a lightweight GoreTex or similar shell to put on over it in really rainy weather – you'll find that you don't need this outer shell that much, so even if it's not that abrasion resistant, it doesn't get used that much anyway.

Cloudveil also, in 2005, came out with Inertia Plus, which was a very thin, stretch, shell fabric like a thinner version of Dryskin. In my informal tests, it stretches about 1.15%, so not nearly as much as PowerStretch, but more than some other fabrics that claim to be stretchy. It has a soft outer finish, unlike Schoeller's Dynamic or Cloudveil's DryForce. As far as I can tell, it was more breathable than DrySkin, just as durable, significantly less windproof and waterproof, about as stretchy if not a bit more, about as wicking, actually a "hand," but less than half the thickness and half the weight. That means it's not as warm, I supposed, but it seemed like great softshell material. Some people wear garments of this Inertia as a shirt. I've got a medium-size Cloudveil hooded Prospector jacket that makes a

very nice softshell jacket (the only problem is that they designed it without a hood drawstring – I ended up adding one myself – it now lives in my bike panniers.) I also have a size small non-hooded jacket that works as a 3-season shirt/jacket – very nice – and a pair of shorts and pants in the same material which are now my favorite summertime pants and shorts.

But when I ordered some more pants and shorts in the spring of 2007, I found that Cloudveil had changed the cloth – Inertia Plus is now about twice the thickness and twice the weight. It's now more than half the weight and thickness of Schoeller's Dryskin. In fact, after rolling up and comparing shorts, I found that the old Inertia Plus pants weighed 6 ounces, and the new Inertia Plus shorts weighed 10 ounces. The finish on the new Inertia Plus is quite a bit harder; the old Inertia Plus was very light and supple, and the new Inertia Plus is quite a bit harder and less supple. The outside of the material is like a hard-finished cotton twill; a bit like new, tight cotton denim. Initially, I wasn't too pleased with it. But after a bit, it's been growing on me. I think it's softening a bit, and indeed it provides significantly better protection for elbows and knees. But I still miss the original Inertia Plus; for super-lightweight summer wear that provides wicking, and just a bit of protection, it was great. I've been wearing these shorts and pants of the thicker Inertia Plus all the time since they first came out, and except for a few minor thorn-pulls, they look like new.

I did find that my Prospector jackets of the pre-2007 Inertia Plus were pretty good for wind, but in a thunderstorm with big droplets, the droplets just forced themselves through the weave – not very rain-resistant at all. The 2007 Inertia Plus fares a bit better in a storm.

In about 2006, North Face started using a fabric similar to Cloudveil's Inertia; it's called Apex. It seems quite popular.

NikWax

Many of my European mountain rescue friends swear by [NikWax](#). Now NikWax is a company that makes lots of different things, including a big line of detergents and treatments for clothing. If you go to any REI store, you'll find a whole display of NikWax products, including stuff for washing down, for replacing the DWR treatment (durable water-resistant) for softshell garments (which works quite well – I've used it on my older softshell garments), etc.

But what the Europeans swear by (and I've told myself over and over I'm going to try) are garments specifically made of materials that are waterproofed by a special NikWax wax treatment. Those who hang out in the wet cold of northern England, Wales, Ireland and Scotland ("where we have a wee problem with horizontal precipitation" as my Scottish climbing guide friend Eric Pirie puts it) swear by the stuff. Some are very much into good GoreTex, and indeed my Marmot Cairngorm hardshell GoreTex parka, designed by Marmot in coordination with the climbing guides at Glenmore Lodge, is one of my prize possessions. (It was my big Christmas present from my wife a few years ago.) But a sizable fraction use the NikWax garments and swear by them. William Lumb, a mountain rescue doctor from the north of England, puts it thus: after a wet, cold day-trip in the mountains, you can take off your NikWax top, leave on the NikWax bibs, and drive hours back home while still wearing them, in perfect comfort—something seldom done with GoreTex bibs. But they nonetheless keep you dry in wet, cold conditions.

Though NikWax is similar to other DWR treatments, the actual wax product, used on specific softshell materials, seems to provide a level of waterproofness and breathability similar to GoreTex. [Paramo](#) has a big line of softshell NikWax-treated "waterproofs" that are very popular in the UK and Ireland. They are available [online](#). They do require retreatment with the NikWax wax waterproofing solution every couple of years (with average use) but this can be reapplied indefinitely.

I often wonder if the marine climate of the British Isles has something to do with the clothing preferences of British and Irish outdoorspeople – it's wet and cold, but the change in temperature throughout the day is seldom much, and it's very rare to have sudden changes in temperature, unlike the more continental climates in the Alps and in many parts of the USA. British and Irish climbers also tend to do lots of day trips and not many multi-day climbs, at least proportional to what happens in the USA, and I wonder if this affects choice of clothing materials. I'd be interested in hearing anyone who uses NikWax-specific "waterproofs" in place of GoreTex in the USA.

Higher-Tech Flash-in-the-Pan: PCMs et al

People are always trying something new, from battery-operated sock heaters (forget them) to Phase-Change Materials (PCMs) such as [Outlast](#) and ComforTemp. PCMs are basically materials that absorb lots of heat when warm (like when you're struggling up the side of the mountain) and then release it when you get cold (like coming back down). Once when coming down off a snowy peak in the Cairngorms (Scotland) I had a mitten with Outlast in it on one hand and one without on the other hand. It didn't make a big difference, but it did seem a bit warmer than the other mitten. In 2011, this idea to have gone out of vogue.

In 2005, W.L. Gore also came out with Airvantage: breathable clothing you blow up to make it thicker and warmer when needed. Marmot made an *Echo Airvantage Vest* out of the stuff for \$150, and Victorinox a \$350 jacket made of the stuff. Supposedly it fluffs up to the same insulation as 200-weight fleece. But I don't know what kind of insulation it offered before you blew it up, or how much it weighed, or how durable it was. By 2011, it seems to have died a natural death.

Old is New: Wool and ThinShell

For this first update in several years (August 2011), I would like to highlight two new materials that are really old materials: wool and nylon.

Wool is in. As far as I'm concerned, wool has always been in – at least for socks. Socks that are at least partly made from wool are superior to any synthetics. True, they're smelly when wet, and take a long time to dry compared to synthetics. But unlike synthetics, they keep their spring, and avoid matting down under your foot. And the padding provided by wool under your foot is nothing to sneeze at. A good wool sock can extend by hours the time when the bottom of your feet say "no more"! But wool socks were so scratchy that people hated them. Used to be, everyone wore Ragg wool socks made of hard, scratchy wool, and thin liner socks to protect us from the scratchy Ragg socks. (Don't believe those who said it was to prevent blisters.) You can buy things called Ragg socks but they're pale, soft and wimpy imitations of the he-man Ragg socks that were available back in the 1950s and 60s.

Ah, but if your socks are made of a fine merino wool – like expensive dress socks only thicker – they aren't scratchy! It used to be that only Rohner of Switzerland made merino-wool socks. Merino wool is soft, tough, and expensive. Their socks are great – I seldom wear anything else. But the only place I can get them is remaindered at sierratradingpost.com. Nobody thought that customers in the U.S. would pay the extra for merino wool outdoor socks.

But then in 1994, SmartWool started selling expensive merino wool socks, and they sold like hotcakes. And soon everyone was selling merino-blend socks. The [footnote to Cotton](#) discusses Hamlet Socks, which Murray Hamlet developed for the military to prevent blisters. They're like Smartwool socks, but inside out, with the terry-loop towel-like bits on the outside of the sock. This prevents blisters better, and you can reproduce this effect by wearing your SmartWools inside out. The Rohner socks I wear all the time are already built inside out like this, and indeed their terry-loop is denser and harder than SmartWool's, which Murray reproduced in his military sock design.

More recently, several outdoor clothing companies – SmartWool being one – have started selling merino wool clothing, from summer T-shirts to thick winter sweaters. [Ibex](#) is the best-known manufacturer of wool outdoor gear. I have one of their vests, but to be truthful, it's so nice that I wear it with my work clothes all the time (and get compliments on it) and use my Powerstretch vest for true outdoor use.

Aficionados of wool point out that it ventilates better than fleece. And it's true. This past winter, whenever I would go out for a half-day walk or a dayhike, I would wear wicking baselayer (often one of those Patagonia R 0.5 tops I mentioned above), a thick looseknit wool sweater, and a wind shell, with hat, mittens or gloves, and a facemask. By unzipping the wind shell, I could let some wind into the sweater and easily ventilate going uphill, and then zip up when on a windy ridge or heading downhill. For fall 2011, Ibex is introducing a full-zip version of their thick Guide sweater (I want a full zip for better ventilation and ease in donning and removing), and I plan to get one, as it's a lot lighter than the "street" wool sweater I wore a lot last winter.

This brings up another "old is new" – nylon wind shells. I am also going to coin a new phrase (September 2011), and we'll see if it catches on: **ThinShell** (or perhaps **LightShell**). A decade or two ago, SoftShell was all the rage: water-resistant but highly-breathable shells with a wicking construction on the inside. Now, new very thin-and-light, water-resistant and highly-breathable nylon fabrics such as Gossamera make a new kind of shell possible.

Most of this past winter, I used an old CloudVeil Cirque jacket. This is a thin nylon shell jacket, DWR (Durable Water-Resistant = mildly water resistant, but very breathable), with a generous hood to accommodate a helmet or hat, a half-zipper in the front, and two big pockets on the front to hold hat, gloves and facemask when going uphill. I found this was fine even in wet snow around freezing; it was water-resistant enough for me to never have resorted to my GoreTex shell jacket.

The only thing I really didn't like about it was that half zip in front. I really wanted a wind shell that would allow me to ventilate better. And I figured that I would be able to get something in a lighter, thinner nylon.

First, I got one of the new, lighter nylon [Pertex](#) 685 shells – made by [Integral Designs](#) ("Pertex Wind Jacket" – a true, descriptive name for a change). It's designed to be ultralight. It weighs only 4.6 ounces and will fit into your pocket with room left over. It seems quite breathable and water-resistant enough to keep me quite dry during some light freezing rain showers. The material, Pertex 685, is impressive stuff. I found this online: Pertex 685 is a 40 denier microfibre ripstop nylon weighing 1.85 oz per square yard. The purpose of this fabric is to use fine filament, closely woven calendered materials to create a low bulk product that is windproof, water repellent and breathable. *Pertex 685 is constructed using the same DWR + technology as Pertex Microlight (see above). However, the 40 denier base fabric is more robust and abrasion resistant than Microlight, making it the fabric of choice as a shell fabric for PrimaLoft insulated clothing.* It's about twice the weight of Pertex Quantum, which is used for down gear linings.

However, it has no pockets for my gloves and hat. And, the hood's front closure is bizarre – to save weight, it merely has some elastic around it, no actual drawcord. That means that when the wind comes up – and remember, this is supposed to be a windshell – that the wind comes in around your head and chills your head and neck, and there's just no way to prevent this. I was unhappy enough with this – bad hood design, no pockets for my gloves and hat – that I relegated it to emergency use as a loaner and it went into the back of my car. I also found it had basically zero resistance to rain.

Next, I got an [Arc'teryx](#) Squamish Hoodie, which I think is more designed for warm-weather use than my intended use as an outer shell for the winter. I got a large so it would fit over my heavy sweater or a couple of layers of fleece. It has a great hood design with a drawstring closure with hidden ends to avoid them slapping you in the face when windy, Velcro wrist closures with just enough stretch to get on without undoing the Velcro, excellent tailoring and design overall, and a full front zip for ventilation. It only has one pocket in front, and it's a tight squeeze to get a facemask, hat and gloves in there, but I can make it work. The tailoring is excellent.

Most interestingly, the Squamish is made of Gossamera, a very light micro-ripstop nylon with a very thin urethane coating on the inside. It has an air permeability of 7 cubic feet/minute, comparable to Pertex Quantum's 5 cfm. It has a harder finish than Pertex Quantum. Despite being as light as gossamer, it really seems quite tough, though I'm not sure I'd do a long climb on rough rock wearing it. It seems quite breathable, much more so than my current HyVent North Face ultralight GoreTex equivalent pullover (to which I added pit zips).

Like the Pertex wind jacket, the Squamish has a DWR finish. I once went for an hour-long walk in a mild to moderate cold rain. At the end, when I took off the jacket and looked at the inside, there was a little water coming in the seams, and just a bit of water coming through the shoulders, but really only a tad more than I would expect from condensation inside a GoreTex jacket. I liked it so much I also got a small to carry in the summer, and it certainly sheds water a lot better than the Pertex shell.

This Gossamera wind shells are about half the weight of my old nylon CloudVeil Cirque windshirt, more water-resistant, more wind-resistant, seem to be tougher and just as breathable, and are full-zip. I'm very pleased with them. As with anything made by Arc'teryx, they are relatively expensive, but the design and tailoring are impeccable.

This combination: a wicking layer, covered by a highly-breathable merino wool layer, covered by a ThinShell of Gossamera, is in my opinion a better solution than a softshell jacket in many ways. The most important is weight; using wool rather than fleece adds some weight but using a Gossamera shell instead of a "wicking" softshell saves a lot more weight.

So. ThinShell is in. Wool and nylon are dead. Long live wool and nylon!

Softshell vs. Hardshell

No, I'm not talking about crabs.

For the past decade, people have been talking (cf the Mountain Gear 2003 catalog) about the "old" method of outdoor dressing, i.e., wearing a "hardshell" GoreTex parka over middle and inner layers that really don't resist wind or rain. They contrast this with the new "softshell" where the middle layers not only provide stretchy insulation but also shed wind and rain to a degree (as well as providing significant protection against abrasion, mud and dirt, which the older fleece didn't). Having worn some of these "softshell" garments, I have to admit I'm impressed with the idea. With "softshell" dressing, you rarely take out your GoreTex parka, and can therefore have a relatively thinner and lighter shell which stays in your pack most of the time.

These relatively new fabrics, pioneered by Schoeller of Switzerland, are woven so that they have a tough nylon on the outside and a warm, fuzzy, wicking CoolMax on the inside. Malden Mills also tried a kind of fleece called "BiPolar" that is similar in intent, but the outside is really just shaved pile, not a heavy-duty shell like the Schoeller fabrics – but now they are getting into the field with a vengeance with some of their newer fabrics. Malden Powerstretch, for example, has a bit more of a "shell" on the outside, though still nothing compared to Schoeller Dryskin Extreme. However, the newer Malden fabrics like PowerShield, as they mature, may give Scholler a run for its money. Most of these softshell garments, especially the Schoeller, have moderate wind resistance but are extremely breathable. Even for heavy-sweating people like me, they may do OK without pit zips (unlike any kind of GoreTex equivalent).

I will admit that I'm moving back towards the hard-shell idea – due to the advent of very, very thin and light windshells like the Gossamera one I mentioned above. Or, more accurately, moving back in time even before GoreTex. Back in the day, we used to hike and climb always with two parkas. One was a light windshell – at first cotton, later nylon as soon as it came out, that was quite breathable. Then there was your "waterproof" – a non-breathable parka for bad rain. Well, I'm back at the same place, only now I'm carrying my ultralight Gossamera for daily use, and an ultralight GoreTex with pit zips for my "hard shell." Same basic idea, but a tenth of the weight. And now I'm wearing softshell garments for pants and shirt, so I guess the softshell has moved inwards.

There are two bit of innovation in soft shells that, in 2011, I find intriguing.

First, Cloudveil and [Vaude](#) offer jackets in a new soft shell material, Cyclone, that, unlike prior soft shells, has a thick inner fleece lining. I just got a Cloudveil FirstTurn jacket made out of Cyclone. It's thicker and heavier than my old Cloudveil Serendipity jacket made out of Schoeller Dryskin, but seems pretty bombproof in terms of wind and water resistance, and even likely abrasion resistance, much more so than DrySkin. Will be interested to see if it lasts. (BTW, Vaude offers some very, very nice ultralight but big daypacks/climbing packs. My wife and daughter and I all use them all the time.)

Second, Polartec has a new softshell, NeoShell, that sounds interesting. Well, anything Polartec comes out with sounds interesting, although the marketese on their new [NeoShell website](#) makes me nauseated; not a figure of speech, literally. I guess I have a low tolerance for marketing hype.

Where to Learn More

Mark Verber has a fairly long page with detailed discussion and specific recommendations for different types of outdoor clothing at www.verber.com/mark/outdoors/gear/clothing.html. Backpacking Light has a page with the [names and lineages of breathable fabrics](#), but without detailed information on most fabrics. There are websites at www.gearreview.com and www.backpackgearthest.org that

feature detailed reviews of many pieces of outdoor clothing, some with comments about their materials. The current Polartec website has a [page](#) devoted to a history of their fabrics. Crestone Designs has [a page](#) about the fabrics they use.

There are zillions of different brand names listed here, and so in this document – no matter how overwhelming it might seem – I just try to hit the high points. There are many, many outdoor garment manufacturers. The ones I know well and/or like are listed as links in the footnotes. Because there are so many good outdoor clothing materials, each garment manufacturer has to choose just a few fabrics. Thus, if you shop around, you can find many similar garments in different materials. The fabric and garment manufacturers use the same name for many different fabrics, and sometimes a single fabric has more than one name, *and* sometimes they keep the same name but change the fabric. Sigh.

Keith's Picks in Bold		comfort against skin	warmth (not per weight)	warmth when wet?	water resistance	wind resistance	abrasion resistance	stretch	wicking and sweaty comfort	resistance to pilling	thorn-pull resistance	Speed of Drying	Wrinkle- resistance	Resistance to matting	
Against the Skin Everyday Clothing															
Shell-Wicking "SoftShell"	Schoeller Dynamicⁱ	++	+	++	+	++	++	++	++	NA	xxx	+++	+	+	
	Schoeller Dryskinⁱⁱ	++++	+++	+++	+	++	+++	+++	++++	NA	x	+++	++	++	
	Schoeller WB-400 and F-Shell ⁱⁱⁱ	?	?	?	?	?	?	?	?	?	?	?	?	?	
	Polartec Powerstretch Cordura ^{iv}	?	?	?	?	?	?	?	?	?	?	?	?	?	
	Polartec PowerShield ^v	?	?	?	?	?	?	?	?	?	?	?	?	?	
	Gore Windstopper ^{vi}	x	+	+	++	++++	?	+	x	?	?	?	++	++	
	Malden Windbloc	+	++	+	++	++++	?	+++	+	?	?	?	++	++	
	Malden Aqua Shell ^{vii}	?	?	?	?	?	?	?	?	?	?	?	?	?	
	Cloudveil Inertia, Schoeller Dynamic Extreme, North Face Apex ^{viii}	+++	++	++	+++	+++	++++	+++	++++	+++	++	+	++++	+++	na
	Cloudveil Cyclone Plus^{ix}	+++	++	++	+++	+++	++++	+++	++++	+++	+++	++	++++	+++	na
Patagonia Tactile Aspira (extinct) ^x	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
Gore-Tex Soft Shell II Masai, now just Gore-Tex Soft Shell ^{xi}	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
Pile	Helly-Hansen Pile ^{xii}	+++	+++	+++	x	x	x	+	++	+	x	++	++	x	

	Non-Helly-Hansen Pile ^{xiii}	+++	+++	+++	x	x	x	+	++	xxx	x	++	++	x
	Malden ^{xiv} Polartec 100/200	+++	+++	+++	x	x	+	++	++++	++	x	+++++	+++++	+
	Marmot Outlast (extinct) ^{xv}	++	+++	+++	x	x	x	+	++	+	x	+	+	?
	Polartec Powerstretch 100/200 ^{xvi}	++++	+++	++++	x	x	+	++++	+++++	++	x	+++++	+++++	+
	Therma Fleece ^{xvii}	++++	+++	++++	x	x	x	++	++++	++	x	++++	++++	+
	Paramo Parameta-S ^{xviii}	++	++	++	x	x	x	+	++	?	x	++	++	++
	Patagonia RI and R0.5/ Capilene 4	++++	+++	+++	x	x	x	++/ ++++	++++	+++	x	++++	+++	?
Shellish Clothing	Water-proof Zippers ^{dx}	xx	xx	xx	++	++	+	x	x	na	na	na	na	na
	Nylon ^{xx}	x	x	x	++	++++	+	xxxx	x	++++	+	++++	+	na
	Coated Nylon (SilNylon, Nextec Epic, Gossamera) ^{xxi}	xxx	++	x	++- ++++	++- ++++	+--+				++			
	Supplex ^{xxii} Nylon	+	x	x	++	++++	++	xxxx	x	na	++	++++	++	na
	Spandura ^{xxiii}	x	+	+	+	++	++++	+++	x	+++++	x	++	++	na
	Supplex Ripstop Nylon ^{xxiv}	++	x	x	++	++++	+++	xxxxx	++	na	++++	++++	+++	na
	Goretex ^{xxv}	x	+	+	++++	+++++	varies xxvi	x ^{xxvii}	xxxx	na	+++	++	varies	NA
	Pertex ^{xxviii}	x	+	+	++	+++++	varies	x	xxx	na	+++	++	varies	na
Everyday Materials/Base Layer	Wool ^{xxix}	x	++	++	x	x	++	+	x	x	+++	x	+++	+++++
	Silk	++	+	++	+	++	++	+	xxx	na	x	+	xx	na
	Cotton ^{xxx}	++ ^{xxxi}	+++	xxxxx	xxx	++	+	x	x ^{xxxii}	+++++	++++	xxxxx	xx	xx
	Malden Powerdry ^{xxxiii}	++++	++	+++	x	x	x	++++	+++++	++	x	+++	++++	++
	Intera ^{xxxiv}	+++	+	+	x	+++	++	x	++++	na	+	+++	+++++	na
	Intera DryForce ^{xxxv}	+++	+	++	+	+	x	++	++++	+++	x	++++	++++	na
	Tencel ^{xxxvi}	+++	x	+	x	++	x	x	x	na	x	+	+++	na

	Polyester Microfiber <small>xxvii</small>	++	+	++	x	+++	x	+	++	na	x	+++	+++	na
	CoolMax (as everyday clothing) <small>xxviii</small>	++	++	+	x	x	x	+++	+++	xx	xx	+++	+	na
	Polarmax <small>xxix</small>													
		comfort against skin	warmth (not per weight)	warmth when wet?	water resistance	wind resistance	abrasion resistance	stretch	wicking and sweaty resistance	resistance to pilling	thorn-pull resistance	Speed of Drying	Wrinkle- resistance	Resistance to matting

<i>Layering and Sleeping Bag Materials</i>													
Down/shell	na	++++	xxxx	na	na	na	na	xxxx	na	na	xxxxx	na	xxxxx
Dacron-88	na	++	++	na	na	na	na	+	na	na	xxxx	na	xx
Hollofill	na	+++	++	na	na	na	na	++	na	na	xxx	na	xx
Qualofill	na	+++	++	na	na	na	na	++	na	na	xxx	na	xx
Primaloft/ Liteloft ^{xi}	na	++++	++	na	na	na	na	+++	na	na	xx	na	xx
3M Thinsulate matting ^{xlii}	na	++++	++	na	na	na	na	+++	na	na	xx	na	xxxx
	comfort against skin	warmth (not per weight)	warmth when wet?	water resistance	wind resistance	abrasion resistance	stretch	wicking and sweaty comfort	resistance to pilling	thorn-pull resistance	Speed of Drying	Wrinkle- resistance	Resistance to matting
<i>Underwear Materials</i>													
Polypropylene ^{xlii}	++	+	++	na	na	xxx	+++	^{xliii}	xxx	xxx	++	x	x
CoolMax polyester ^{xliv}	++++	++	+++	na	na	xxx	+++	++++ +	xxx	xxx	+++	x	x
Thermax polyester ^{xlv}	+++	++	+++	na	na	xxx	+++	+++	xxx	xxx	+++	x	x
Other polyester ^{xlvi}	++++	++	+++	na	na	xxx	+++	++++	xxx	xxx	+++	x	x
<i>Unique Clothing Materials</i>													
crystalline alkanes ^{xlvii}													
gel-bead bandannas ^{xlviii}													
treated leather ^{xlix}													

NOTES:

ⁱ**Schoeller Dynamic:** My pick for pants and thin jacket for mild conditions. Cloudveil used to make nice pants (“Maverick”) and a pullover.

ⁱⁱ**Schoeller Dryskin** Somewhat thicker than Dynamic, and ideal for cool conditions. The Cloudveil Symmetry pants made out of Scholler Dryskin Extreme are the best pants I’ve ever had, perfect for inside, outside, wherever, a very wide comfort range. The Cloudveil Serindipity jacket is a great all-around jacket. Dry skin is stretchy enough to be quite comfortable – I’ve found that I wear a size smaller than normal (small instead of medium) and the pants don’t bind at all. There is Dryskin, then Dryskin Extreme, then Dryskin Extreme with 3XDry – all just marketese for minor improvements in the fabric.

ⁱⁱⁱ**Schoeller WB-400** is a bit like their Dryskin but with a layer of fleece inside. [Mountain Gear](#) used to offer a Cloudwalker vest/bib and a top of this material. Compared with Dryskin it’s warmer, heavier, not as stretchy, not as breathable, but more snag-resistant. It looks as though now it’s relegated to knuckle patches on gloves, and an occasional pair of pants ([Outdoor Research](#) made some) and jacket ([Cloudveil](#) makes one). **Schoeller F-Shell** seems to be similar. There seems to be a trend (e.g, the Cloudveil Rayzar jacket) to use WB-400 in the shoulders of jackets for better rain resistance.

^{iv}**Polartec Powerstretch Cordura:** [Crestone Designs](#) offers tops and bottoms of this material, which I haven’t tried. They also will make custom-fitted clothing of many Polartec fabrics. Anyone who’s tried this material please let me know how you like it.

^v**Polartec Powershield** This is a combination of 100-weight Polartec fleece combined with a breathable barrier (GoreTex equivalent) and stretch nylon/Lycra outside. The garments made of it seemed way too heavy to me, but I’m sure they’re bombproof in bad weather.

^{vi}**Gore Windstopper and Malden WindBloc:** Both the Gore and Malden wind-blocking fleece seem a bit silly – the nice thing about fleece is that it is stretchy and porous, and works nicely under a shell garment. They seem especially silly, since the fleece is on the outside where it does virtually no good. Theories for this include (1) fashion, and (2) protection of the wind-blocking layer from abrasion. The Malden WindBloc, in my opinion, has it all over the Gore Windstopper. Winbloc is stretchier by far. And Windstopper feels, well, yucky against the skin. Malden now has WindBloc ACT, which only blocks 98% of the wind, to allow better ventilation. They also have WindPro which is a somewhat wind-resistant fleece. Gore came out with “WindStopper N2S” (next to skin), thereby admitting the yuckiness of WindStopper, but it’s quite thin. Except for gloves, stick with Malden or Schoeller for wind-resistant fleecy stuff.

^{vii}**Malden Aqua Shell (AKA Thermal Stretch)** This material was made for whitewater sports and sailing and perhaps diving – it’s touted as a replacement for 2.5/3 mm neoprene wetsuit materials. Gotten some good reviews for diving in warmer water. By 2011 seems to have disappeared.

^{viii}**Inertia:** is a proprietary softshell fabric from Cloudveil. Think of the drape and “hand” of a pullover made of fine, tightly-weaved but very soft long-staple cotton. Inertia is soft, flexible, feels very nice to the hand but is highly wind-resistant, quiet, very tough, very thin, wicking – everything you wanted your nylon windshell to be but it wasn’t. Very nice stuff. Any downsides? Not very stretchy (about 1.15%) compared to, say, PowerStretch. Not quite as windproof as Dryskin. North Face has their thin softshell (Apex) that feels similar, and Schoeller has (2006) a Dynamic Extreme, which seems to have a much softer hand than the original Dynamic, and is stretchier; I got a pair of REI short gaiters made of Schoeller Dynamic Extreme, but I haven’t tried any large garments of it or the North Face Apex cloth. However, I have a small Prospector jacket from Cloudveil that’s made out of Intertia Plus fabric of 2005-6 vintage, and it’s rapidly becoming one of my favorite jackets. Seems significantly better than the larger Prospector hooded jacket I got two years previously as the Inertia got thicker but also much more wind- and water-resistant. The Prospector hood didn’t have a drawstring around the hood opening (bizarre) and so I added one myself. But the newer Inertia cloth has the hand of a fine, well-worn cotton with a soft, wicking internal layer, enough stretch to make a difference (though again still not like Powerstretch) and a very durable outer shell. Highly wind-resistant, moderately waterproof, and very breathable.

^{ix}For many of its softshell jackets, Cloudveil switched from Schoeller fabric to Cyclone Plus, a softshell fabric proprietary to Cloudveil (I wonder if Schoeller makes it for them?). Their Cyclone Plus FirstTurn jacket won a Gear of the Year award from Outside Magazine in 2009. Cyclone Plus started as a mix of spandex and polyester with fleece on the inside, very similar to Schoeller DrySkin. The 2011 version of Cyclone now incorporates some wool as well.

^x**Patagonia Tactile Aspira:** a fabric from Dupont very similar to Schoeller [WB-400](#).

^{xi}**GORE-TEX Soft Shell II Masai** is a waterproof shell outer with a laminated 100-weight fleece liner, introduced in the winter 2005-2006. [Berghaus](#) was the first to make a parka made of the material. If you have a garment.

^{xii}**Helly-Hansen Pile:** the original pile (see text above table)

^{xiii}**Non-Helly-Hansen Pile** copies of Helly-Hansen pile by other companies used different, non-knit base (basically, glued); they pilled a lot, matted down after a while. Not as good as the patented original Helly-Hansen stuff.

^{xiv}**Malden Polartec 100-micro, 100, 200, 300, Bipolar, DWR, High Void Grid, Regulator, Thermal Pro, Thermal-FR (flame-resistant), Aircore-200, Lattice, Monkey Phur, etc.**

^{xv}**Marmot Outlast** is a type of thick pile for gloves, but with tiny beads of wax embedded in the material – the idea is that the beads absorb heat when your hands are warm and then reradiate it to your hands when they are cold. I would have said that this was a bizarre and unworkable idea but it really does seem to work. A friend who’s an instructor at the Scottish National Outdoor Center at Glenmore Lodge has tried alternating them with similar gloves during winter climbs – and the hand with the Outlast glove always stayed warmer. I tried one of his Outlast gloves on a winter trip near Cairngorm and indeed, it really seemed to work, at least a bit.

^{xvi}**Malden Powerstretch (and Powerstretch RX, and Special Edition Powerstretch 9400)**

Very, very stretchy, bipolar construction for wicking. I loaned my Powerstretch pullover to a colleague during a wet-cold Wilderness EMT exercise where he was a victim. He liked it so much I had a very hard time getting it back! This stuff is as stretchy as Spandex – or maybe more so. As with Schoeller Dryskin, I’ve found I wear a small instead of a medium as I usually do. It is so stretchy that getting pullovers on and off is very easy. Used for layering usually right over a fishnet (mesh) CoolMax shirt, or a Patagonia R .5 top, and with a shell over it when needed, this stuff is great. Indeed, Malden Mills markets it as an against-the-skin fabric, and it’s indeed comfortable that way, though it doesn’t wick as well as a true baselayer like Capilene.

[Cloudveil](#) makes a very nice Run Don’t Walk pullover and vest (I have both and wear them all the time); and [Crestone Designs](#) makes a variety of garments out of Powerstretch 100 – I particularly like Crestone’s designs as they all include lots of long zippers for ventilation, which I think is very important. For women, Crestone even makes bra tops of Powerstretch 100.

[Toesteesoaks](#) makes custom whole-body suits that are great under a caving suit; mine is quite comfortable even when wet; BTW, for a shell over this, the best custom caving suits are from [B&C Wunderwear](#).

Although Malden's website used to show Polartec 100/200/300 having mild-moderate wind resistance and Powerstretch having moderate wind resistance, really this stuff isn't very wind resistant, even the Powerstretch. Nonetheless it make a great layering material – *very* stretchy, very comfortable.

The original Powerstretch has been gradually improved, first a version with a durable water-repellent treatment, then treated with silver to prevent bacterial growth that causes bad odors. In the summer of 2002, I got some garments from [Low Alpine Systems](#) (their MultiPro line) made of **Special Edition Powerstretch 9400** which is different from "standard" Powerstretch in that the fuzzy inner layer is only about 1/4 there: it's a series of "dots" that hold the garment away from the skin. This makes a bit smaller-packing and lighter garment with a bit less insulation but a better warmth/weight ratio than standard Powerstretch. I'm tried this stuff under a variety of conditions and it seems to work pretty well, but I like the Patagonia R1 and R .5 a bit better, perhaps because I bought it a couple of years later and Malden's technology improved.

All in all, Powerstretch is recommended highly.

^{xvii}From DashAmerica, Inc.: a cheaper and not as stretchy clone of Malden PowerStretch. Pearl Izumi uses it in bicycle clothing.

^{xviii}**Parameta-S** from [Paramo](#) is an interesting material, or at least interesting marketing. This is a bipolar material, hydrophilic on one side and hydrophobic on the other. The interesting twist is that it's reversible clothing -- wear the fleecy side, which is like a fine plush velour, against your skin for warmth. The plush velour fleece is hydrophobic, but the hydrophilic outer layer attracts moisture away from the skin (sort of like DriClima – if you dip the material in water then feel it, the plush side feels dry). If you find it too warm, you take it off and put it back on inside out. Nice idea, but you can tell that, because they ship them with the plush on the inside and the pockets on the outside only, that you're expected to wear it mostly with the plush side inside. But I must admit, wearing it inside out when you're sweating a bit makes it a bit cooler and more comfortable. They make a Mountain Shirt that's a pullover with a snap mock turtleneck and sleeves designed for reaching above your neck (I have one I got in the UK; I wear it for walking the dog and the the odd half-day hike, but it's not stretchy like Powerstretch, so I don't use it for true outdoor pursuits), and a Trail Shirt that's cut on a standard shirt design with a collar and a full set of front snaps. Interesting and different, but not on a par with Powerstretch (and it's about the same as Powerstretch without the stretch), Powerdry or Scholler Dryskin Extreme.

^{xix}**Waterproof Zippers** I first saw these on Arc'Teryx packs, but now they're appearing everywhere. Arc'Teryx calls them WaterTight zips, and Mountain Hardware calls the Simplex zips, and YKK (who makes them) calls them Reverso zippers. Regardless of the name, they allow manufacturers to eliminate flaps over zippers. Though the waterproof zippers are stiff compared with non-waterproof zippers, they're flexible enough, at least on rainpants, that they do cut down on bulk and weight without impeding movement. In 2004 or so, I was finally able to get some of these zippers from [Quest Outfitters](#), and sew them into some of my existing parkas as pit zips. Very nice.

^{xx}**Nylon** Retains a feeling of warmth next to skin, while still allowing lots of heat through; bad against the skin (cold in winter, uncomfortable in summer). [Tactel](#) is DuPont/Invista's tradename for its nylons, and Tactel Aquator is their tradename for a special construction of nylon with a bipolar construction – the only thing I could find that was made out of this stuff was a dress riding shirt, no outdoor garments, and the Dupont site had little information other than that it's a bipolar sweat-moving fabric. It seems to have disappeared somewhen about 2005. However, there has been a gradual change in nylon over the years – the fibers of the thread are getting smaller, providing a better "hand" and less of a rustle when walking, and making it more comfortable against the skin. For instance, I have a couple pair of very nice Mountain Hardware nylon pants, made from a very soft but quick-drying nylon. Some of these are zip-off pants that turn into shorts, and some are extremely light yet still quite comfortable and durable.

Ex-Officio is now using a material called DryFlyLite (no kidding) that is 80% Nylon / 20% Polyester

Also, see the Supplex Nylon below, and the section "Old is New" above the table about Gossamera.

^{xxi}**Silnylon** is nylon coated with silicone. The older K-Cote treated nylon was waterproof, but the coating was heavy, it flaked off after a few years of use, and if packed wet, or after a few years in the basement even if not wet, started smelling like an overripe herring. But modern silicone-coated nylon is very light, very tough, doesn't delaminate, and smells only like whatever you spill on it. **Nextec Epic** ([Nextec](#) is the company, Epic is the treatment/material), AKA **EncapSIL**, works a bit similarly to GoreTex, but instead of a laminated membrane, Epic consists of a coating applied to the fibers of the fabric itself—the silicone coats the fibers themselves, leaving holes the right size to pass water vapor but small enough to not pass liquid water. Seems similar to Pertex in that it's not as waterproof as GoreTex (GoreTex is >40 PSI waterproof, but Epic is reportedly only ~1 PSI waterproof), but very windproof and very breathable, and reputedly it will last longer than GoreTex or DWR coatings. Does not stretch, but very light. [Wild Things](#) uses Epic in many of its garments, as does [Mountain Hardware](#). Gossamera (see text above table) is most interesting recent evolution of nylon: very light, reasonably tough, water-resistant, windproof, breathable.

^{xxii}**Supplex** is DuPont/Invista's trade name for microfiber nylon. I've had good experiences in cool, rainy weather in Ireland and Scotland with wearing Supplex nylon clothing from [Ex-Officio](#) over some thin wicking layer of underwear – many of Ex-Officio's shirts are ventilated with mesh inserts. [RailRiders](#) offers Supplex nylon shirts and pants that have even more ventilation in the form of CoolMax mesh inserts. Their EcoMesh pants have zippers that close over the CoolMax inserts, allowing a degree of control over

warmth/ventilation – however, even though I am not all that fat around the middle, I found that the EcoMesh pants that fit my waist were way too long, and with the zippers the way they are they're a pain to tailor.

^{xxiii}**Spandura** A combination of Lycra and Cordura nylon. [Outdoor Research](#) used to make a variety of garments, especially pants, out of Spandura. Not very comfortable against the skin, and my Spandura pants caused bleeding abrasions on the back of the knees after a day of climbing or hiking, but stretchy and tough. Mine lie unused in the bottom of one of my dresser drawers, which is likely why all the outdoor clothing manufacturers seemed to have stopped using it.

^{xxiv}**Supplex Ripstop Nylon** As with Intera shirts, the combination of a ripstop-style weave with a wicking coating on the fibers makes this stuff a lot more comfortable against the skin than non-ripstop nylon and Supplex nylon materials. A Supplex ripstop-texture shirt from LL Bean (that they don't offer any more) is my favorite for really wet weather; tough, and unlike plain supplex, the ripstop texture means it doesn't stick to my skin when wet.

^{xxv}**GoreTex et al** I include here GoreTex and all the various similar fabrics, now that the original patent has expired. Please email with similar fabrics you've seen and I'll add them here. Of particular interest is the GoreTex XCR fabric which is just as waterproof as classic Goretex but 25% more breathable, or at least so they say; also their Paclite which is a very thin but durable lighter-weight GoreTex. Cloudveil (Dermizax) and Marmot (MemBrain) have stretchy-versions of GoreTex, but they're really not that stretchy compared to some of the other fabrics available now. Also note GoreTex Windstopper which competes directly with the Malden Mills WindBloc fleece fabric. I personally find the idea of a windproof layer **INSIDE** of a wool or pile or fleece layer one of the stupidest things I've ever seen of. (Every heard of [Bloody Stupid Johnson](#) in Terry Pratchett's Discworld novels? He must have designed these fabrics.)

^{xxvi}**GoreTex et al Abrasion Resistance** The abrasion resistance of GoreTex and Pertex and similar waterproof/breathable materials (generally some form of expanded polytetrafluoroethylene = PTFE = Teflon) is nil. The abrasion resistance is entirely dependent on whatever it's laminated to. Some of the materials are simply thin nylon (I have an LL Bean nylon-Goretex parka like this that folds up into almost nothing) but are not suitable for abrasion on rocks – others, such as parkas made by Patagonia, Marmot, Cloudveil, Arcteryx and other top-end suppliers, are much more abrasion resistant. One of the most interesting variants is something called ToddTex – developed by Todd Bibler for [Bibler tents](#). It has a fuzzy internal laminate that works like a built-in frost liner. Nice stuff, but fragile – I've had to repair some abraded holes in my Bibler Torre tent where something rubbed against the ToddTex. Pertex and similar materials sacrifice some waterproofness for breathability. I have a British-style bivouac shelter (a [Terra Nova Bothy 4](#), from [Cotswold Outdoor Equipment](#), who will sell these by email) of Pertex, which is very light but provides a sort of floorless tent to throw over four people (four very friendly people, or two if you want room to eat lunch in the rain). The Pertex is waterproof enough that you won't notice any rain coming through compared to the condensation, even with two vents. Terra Nova now also offers lighter but more expensive SilNylon versions. These shelters are great for day-hikes in marginal weather and high terrain, or for wilderness first aid to quickly shelter an injured person.

^{xxvii}**GoreTex et al Stretch** There are a few stretchy Goretex-like materials on the market. None of them stretch much compared to, say, Malden Mills' Polartec Powerstretch, or Spandura. Cloudveil, for instance, made a pair of pants that look like regular pants but were stretchy (slightly), waterproof yet breathable. The material is called Dermizax Stretch Light (where DO they get these names?) and it's called the Snaz line, they also make a parka. I've tried the pants in the rain a couple of times, they're OK, but you still sweat in them, a lot. Remember that Goretex covered with water doesn't breathe. But with intermittent wind and rain, these pants are pretty nice. And they stretch enough to be better than most rainpants (although my Arcteryx rainpants that have waterproof zips up the side are very, very nice, and roll up quite small for good sturdy rainpants). I use my Snaz pants when I'm going out for a hike in cool weather and I know it's going to rain all day.

^{xxviii}**Pertex et al** This includes a variety of similar fabrics—a fairly open PTFE layer bonded to some other fabric, which is water-resistant (not waterproof like the original Goretex and clones) but very windproof and somewhat breathable (not as breathable as they'd like you to believe, though!) Examples other than Pertex include Activent for shell clothing and Dryloft for sleeping bags from W.L. Gore; interestingly, at least one of the companies that makes expedition-style down parkas went from Dryloft back to regular Goretex as the Dryloft wasn't durable enough, same with some sleeping bag manufacturers)

^{xxix}**Wool** The scales on the outside of wool fibers break up surface tension, and resist wetting. The lanolin (oil) on wool also helps resist water, and it olden days, oiled wool sweaters (with extra lanolin added back after the material was made) were the standard for cold, wet conditions. But when wool gets very wet, the hydrophilic core soaks up water, is heavy, and requires lot of body warmth to dry out; wool is kinky, no parallel surfaces to hold water (such as in cotton). Wool is still king for socks. Some comments on socks may be found in the emails below the chart but above these footnotes. In particular, Jacob Rohner of Switzerland makes what are probably the best everyday socks in the world—all of the socks I wear every day are Rohner trekking socks. Expensive but worth it. Sometimes you can get closeouts on Rohner socks from Sierra Trading Post.

^{xxx}**Cotton** Has a reputation for killing people in cold, wet conditions, and deservedly so. I had originally planned to leave it off the table entirely. However, in hot, dry conditions, wet cotton's ability to absorb and hold lots of water, and to act like a heat pump, and to wick and rapidly spread water from one place to another, is a positive benefit. In hot, dry environments, it's common to wear a cotton T-shirt with a loose, long-sleeve cotton shirt over it. And I've heard that at Outward Bound in Texas, not only the women but some of the

men hike in ankle-length loose cotton skirts to protect against the sun while allowing ventilation. (Thanks to Suzanne Atkinson of [Allegheny Mountain Rescue Group](#) for this tip.)

Subject: RE: Clothing Materials Table/no cotton?
To: NCRC Discussion List <NCRC@ontosystems.com>
Copies to: sar-1@listserv.islandnet.com, mra@altadena.net
Send reply to: kconover@pitt.edu
Priority: normal

On 16 Aug 2000, at 15:54, Steve Knutson wrote:

> Regarding cotton, I think it is absolutely necessary if you want to have "perfect" clothing. On the feet,
> it should be either cotton or wool (some people are allergic to wool) next to the skin--the coefficient of
> friction of synthetics is much higher than natural fabrics and you will be more prone to blisters and skin
> irritation in tropical conditions with synthetic socks.

Interesting point. I don't like cotton for liner socks because they tend to hold water against your skin, causing maceration ("prunification") and thus predispose to blisters.

Nevertheless, this at least is something on which we have some scientific evidence. Murray Hamlet of the U.S. Army looked at various types and combinations of socks in various materials, because the Army has a BIG interest in preventing blisters. He finally decided that there were no socks out there that were ideal, and so ended up contracting for what are now known as "Hamlet Socks" -- a combination of an outer very thick sock, made mostly of Merino (=expensive) wool, with the plush layer on the outside and the flat, smooth surface on the inside. The fibers are very highly twisted during material construction, both to resist matting and for durability, and despite the military's desire for multiple suppliers, they've only got one supplier at present. I got a pair of the original Hamlet socks and they are the best socks I've ever had. However, then I ordered some more and they, to put it bluntly, sucked. I found out from Murray that the original company basically went bankrupt and their quality was terrible -- later they got bought out and the socks are now back up to Murray's exacting standards.

Interestingly, he specifies a Coolmax liner sock. And with this combination, compared to normal wool Army socks, he found a lot less blisters. Specifically, he went to the US Marine Corps base at Paris Island, South Carolina and outfitted recruits and their drill sergeants with Hamlet socks, Coolmax liners, and then let them get on with their 14 hours/day of basic training. Blisters dropped by a factor of 3! This is the best scientific evidence for any particular sock actually making blisters less likely.

A poor second best, he says, is to get SmartWool socks with CoolMax liners, but wear the SmartWool socks inside-out.

To buy Hamlet socks, call 800-392-8500 and speak with Joe Gallagher.

I have no affiliation nor do I receive any kind of remuneration for endorsing these socks.

Addendum 2006: The quality of the TechSpun socks has been variable. The first pair I got were outstanding; a subsequent box from about 2001 showed poor construction, with there being "dog-ears" at the seams that made big lumps that pressed on your toes. Some subsequent socks I got from them a year or two ago were much better, but not up to the quality of their first socks. Others including Cheng Hu emailed me with similar experiences from 2002-2003. If you got some then and were disappointed, try again.

> Remember that synthetics DO NOT wick moisture--the myth that they do is an advertising ploy and has no reality.
> Synthetics are almost always hydrophobic and thus CANNOT wick moisture. What happens is that your body heat
> drives the moisture in vapor form through the fabric, but this doesn't happen when you are very cold. Drylete
> and other dual fiber fabrics (with a hydrophillic yarn on one side and hydrophobic on the other) are the only
> synthetics that wick moisture. Cotton underwear shorts are also much kinder to your skin. This is
> especially important in the tropics.

You know, I've heard this before, but certainly there are a lot of people, Murray Hamlet included, who disagree, and indeed have done some studies to show that these wicking treatments do work. For instance, remember the British ship hit by an Exocet missile during the Falklands war? They were wearing polypro, and during the explosion, there were a lot of burns, and there was melted polypro all over them. But the British docs found the polypro actually helped the debridement of the burns slightly, rather than causing much additional burning as rumored. So, the British still wear polypro -- but have a silverized outer layer that helps protect against flash burns. (Information from the British via Murray Hamlet of the U.S. Army, again.) Maybe this should make us reconsider the polypro vs. cotton/fireproof fabrics for domestic mountain rescue helicopter use?

[Massif (<http://www.massif.com>) has a line of Nomex fleece—fire-resistant, but insulating/wicking qualities not well known. – KC.]

Indeed, there is an easy way to test this yourself. Take a bowl of water and hang some of the material in it. Wait an hour and see how high the moisture has climbed up the material. Cotton is clearly the champ, but the fact that it also acts like a heat pump when wet, along with the large amount of water that it retains.

However, this is a poor test of wicking related to what we really want it to do, as in wicking sweat off the skin. I suspect that the Army has done some more detailed tests, and I'll ask Murray what he's found in his lab at Natick, MA and let everyone know.

And John Gookin wrote:

> Thanks for posting this great information. Good stuff. I completely agree with the confusion created by
> manufacturers' claims.

Not sure it's "great," in fact I'm sure, especially after looking at all the typos and stupidity in version 0.1 (0.2 is up now) that it's pretty cr**py information. But I just couldn't find anything quite like it, and whenever I do something for my own use, I like to share it. A few others might find it interesting, and many others like you with more knowledge than me may give me some pointers.

> I wrote the clothing chapter for Paul Auerbach's upcoming edition of his big Wilderness Med book. My point
> isn't that I'm smart; it is that I recently researched these topics pret I included cotton in the fabrics (in
> PA's book) for a few reasons. 1) "Cotton kills", so people who do serious stuff need to see how far off
> scale it is in temperate or cold environs. People often want to do micro-analyses of various fabrics when 2)
> In hot weather, "cotton's cool" because it wicks moisture so well. 3) Firefighters, welders, helo crews and
> others exposed to flames like the slow burn/melt rate of cotton. 4) When we are going in and out of heated
> spaces the absorbancy of cotton socks CAN BE healthier for athlete's foot or even immersion foot. I think
> cotton socks cause more immersi Don't get me wrong. I don't WANT all those firefighters & EMT's to
> keep wearing jeans when they come "lend a hand" in the deep snow. But I think cotton has its little niche as a
> t

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OK, OK, I'll add cotton. And the things that make cotton bad in cold- wet conditions makes it good in the heat -- retaining lots of water and acting like a heat-pump. Speaking of which, I've tried those "cool bandannas" with beads of some sort of polymer in them that hold water -- and though they do indeed hold a lot of water for a long time, they give it up pretty sparingly. In the humidity of the East they're useless. So last week I tried one of them at 10,000 feet in Utah. The outer cotton dried out pretty quickly, cutting down on the coolness and evaporative cooling, even though the polymer beads had lots of water still left in them. So I think a nice cotton headband, wetted every hour or so, is probably a lot better brow-cooler.

And Rebecca Jones wrote:

> Just a note, this is the way these fibers perform under "ideal" conditions. Add dirt, and all bets are off.
> Mud encrusted clothing can't wick, no matter what it's made of. "Resistance to Compression Matting" is
> probably the best indication that, after thorough washing, a garment will regain its
> characteristics.

True. When your clothing is covered with cave mud, you're basically wearing cave-mud laminate, and it doesn't really matter what the inner layer is. Which is one of the reasons why my caving suits have pitzips for ventilation. Surprisingly, I've had no failures or problems with them over the past 10 years.

And Anmar Mirza wrote:

> Further, I really like jeans for caving in the conditions in which I normally cave for a number of reasons.
> (some of my trips extend 15-20 hours. Mostly non immersed but many slimy and wet)
> 1. Jeans are very cheap. \$10 a pair from wally world, I can wear them for a few months then retire them for
> caving.

Point. Most of these new materials are expensive.

> 2. Jeans are fairly durable. I cave a *lot* (1-2 trips a week) and some of the places I go are very hard on
> clothing. I can't afford to buy a new cave suit every couple of months which is what I would have to
> do given the type and quantity of caving I do. (this is based on experience)

> 3. Jeans are flexible (unless you buy them too tight).

> I also like surplus light jackets which are also made of cotton. I can get these for \$5-10 and they last a
> long time (except for having to sew the buttons back on).

> I cave *hot* so normally being cold is not a problem for me. For others this is not the case. Cotton is
> pretty good when it comes to hot weather stuff, combine this with it being cheap and you have a resource
> that should not be ignored.

I suspect that you are in excellent aerobic condition, too -- so you don't tire out where others might. And the problem with cotton comes when one's energy runs down -- and there's still all that cold water held against your skin. I'd suggest that your wearing cotton is a lot like rock-climbing without a helmet or belaying without gloves -- some people can get away with it but it's certainly not something to suggest to a newbie, or to even allow them to know about.

> When I am going into a wet cave, or a cold cave, or cold weather conditions, of course my clothing fabric
> choices will change (34f caving, expedition weight polypros, a 3mm shorty wetsuit, and a full
> nylon caving suit. 72f caving, shorts, tshirt and knee and elbow pads...) But for 90% of the caving I do and
> a third of the outdoor stuff, the cotton shell I use suits my needs pretty well.

> While it is fine to say "cotton kills," what really kills is ignorance and lack of experience/training.

> Just like I said in another thread on this list, I think that using equipment and resources when and where
> appropriate is much better than trying to make a rule of thumb fit every occasion.

> Other than that think the table is a neat idea. Even though it is subjective, it gives folks a good starting
> point. I've got it bookmarked, thanks Keith!

> Anmar Mirza - Central Region National Cave Rescue Commission

> Coordinator EMT-A: Amateur Radio N9ISY: Cave Rescue Coordinator for

> LCSAR IKC Rescue Coordinator

Well, please let me know about all of the errors and omissions. I've added Goretex and Pertex and will need to add Activent, Bipolar, and some others. As well as some links to some good sites with more information about clothing materials. There are so many different materials that I'm going to have to, I think, keep it a selective list, with the best/most popular only (with the ones I like best featured, of course).

Thanks for all the comments!

--Keith Conover, M.D., FACEP

<http://www.pitt.edu/~kconover>

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=====
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to sar-l-request@listserv.islandnet.com with the word 'help' in the
subject field.

=====
From: Keith Conover, M.D., FACEP <kconover@pitt.edu>
To: sar-l@listserv.islandnet.com, Allegheny Mtn. Rescue Maillist <amrg@list.pitt.edu>
Subject: more on Hamlet socks
Copies to: mra@altadena.net, NCRC@ontosystems.com (NCRC Discussion List)
Send reply to: kconover+@pitt.edu
Date sent: Fri, 25 Aug 2000 08:13:13 -0400

Some more information on the military-designed Hamlet socks I have been raving about recently. The company is Double Lay-R doing business as TechSpun, and is reachable via the email <tecspun@aol.com> (Joe said that AOL wouldn't let him put in the "h". Go figure.). Or 1-800-392-8500. They offer several different socks.

1. Double Lay-R Blister Free.

These double-layer socks have outer and inner faces that are designed to be high-friction, and the matching faces are designed to slip against one another. I used to use some of these socks as liner socks, and they worked pretty well to prevent blisters. However, you have to be careful in putting them on so as not to get wrinkles, and your foot does slide a bit, which can be a bit of a problem going downhill.

2. Seamfree seamless socks.

These are designed for people with diabetes and ischemic feet.

3. All-Weather Lightweight Sock System.

These are a somewhat lighter version of the "true" Hamlet socks, below. Includes a lightweight Coolmax liner sock and a thicker outer sock, about the same weight as a usual boot or Ragg sock. If your boots fit snugly, you won't be able to wear the "real" Hamlet sock without your boot fitting too tightly, so order these. Retail price is \$13.75/set as of August 2000 (? if that includes the liners). High-density reverse nap, same as the "real" Hamlet socks. Liners are 80% Coolmax, 20% nylon. Socks proper are 40% long-staple wool, 40% polypro, 10% nylon in the toe and leg, and 50% long-staple wool, 50% polypro in the foot.

4. All Weather "Extreme Weather" Heavyweight

This is the "real" Hamlet sock, the one with the 3-fold decrease in blisters in Marine boot camp recruits and DIs at Paris Island. Work well in very hot or very cold, but may require a boot one size larger than usual. As of August 2000, retail price was \$14.75/set. (Actually, I think it's \$5 extra for the liners -- although maybe that's for extra liners.)

Bulk pricing is available if you order in lots of 12, especially for SAR teams -- available in whole sizes 7-15. Cost varies with sock size and number of socks and shipping, but less than \$10/pr for the outer socks, and \$3/pair plus shipping for the liners.

Again, I have no affiliation with this company at all, I just really, really like the socks and respect the guy from the Army who designed them (who also makes no money at all from their sales).

^{xxxi}**Cotton Comfort** For cotton, comfort against skin is really +++++ when dry and XXXXX when wet. Take your pick.

^{xxxii}**Cotton Wicking** For cotton, when sweaty, it starts off great, but after it gets soaked it's miserable.

^{xxxiii}**Malden Powerdry** Against your skin, this stuff is as comfortable as a well-worn cotton sweatshirt -- and soaks up your sweat as well (must be the way that they make the inner portion). However, it's warm when wet and dries quickly. Great stuff. Cloudveil's TeeWinot line used to use this material. I think the fuzziness of the inner face of this fabric is what allows it to soak up the sweat so well. Just like the original polypro spread out the sweat better than wool, and wicking treatments for polypro and now polyester allow underwear to wick sweat better than the original polypro, this stuff beats other treated polyester -- the best wicking layer I've experienced. The Cloudveil TeeWinot line also looks good, good enough to replace a polo shirt for when you need to be dressed up just slightly. Unfortunately, Cloudveil quit making the TeeWinot line, and Malden had also changed PowerDry. There is one version of PowerDry used in the Patagonia R 0.5 line (with fuzzy bumps inside), and another that is thin and somewhat silky. OK, but I have to admit I liked the earlier thin PowerDry—it looked and felt like a well-worn cotton T-shirt, only stretchier, and wicking. If anyone has any used TeeWinot shortsleeve shirts, size small, let me know and I'll pay you top dollar for them. Sigh.

^{xxxiv}**Intera** Intera is a coating for either nylon or polyester, a permanent wicking coating (at least they say it's permanent, and have some test data on their website that, if accurate, supports this, and nothing on the other companies' websites contradicts it). But as I know it from two shirts I have, is type of almost ripstop-like nylon, and the Intera shirts I own have alternating thicker and thinner threads in the weave. Although a relatively hard fabric, it's nonetheless relatively comfortable against the skin when you're sweating. I got a couple of shirts from LL Bean out of this fabric, and they are indestructible, almost totally impervious to wrinkles, and look good. Ideal for travel clothing. They still have something called a Journey shirt that is made of ripstop with a wicking treatment, but may not be the Intera tradename. They point out on their [website](#), though, that using fabric softeners can ruin the coating.

^{xxxv}**Intera DryForce** is listed as separate from plain Intera as it's a very different material. No coating, this is a bipolar material similar to Parameta-S or Powerstretch. It has a smooth, silky outside that feels like fine nylon tricot, and a fuzzy inside that feels like the inside of Powerstretch, but the shirt I got from Cloudveil is only about half the thickness of Powerstretch; not quite as stretchy as Powerstretch but a nice "hand" to it, drapes well.

^{xxxvi}**Tencel [Tencel](#)** is a fabric made from reprocessed cotton. The main marketing feature is that it feels like silk. It does, and drapes nicely -- I have a couple of [mock-denim shirts](#) out of the stuff and they're *quite* nice. Seem to wick a bit less than cotton, hold a great deal less water than cotton, and wrinkle quite a bit less (though not so wrinkle-resistant as Intera).

^{xxxvii}**Polyester microfiber** Despite the reputation of polyester from the 1960's, this is a great material. It's really not an "outdoor" fabric, but as I'm a fan of wearing "outdoor" clothing everyday (I don't see why *everyone* doesn't switch from cotton to CoolMax underpants) I have several pair of dress pants in polyester microfiber from [Travelsmith](#), which are virtually indistinguishable from fine worsted wool trousers -- but resist stains better, dries more quickly, doesn't wrinkle as much (though worsted wool is quite good for resisting wrinkles) and can be washed in a hotel sink and hung up, and they will be dry the next morning. Travelsmith has shirts and pants, and LL Bean also makes a nice pair of pants in microfiber. I also have a blazer from Travelsmith in "tropical" microfiber -- relatively light, looks nice, doesn't wrinkle, stains come out easily. Indeed, one of the nursing supervisors at my hospital spilled some coffee on my blazer, and she was horrified and was afraid she'd ruined it. I threw the arm of the jacket in the sink, rinsed a bit of hand soap through it, rinsed it out, and hung it up on the back of a chair for an hour. After that it was dry and looked good as new.

^{xxxviii}**CoolMax everyday wear** I got a pair of pants from Travelsmith in sort of a stretchy CoolMax canvas back about 1999. They pill a lot, get a lot of pulls, and are sort of ugly. Totally unlike their polyester microfiber.

^{xxxix}**PolarMax** is a brand of wicking polyester. I like it because their mock turtlenecks look quite dressy, and you can wear them with a (polyester microfiber) sport coat and look like you're semi dressed up, yet still be dressed in wicking warm-when-wet clothing.

^{xi}**Primaloft/Liteloft** Three different diameters together, crimped, larger fibers on the outside layers,

^{xli}**Thinsulate** Once washed, the insulation value goes down; made by blowing fibers onto a surface; good for high-compression areas, too stiff for most handwear, OK for boots and similar.

^{xlii}**Polypropylene** There are many various coatings for polypro and polyester underwear, with various brand names and various claims. However, polyesters have generally replaced polypro for against-the-skin wear—does better in hot dryers and near campfires without melting, doesn't hold odors as much, doesn't "pill" as much.

^{xliii}**Polypro Wicking** Depends on coating.

^{xliv}**CoolMax Polyester** CoolMax is an extruded material with dips in it, better than Thermax; very good against-the-skin material. There is also now a CoolMax Alta fabric, which reputedly is better in all sorts of ways -- as far as I can tell from one T-shirt I got (from [Campmor](#), by Duofold: Hybrid Lightweight T-shirt), it's a bit thinner yarn, which can make a thinner layer against your skin (although I'm sure they can make it thicker), and it's a bit more durable (doesn't pill as much). So it's probably just the next generation CoolMax. Look for it to replace CoolMax. However, it seems a bit fragile—my T-shirt developed several holes after only having it for a few months.

^{xlv}**Thermax Polyester** Extruded hollow polyester; doesn't pass moisture well compared with CoolMax; seems to be extinct.

^{xlvi}**Other Polyester** Capilene, others—no independent confirmation of various wicking claims. Some of the materials/coatings include: Terramar's Body Sensors EC2 Qwik-Dri fabric (I hope they didn't pay much to the agency that came up with these names), which claims it moves perspiration by electrostatics and not by wicking. They say that this makes it work better because it sucks water vapor away even where it's not in contact with the skin. Of interest, Terramar has trademarked the phrase "There is no such thing as bad weather, only bad clothing." The way I'd heard it was "There's no such thing as bad weather, just the wrong clothes. —anon Norwegian" Whatever.

I gotta admit all these materials/coatings seem to wick pretty well, and except for Malden Power Dry, none seems to be much better than the other. See also the notes on [Intera](#), above.

^{xlvii}**Crystalline Alkanes** [Talion Corporation](#) makes vests, for both humans and dogs, of this special material that cools as it melts. Objective testing by the U.S. Air Force, [quoted on their website](#), confirms its efficacy. Certainly for hot, humid conditions, like inside a HazMat suit, or in Florida or Louisiana or the tropics, evaporation is of limited use. Amir Findling of [Western New York SearchDogs](#) says the vests are somewhat heavy, pricey, and maybe not durable enough for a dog in a backcountry search task, but did a great job of cooling for about 4 hours.

^{xlviii}**Gel-Bead Bandannas** These are marketed under a variety of names. The gel inside the "bandanna" soaks up water and lets it evaporate slowly. These are, by my testing, totally useless anywhere in the East or the Appalachians in the summer. I've used them in dry conditions in Utah and they help, a little bit, but the beads evaporate so slowly they don't cool enough. Despite some good testimonials from some people, my recommendation is to get a stretchy cotton terry cloth sweatband and keep soaking it with water instead. The Sharper Image used to market an active cooling device for the back of the neck. It had a metal plate for good heat transfer to the neck, a reservoir for water, and a little fan powered by a single AA cell. It had a number of significant design flaws and some signs of frantic last-minute modifications. I got one to play with and wasn't impressed. A nice water-soaked terry-cloth sweatband and a small bottle of water will work better and weigh less.

^{xlix} Pittards of England is the best known, and some Lake winter bike boots I recently bought (very, very nice) had a card for Pittards WR100, which is I guess their current leather treatment. I know almost nothing else about it.