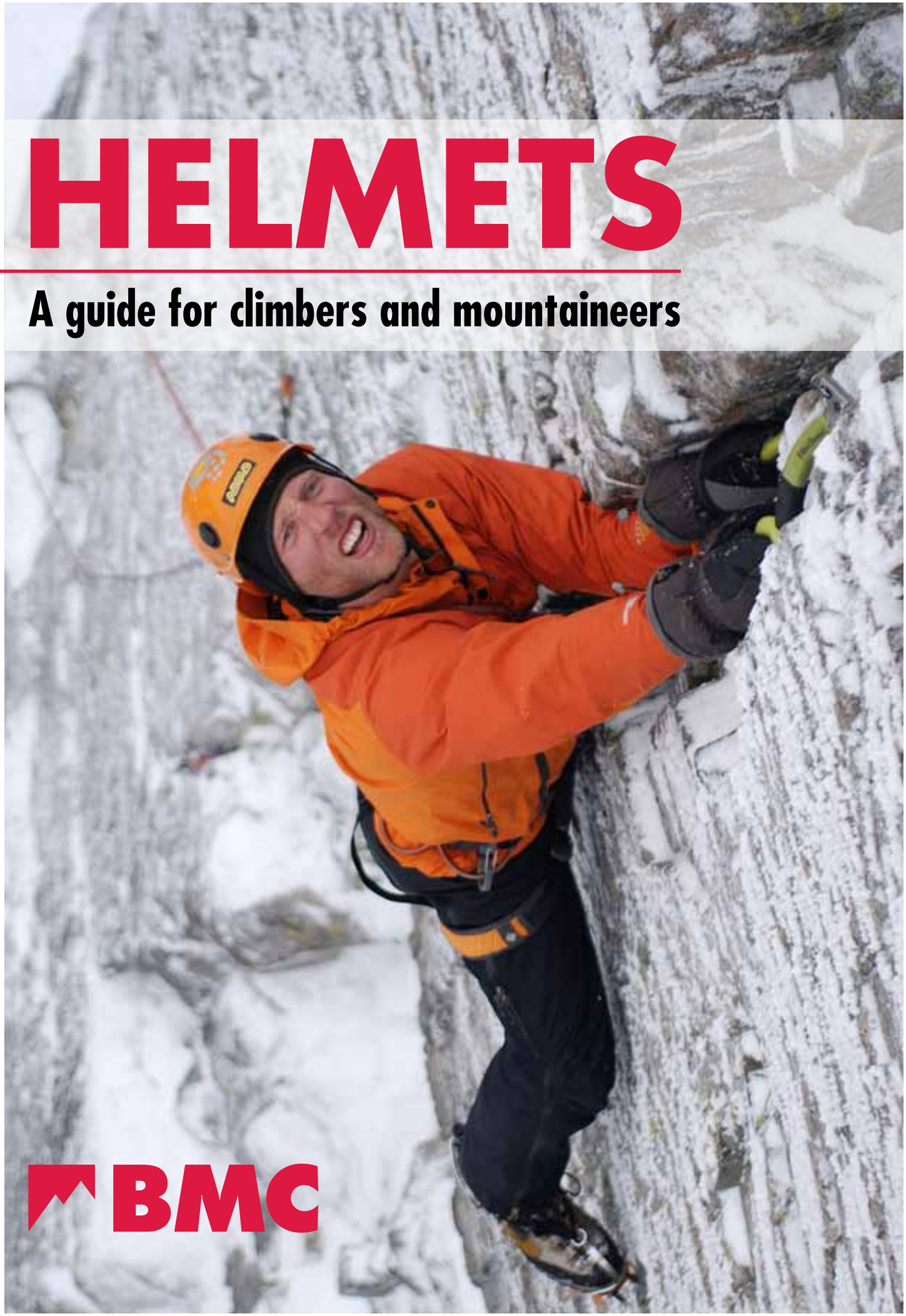
HELMETS

A guide for climbers and mountaineers



BMC

Photo: Ian Parnell

Wearing a helmet – a no brainer?

"This was a 50ft fall in which I was inverted before hitting the ground on the stretch of the rope. The helmet had a 4 inch diameter hole in it. I walked away without even needing to go to hospital. Without the helmet I would certainly have died – hopefully instantly! Based on my experience and with recent advances in the comfort of helmets frankly I think it is crazy of anyone not to wear one. Of course that should be their choice – but if I had not worn one I'd no longer be making any choices."

BMC Head Injury Survey 2008

Stories like this can lead to the idea that anybody who doesn't always wear a helmet is being irresponsible. Some climbers even refuse to team up with partners who refrain from donning a lid. Is this fair? Well every year, some climbers will be killed or injured even when wearing a helmet. On the other hand, climbers who refuse to wear a helmet out of vanity should perhaps realise that nobody looks good stretched out on a slab.

A big and thrilling part of our sport is about managing risk, and this extends to deciding when to wear a helmet. People will come to different conclusions as to what is right on the day for them, after sensibly assessing the risk. Most will choose a helmet for winter and alpine climbing; many for sea cliff and mountain routes. What about for sport climbing, bouldering and outcrops? Do you take your helmet off to eat your lunch at the bottom of the crag, as seen most summer weekends at our mountain crags?

The BMC line is that it's all up to you. We encourage you to think carefully, weigh up the risks, and make your own decisions. There's a photo in the 2007 BMC Stanage guide. The spotter is wearing a helmet, but the climber has chosen not to. Each has made the best choice for them, on the day.

This policy doesn't mean that the BMC has ignored the issue of helmets. For more than 30 years, the BMC has studied helmets and their performance. This booklet is the distillation of that knowledge. If you are choosing a helmet, it will help you to select from the many that are now available. You'll find advice on care and maintenance, and guidance on when to retire your helmet. It contains information about how helmets work, and a brief history of climbing helmets. Finally there is a summary of helmet standards, and where to get further information.

How does a helmet protect you?

There aren't many statistics available for injury reporting in climbing and mountaineering. Reports that do exist are collected by mountain rescue teams, and these paint a clear picture. Most injuries are to the lower leg, but the majority of fatalities are at least partly due to head injury.

The head is vulnerable, and for the climber there are two key risks to guard against. The first is the one most people think about, which is being hit by falling debris. This can be falling rock, ice or snow. It could be a dropped piece of kit or even a climber! The second, which is sometimes forgotten about, is the chance of impact during a fall. Getting flipped upside down by the rope, taking a swinging pendulum – the possibilities for banging your head are almost endless.

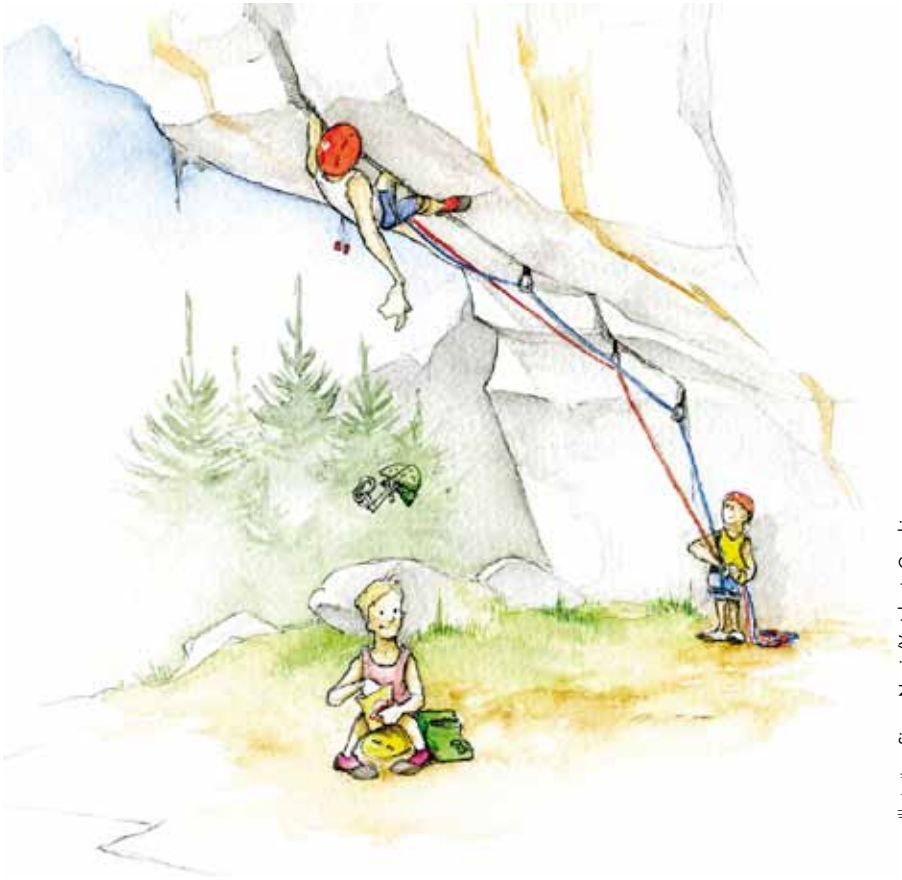


Illustration: Simon Norris/Vertebrate Graphics

In the event of an impact, there are two main ways that head injuries can be caused. The first way is the obvious physical one; a sharp object may penetrate and fracture the skull, or a blunt one cause crushing or a blunt trauma injury. Less obvious is the effect of rapid acceleration of the head caused by the impact.

This isn't the place for a detailed discussion about the biomechanics of head injury; suffice to say that keeping transmitted forces and accelerations to the head as low as possible will reduce the severity of any injury and trauma. To protect the wearer, a climbing helmet must effectively manage the impact energy of a collision, whilst at the same time keeping the colliding object from contacting the head.

It's important for a helmet to be lightweight and compact; also that it should be comfortable, well ventilated and provide the wearer with good visibility. In practice, it is these factors that restrict the amount of protection that a helmet can provide. It is important to understand that no helmet can offer total protection.

Choosing your helmet

The best helmet is a good fit, is comfortable, and is affordable.

When choosing your helmet there are two things you need to consider: the one that best fits your head, and the one that best suits your needs. The best helmet is a good fit, is comfortable, and is affordable. All the neat design features in the world aren't going to help unless the helmet is where it needs to be to protect you – fitted securely to your head. When choosing one, try lots of different helmets on, not just the one your idol is wearing in their latest video. See if you can adjust it to fit you well and if it easily slips out of position, don't buy it.

With any luck you'll have a choice of several that fit you and your budget. To help you choose the helmet that best meets your needs, it is useful to know that most modern helmets fit into one of three categories – hardshell, foam and hybrid. Use this guide to choose which is most appropriate to your activity.

Hardshells – a tough nut to crack?

Picture Joe Brown in his prime, wearing breeches and a big red lid, somewhere knarly in the Alps. He's wearing a hardshell helmet, and back then it was that or a flat cap. Hardshell helmets consist of a hard shell, combined with a flexible internal cradle made of webbing. The cradle is essential not only for comfort and to hold the helmet on the head, but to manage impacts by stretching.

During small impacts, modern plastic hardshells will return to their original shape and remain undamaged. This makes them pretty robust, so they are ideal for group helmets. With larger impacts the shell begins to deform permanently, evident by distortion from the original shape, and sometimes by discolouration where the plastic has yielded. Large impacts also result in permanent stretching of the internal cradle, after which the helmet can no longer provide the same amount of impact protection.

Fibre-reinforced plastic (FRP) shells are made from fibres in a plastic resin. Joe liked his so much he started making his own, but times change and these days nobody makes them anymore. Heavy but strong, yet easily damaged, any still in use must be getting close to the end of their useful lifetime.

A drawback to all hardshells is that none offer much protection towards the rim of the helmet. During off-centre impacts, the cradle collapses inwards without stretching. Top impact performance of hardshell helmets is often very good, with the advantage that even when damaged the helmet will often still provide some level of protection. These two features make hardshells a good choice for longer, committing routes where stone and ice fall is likely.

HARDSHELL	
✔	Top impact (good against rock/ice fall) Residual protection Durability (transport/rough handling)
✘	Off-centre impact (little protection towards the rim) Weight/ventilation
BEST FOR	Mountaineering/long routes, groups, rescue teams, caving

Foam helmets – soft in the head?

For quite a while, wearing a helmet marked you out as an arch-traditionalist. A helmet meant climbing VDiff's in all weathers, drinking warm beer, and wearing Ron Hills to the pub. Cool climbers didn't wear helmets, because they went sport climbing and bouldering instead. That all changed when Neil Bentley climbed Britain's first E10. You couldn't get any cooler than this, and yet he was wearing a lid. And no ordinary helmet either, this was new, this was funky – this was foam!

Your typical foam helmet is made from expanded polystyrene (EPS) with a very thin polycarbonate shell. Compared to hardshells they are light and often very well ventilated, and it was these comfort factors as well as being new and fashionable which propelled them into a must have item for the aspiring wad.

In contrast to hardshell helmets, foam helmets provide protection even close to the rim. The thicker the foam is towards the rim, the greater the level of off-centre protection provided. This feature makes this type of helmet a good choice for the sorts of climbing where the main risk is banging your head in a fall. You can hit your head almost anywhere in a fall, whereas stone and ice fall mostly hits the top of the head (unless you look up!)

Impacts cause the cells in the foam to progressively collapse. The foam can crack into pieces, or even crumble completely with a large impact. For this reason foam helmets are not the best choice for longer routes and mountaineering where you can't just pack up and go home. Damage during transport is also more likely than with other types of helmet.

FOAM	
✔	Off-centre impact (good for climber falls) Weight/ventilation
✘	Durability Residual protection
BEST FOR	Short routes, outcrop & sport climbing

Hybrid – the best of both worlds?

Whilst foam and hardshell helmets both shine in their respective fields, a good all-rounder would combine the best of both. That's where the hybrid comes in, and unsurprisingly these have become very popular. They provide a good balance of properties which work well for most situations.

A fairly rigid plastic shell is combined with a foam inner. The foam layer is the main protective component. In order to reduce weight and improve comfort, in most hybrid designs the foam does not extend to the rim of the helmet. Unfortunately this results in less protection from off-centre impacts than is provided by most foam helmets.

The rigid shell helps hybrid helmets to be more resistant to rough handling than foam helmets. Compared to hardshell helmets, weight is usually reduced, because there is no need for an internal cradle and the shell can be thinner.

HYBRID	
✔	All round performance
✘	Off-centre protection only where foam present
BEST FOR	All round climbing & mountaineering

Photo: Alex Messenger

Spoilt for choice?

There are helmets now available, which also conform to other standards than those for climbing, including kayaking, skiing, cycling and horse riding.

With the apparent increased usage of helmets and the ever wider range of adventurous activities for people to engage in, some helmets now cater for specific niche markets. The most notable of these are ones with visors or face guards designed to protect the face from debris and tools whilst icefall climbing.

At the other extreme, there are helmets now available, which also conform to other standards than those for climbing, including kayaking, skiing, cycling and horse riding. These multi-activity helmets can be useful for a variety of users including the cost conscious, adventure racers and those travelling and seeking to minimise their baggage.

Other developments include: a helmet which folds up to reduce bulk during transport; a modular helmet in which a foam helmet has a hard shell which clips onto the outside to increase the level of protection; and a helmet designed to fit around a ponytail which is marketed to female climbers in particular.

Photo: Alex Messenger

Helmets for children

Photo: John Beatty

Some manufacturers produce helmets in several sizes, with the small sizes fitting fairly young people. In addition, there are helmet designs specifically for children. Younger children tend to have less well developed neck muscles, so that a light helmet is much less tiring to wear than a heavier one. Standards for climbing helmets, however, make no differentiation between those for adults and for children – the test requirements are the same.

Helmet Performance – A General Guide

	HARDSHELL	FOAM	HYBRID
TOP IMPACTS	*****	***	****
OFF-CENTRE IMPACTS	*	*****	***
DURABILITY	*****	**	****
WEIGHT	***	*****	****
BEST FOR	Winter/Alpine	Outcrop/Sport	All Round

Other considerations

Some designs have variable venting or vent plugs.

A helmet that makes your head too warm may cause more of a problem than just the discomfort. At best it could lead to a reduction in your performance, at worst it could lead to you making errors in judgement which lead to injury.

In full-on winter conditions, the presence of large vents may be very noisy due to wind, as well as being cold. Some designs have variable venting or vent plugs, which are useful features if the helmet is to be used through the full range of conditions and seasons.

Don't forget to check for those additional features you require before making your final choice, such as head torch clips and visor attachments.

Looking after your lid

Photo: Alex Messenger

Look after your helmet, and it will look after you – it may even save your life! The main components are made from plastics and textiles, so treat accordingly.

- Avoid high temperatures (above 50°C), and strong light: you might have no choice when climbing somewhere hot and sunny, but storing your helmet somewhere cool and dark when not in use will help prolong its lifetime. Some models come with a protective storage bag.

- Squashing your helmet into your pack and then sitting on it is a guaranteed way to damage it. Some lightweight designs can be completely destroyed doing this. It can help to pad the interior of the helmet out for extra protection when travelling, and take care when packing it.

- Some commonly available solvents and chemicals can damage the shell material of your helmet; polycarbonate is particularly susceptible in this respect. It's impractical for manufacturers to test the effect of every possible contaminant on their products, but if you do have a mishap it's worth washing and drying the helmet off as best you can, and then contacting them. If in doubt, it's probably best to err on the side of caution and retire the helmet.

- Stickers and marker pens can also cause damage – avoid unless they have been specifically recommended by the manufacturer. Marking the shell with a pen will generally invalidate any warranty, as well as potentially weakening the helmet. Some modern designs of helmet have specific areas set aside for identification markings. Otherwise adopt a common sense approach; for example, marking non-load bearing parts such as the headlamp clips is better than writing on top of the shell.

- Allow to dry naturally before putting away. Storing wet may cause any metallic components to corrode rapidly.

Cleaning

Because of the wide range of cleaning products available, it is impossible to provide a definitive list of those which are suitable. In general though, soaps and non-biological detergents are fine to use. Always thoroughly rinse off in cold water, and allow to air dry. Read the helmet instructions, and if in any doubt, contact the manufacturer for advice on which products are safe to use.

Inspection and retirement

Cracked foam helmet

It's wise to regularly inspect your helmet for any damage:

- Check the shell for cracks, impact marks and damage from chemicals. Gently flexing the shell will bring any cracks more easily into view. Check inside and outside the helmet. Not all damage is easily visible – crushed foam can be hidden under the outer shell. Any helmet which has suffered a major impact should be retired.
- Make sure all webbing straps are free from cuts, abrasion etc.
- Ensure any straps are securely attached, and that any rivets are not badly corroded.
- Any adjustment mechanisms and buckles should operate smoothly, and not come undone under gentle pressure.

A helmet failing any of these tests should be retired from use.

Lifetime

Old plastic shell after impact testing

Lifetime is the maximum period that the manufacturer feels that the product would be able to provide adequate protection over. It assumes a helmet that has been well cared for and hasn't sustained any damage.

The practical lifetime of a helmet could be a single use, if the user is unlucky enough to be hit on the head the first time they use it. What about a perfectly fine looking helmet, which is old but has never been used? It depends to a certain extent on the type of helmet. Tests on older FRP helmets show little reduction in performance even after ten years of storage, whereas some thermoplastic shells have been found to be substantially weakened after a five year period.

Ideally you will have kept the manufacturer's instructions, and you should follow these to determine whether the helmet should be retired. For example, Petzl helmets have a ten year lifetime from the date of manufacture. Another system which is commonly used is to allow five years usable lifetime from the date of first use. If you can't find out how old it is, then make an estimate and retire a helmet if you suspect it to have exceeded the manufacturer's stated lifetime. Always remember, a helmet can be replaced, you cannot.

Performance of hardshells

During an impact, the shell is deflected at the point of impact, towards the head. In addition, the cradle stretches to allow the shell as a whole to move towards the head. Matching the stiffness of the shell and the cradle is essential. Too stiff and transmitted forces will be too high. Not stiff enough, and the shell will end up in contact with the head whilst there is still impact energy left to transfer. The result of any contact is an upward spike in the force-time curve. In general, plastic shells aren't stiff enough to prevent contact. Most use a small piece of foam or internal stiffening to prevent contact during a crown impact.

The clearance distance between the shell and the head is also critical. Too small and the peak transmitted force will be much higher than if the clearance is above the critical distance to prevent contact. This has ramifications for quality control procedures during manufacture, and makes it important not to store equipment inside the helmet when wearing it!

Performance of foam and hybrids

Foam helmet after impact testing

These can be discussed together, because the foam part of hybrids do most of the work. During impact the foam decelerates the striking object by buckling of the individual foam cells. In order to have a compact, nice looking helmet, the designer usually wants to use the thinnest foam possible, which means using a stiff foam. One problem with stiff foam is that with small impacts, the cells don't buckle at all and the transmitted force is much higher than it could be. The stiff foam protects well against large impacts, but not so well against the smaller impacts which tend to lead to concussion. This also makes foam helmets less suitable for caving.

Softer foam gives a different problem, of bottoming out during high energy impacts. If the striking object is still moving when all of the foam cells have buckled, the transmitted force spikes to an unacceptably high level. A deeper layer of foam would be needed, but this generally leads to lower consumer acceptance for the helmet. Rate sensitive foams could offer a solution to this problem, but so far none have been developed for use in climbing helmets. Another possible method would be to use stiff/soft foam laminates.

Another other area of potential development is the use of elastic foams. Already in common use in multiple impact sport helmets such as American football, these have cells which rebound after impact. Some of the disadvantages of using foam materials for helmets might be resolved if research was made into using foam formulations other than the basic EPS foams, which so far have been almost omnipresent in climbing helmets.

Penetration resistance

One aspect of helmet performance is difficult to characterise: penetration resistance. The requirements for the standards are a pass/fail test. Unlike impact force tests, there is no way of ranking different helmet types. Intuitively, we'd expect hardshell and hybrid helmets to perform better than foam helmets. Some experts agree, but without further testing and research there is no simple answer to this question.

A bit of history

Photo: Jon Barton

Prior to WW2, apart from the rope, the safety aids available to the climber were very limited. The use of helmets of any kind for climbing is virtually unheard of before this time. After the war the number of climbers increased, with a wider social mix than before. The war had led to the development of new equipment such as polyamide ropes and lightweight karabiners, which these new climbers used to protect their climbs. Purpose made leader placed protection became in available in Britain in 1961, harnesses started to become popular in the late 1960s.

In the late 1960s few designs of protective helmet for climbers were available. Most were imported and designed to protect only from stone fall in the Alps. The only helmet offering protection in the event of a fall was the Compton Climber. This was a development from the motorcycle helmets of the time and was heavy and cumbersome, and few chose to wear it. These helmets were glass reinforced polyester resin shells with a 7mm thick layer of cork glued to the inside surface.

Whilst working at a Peak District outdoor centre, the legendary Joe Brown designed a helmet to be lighter than the Compton and offer at least as much protection. The eponymous helmet was manufactured for a time in his garage. Production moved to North Wales and the company became Snowdon Mouldings, which produced the Joe Brown helmet right up until 1996.

In the late 1970s cutting edge climbing helmet technology was still the Joe Brown. The introduction of a new standard by the UIAA, with lower requirements than the existing British standard, resulted in the appearance of new helmets with no padding to protect from side impacts.

Through the 1980s new helmets were introduced, many still using the glass fibre reinforced resin shells but with improved cradles and often without foam to lighten the product. During this time injection moulded polymer helmets started to be manufactured. These were popular due to the low price compared to the handmade glass fibre helmets.

From the 1970s onwards, climbing helmets fell from widespread favour as climbers looked for a free style, cutting away anything that would hold them back and inhibit their connection with the rock. Helmets also became associated with 'the establishment' and following rules went against the rebellious nature of British climbing. As result of this un-cool image helmets fell from favour for the majority of climbers in the UK, saved for designated "loose" crags, and winter and Alpine mountaineering.

Things changed again in 1996 when Petzl introduced the first foam climbing helmet, the Meteor. These quickly became popular as pictures were seen everywhere of elite climbers wearing them. This opened the floodgates and there are now many 'lightweight' helmets on sale. This influx of new designs appears to have tempted many climbers to wear helmets again.

Testing and standards

Testing an old Joe Brown hardshell helmet

To be sold within the EU, climbing helmets must have been independently tested and shown to have met or exceeded the requirements of the EN12492 standard. In addition, if the slightly stricter requirements of the UIAA 106 standard are met, then the manufacturer has the option of applying the UIAA Safety Label to the product.

It should be remembered that standards set minimum performance criteria. There is an argument that standards encourage manufacturers to produce helmets that barely pass. Some manufacturers use this to produce the lightest possible helmet, or to keep costs down and produce budget models. It could equally be argued that it is better to encourage helmet use by competitive pricing and enhancing user friendliness, at the cost of some performance. One of the purposes of the independent BMC helmet testing programme is to give users the option to make an informed choice when buying a helmet, and balance performance against comfort and affordability.

Further Information

The BMC

The British Mountaineering Council (BMC) is the representative body that protects the freedoms and interests of climbers, hill walkers and mountaineers, including ski-mountaineers.

The BMC recognises that climbing, hill walking and mountaineering are activities with a danger of personal injury and death. Participants in these activities should be aware of and accept these risks and be responsible for their own actions.

This booklet is published by the BMC Technical Committee. The committee exists to provide an informed source of technical knowledge and technical advice to climbers, hill walkers and mountaineers on safety related mountaineering equipment and its use.

For more information on helmets and mountaineering equipment, go to the BMC website and click on Equipment Advice.

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Other useful websites

UIAA **www.theuiaa.org**

Black Diamond **www.blackdiamondequipment.com**

Camp **www.camp.it**

Cassin **www.cassin.it**

DMM **www.dmmclimbing.com**

Edelrid **www.edelrid.de**

Grivel **www.grivel.com**

Petzl **www.petzl.com**

Salewa **www.salewa.com**

Simond **www.simond.com**

Wild Country **www.wildcountry.co.uk**

Zero G **www.zerogclimbing.co.uk**