



Body armour for sports players

Many sporting activities involve an element of physical risk whether players are involved individually or as part of a team. Some risks can be alleviated by safe practice and strict adherence to rules and regulations, but others are inherent to the activity and can only be reduced by wearing specialised personal protective equipment (PPE).

Developed to protect against the most likely hazards and reduce the severity of common injuries, PPE has many forms and varies widely from one sporting activity to another. It may be, and often is, embodied into the playing rules. The type of equipment will depend on the ongoing or potential hazards of the particular sport and, where it is well established, it will possibly have been developed over a long period of time, not only for its protective qualities but also to suit the rules and traditions of the game.

Where sports have become competitive more recently, then the need for protective equipment has been identified at an early stage and products have been developed specifically to provide protection. Any subsequent development of the activity has led to the protective requirement being incorporated into the rules with little room for compromise.

Deflecting impact; countering abrasion

PPE has always been a feature of sports where protection is principally required against impacts and blows from balls or sticks. Traditionally this was limited to leg pads and genital 'boxes' but, latterly, protection has been extended to thighs, the chest, arms and the head, even though much of it is subject to maximum dimension limitations. For example the leg pads worn by the goalkeeper in hockey have a specified maximum width that is sufficient to protect the wearer, but prevents the player using oversized

pads as an extra defensive aid. Conversely, batsmen in cricket need impact protection, but are reluctant to wear anything that increases their profile since it could add to the possibility of being caught 'out' from a ricochet.

Sports-based PPE is continually evolving as greater risks become evident in the search for improved performance. Thus shin guards are well-established soccer protectors, but padded vests for goalkeepers are a recent innovation. The skeletal scrum caps for rugby forwards had their devotees and provided the only defence against the machinations of the opposing team in ruck and scrum, but the range of modern product includes full head protection and impact defence for the shoulders and the ribcage.

Protection generally splits into two main categories: against abrasion and against impact, but it is possible for protection to be required against both simultaneously, for example in tobogganing or motorcycling. Where clothing is itself the PPE, then it is inevitably to provide protection against abrasion and cutting. Some sports have a three-dimensional aspect where other forms of protection may be needed, such as buoyancy aids in slalom canoeing.

Protection against impacts and abrasion is achieved in a number of ways. Impacts are often



Brock- lightweight, breathable impact diffusion technology designed specifically for sports.

Displacement, not deformation

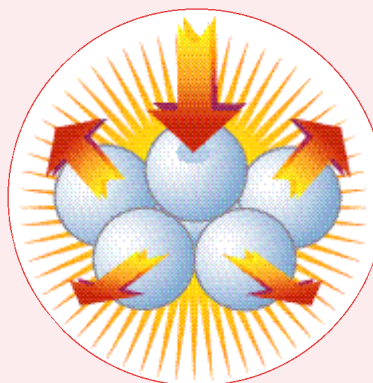
Displacement rather than deformation is the preferred method of impact shock absorption from Colorado-based Brock USA. Using a range of pads filled with closed-cell foam beads, the company claims that not only is impact energy absorbed more efficiently but there is also a significant physiological benefit in terms of a reduction in body temperature during exertion.

What is aptly-named 'independent bead technology' relies on the simple fact that no two solids of equal proportion can occupy the same space. The foam beads are blown and compacted into ergonomically shaped containers manufactured in wicking fabrics to give a range of flexible, 'breathing' pads which mould themselves to the player's body. When struck, with ball, bat or another body, the beads move laterally against each other, transferring the impact energy sideways and dissipating the shock.

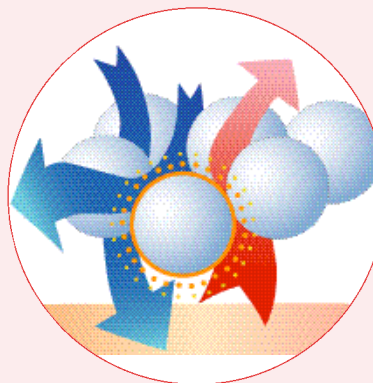
The beads enhance the transpiratory effect of the outer fabric since they also create a series of air channels to assist in carrying heat and water vapour away from the body. Brock USA reports that, in 1999, a series of physiological tests conducted by the Human Performance Laboratory of the St Cloud State University established a significant improvement in the overall stress levels experienced by athletes when using padding manufactured with the bead technology.

Test results showed that athletes padded with its products developed a lower heart rate, improved recovery times, a lower core temperature at peak activity levels and a lower rate of perceived exertion. Fluid loss through sweating was reduced and there was generally less stress on the body. One of the lead researchers, Dr Edmund Burke of the University of Colorado, said: "These results will change the way that the sports world looks at protective padding."

At the beginning of 2001 Brock USA announced that all its foam products would in future have the added benefits of titanium to strengthen the molecular structure and improve the tactility of the pads. Asked for an explanation of just how titanium confers the benefits, Dan Sawyer, Brock's vice president for marketing, said:



Brock's 'independent bead technology' absorbs more energy than conventional sports forms by transmitting it through a multitude of beads.



The Brock system also actively circulates air in all directions, transmitting heat and moisture away from the body.

"You cannot think of it in terms of the titanium we have been used to, i.e. as an additive to produce metallic alloys. In the context of our foam beads we are using the chemical bonding aspects of the titanium as an additive to our adhesion process, taking advantage of the energy of its atomic structure and its compatibility with the energy of our adhesive.

"We are using it to strengthen the bonds between the beads without stiffening the whole. In fact the material does not get stiffer during the process, but becomes more supple overall."

The Brock products are presently being used in the production of padding for team players in hockey, baseball and lacrosse. We are assured that football-based products are in the pipeline.

of extremely short duration and affect only a small area. This spatial and temporal concentration of kinetic energy is what causes the injury. Protectors for use against impacts are therefore designed to slow the energy and spread the force over a longer time and over a larger area. Compressible foams are used for extending the time of impact, but spreading the impact over a larger area requires more rigid materials. Very often a mixture of the two mechanisms will be employed. For example, shin, knee and elbow protectors for skateboarding and in-line skating applications often have a rigid outer shell on top of a softer foam inner. In this case the rigid outer shell also plays a significant role in preventing penetration by sharp objects. Some protection against abrasion takes the form of hard outer surfaces, generally of plastic, which are difficult to wear

down, or otherwise localised padding sewn into garments permanently or restrained using touch 'n' close fasteners. Leather and man-made materials incorporating abrasion-resisting properties, such as DuPont Kevlar and Schoeller's Keprotec, are often used here. Some PPE relies on the 'defended space principle' where the impact energy is diverted around an area at risk with minimal deformation of the product. Perhaps the best example of this is the male genital protector or 'box'.

Flexible protection

Softer, more flexible materials, such as polyethylene and PVC-nitride foams are used in body protectors for equestrian use. They also have application in other activities, such as field hockey and martial arts, where a greater degree of movement is required. These materials may be in

When rider and machine part company

Motorcycling, as sport or occupation, is an activity that demands protection from the elements - and against abrasion when rider and machine part company. Welsh protection-wear specialist Proline is one manufacturer that's made a thriving business and a virtue out of the necessity to protect and support sports injuries. In doing so it hasn't neglected motorcycle riders and produces a complete range of garments in full-grain leather to meet their needs.

The majority of Proline's leather range includes a pocketed facility to fit CE-approved armour in the form of high-density foam pads. Shaped to match the vulnerable points on a rider's body, the pads offer the option to protect shoulders, elbows, the back, hips and knees. Additionally most garments carry inbuilt padding as part of the base specification.

Proline's motorcycling suit includes armour for back, elbows, shoulder, knee and hip areas.



In the sports protection market sector Proline also pioneered the now-growing application of Stomatex neoprene, which uses a perforated and chambered configuration to remove water vapour and heat from the surface of the skin and promotes a comfort-inducing microclimate between the support and the body. The performance factors are particularly relevant to the production of sports thermal wear and the Proline's 'Skins' series of undergarments capitalises on these.

Suggested applications include skiing, snowboarding, sailing, diving and cycling - in fact any activity likely to be carried out in cold, wet conditions and where the necessity to remove substantial amounts of perspiration and heat is vital to maintain warmth and comfort.

Proline's Skins are an under garment range made from breathable Stomatex. It provides immediate thermal warmth and comfort making them ideal for extreme, winter and water sports.

the form of single or multiple sheets, or moulded materials with slots or holes to improve flexibility and cooling.

A number of standards-making bodies have developed sports protection standards world-wide and, while there are a number of differences in approach, the common challenge is to develop laboratory tests that reflect real situations as far as is practical. These must be reliable and repeatable by other testing organisations, while at the same time ensuring some continuity of equipment that keeps the costs of testing to a minimum.

Legislation and conformation

Protective sports products are also subject to legislation, and in the European Union there is a

statutory obligation for manufacturers or importers supplying the European market to conform to the PPE Directive and have their products 'CE' marked. Products, which claim to provide protection against risks of severe injury rather than just minor knocks and abrasions, are considered in the 'intermediate' category. The design of the prototype and associated documentation of these items of PPE must be certified by a Notified Body. This involves examination of the technical file, the basic design data and ensuring that the product conforms to the relevant sections from basic health and safety requirements in Annex II of the PPE Directive. The performance of the product is confirmed through tests and examinations of a sample.



PPE should not introduce additional hazards into the sporting activity. Products should not be designed in any way that could injure either the wearer or anyone who comes into contact with him or her. This is particularly important when considering the methods of fastening or restraint, which should be as innocuous as possible. Many products incorporate touch 'n' close fasteners instead of buckles, deeming the former to be more 'contact-friendly'. Materials should also be free from toxicity and potentially harmful substances. These requirements can vary between countries and suppliers of equipment should check individual regulations with respect to areas such as pH factors and azo dyes.

Testing times and compromise

While it is not practical to reproduce all known injury scenarios to determine whether the PPE is adequate, test methods often involve simulating frequent or 'worst case' situations. Research in the automotive industry investigates forces required to cause bruises or fractures in various parts of the human body, and this information, along with other medical data, is frequently used to set pass/fail thresholds for sports equipment testing methods. Factors also involve assessing which parts of the body are vulnerable and devising test equipment to simulate the hazards.

The amount of the body that the protection covers is also important; insufficient protective area increases the risk of injury whilst excessive coverage reduces ergonomic effectiveness. PPE for sport can sometimes be a compromise between these two issues and this is recognised in many standards by having different levels of protection. The consumer can then make a reasoned and informed choice.

There are many forms of PPE that are intended to prevent some injuries and reduce the severity of others. PPE often has to be a compromise, to ensure protection while still enabling the activity to be carried out. It is the user's responsibility to choose the most appropriate form of protection for their particular sport. In general, the increased use of PPE should help reduce the frequency and severity of many injuries associated with abrasion, impact and sharp object penetration. However, the use of PPE is not a guarantee against injury, since most forms do not protect against crushing and torsion injuries - and are not specifically intended to prevent damage to muscles and ligaments caused by strains and sprains.

A growing trend in some sports is for participants to take greater risks when wearing PPE particularly in team games where one side is better protected than its rivals. As a consequence it is important that all PPE is adequately marked to confirm what form and level of protection is provided, and that sports governing bodies ensure the rules of the sport provide a 'level playing field'.

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Ruling rugby

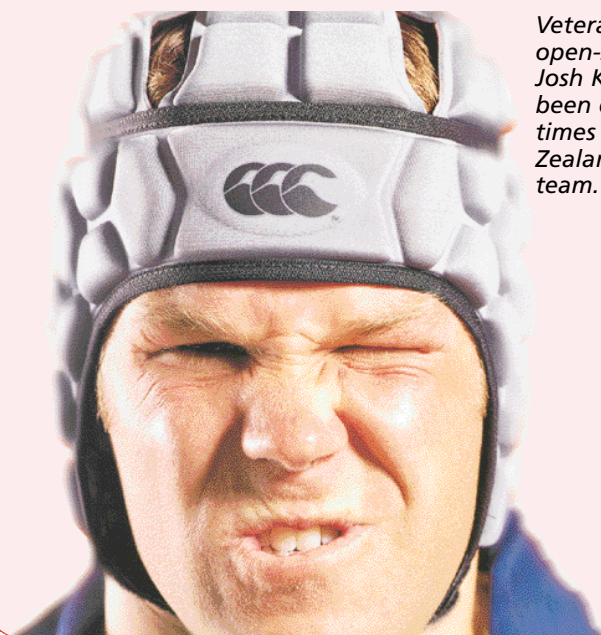
Only in the last decade has the question of headgear for rugby players won any form of universal support. As training and participation in ruck, maul and scrum has moved from rough and tumble to science-based strategy, the function of some form of protection for the skull has progressed from the occasional ownership of a scrum cap (in all its skeletal inefficiency) to the availability of high-tech protective headgear which relies heavily on the science of ergonomics for design and functionality.

A leading light in this evolutionary period, as indeed it has been since the 1920s, is Canterbury of New Zealand. Formed in 1923 solely to manufacture and supply rugby jerseys to the New Zealand national team, the All Blacks, it can be said to have grown in stature and product confidence as the game of rugby spread in influence throughout both the Old and the New World. It supplies team uniforms to over 100 of the world's leading clubs and national squads – and within the last twelve months has launched a full range of padded protective wear including tackle suits, shoulder pads, shoulder vests and head gear.

The last-mentioned piece of equipment lends almost as much visual ferocity as it affords protection – as our picture of All Black Josh Kronfeld shows – but it is all the more remarkable for its high-tech approach to an apparently mundane piece of kit. 'Tech headgear honeycomb', to give its full title, has been developed to fit closely to the planes and contours of the skull. Manufactured in two parts, which are hand sewn together to ensure perfect matching, the overall fit is governed by a laced closure at the back and a touch 'n' close fastening under the jaw.

The 'honeycomb' of the title refers to the shape of the segments moulded in closed-cell foam into the lower half of the helmet. Their interactive edges allow the helmet to provide protection from temple to jawline, without loss of coverage due to deformation or gapping. A fully guarded ear opening enables coaching or captain's instructions to be heard clearly and Canterbury claims that the helmet does not restrict peripheral vision in any way. The segments of the upper area are rectangular in section, providing the requisite protection and a more or less flat surface to opposing heads, shoulders, elbows or knees.

The helmet's interior is lined with a smooth synthetic knit; both this and the foam have been treated with an antibacterial process to inhibit the growth of mildew and bacteria even after a week at the bottom of a gear bag.



Veteran All Blacks open-side flanker, Josh Kronfeld, has been capped 54 times for the New Zealand national team.