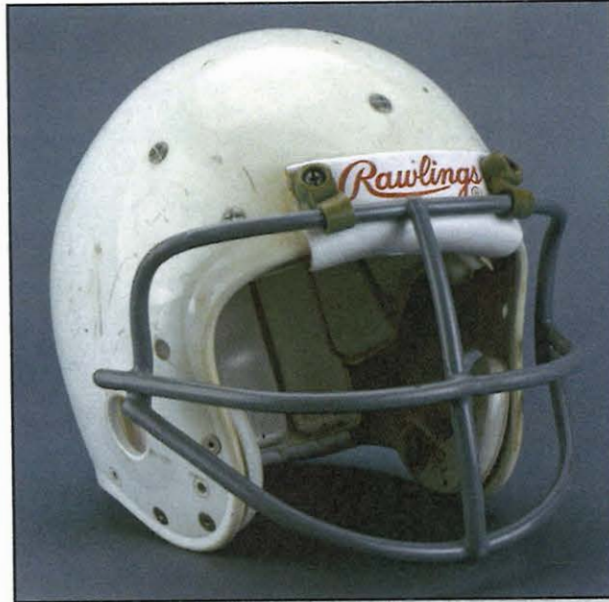


Spalding and Rawlings continued in the field launching new models periodically.



Spalding Titanite. Photographed by Stephen Fenn.



Rawlings RTS-1 football helmet, c. 1980.
Photographed by Stephen Fenn.



Rawlings interior.



Spalding Titanite interior.

Rawlings was involved in the football business as far back as 1899. Their first football helmet, a leather head harness lined with felt, was apparently introduced in 1909. In 1946, they introduced their first helmets with molded plastic shells. The model shown here from the early 1980s employs a most ingenious approach to energy management and ventilation by using the rubber tube matrix seen here. In 1988, Rawlings Sporting Goods decided to stop manufacturing or selling football helmets. Rawlings was the 18th company to discontinue the manufacture of this product, joining Hutch, Spalding, Wilson and MacGregor.⁴⁸

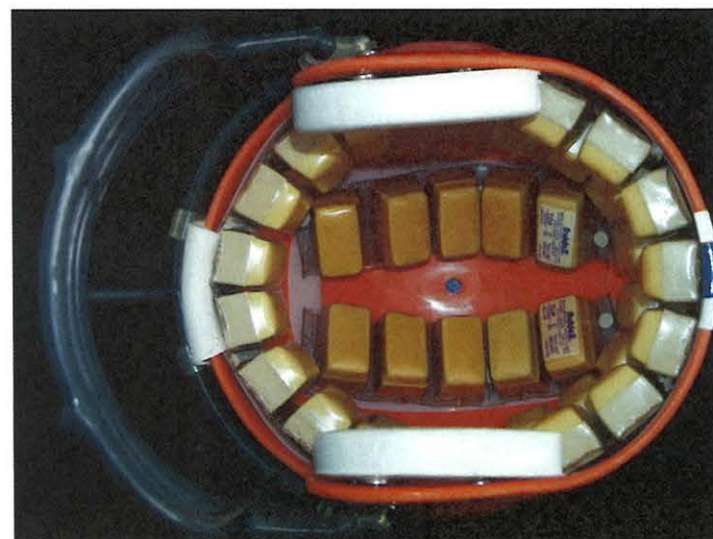


Riddell PAC-44
helmet, c. 1975.
Author's collection.

In 1971 Gerry Morgan, later to become CEO of Riddell, was granted a patent for a helmet with an inflatable liner. Production models were designated as *MICROFIT* helmets. They also had interconnected chambers filled with glycol that channeled back and forth upon impact. They were heavier than the suspension models and did not ventilate as well either so the suspension design hung around for quite a while before disappearing for good.

In the mid-seventies, Riddell introduced the PAC-3 helmet which had 32 individual vinyl air cushions with layers of energy-absorbing foam inside. PAC stood for *padded aero cell*. The PAC-44 shown here was a youth version of the PAC-3.

NOCSAE label and logo prominently molded into the rear of the shell as it continues to be today on certified headgear.



PAC-44 interior.

Following the publication of the NOC-
SAE standard in 1974 (and the subsequent
requirement by all football organizations
in the US that helmets be NOCSAE certi-
fied), many manufacturers dropped out of
the field.

In the early 1980s, Riddell refined the
PAC-3 design and introduced the WD-1.
This helmet did not have air inflatable
bladders and size accommodation was via
different size shells and relatively soft foam
backed up by stiffer energy-absorbing ma-
terial. In 1986 the design was superseded
by the VSR (Variable Size Range) series of
helmets which reintroduced air bladders
to Riddell's helmets.

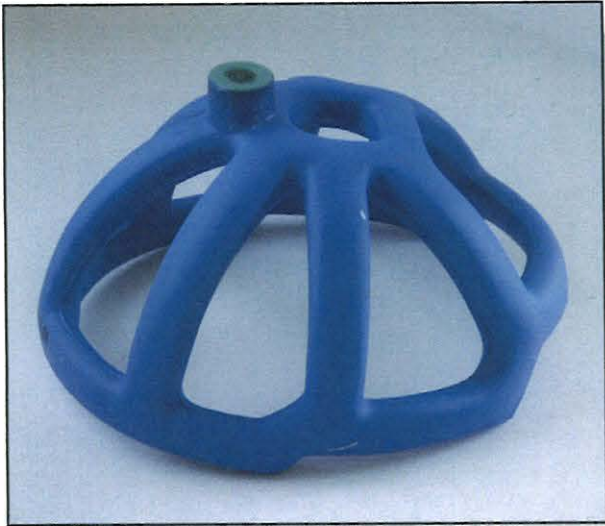


The Riddell VSR-4, introduced in 1992, is still a
popular helmet today.

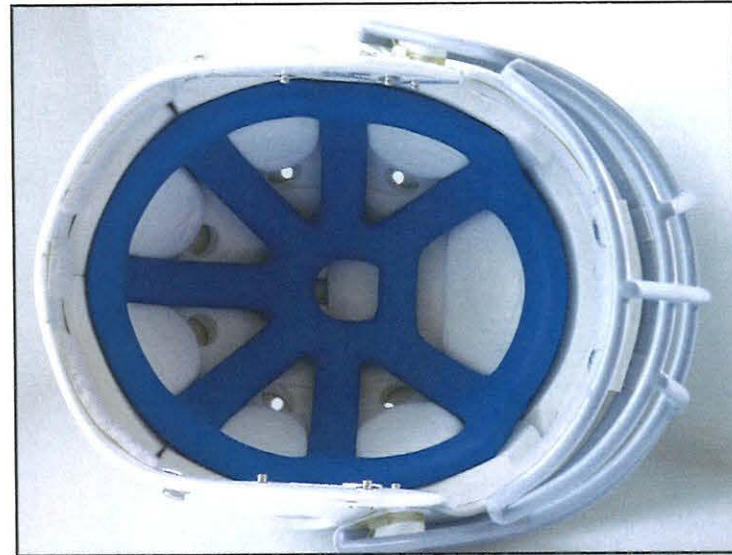
Schutt Sports, the other big player in the
football helmet business, has actually been
around since the early 1900s. It manufactured
and sold faceguards for football as far back
as 1935. In 1987 it acquired and marketed the
Air football helmet, first introduced in 1974.
This was actually the first helmet to have a
separate inflatable liner system.



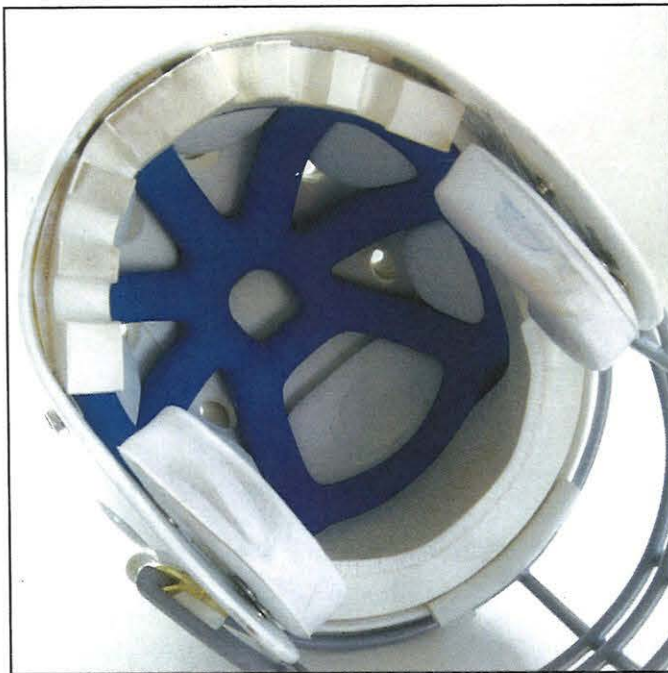
The Schutt Air helmet.



The Schutt internal bladder.



Helmet interior minus the cheek pads and the forehead and back padding.



Fully assembled interior. Various padding thicknesses allow different head sizes to be accommodated.

For the next 20 years, very little change occurred in football helmet design. However, in the early 2000s, substantial design innovations started to take place. Precipitated by an unhealthy and highly publicized flurry of concussions to NFL stars, companies decided it was time to upgrade their products. Two manufacturers had pretty much dominated the field, Schutt and Riddell. The Bike Athletic Company introduced its new helmet in 2000. When the company making many of the Bike helmet components filed for bankruptcy, the Bike helmet design was acquired by Adams USA.

Adams USA, originally Adams Plastics, started in the athletic sporting goods business in the early 1950s with the design of a new and better football mouthguard and of better helmet chin straps. In 2005, they reintroduced an improved model the *Elite* shown here. It is a somewhat complex construction employing within its polycarbonate outer shell, an EPP resilient liner as well as a vinyl nitrile padding system for impact energy management. In addition there is an air inflatable bladder system to customize fit.



Adams Elite football helmet.



Elite interior. A complex and very sophisticated energy management system.



Schutt DNA football helmet. Looking quite traditional on the outside, with the exception of the spiffy vent holes, the DNA's innovations are on the inside.

Schutt's newest helmet, the DNA, goes way beyond simple inflatable liners. It does employ crown and lateral air bladders for fitting but the use of Skydex padding is a first for impact management. The ultimate success of this approach remains to be seen, but it certainly appears promising.



Schutt DNA cross section.

Riddell's entry into the new football helmet field is both conventional and in some ways radical. The interior energy management system is made entirely of vinyl nitrile foam padding of a single uniform density. Unlike other helmets, its air bladder system for fitting the helmet is integrated with the main padding system. The most radical design change was to the ear-chin area. The shell and the padding are extended forward quite a bit more than earlier design. In addition, the conventional cheek pads that did little for impact management have been replaced by more suitable energy-absorbing foam. These changes appear to have reduced the incidence of concussion by over 30%.⁴⁹



Revolution interior.



Riddell Revolution football helmet.

As you can see, football helmet design has changed but not significantly in the past 50 years. Little by little, it's been getting better. But until some fundamental changes are made to the way these helmets are evaluated in the lab, i.e. how they are tested, very little additional progress can be expected. Fortunately, there are efforts afoot to refine the relevant standards and to make performance requirements more in line with the reality of American football — rather than relying solely upon intuition as we have had to largely rely upon till now.

6.5 Hockey Helmets

Injuries of course can occur in any athletic endeavor. This is particularly true in the case of ice hockey. The high speeds of the players, the ballistic nature of the puck, the really hard surface of the ice and the boards, and as someone once put it, *zealous young men with knives on their feet and clubs in their hands*, all add up to injuries. Over the years in North America and Europe, head and facial injuries have been inflicted during game play. Injuries are most often not life-threatening, but concussions are common and there has been the occasional fractured skull and fatality. In spite of the apparent dangers of the game, widespread use of protective headgear was not the custom until the mid 1970s.

Awareness of the need for head protection may have first come to the public's attention when, in a game between the Boston Bruins and the Toronto Maple Leafs in 1933, Boston's Eddie Shore, who had been dumped by the opposing Ace Bailey, retaliated and brought Bailey down. Bailey's skull was badly fractured and his career ended that night.

In February 1934, Shore and Bailey met again at Toronto's Maple Leaf Gardens but this time to simply shake hands. Ironically, Shore came that night wearing a leather helmet, becoming one of the pioneers of head protection in hockey. (*Hockey Hall of Fame*).



In Europe, the first country to take these matters seriously was Sweden, where the use of helmets began in the mid 1950s and became mandatory for all players taking part in the game in 1963. All players were required to wear Swedish Hockey Association *approved* helmets.

Two years later in 1965 the Canadian Amateur Hockey Association made helmet wearing mandatory for all non-adults playing as amateurs. Subsequently the Amateur Hockey Association of the United States established a new rule requiring players to wear head protection as well. Unfortunately at that time, except for the rather ill-defined standard in Sweden, there were no accepted performance specifications for hockey helmets and many of them were little better than nothing at all.

In January 1968 Bill Masterson of the Minnesota North Stars became the National Hockey League's first fatality. During a game he fell and struck the back of his head on the ice surface. Needless to say Masterson was not wearing any form of protective headgear. That same year, two teenage hockey players in Canada died from closed head injuries sustained even though both were wearing *helmets*. This led to a request by the CAHA to the Canadian Standards Association to form a technical committee to develop a set of realistic performance specifications for hockey headgear and for a procedure to certify product to that standard. The CSA technical committee was charged with this in 1969. In 1975 the first CSA standard for hockey helmets was published and that same year all CAHA players were required to wear CSA certified helmets.

Hockey is well known for its occasional outburst of violence between players during a game. Usually this results in more bruised egos and fists than bruised heads and faces, but sometimes things can get out of hand. One of the more memorable fights occurred over 35 years ago. In 1969 during an exhibition game in Ottawa, Wayne Maki and Ted Green had a serious duel with their sticks. Green sustained a major skull fracture which was expected to end his career. But the following year, after extensive surgery and rehabilitation, he returned to the ice and continued as a Boston Bruin, this time helmeted, for nine more years. 30 years later, though helmeted, Donald Brashear became the victim of a vicious whack on the head from Marty McSorley's stick.

It took until 1979 before the National Hockey League and the NHL Players Association agreed on mandatory helmet use. Even then, many players refused to wear a helmet because they were *uncomfortable*. In reality however, in those days the doffing of ones helmet was a signal to the world that you had made it to the big-time, the NHL. One can only speculate if the career of former St. Louis Blues defenseman Ed Kea might not have ended from head injury in 1983 had he adopted the new NHL policy on helmet wearing.

Back in the 1930s, helmets available to Shore and others were typically of the soft padded leather hat variety such as the Stall and Dean models shown here. The first is their model 5672, the second the subsequent 5673. Both have sewn on chin straps and both provide the same limited size adjustment via

the three separate front tangs which are tied at the top with the lace shown. The *newer* model provided additional external padding over the ears and it had a slightly different chin strap. The concept of external pads over the ears would surface again some 40 years later.



Stall and Dean Model 5673 leather hockey helmet, c. 1930. *Author's collection.*



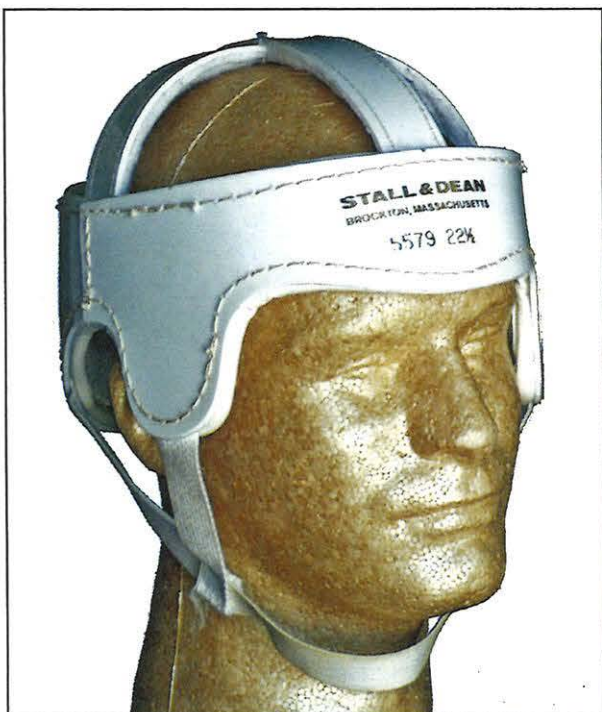
Stall and Dean Model 5672 leather hockey helmet, c. 1930. *Author's collection.*



Top view of Stall and Dean leather hockey helmet.

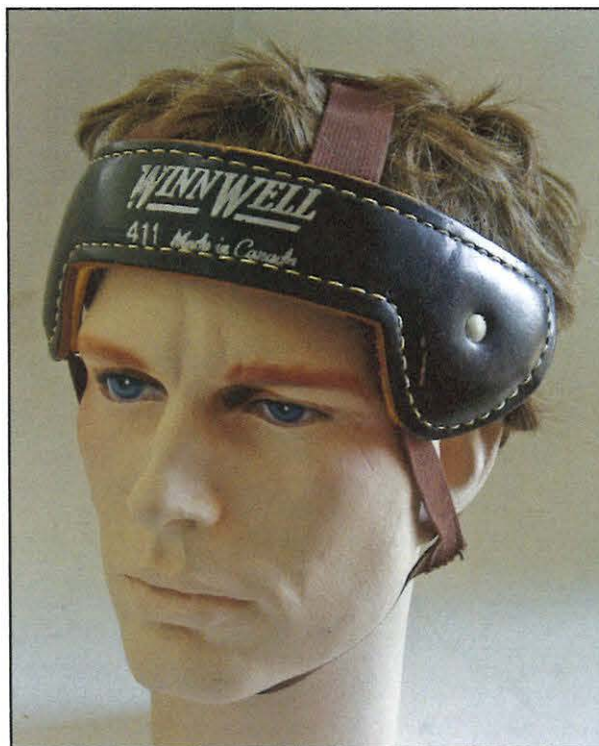


Interior view of Stall and Dean leather hockey helmet.



Stall and Dean Model 5579 Plastic hockey helmet. *Author's collection.*

With the increasing popularity of plastics, by the 1950s Stall and Dean had switched from leather to the plastic hat version shown here. Made from sheet polyethylene with some rudimentary cotton padding sewn inside, this non-adjustable unit did little more than perhaps protect against some lacerations for those whom it fit. (Those with a 22.5 inch circumference head.)



Other manufacturers also produced leather helmets such as the model by Winnwell shown here. With no adjustability as such, fitting was accomplished by the elastic straps that held the several pieces together. This model employs hard leather formed somewhat to accommodate the shape of the head

The Winnwell 411 leather hockey helmet, c. 1940. *Author's collection.*





The Mastercraft S1133 hockey helmet — probably manufactured by Stall and Dean. The helmet shown here was sold exclusively under the Mastercraft brand at that most Canadian of all stores, Canadian Tire. Helmets don't get much simpler than this. Two lightly padded, more or less flat, bent pieces of plastic held together with elastic and leather straps. The draw string at the top of the unit provided the only, limited, adjustability. *Author's collection.*



A slightly more elegant model was made by Copper Weeks Ltd. It consisted of three die-cut heat shaped plastic sheets which were held together with nuts and bolts. The inner liner was sheet polyethylene foam — the kind used as packaging material, which was sewn to the plastic shell pieces. The cloth chin strap was sewn in place also. The name Cooper would appear for many years on hockey helmets and the designation SK would become their trademark for (nearly) all successive designs. In fact shortly after this model, *Weeks* disappeared from the title and a new, though similar, Cooper SK10 was introduced.

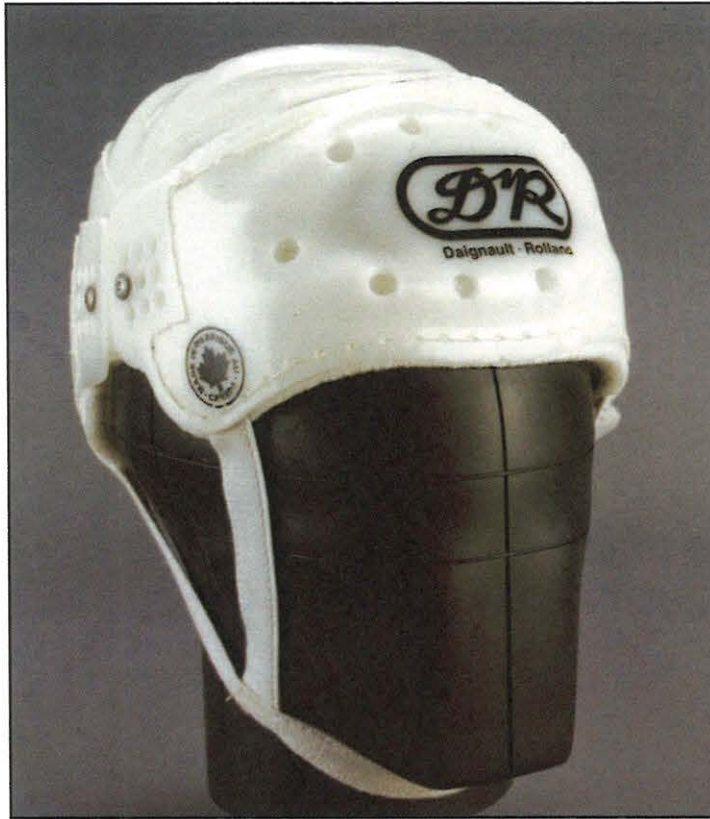


The Cooper Weeks SK10 hockey helmet. *Photographed by Stephen Fenn.*



The Cooper Weeks SK10 hockey helmet.
Photographed by Stephen Fenn.

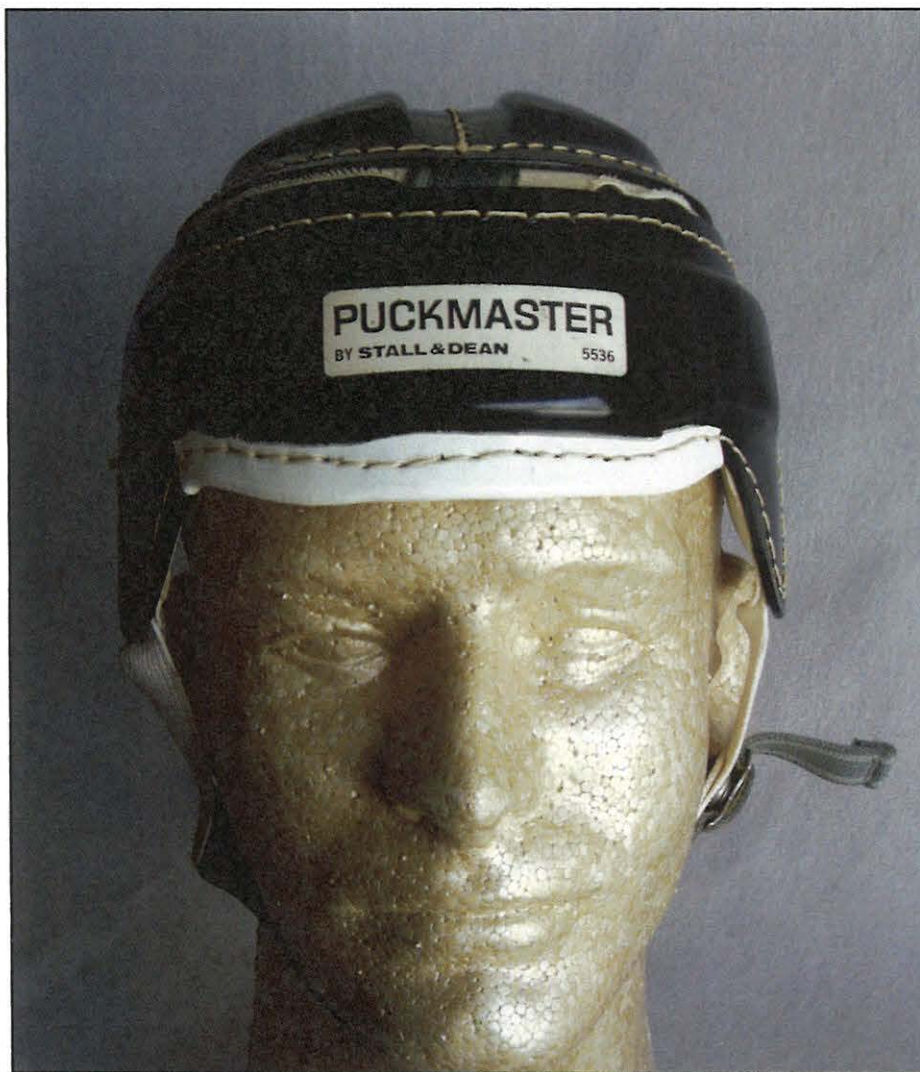
Another Canadian Manufacturer, Daignault-Rolland, had a more sophisticated design as shown here. The helmet comprised three separate pieces each heat formed to produce fairly complex shapes. This served not only to give a different appearance but also structurally stiffened the plastic elements. Like the Cooper Weeks SK10, the shell pieces were attached to each other with nuts and bolts. This, in principle, allowed the helmet to be adjusted to a wide variety of head shapes and sizes. The interior padding was die-cut polyethylene foam sheet which was sewn to the shell. The much less popular Stall and Dean model 5563, also shown, was of similar design except the pieces were connected by fabric straps not metal hardware and the interior padding was fabric not foam. Both were typical of the day but, except for minor cuts and scrapes, neither provided much in the way of head protection.



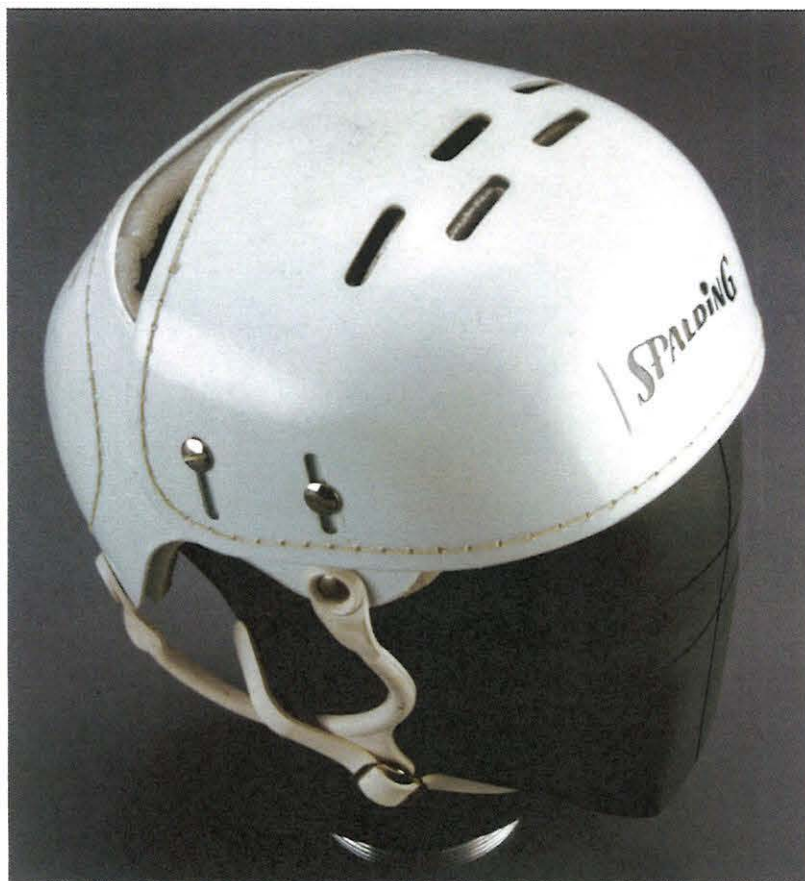
The D-R hockey helmet. Photographed by Stephen Fenn.



Yet another vintage Stall and Dean model is the Puckmaster shown here. Again simple plastic sections held together with elastic tapes and padded with rudimentary fabric lining.



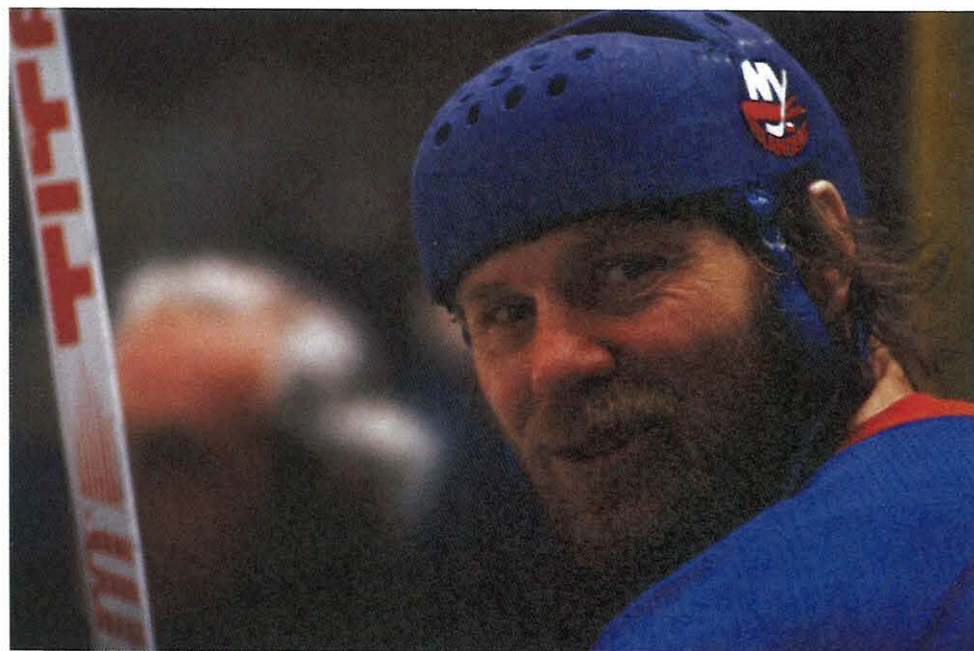
The Puckmaster, front view. *Author's collection.*



The Spalding HH5. Photographed by Stephen Fenn.

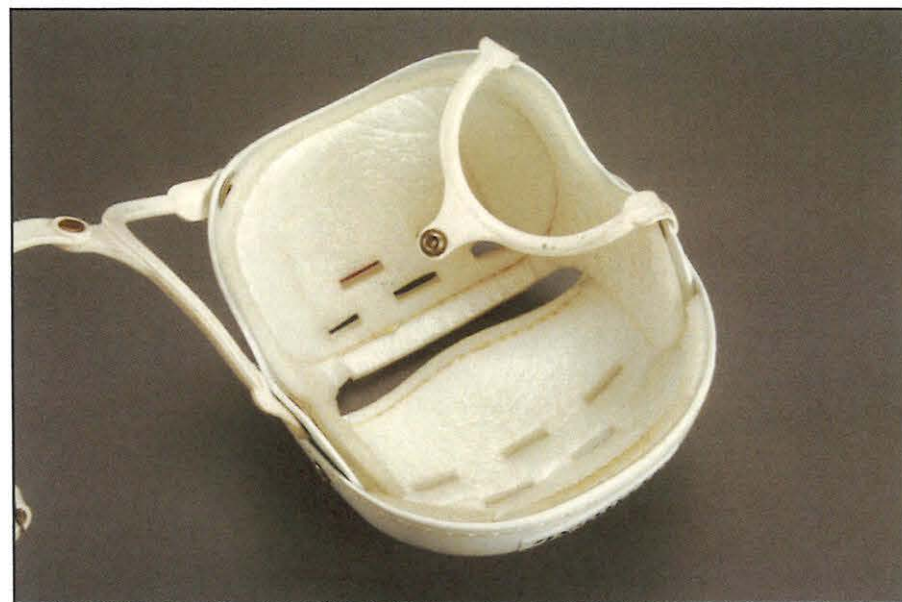
That venerable sporting goods company A. G. Spalding, first entered the hockey helmet arena in the late 1950s with its 2-piece HH5 unit. (It seems there was no HH-3 or 4 and, curiously, HH-1 and 2 were yet to come). The shell components were rather deeply drawn and covered as much of the head as the earlier 3-piece designs. The interior padding was, like the competition, thin polyethylene foam sheet sewn inside. However the chin strap arrangement was new. Molded from pliable plastic and riveted to the shell, it was the first of what would become, more or less, standard hockey helmet retention system design.

Robert *Butch* Goring's 16-year career included time with Los Angeles and Boston, but he will best be remembered for helping the New York Islanders win the Stanley Cup four times in the early 1980s. A tough guy, he played 379 games without missing one to injury. Goring was famous for a helmet, given to him when he was 12 years old, which he wore for his entire professional career, many times painted over to match the team color. *Paul Bereswill photo, Hockey Hall of Fame.*

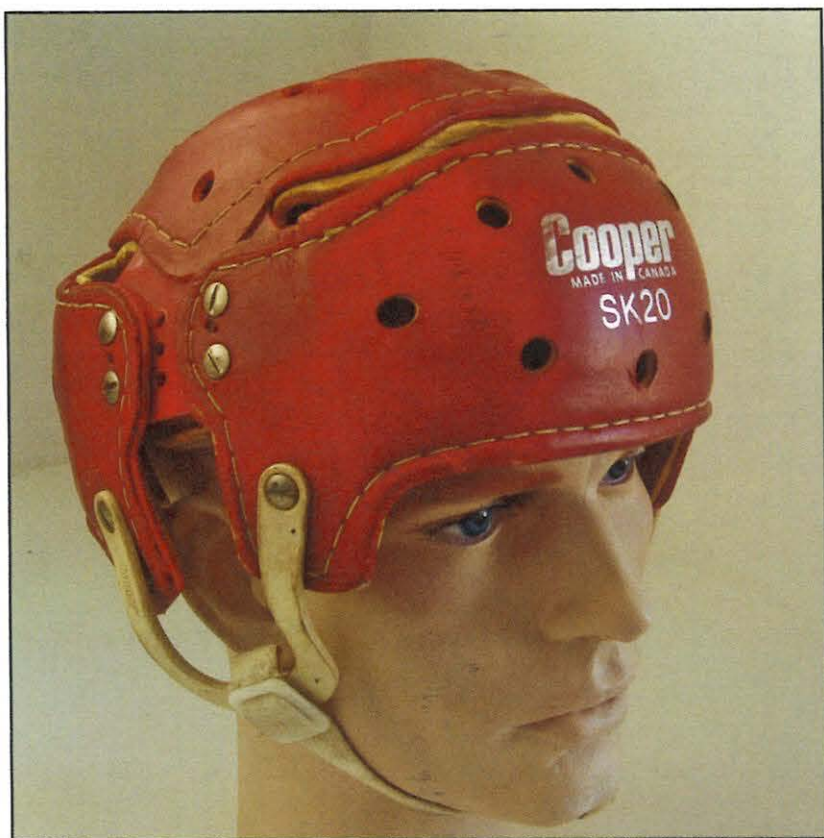




The Spalding HH5 back view. *Photographed by Stephen Fenn.*



The Spalding HH5 inside view. *Photographed by Stephen Fenn.*



Cooper SK20, c. 1965.
Author's collection.

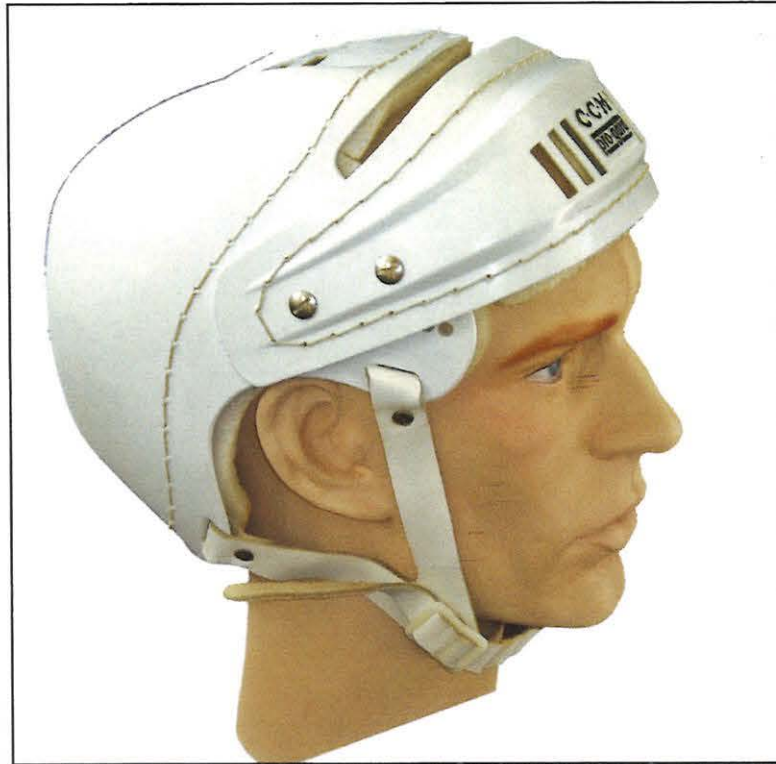
Around 1960, Cooper, now divorced from Weeks, introduced the SK10 based largely on the same former model designation. However, in 1965, they introduced the Cooper SK20 shown here. This was quite a complex design. The three plastic shell components, which permitted size adjustment, were covered with leather on the outside. The interior padding comprised a thin layer of Ensolite®, a closed cell rubber foam, which is also covered with soft leather. The entire assembly was stitched together in the style of the times. This design provided considerably more impact protection than any of the former models.



Cooper SK20 interior detail.

Another proud Canadian company to get into the hockey business was CCM. The Canadian Cycle and Motor Co. Ltd., which was founded in 1899, was mainly involved in the production of bicycles. Their Pro-Guard hockey helmet, introduced in the mid 1960s became virtually an icon and the general design theme has been continued into the new millennium. The design shown here consisted of two injection-molded, high-density polyethylene (HDPE) pieces attached with 4 nuts and bolts. The forehead piece could be adjusted fore-aft for better fitting. The interior liner continued as the familiar sewn in place, polyethylene foam. The chin strap however was at the time novel, in that it was completely made of leather.

CCM declared bankruptcy in 1983 and its hockey equipment interests were purchased by others. The CCM brand name continues on all types of hockey equipment.



The CCM Pro-Guard, c. 1960. *Author's collection.*



A competitor of CCM, Winnwell, introduced its version of the two-piece helmet at about the same time. The difference was that the size of the helmet could be adjusted without the need for tools. The two pieces were simply clipped together as shown here. Also the injection molded high density polyethylene parts were considerably thicker and the liner was thicker more durable, rubber-like, closed-cell foam which was riveted in place. This design probably afforded somewhat more protection than the previous designs but it was not well accepted in hockey and, in any event, was about to become obsolete when the CSA standard was introduced in 1975.

The Winnwell hockey helmet, c. 1975. *Author's collection.*



Winnwell rear view.



Winnwell side view showing size adjustment mechanism.

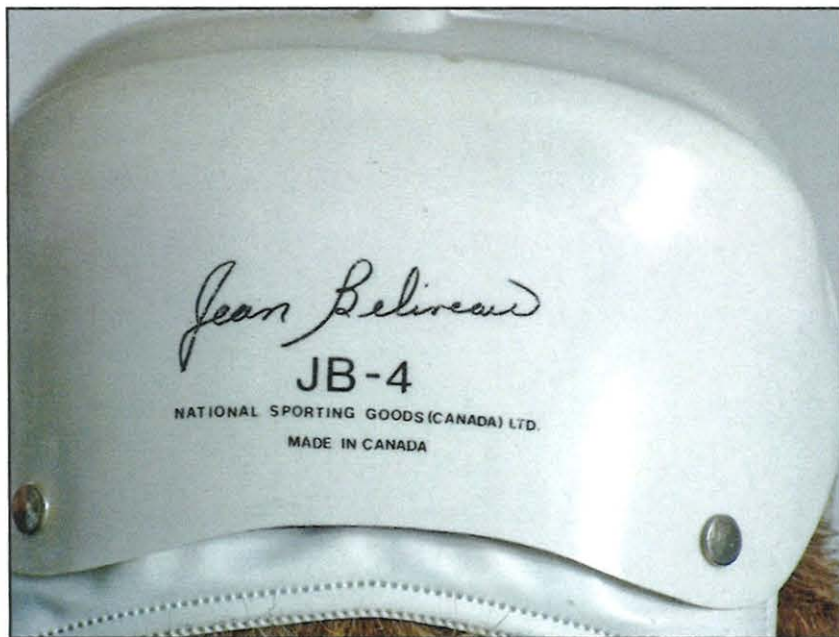


Winnwell interior.

Another *victim* of the new Canadian standard was this design produced by National Sporting Goods of Canada. The two shell sections were injection molded of polycarbonate. This was the first hockey helmet to be made of *space age plastic*. The shell components were of rather complex shapes and the inner liner was quite different from other hockey helmet designs. In fact, the inner suspension system was something of a throw back to much earlier times to the *inverted hammock* design. Despite being endorsed by one of hockey's greatest players (though he never wore a helmet during his illustrious career), the design would disappear after 1975.



National Sporting Goods hockey helmet — referred to sometimes as the *Patterson helmet* after its developer Charlie Patterson. *Author's collection.*



Jean Beliveau endorsement signature.



interior view.

In order to meet the newly published Canadian standard, CCM had to make some radical changes to its design. All new shell tooling had to be built to accommodate a thicker interior lining and the gaping openings above the left and right forehead had to be closed to meet the penetration requirement.

The new shell pieces were injection molded polycarbonate and the liner was a relatively thick foam polymer. The shell shapes were very complex for its time and the tooling for these parts would have been very expensive. When it came time to certify the design, it was found that it failed the impact requirements when struck on the side. The tooling could not be easily modified and there was not enough room inside to add thicker padding. That was when some brilliant fellow at CCM came up with the solution that appeared for many years as part of hockey helmet design lore — the external pads above the ears. (Maybe he'd seen a vintage Stall and Dean 6573 model helmet?).



Close-up of Henderson's CCM helmet.



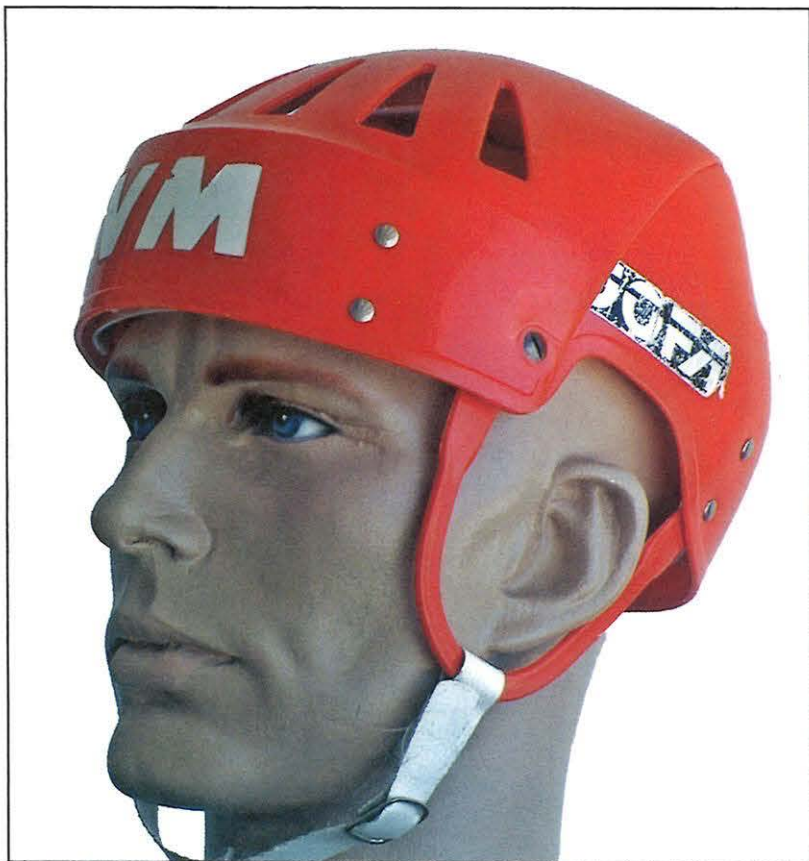
Paul Henderson a Toronto Maple Leaf regular, is probably best known for scoring the winning goal in the Canada-Russia series in 1972. *London Life-Portnoy photo, Hockey Hall of Fame.*



The redesigned CCM helmet with the side bumpers. *Author's collection.*



In Sweden, JOFA was first established as a manufacturer of ski poles in 1926. In 1960 it began to market hockey products and at the same time began the development of its first helmet. In 1962 its first model was accepted by the Swedish Hockey Federation and it was worn by the Swedish Gold medal team at the World Cup at Colorado Springs that same year. An example of that helmet is shown here. The VM on the front is Swedish short form for World Championship.



Early Jofa style interior.

Early JOFA hockey helmet, c. 1960.
Author's collection.



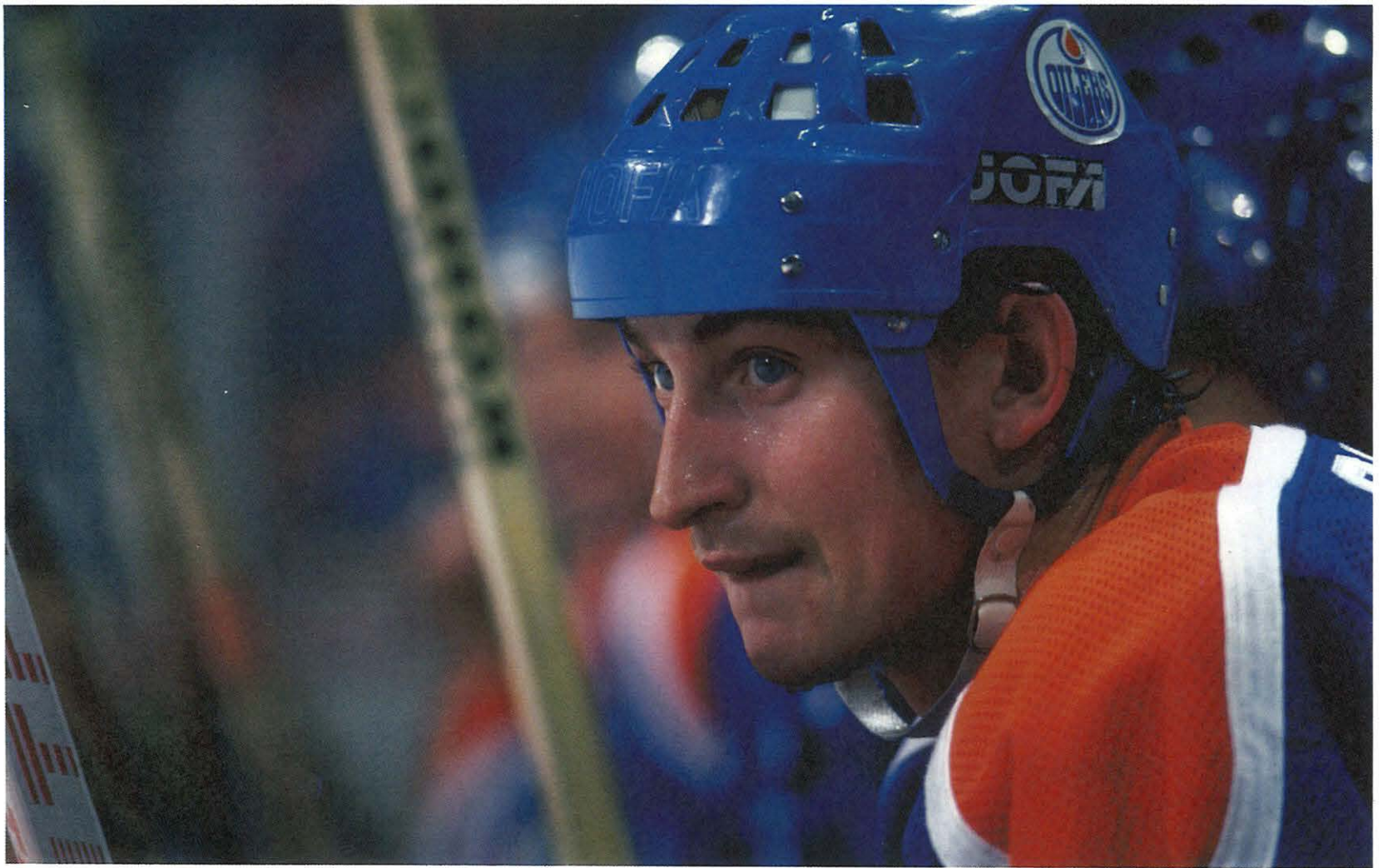
Jofa Model 51234 helmet interior.

The interior of these helmets was an elementary suspension system incapable of absorbing much impact. The earliest model had a series of small plastic spikes molded into the hat band. Presumably these would deform on impact and thereby provide some limited impact energy absorption.

In 1972 the entire Russian team was equipped with JOFA helmets in the unforgettable Canada-Russia tournament. This model (in blue), used a simple padding-suspension design in place of the spikes. This helmet, and variations of it, was subsequently adopted by several (not just Swedish) players in the National Hockey League



The model 51234 Jofa, the Wayne Gretzky helmet. Author's collection.

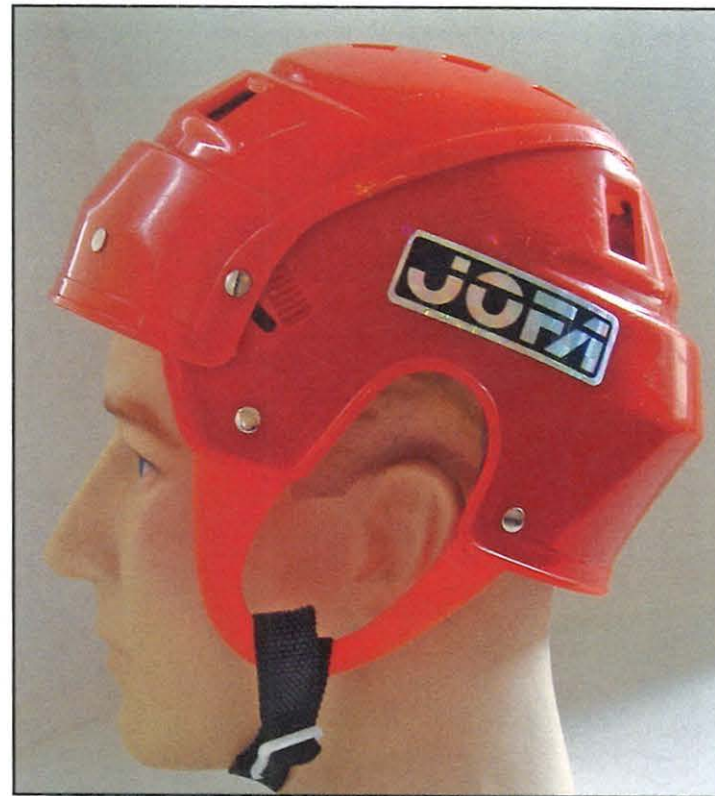


Holder of more awards, records and citations than any other player in the history of the sport, the *Great One*, #99, Wayne Gretzky. *Paul Bereswill photo, Hockey Hall of Fame.*

Without much argument, one of the greatest hockey players of all time is Wayne Gretzky, a fan of JOFA helmets, he had worn the lightweight design for several years before signing an endorsement agreement with JOFA in 1982. Though the JOFA design had progressed to meet the new CSA standard requirements, Gretzky continued to wear the old fashioned version and it became known as the *Gretzky helmet*.



The new generation JOFA helmet retained all of the characteristics of the older designs but, like CCM, it was bigger to accommodate a new thicker liner. The first such design is shown here. *Author's collection.*

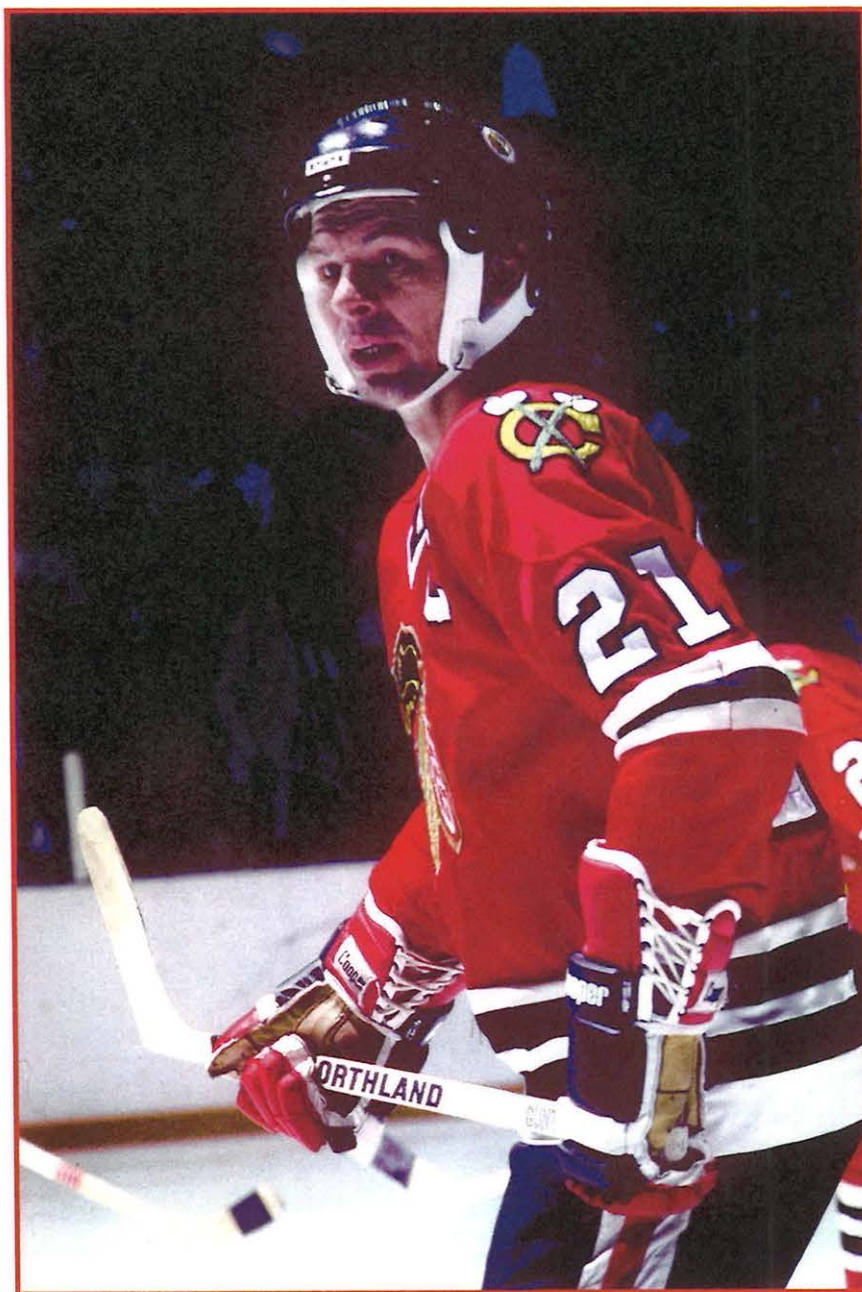


The Jofa side view showing the size adjustment feature.



Jofa padded interior. Not bad, but not good enough to meet the new CSA standard of the time.

One of the best forwards ever to play the position in the history of the National Hockey League, Stan Mikita won awards in numbers not seen again until one Wayne Gretzky arrived in the NHL. Mikita's brilliant career spanned a 22-year period before he retired in 1980. (*Hockey Hall of Fame.*)

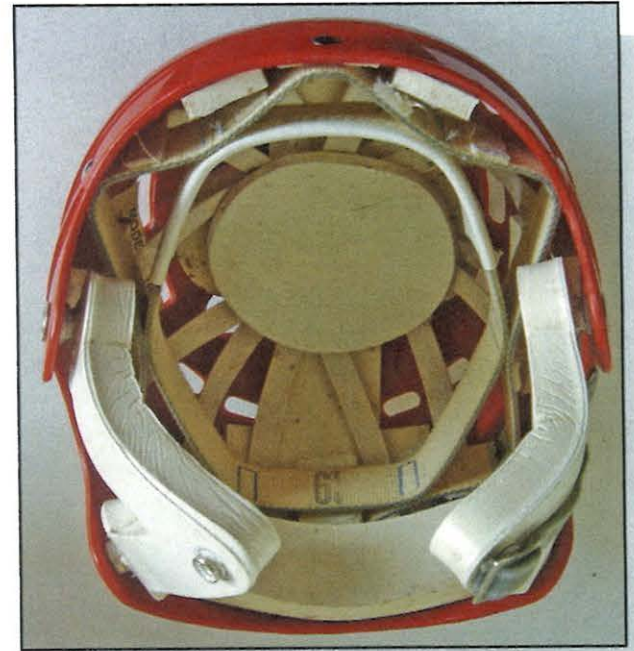


Yet another hockey great, Stan Mikita, made a most significant contribution to helmet design.

At the time when concern for head injuries in hockey was growing, he looked to American football and came up with the model shown here. Like football helmets, his design incorporated a single thick-walled shell with a Riddell-type inner suspension. Unlike football helmets, the shell provided lots of vent openings and the lower portion was cut away to help reduce weight (and improve hearing). The chin strap design was very unusual in that the yokes were heavily padded with foam rubber. The overall design was quite popular with some NHL players. However, it was a complex design, heavy and expensive, and it could not be adjusted to fit different/changing head sizes. The various designs were produced at different times by different companies including Northland and Protective Products Inc. The CSA certified version shown here, like the CCM helmet, also needed a little extra padding on the outside — on the back instead of the sides. This also served as a convenient place for Mikita's signature. A version of this helmet model was introduced later which used a more contemporary interior padding system. It was somewhat lighter and cheaper, and needed no extra padding on the outside, but it still was of a fixed size and the design did not survive beyond the late 1970s



The Mikita helmet by Protective Products. *Author's collection.*

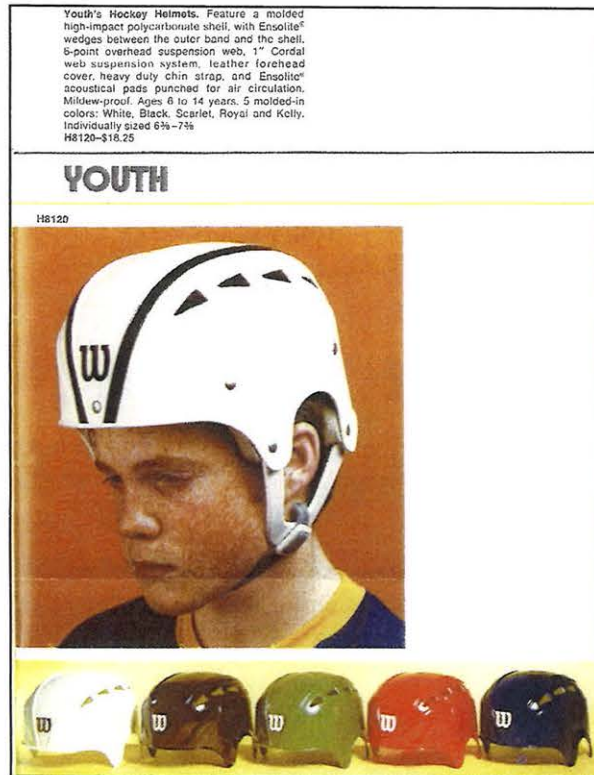


Other players in the football helmet business tried to make it into the hockey helmet field, Wilson and Rawlings being among them. The Wilson H8120 model advertised and shown here also incorporated a football interior suspension. It was produced between 1972 and 1976, but was never certified and, like the Mikita design, disappeared from the market place.

Youth's Hockey Helmets. Feature a molded high-impact polycarbonate shell, with Ensolite® wedges between the outer band and the shell. 5-point overhead suspension web, 1" Cordal web suspension system, leather forehead cover, heavy duty chin strap, and Ensolite® acoustical pads punched for air circulation. Midkew-proof. Ages 6 to 14 years. 5 molded-in colors: White, Black, Scarlet, Royal and Kelly. Individually sized 6½-7½. H8120-\$16.25

YOUTH

H8120

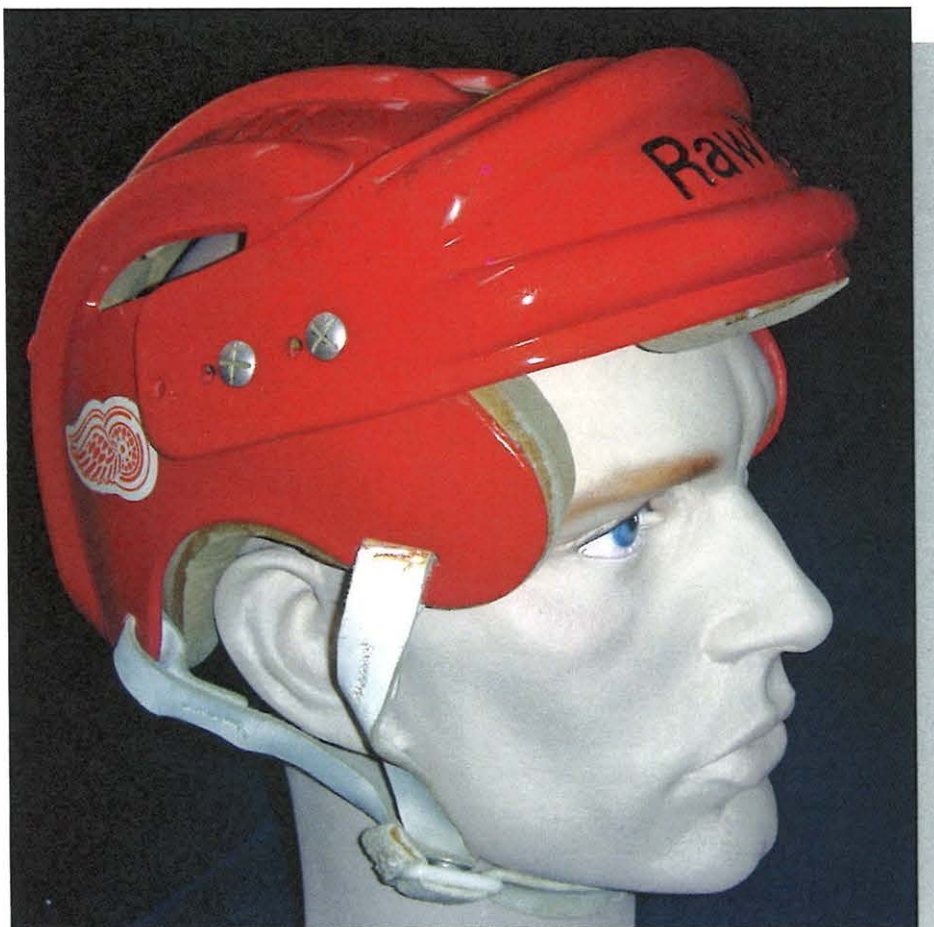


Advertisement for the Wilson Youth hockey helmet. *Courtesy Wilson Sporting Goods.*



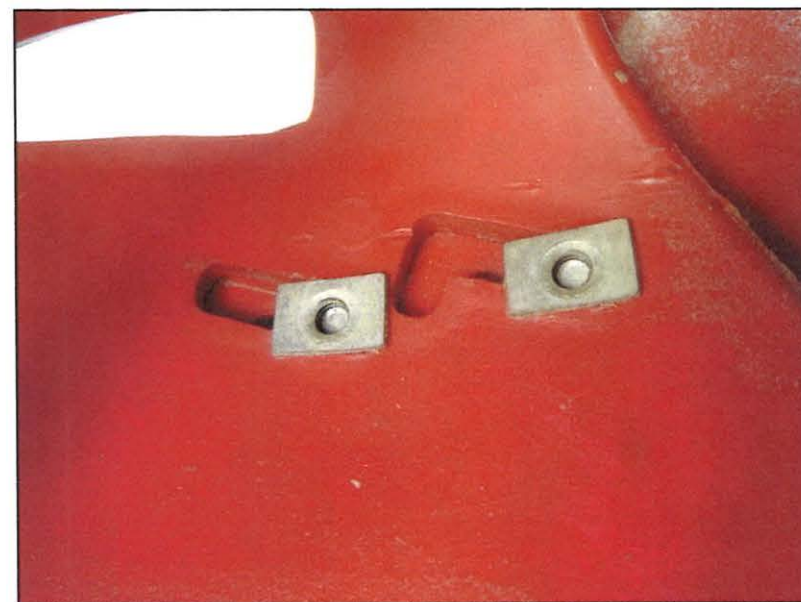
The Wilson hockey helmet. *Author's collection.*





The Rawlings hockey helmet. *Author's collection.*

Rawlings took a CCM-like approach with a padded interior and a two-piece adjustable shell. Frankly, the design was not well executed. It didn't fit very well and the range of adjustability was so limited as to be virtually worthless. The design was not certified and did not last too long after its introduction.

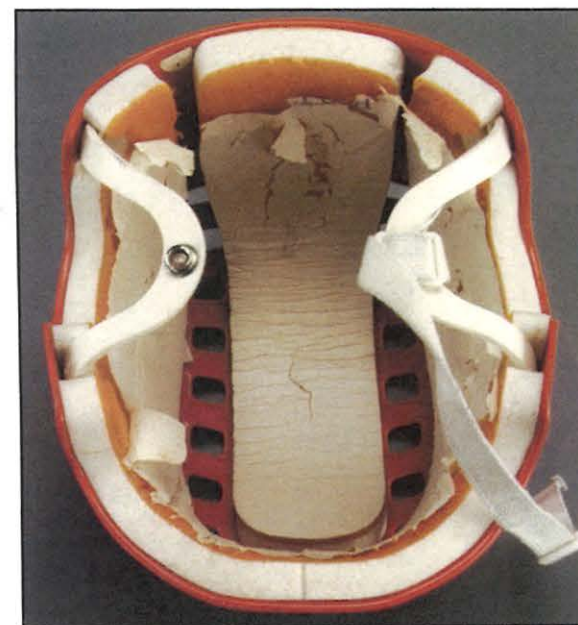


Rawlings helmet size adjustment feature.

One of the oldest and most respected names in the hockey business was Cooper. Making helmets since the 1940s, when the new standard came into effect in 1975, Cooper responded with the SK300 shown here. Like the Mikita and Rawlings design, the shell was an injection molded one-piece unit with vent openings molded in place. The interior comprised thick die-cut, sheet stock padding elements that were glued in place. The *skin* of these pads did not always survive the sweat and abuse of extended play, but they actually worked better than the complex suspension designs. Like some of the competition, the helmet was available only in discreet sizes and could not be adjusted. This was a problem for many parents of children with growing heads. A new helmet every year? In spite of this, this model and its identical successor, the SK500, hung around for quite some time.



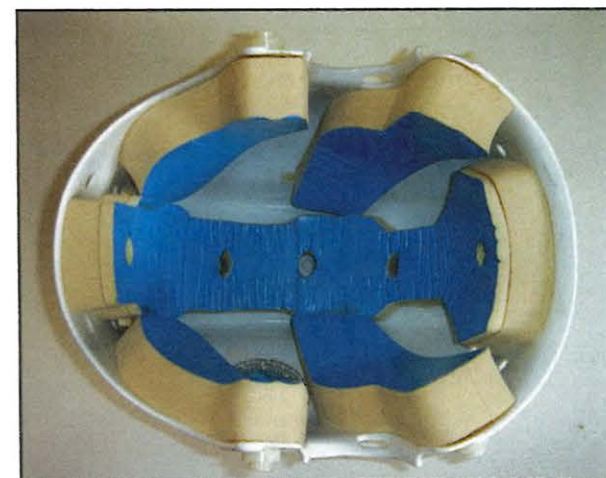
Cooper SK300. Author's collection.



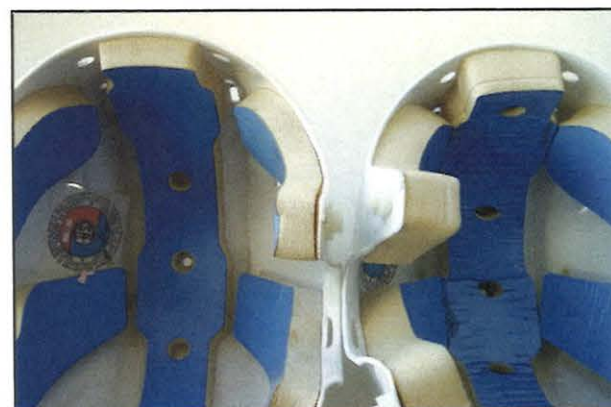
In the late 1960s, Spalding, which had been out of the hockey business for many years, decided to get back in and spear-headed its reintroduction with a brand new helmet, the HH2 shown here. Co-designed by the author, the design was not a great success. A single piece molded shell with multilayered die-cut sheet foam padding elements, the design worked well as a protective unit. However, it too was not adjustable in size. Like so many similar designs, different head sizes were accommodated by factory-installed interior padding of more or less thickness. The myriad of colors and sizes that had to be stocked at any retail facility made the concept impractical. On top of that, the helmet was not well ventilated and the football-like chin cup/strap arrangement did not work all that well. The design was withdrawn from the market after less than 100,000 units were produced.



Spalding model HH2. Author's collection.



Spalding HH2, rear view.



Size 6 1/4 on the right 7 1/4 on the left.

Cooper continued with its SK numbering system and, in the late 1970s, introduced the SK600 as a replacement for the venerable SK500. It retained the same general appearance, but finally got a two-piece adjustable shell design. As seen in the ad below, it was initially produced with a polycarbonate shell. Later, around 1983, this was changed to high density polyethylene and, with few exceptions, that became the material of choice in all future designs.

**new cooper
SK-600**

The SK 600 lets cooler heads prevail, with improved ventilation.

Unique, three-way adjustment. One size fits all heads.

The SK 600 is CSA approved. With style!

Rugged but light polycarbonate shell comes in six action colours: red, blue, green, yellow, black and white.

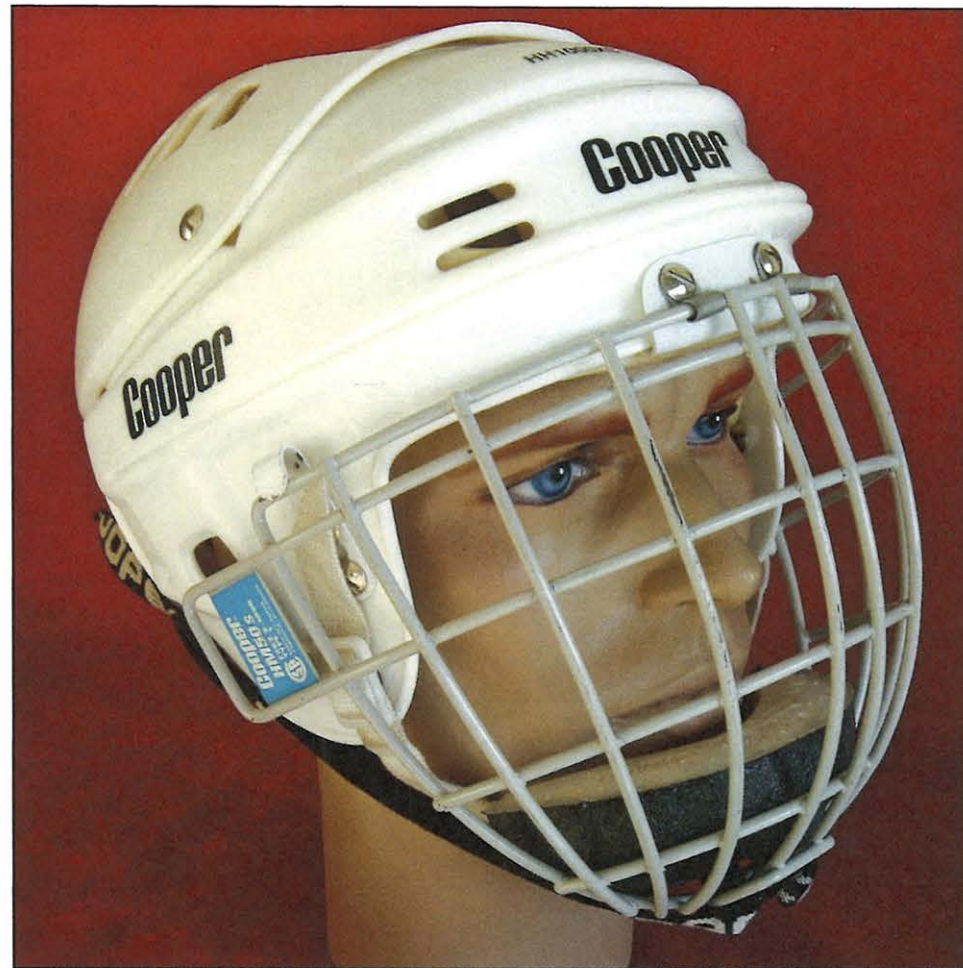
There has never been a helmet that feels this good. The SK 600 features a double lining of foam for a snug, comfortable fit.

Once you've had one on your head, the others will seem old hat.

Try our "hat-trick". Put the SK 600 on your head. And compare its snug, comfortable fit and good looks to any other helmet. A better fit means better protection.

Cooper
The name you see on the pro's.

Cooper Canada Limited, 501 Alliance Avenue, Toronto, Ontario M6N 2J2. Cooper International Inc., 1707 Ridge Rd., Levittown, N.Y. 14022.



Cooper SK1000 with fitted wire cage. Author's collection.

Advertisement for Cooper SK 600, c. 1977.

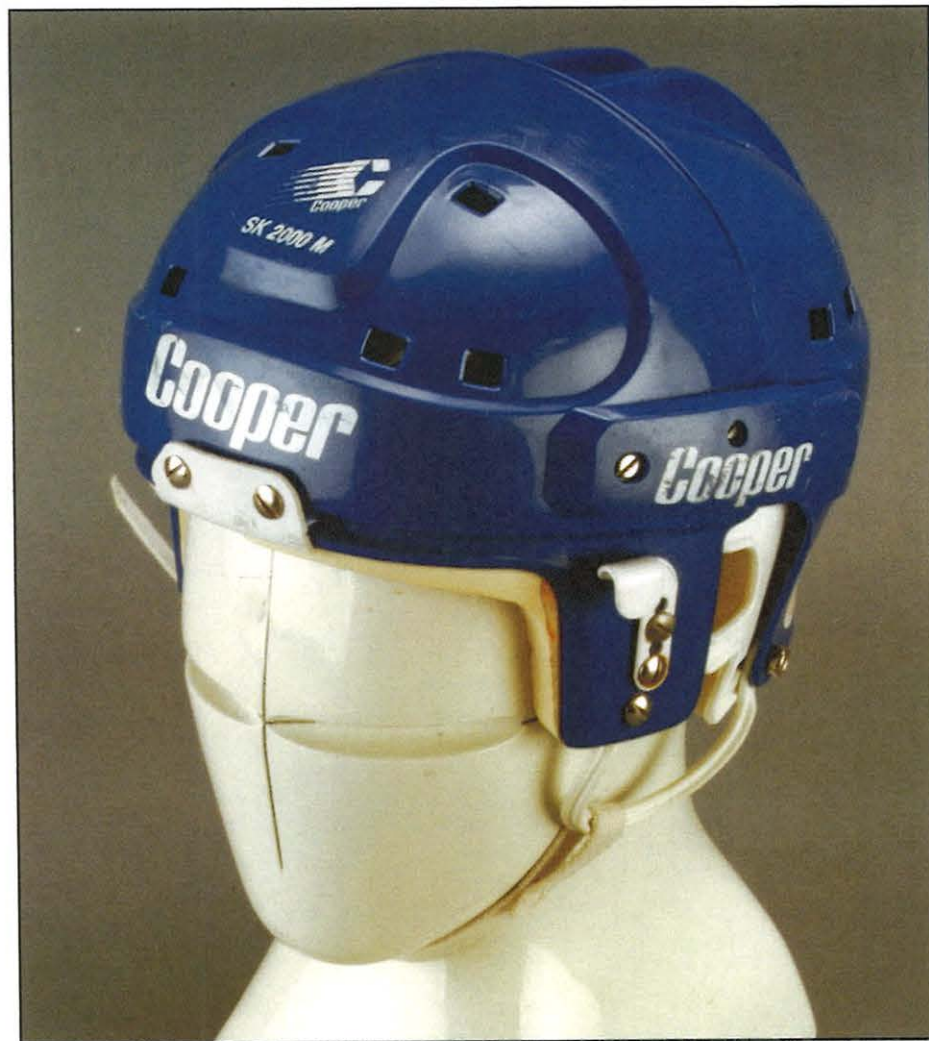


A subsequent variation on the design was the SK1000. This model extended the coverage over the ear region as was then required by a new version of the CSA standard adopted in the mid-1980s. Both models had a liner made from die-cut pieces of closed-cell foam. However the shells were now made from injection molded high density polyethylene HDPE. *Author's collection.*

Cooper Sk1000 disassembled.



Around this time, Cooper, perhaps thinking that hockey helmets were all looking pretty much alike, introduced the next SK helmet, the SK2000. This aggressive looking unit, with shades of Roman gladiator design, was worn by several prominent NHL players. A two-piece shell with typical flat foam padding, the helmet's adjustment hardware was hidden from view by plastic side covers. A few years later the SK2500 was introduced as the last of the SK series helmets. About the only difference between it and its predecessor, mainly because covering the adjustment hardware was unnecessarily expensive (and besides, the covers would often fall off), was a reversion to exposed adjustment hardware.



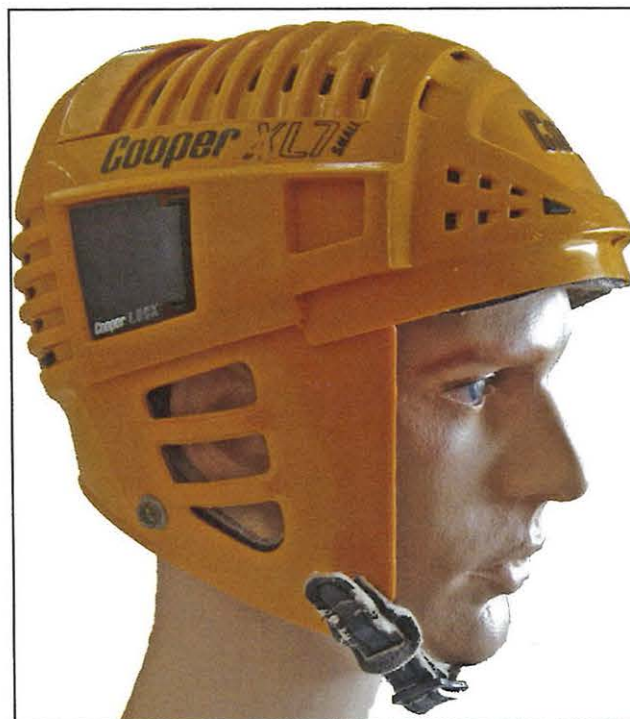
Cooper SK2000. Photographed by Stephen Fenn.



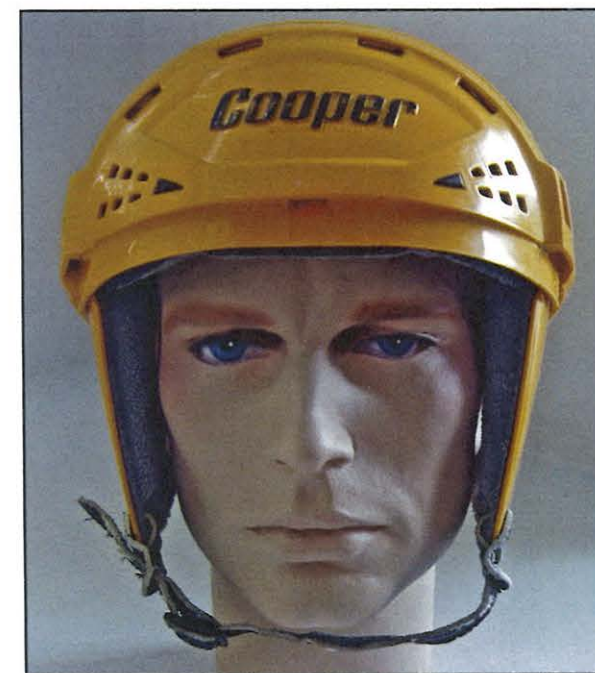
SK2000 adjustment hardware, cover removed.

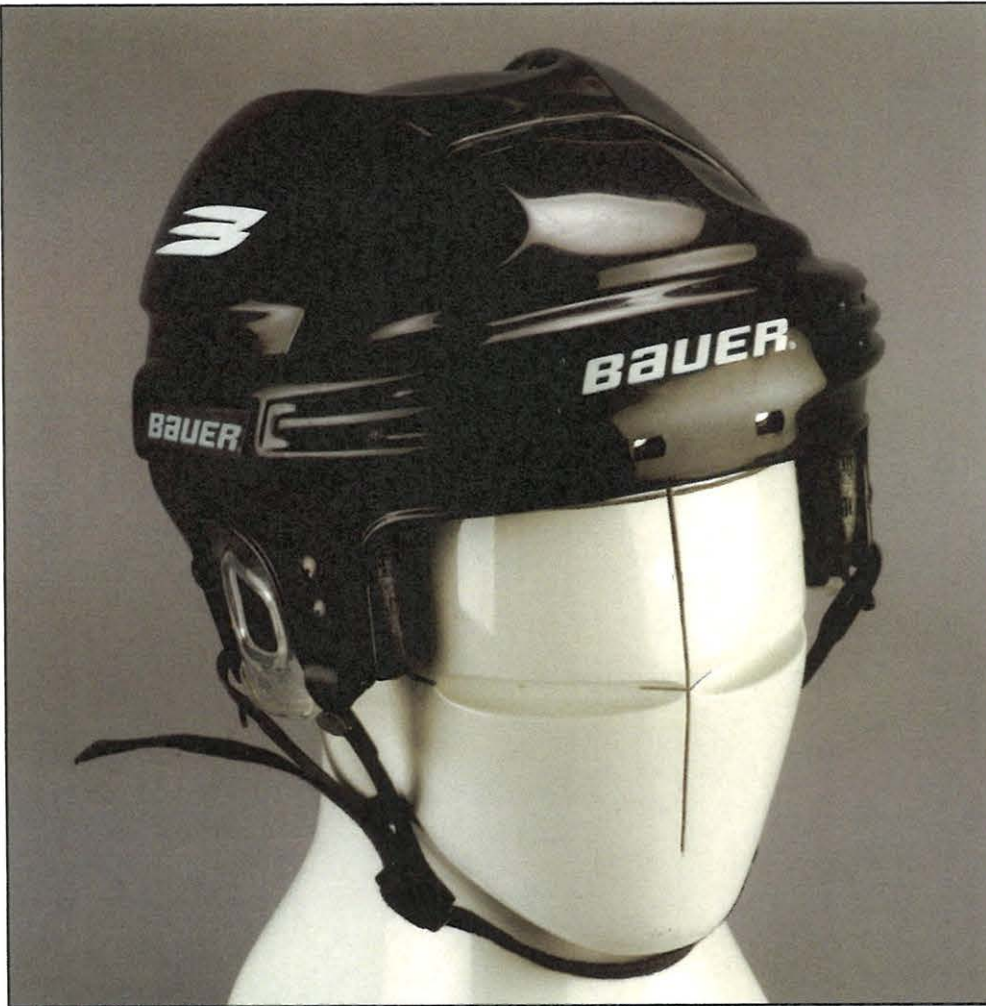


Then came the Cooper XL7. This design created something of a sensation when introduced, for, besides the radical multi-ribbed styling, it incorporated several novel features. To begin with, it could be instantly adjusted with the built-in locking tabs on each side of the helmet. It had the most coverage of any helmet previously available. The interior lining was molded in a way as to create small interconnecting pads. The channels between the pads allowed for improved air circulation. The liner was covered with a comfortable terrycloth-like material, which, regrettably, absorbed sweat and, after a few hot and heavy games, caused the helmet to become rather *unpleasant* to wear.



Cooper XL7 hockey helmet. Author's collection.





The Bauer HH5000. First introduced in 1997, the Bauer HH5000 boasted a dual density liner of EPP foam. To optimize fit, three distinct shell sizes were provided. The translucent surlyn ear covers were provided as required by new standard coverage requirements. *Photographed by Stephen Fenn.*

That was the last we would see of the Cooper name/logo on hockey helmets. The company was sold and the name retained only to appear on baseball batting helmets.

The only name that continued was CCM, but now under the wings of a large sporting goods manufacturing company, The Hockey Company. By the year 2000, names relatively new to this field began to appear, like Bauer, Nike, and Mission.



Bauer HH5000 interior view.



Bauer HH8000 replete with certification and warning labels.



Bauer HH8000. Similar in many ways to the HH5000, it employs an ABS shell and the liner is triple density expanded polypropylene bead foam. Both models are certified to CSA and CE. Photographed by Stephen Fenn.



Mission Intake. This relative newcomer to the field (rink) boasts an interior design using three different materials: molded gel foam pads to improve fit and comfort; multiple density EPP foam for impact attenuation; and an exclusive *dynamo liner*, a channeled fabric material between the shell and EPP foam liner to promote airflow through the helmet. The interior of the helmet also includes the *Mission head lock*, a self-adjusting occipital retention system. The shell is a two-piece design.



Mission Intake interior view.



Mission Intake with transparent shell showing inner components.

Founded in Canada 1989, I-TECH produced and distributed protective equipment, including helmets, for hockey and a variety of other competitive sports. Its most recognizable product was the clear faceshield worn by many hockey players. Its recent merger with Mission has made it one of three or four major suppliers of hockey helmets in the world



Itech HC15. Like so many hockey helmets, the Itech 15 has a two-piece adjustable shell. The padded ear piece is integrated into the design. The liner is that old favorite, die-cut vinyl nitrile.



Itech HC100 with wire face guard. The HC100 also employs a two-piece shell. For impact energy absorption it uses expanded polypropylene EPP bead foam. The comfort liner is made of a *Pro Gel Foam* material. The ear pieces are removable.



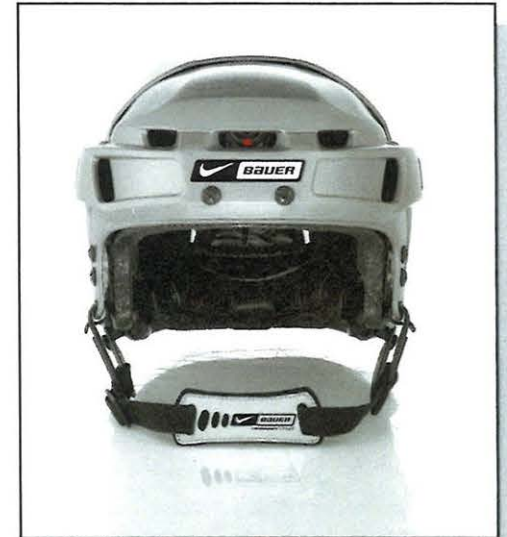
Itech TH2906 youth helmet. This youth model is quite unique with its rounded appearance and integral face guard. The interior liner is made of EPP foam while the comfort padding is polyurethane foam.



Nike Bauer 4500. Like many of its competitors, Nike Bauer brand hockey helmets' shells are injection molded high density polyethylene HDPE. This Nike Bauer model 4500 employs two layers of vinyl nitrile foam for energy absorption.



Nike Bauer 5500. The 5500 model actually uses EPP foam in three different densities. The shell is available in three different sizes to accommodate a wide range of head shapes.



Nike Bauer 8500. The 8500 also uses a triple density EPP foam liner as well as *self-forming* comfort pads. Like most hockey helmets it has a two-piece shell. However it also takes into account the need for lateral size adjustment and does so by repositioning the EPP padding when the shell is adjusted from front to back. This helmet also includes an adjustment at the rear to snug the back of the helmet to the back of the head. The *occipital lock* is similar in purpose to that on the Mission Intake, though the specific design is unique amongst hockey helmets.



CCM 492. A single density die-cut vinyl nitrile liner in a molded HDPE two-piece shell. The *Proguard* look lives on.



CCM 692. Similar to the 492 except the liner is black VN and the ear covers are translucent.



CCM 892. Exact same design as the 692 but the liner is two stage vinyl nitrile foam.



CCM 1092. Shown here with the available wire cage face guard, this model has virtually the same two-piece shell as the 892, but the liner is molded from expanded polypropylene EPB foam.

As you have seen, the design of the hockey helmet has a colorful history, from many manufacturers with multiple models vying for the players' heads to just a few serving the entire world. Like so many sports, traditions do not change easily or quickly and changes to future hockey helmet design will not occur soon.



Interior view of CCM 1092 showing the comfort padding in place.

6.6 Snow Sport Helmets

Alpine skiing, both slalom and downhill, and snow boarding (including alpine, free style, and snowboard cross) are activities for which (for most of history and perhaps rightly so) head protection was deemed unimportant. In fact it is the last of the major sports to widely adopt meaningful protective headgear.

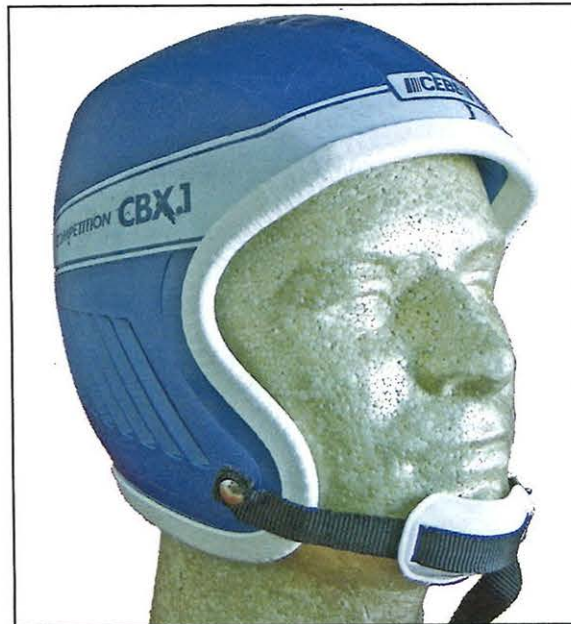
Statistics show that typically fewer than forty Americans a year are killed in skiing accidents. Of course not all die from head injuries and not all die from crashing on their skies. Some are buried under avalanches or fall from ski lifts. And documentation on non-fatal head injuries is not readily available though the consumer Product Safety Commission CPSC in the US estimated that in 2002 over 22,000 skiers and snowboarders sustained head injuries on the slopes.

The 62 year-old singer and politician, Sonny Bono, was killed in 1998 while skiing at Heavenly Ski Resort in California. Bono apparently lost control before crashing into a tree at the Lake Tahoe resort. Bono's death was particularly startling having come just five days after a similar skiing accident killed Michael Kennedy in Aspen, Colorado. Kennedy (the

son of the late Senator Robert F. Kennedy) also crashed into a tree. He had apparently been playing a game popular with his family, tossing a football as they sped down the slopes. In both cases it should not be assumed that any helmet then available would have made much difference.

The only time helmets were seen on the slopes was on the heads of some competitors in downhill or slalom events — and these were not much more than simple plastic hats. There were no regulations to speak of governing their use and there were no standards by which a ski helmet could be properly defined.

Cebe Competition CBX.1 vintage ski helmet. Typical of ski hats of 1960s and 1970s, the plastic shell contained no energy-absorbing liner material. The helmet did little more than *look good* at the time.

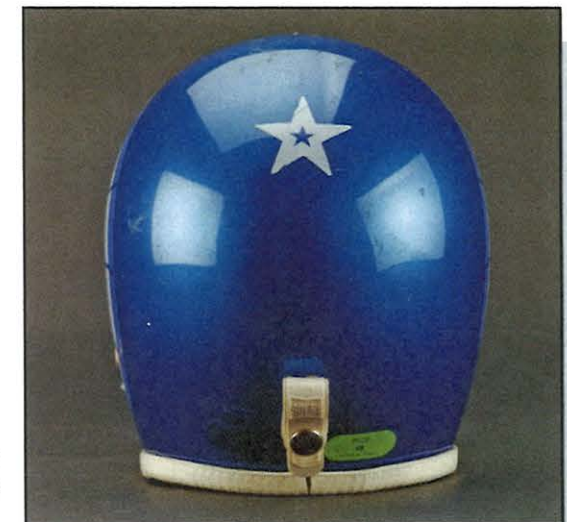




Daron Rahlves, three-time U.S. Olympian and the first American to win the famed Hahnenkamm World Cup downhill at Kitzbuehel, Austria. *Tim Hancock photo courtesy Bell Sports.*



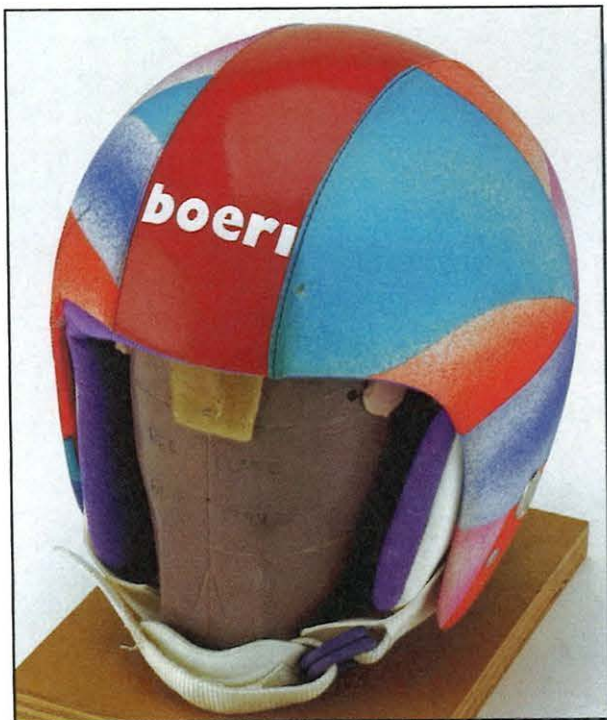
This Italian Boeri vintage child's ski helmet also provided very little protection from impact. It did however look cute, kept the kid's ears warm and may have staved off the occasional scalp bruise. *Photographed by Stephen Fenn.*



Boeri rear view. The star is decorative; the strap/snap piece is to retain the goggle strap.

As early as 1973, the Snell Memorial Foundation took the initiative of publishing an addendum to its general helmet standard that specifically addressed skiing headgear. Helmets produced to this standard however this turned out to be simply cut-down, unvented motorcycle helmets which, being much heavier than the European ski hats were not in big demand and not produced in great numbers.

In the 1980s, the only available ski helmets were made in Europe. But recreational snow sport is a very fashion-conscious activity.



Colorful exterior fabric treatment of vintage Boeri child's ski helmet. Photographed by Stephen Fenn.



This unique European ski helmet is made entirely of rubber with plastic inserts. Presumably the inserts at the front were to provide some ventilation, but their main purpose was to help ward off the posts at the gates in slalom events. Photographed by Stephen Fenn.



The Conte of Florence as seen from the rear. Notice the groove for the goggle strap.

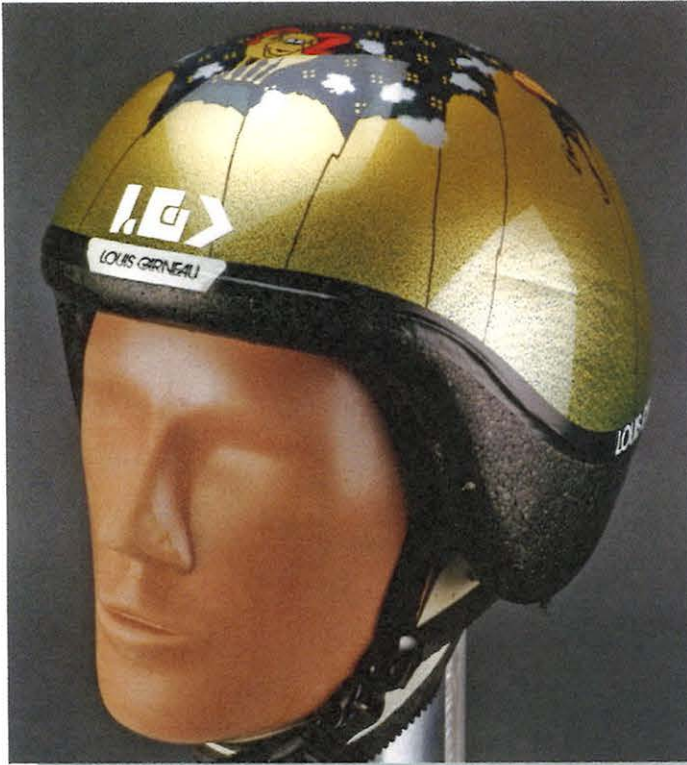


There was no pretext of protection to the back of the head.

When lightweight attractive helmets that actually worked began appearing on the heads of the World's skiing elite, it was natural that most skiers in the World would like to look the same — especially if it coordinated well with the rest of their outfit. Emulation of ones heroes is a trademark of helmet usage in most sporting fields, and skiing and snowboarding are no different. Maybe you can't look or ski quite like Daron Rahlves but you can buy a copy of his helmet. (As well as his skis, suit, boots, etc.).



In the late 1980s Scott sold this slalom *helmet*. It is really no more than a platform to which a visor and chin bar could be mounted.



Early Louis Garneau child's ski helmet. With different graphics, it's also a child's BMX bicycle helmet.
Photographed by Stephen Fenn.

The ski helmet industry is now a very big business. There are at least 30 manufacturers in Europe alone. Thousands of styles are available all of which are variations on the same theme. It needs to look right and meet the current standards of Europe, EN1077, and in America, ASTM 2040.

The next few examples from Scott illustrate some of the design features of modern ski helmets.



Scott Biomex. The shell is an injection molded polycarbonate alloy. The earpieces are removable for better hearing and cooler ears. The multi-hole vents are actually anodized aluminum plates.



The 3-point goggle clip at the rear of the Biomex.



The Biomex interior fabric lining features a unique three-layer knit construction which is odor-resistant and highly durable — and it's removable and washable.



Scott MS1.



Scott Watu in impressive style.



Scott open face, full shell ski helmet.



Scott ski helmet with detachable chin piece.



Scott full-face ski helmet with integrated chin piece.

In the US, Giro, famous for its cycling helmets, applied its technical know how to the skiing and snowboard helmet business with these examples from its hundreds of models.



Giro Mad Max S. A silver carbon fiber shell over an EPS liner, this is the same Mad Max sold as a mountain bike helmet. And why not? It looks good either place.



Giro Sestriere. The shell of this helmet is molded ABS.



Giro G10 uses an in-molded polycarbonate micro shell over an EPS liner.



Giro G10MX snow camouflage. The MX version includes a removable visor.



Giro Bad Lieutenant snowboard helmet. An unvented injection molded ABS shell over an EPS liner, this helmet is available in a variety of colors and styles. This one is covered in black fabric. Very b-a-a-a-d.



Giro Fuse employs an in-molded shell and has adjustable vents.



Giro Nine with an in-molded shell.

The Canadian firm Louis Garneau also produces some fine ski helmets, examples of which are shown here.



Louis Garneau Universe. The carbon fiber appearance is simply decorative.

Louis Garneau Stream-Z helmet. The outer shell is molded ABS. The liner is EPS foam.



Louis Garneau Pilot. This junior helmet has fiber mesh covering the vents, which are adjustable.



There are of course many ski helmet producers in Italy. One of them, Dainese makes these beauties. Only the ones in the picture above actually produce their own flames.

Sparks of Passion helmets produced by Dainese for the 2006 Winter Olympic Games Torino. *Photo courtesy of Dainese.*



Dainese S3 Lite.





Dainese Scarface.

Dainese Fun.





Dainese Kombat.



Dainese Stinger Bluetooth equipped. Communicate with your world while on the slopes.

6.7 Odds and Ends

This chapter contains pictures of helmets that either don't fit easily into the former categories, don't have categories as such or perhaps simply do not have a rich enough history or market to warrant their own chapter. Being in this last section of chapter 6 makes them no less important.



A hard hat with an energy-absorbing shell. Developed by Biokinetics and Associates Ltd. In conjunction with the Construction Safety Association of Ontario, the collapsible fins on the outside of the shell serve to absorb impact energy when struck by some object. This concept was developed primarily for industrial applications but perhaps could be considered in some extreme sports too? *Photographed by Stephen Fenn.*



A prototype produced by the author in 1975 meant simply to explore a variety of concepts. It was never intended for any specific application. In retrospect it's not unlike a modern BMX helmet. *Photographed by Stephen Fenn.*

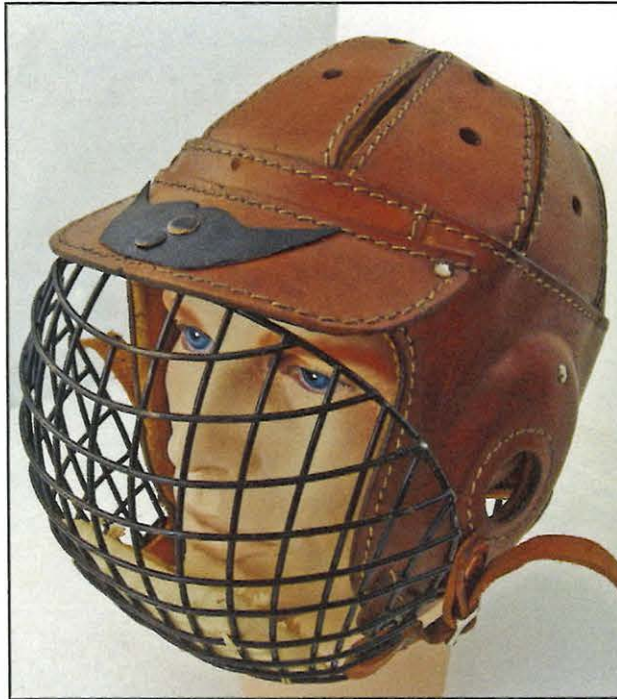
From drag racing to running around with a big stick, lacrosse comes in two varieties. In Canada, box lacrosse is the country's national summer sport. It is usually played indoors on otherwise vacant ice rinks (without the ice). Field lacrosse on the other hand is played outdoors on a football pitch elsewhere in North America. In spite of the apparent dangers of the sport, it does not have a reputation for serious head injuries. In fact in Canada, there is no standard for lacrosse headgear. Ice hockey helmets with metal faceguards are customary apparel. In the US the sport went for years without the apparent need for a helmet performance standard. However, in 2004 NOCSAE, published its first such requirement.



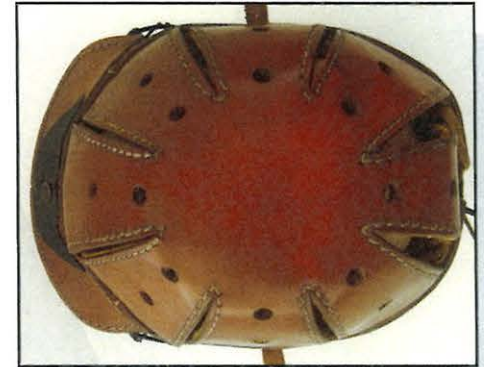
The Newman prototype rear view.



This helmet is the Bell XF GP. The ominous-looking unit was designed for Top Fuel Drag racing and used by the likes of Shirley Muldowney and *Big Daddy* Don Garlits. It provides about as much coverage as you can get. The tiny eye holes, which will be further protected by a transparent shield, suggest that the driver need only to look straight ahead. C. 1980. *Ryan Parks photo courtesy of Bell Sports.*



This is a field lacrosse helmet from the 1940s. Beautifully made entirely of leather, it is the massive metal faceguard that distinguishes the design. Lacrosse has historically been a safe sport from a head injury perspective. However the threat of getting whacked in the face with a lacrosse stick has always warranted significant facial protection. *Author's collection.*



The top of the helmet was fabricated from a flat piece of leather that was cut radially and folded to form the crown of the helmet.



Now that's face protection. A large foam pad at the chin supplements the impact resistance.



The advent of plastic did not change the design of lacrosse helmets significantly. This Brine model from the 1980s continues with the hinged crown design and the massive faceguard. *Photographed by Stephen Fenn.*



By the 2000s, with the introduction of the NOCSAE standard in the US, designs changed to look more like this Cascade model. Designs now had injection molded shells with thick EPP foam inside to better protect the head. *Photographed by Stephen Fenn.*



Be warned — and then look under the visor.

This modern Riddell field lacrosse helmet employs the same approach to the interior padding as used in its Revolution football helmets.



This even more modern Cascade helmet has a faceguard made from titanium alloy. Photographed by Stephen Fenn.



A lightweight motocross-style helmet considered for adoption by the Canadian ski team during the reign of the *Crazy Canucks*. This picture taken in 1985 shows the helmet being worn by the 2005 Chair of the CSA Alpine Ski Helmet Committee, Dr. Jocelyn Pedder.

The operator of this jet ski or personal watercraft as they are formally called, needs to wear a helmet during competitions such as this. *Photo courtesy of Dainese.*





The Dainese watersport helmet. It can also be used as a downhill MTB helmet.





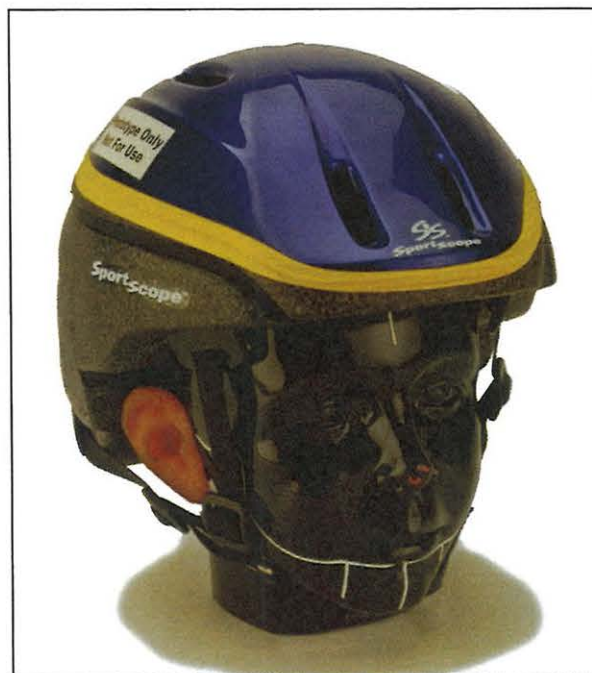
Arai dual sport. Author's collection.



This helmet was marketed by Arai when *dual sport* motorcycles (on- or off-road) were popular. The helmet presumably could be worn in either situation.



Here's a great concept developed at Biokinetics that didn't survive due to high manufacturing costs. This was probably the only *collapsible* helmet ever designed. It comprised five major segments that allowed the helmet to expand or contract to fit the wearer's head almost perfectly. Shown here is the youth version. The head-form on which it is worn, representing a nine year-old boy, had been dubbed *Alan Average* and is used in hockey faceshield testing. Photographed by Stephen Fenn.



Viewed from the rear, several segments can be seen. They are connected internally by a network of flexible material. Careful examination may also reveal the autographs of members of the design team.



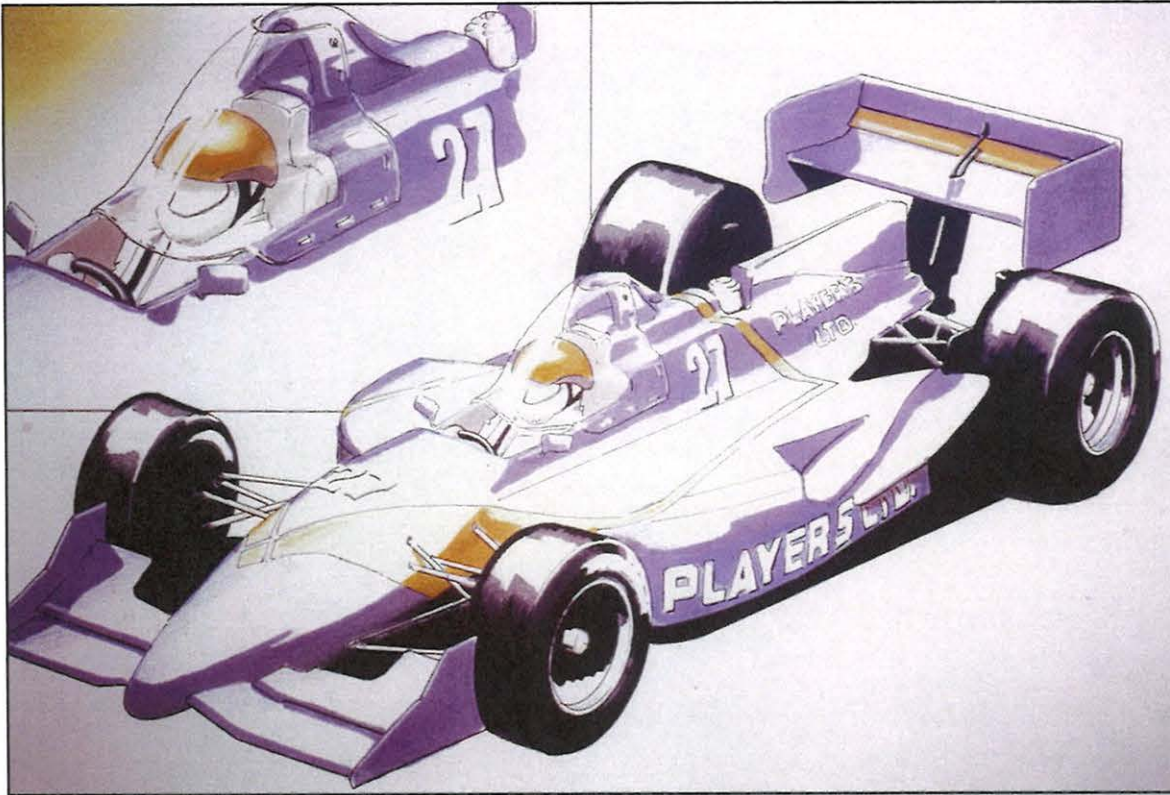
Another *helmet* posing on Alan Average, is the first hand made prototype (made by the author) of the Spalding HH2 discussed in chapter 6.5. C. 1972. Photographed by Stephen Fenn.



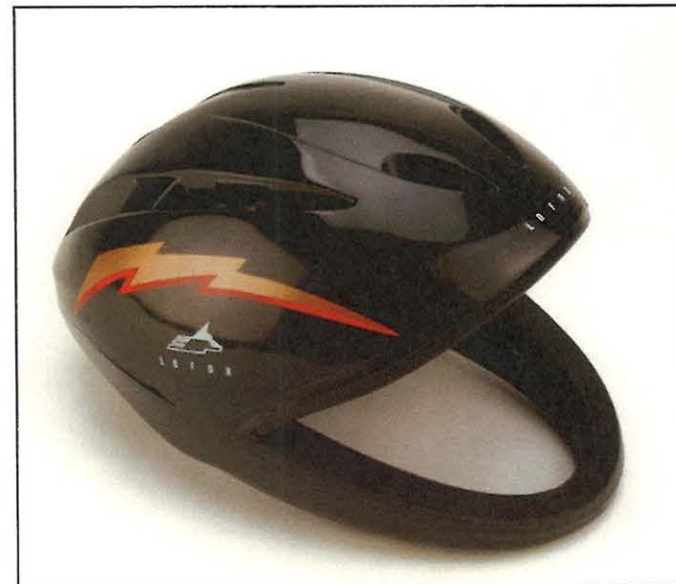
This helmet with the very large face opening is one of Impact Racing's crew helmets used on pit lane in motor racing.



The Bell Biker bicentennial model. The author was one of the co-designers of the Biker and when he left his stay with Bell Helmets in December 1975, the staff presented him with the only Bell Biker to ever be fabricated with a shell which was blue — not white as every Biker helmet was and has ever been. Because of the red, white, and blue colors and, of course, the coming year 1976, it was dubbed the bicentennial helmet. Regrettably, the original was lost during some obscure research experiments in 1979. This recreation is all that remains of the one and only *Bicentennial Biker*.



A new concept in race car driver head protection moved the helmet shell (and most of the helmet weight) off the driver's head, made it transparent and fixed it to the car, c. 1996. The concept has not yet been adopted.



The very first of the full-face bicycle helmets. Developed at Biokinetics, the Lofox was ahead of its time. Assembled from two pieces of molded polypropylene foam, the helmet met every bicycle helmet standard in the world at the time. The styling was however too radical to be a success. C. 1990. Photographed by Stephen Fenn.



Looks like a cowboy hat right? Look again. The outer portion is actually a molded plastic cap that's available in a variety of colors.



Look inside and there's a full blown head harness suitable for industrial applications. Manufactured by Western Hardhat International, maybe it's something rodeo riders might consider?

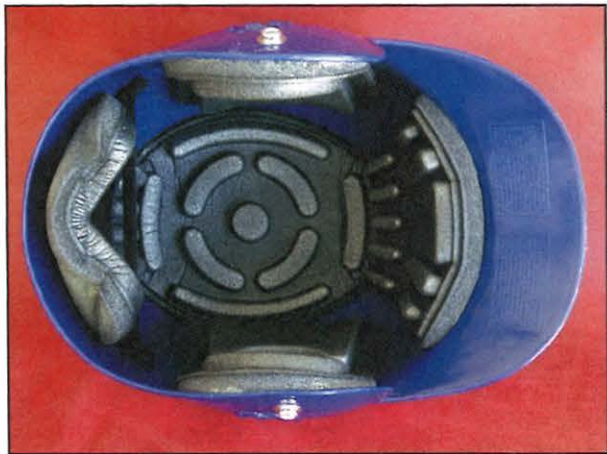


OK, admit it. This vintage Rawlings PL-50 batter's hat is a little odd looking. The design is based on the premise that you were not going to get hit on the top or the back of the head so why put helmet there? Unfortunately this design did not take into account that those missing parts of the helmet greatly helped fitting the unit to the wearer's head. *Author's collection.*



This sample is from the 1960s and the elastic straps are shot. Perhaps during their infancy, it may have made the fit a little better.

Baseball in the US struggled for a long time about whether or not protective headgear was necessary. Kids and amateurs had been wearing some form of protective cap for years, but the professionals took to their use relatively recently. The only real threat is getting *beaned* by a pitch and most batters thought they could get out of the way in time. A hundred mile per hour fastball, however, doesn't take long to get home from the pitcher's mound and occasionally batters did, and still do, get struck on the head. According to recent statistics, over 60,000 players are treated in hospital emergency rooms in the US each year for head injuries from baseball and softball.⁵⁰ That's more than football and hockey combined! Considering the nature of these games, it doesn't say a lot about the utilization and/or the effectiveness of current baseball headgear.



The interior of this NOCSAE certified batter's helmet is nicely padded with soft but durable energy-absorbing polyurethane foam.



Following the publication of the NOCSAE standard for batter's helmets in the late 1990s, helmet design looked a little more conventional. This particular sample is being worn by a Hybrid 3 automotive crash dummy head that has been modified at Biokinetics for helmet R&D work. Photographed by Stephen Fenn.



This odd looking unit is made entirely of leather and has three padded strips down the middle. It's believed to have been meant for that nearly extinct activity of riding in a motorcycle sidecar. Motorcycle sidecar racing is however still alive and well in Europe. *Author's collection.*

Snowmobiling is a popular winter sport in many parts of the World. In the past, participants have typically used motorcycle helmets. Though there are no standards for snowmobile helmets as such, several manufacturers have gone out of their way to better adapt the motorcycle helmet for this cold weather application.



One adaptation of a vintage motocross helmet for snowmobiling was the addition of this large pivoted flat faceshield attached where the visor usually goes. This addition still allowed goggles to be worn. *Author's collection.*

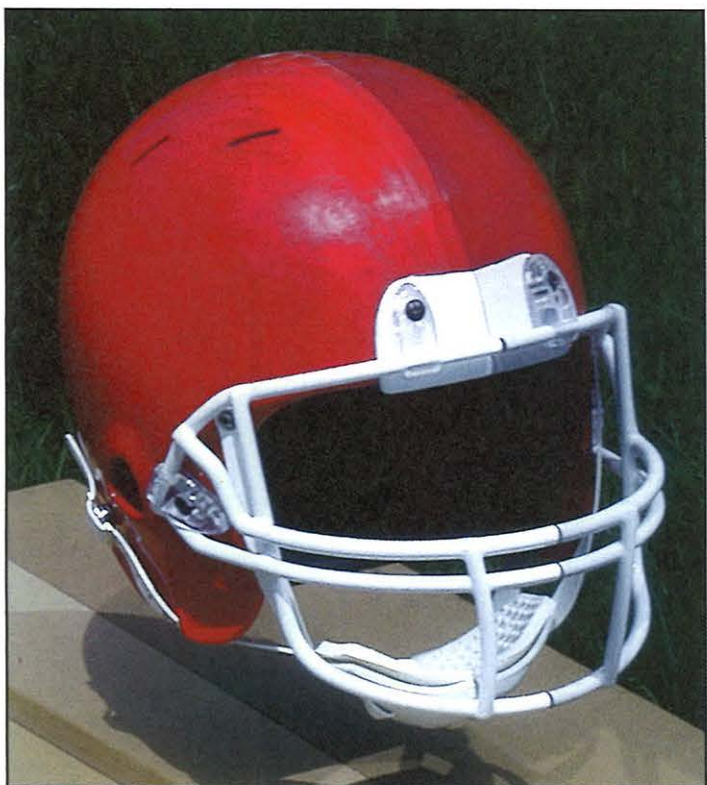




A more sophisticated approach is shown here. This prototype is based on a full-face style helmet. The importance in cold weather of controlling fogging of the faceshield can be seen by the use of a breath guard not often used on motorcycle helmets. In addition, the faceshield is electrically heated. *Photographed by Stephen Fenn.*



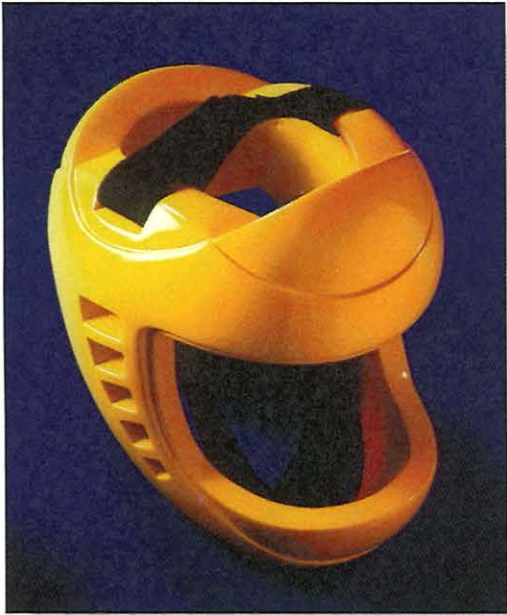
An even more advanced snowmobile helmet design is this one from Bombardier. Not only does it have two independent visors, the front of the helmet can be raised entirely when the operator stops for a break or to talk with someone. The protrusion at the front is a dial that can be used to adjust the seal of the breath guard over the wearer's nose and mouth when the helmet is closed. *Photographed by Stephen Fenn.*



Now look closely. See anything odd here? No, this football helmet is not floating in space. It's a half model mock-up placed up against a mirror during Biokinetics work on a new football helmet. This, though it looks little like it, was the predecessor to the Riddell Revolution football helmet. For prototype work, it's easier to build half model than a whole. *Photographed by Stephen Fenn.*



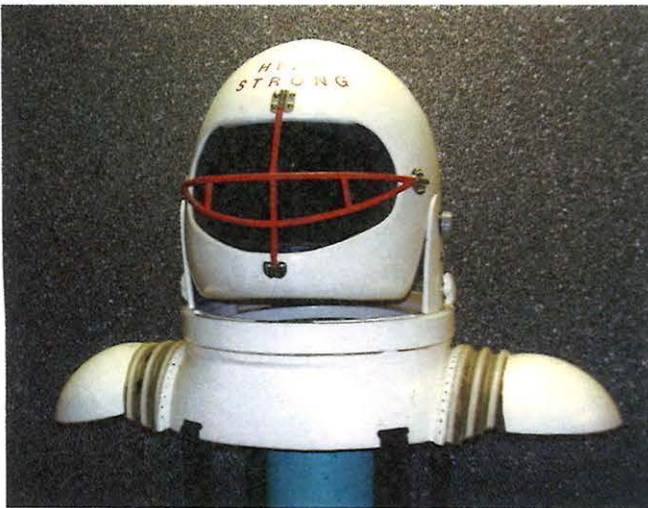
This is a picture of a very rare Bell ATC (All Terrain Cycle) helmet. It was really no more than a stylistic variant of the Moto3 motocross helmet. The demise of the three wheel ATC and of this helmet was coincident. *Ryan Parks photo courtesy of Bell Sports.*



Designed by TNO in the Netherlands back in the nineties, this helmet is one of the world's most unique. Intended for youngsters when skating or skateboarding, it was to be formed as a single molded piece of compliant urethane foam. It provided superb padding to the front, back and sides of the head as well as to the chin area. The top was left open as data suggested hardly anyone actually ever struck the top of their head when they fell (seems reasonable). Regrettably the design never got beyond this prototype stage and the project was terminated without a commercially available product. *Courtesy TNO, Delft.*



A cool looking helmet, the Louis Garneau Prologue is used in bicycle time trials and sprint racing.



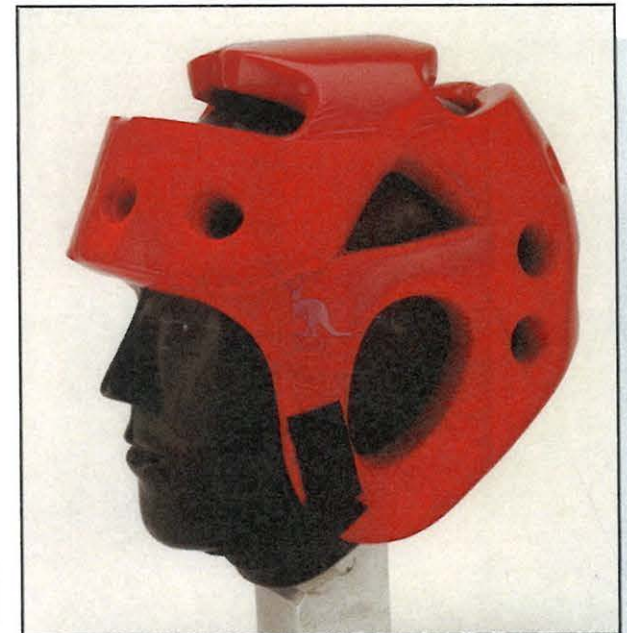
Somewhat reminiscent of a robot from a 1950s sci-fi. movie, the *Headstrong* is another interesting prototype that didn't make it into production. This was one of several football helmet concepts from the 1980s the objective of which was to redirect the impact reaction forces from the wearer's neck onto his shoulders. It worked, but head mobility limitations and concern for other players who might be struck by the Headstrong wearer, put a serious damper on the idea. *Courtesy David Halstead. Photographed by Larry Maddux.*



An equally good looking, and somewhat longer aerodynamic helmet, is the Rev IV from Giro.



From maximal coverage to minimal. This goalkeeper is wearing the newest form of head protection in soccer, the Full90. *Andreas Hillergren photo courtesy Full90.*

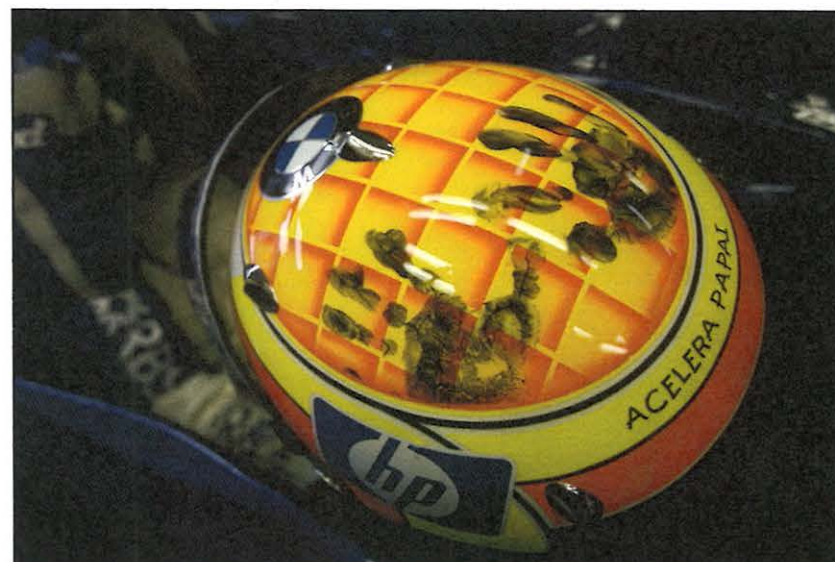


A different approach to soccer head protection is seen here in the Kangaroo. Intended for youths, the helmet is formed from a few pieces of thick die-cut foam that are bent and bonded to each other. The assembly is then covered with a vinyl coating. *Photographed by Stephen Fenn.*



Everyone's heard of Gilles's son Jacques Villeneuve right? F1 World Champion in 1997. Well, this *isn't* his helmet. There's another somewhat less heralded Jacques Villeneuve, Gilles's brother. A world class snowmobile racer and F1 participant himself, the first Canadian to win a CART race, this is a replica of L'oncle Jacques's helmet, c. 1985. *Ryan Parks photo courtesy Bell Sports.*

For the 2005 Brazilian Grand Prix Friday practice, Williams F1 BMW driver Antonio Pizzonia, has had his child's hand prints painted on his helmet. *Steven Lee photo courtesy of LAT Photography.*



7 Be Warned



A popular helmet amongst hang glider pilots is this stylish unit, the Charly Insider. The outer shell is made from a Kevlar fiber glass composite and the interior is EPS foam. It does not come with any form of visor or faceshield. Photo courtesy of Gene Atkins, Wills Wing.

So there you have it, a thumbnail sketch of some helmets you may not be entirely familiar with (lacrosse and ball players excepted). Who knows, maybe in 50 years many of these will appear in some book on vintage helmets, eh?

Statistical considerations and the variability of humans aside, nearly every helmet made today comes with a warning, more of an admonishment really, that wearing this thing is not necessarily going to save your noggin in every case.

It all started back in the early 1960s when the Snell Memorial Foundation issued certification stickers containing the seemingly innocent phrase *"No protective headgear can protect the wearer against all foreseeable impacts."*

This was later revised to *"No helmet can protect the wearer against all possible or foreseeable impacts."*

And if this wasn't clear enough, by the mid 1980s it read *"Some reasonably foreseeable impacts may exceed this helmet's capability to protect against severe injury or death."*

Another from a Simpson helmet of the same period is even less vague. *"Warning. This article is sold without warranty, expressed or implied. No representation is made as to this product's ability to protect the user from any injury or death."*

This warning calls it everything but a helmet. Perhaps users' expectations of a *product* or *article* are less when you don't call it a helmet. After all, a user would expect a helmet to *protect the user*.

Typical of really scary warnings is the following from a Rawlings football helmet of the 80s. It starts *"This football helmet is intended to protect your head,"* and concludes, *"This*

helmet can not prevent injury to your brain, neck or spinal cord under conditions which may occur while you participate in football."

How's that for being ambivalent? That same label also warned the coaches of the game to make sure that the *"Coaching staff and the player to whom this helmet is to be issued fully understand the warning statements."*

Just how a coach might explain to a player that his helmet is intended to protect his head, but it can not prevent, among others, brain injury, would, one would suspect, present quite a challenge.

American baseball batter's helmets carry the rather foreboding warning that *"Severe head or neck injury including paralysis or death may occur to you despite using this helmet."*

And in that head injury most probable sport of all, boxing, amateur protective headgear labeling says *"Users of this product are subject to severe personal injury. Severe head, neck and other injuries including death and paralysis may occur despite using this equipment."* The same warning label also carries the advice that *"Persons with prior brain injuries should not participate in these sports."*

Do you get the feeling that if people actually paid attention to all these warnings there would be no sports?

In the *old days* there were no such warnings and indeed people did occasionally sustain head injury even though wearing a helmet

of some sort. This led to the engagement of members of the legal profession, particularly plaintiff lawyers, which led eventually to the demise of many producers of protective headgear and the proliferation of disclaimers by those who remained in business.

If you have aspirations of getting into the helmet business, don't say you haven't been warned.

Trademarks

The following trademarks have been referenced to in this book.

Kralastic - trademark of Nippon A&L for ABS plastic

Kevlar - trademark of E.I. DuPont de Nemours and Company for polyaramide fiber.

Cordura - a woven nylon fabric manufactured by Dupont.

Spectra - trademark of Honeywell Corporation for polyethylene fiber

Dyneema - trademark of Royal DSM for polyethylene fiber

Lexan - trademark pf GE Plastics for polycarbonate plastic

GECET - trademark of GE Plastics for enhanced polystyrene foam.

Skydex - trademark of Skydex Corporation

Brock - trademark of Brock USA

Styrofoam - trademark of the Dow Chemical Company for expanded polystyrene foam.

Velcro - trademark of Velcro Industries B.V. for hook and loop fastener system

Nomex - trademark of Dupont Corporation for fire retardant fabric

HANS - trademark of the Head and Neck System of HANS Performance Products.

Ensolite - trademark for a closed cell synthetic rubber foam of Rubatex International.

CarbonX - trademark of Chapman Innovations for fire proof materials.

Jell-O - brand name of Kraft Foods Ltd.

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8 Endnotes

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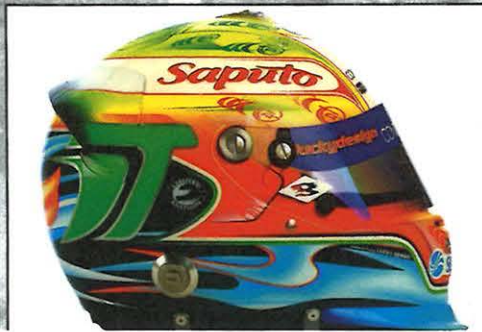
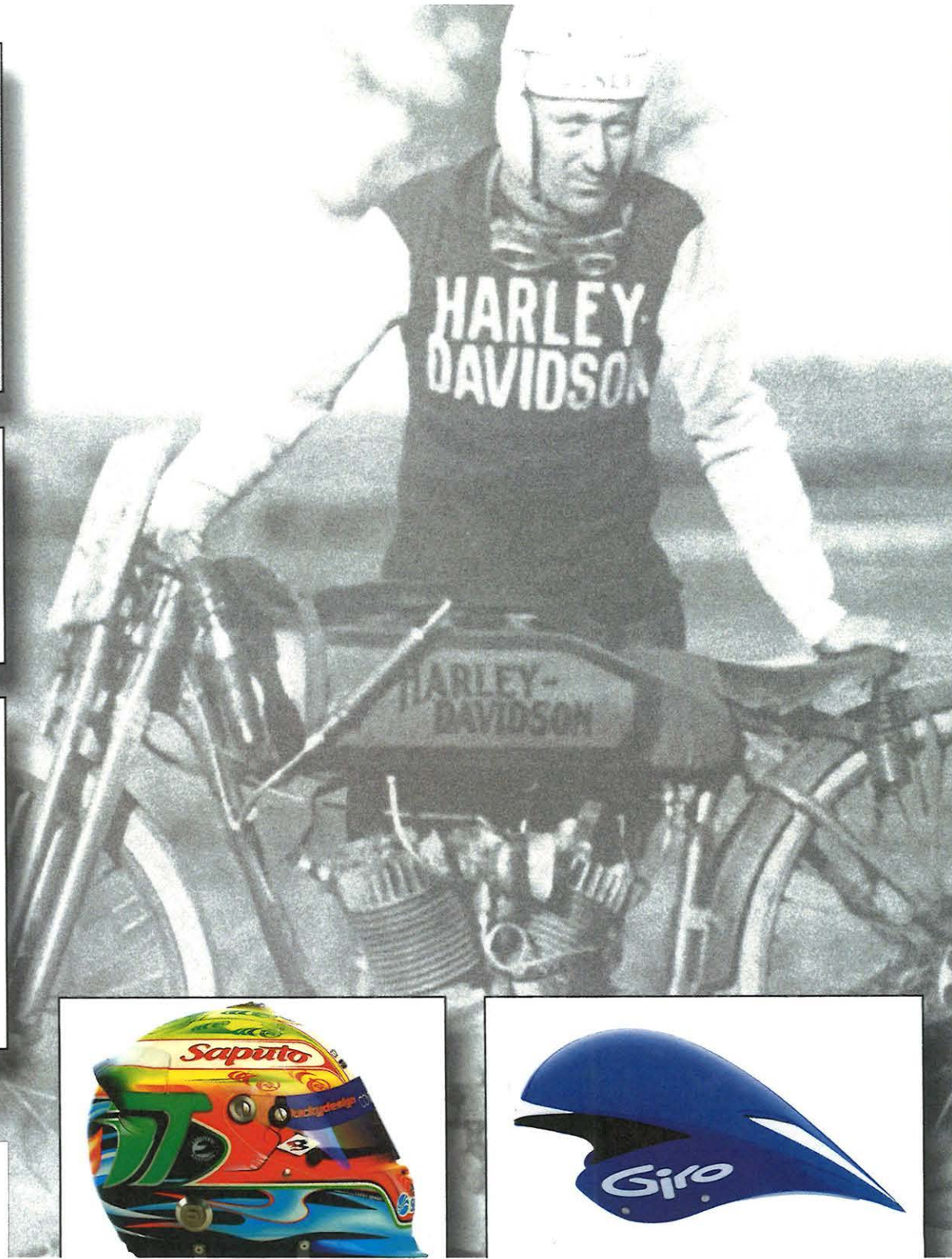
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Notes







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