Application Standard method	Headform type	Drop assembly mass (kg)	Impact surface	Impact energy (Joules)	Rejection criteria
Airborne sports					
EN 966-1996	Metal (EN 960)	3.1-6.1	Flat and curbstone	69 (mass of helmet incl.)	a > 250g
Auto racing					
Snell SA2005	ISO metal	A, E, J, M, O (5)	Flat	150 (1st impact) 110 (2nd impact) .	a > 300g
			Hemisphere	150 (1st impact) 110 (2nd impact)	
			Edge. Roll bar	150 150 (1st impact) 120 (2nd impact) 100 (3rd impact)	
FIA 8860-2004	ISO metal	A, E, J, M, O (5)	Flat, hemisphere, roll bar, edge anvil	225 SA2000 test zone HIC > 3,500	a > 300g
			Per ECE Reg 22	71 chinbar HIC > 2,400	a > 275g
Bicycling-Skateboarding					
CPSC	ISO metal	A, E, J, M, O (5)	Steel flat, hemi V-anvil	90 56	a > 300g
Snell B95	ISO metal	A, E, J, M, O (5)	Steel flat	110 for certification testing 100 for all other, testing	a > 300g
			Hemispherical	72 for certification testing 65 for all other testing'	
			Curbstone	72 for certification testing 65 for all other testing	
CSA D113.2- M89 rev. 5/96	ISO metal	E, J, M (5)	Flat-2 sites Flat-2 sites Cylindrical-2 sites	80 55 55	a > 250g a > 200g a > 250g SI > 1,500
EN 1078/1080	Metal (EN 960)	5.0	Steel flat, curbstone	72, 52	a > 250g
Equestrian					
ASTM F1163	Magnesium alloy (ISO)	A, E, J, M (5.0)	Steel flat, V anvil	90 63	a > 300g
NOCSAE Polo	Urethane	4.01, 4.85, 5.83	Hemisphere and equestrian anvil. 38 Shore A flat	72-121 (size dependent) 36-62 72-121	SI > 1,200 SI > 300 SI > 1,200
EN 1384-1997	Metal (EN 960)	3.1 - 6.1	Flat	69 (mass of helmet inc.)	a > 250g and t@150g, > 5msec
Snell H2000 Harness racing	Metal (ISO)	A, E, J, M, O (5)	Steel flat, hemisphere and equestrian anvil.	145	a > 300g
Football (US)					
NOCSAE-98m03	Urethane	4.01, 4.85, 5.83	38 Shore A flat	57 to 95 (size dependent) 62 to 104 72 to 121	SI > 1,200

REVELYST 1025
Part 2 of 3

Application Standard method	Headform type	Drop assembly mass (kg)	Impact surface	Impact energy (Joules)	Rejection criteria
Hockey (Ice)					
CSA Z262 1- M90	Epoxy-Urethane(ISO)	A, E, J, M (5.0)	Steel flat	40	a > 275g, SI > 1,500(opt.)
NOCSAE 04m04	Urethane	4.01, 4.85, 5.83	38 Shore A flat	31 to 52 (size dependent) 62 to 104 72 to 121	SI > 300 SI > 1,200 SI > 1,200
ISO 10256-2003	Metal (EN 960)	3.1-6.1	Steel flat	37-69	a > 300g SI > 1,500
ASTM 1045-2004	Metal (ISO)	A, E, J, M (5.0)	60 Shore A flat	50	a > 300g,
Lacrosse					
NOCSAE 041	Urethane	4.01, 4.85, 5.83	38 Shore A flat	31 to 52 (size dependent) 62 to 104	SI > 300 SI > 1,200
Motorcycle					
Snell M2000	Metal (ISO)	A, E, J, M, O (5)	Flat	150 (1st impact) 110 (2nd impact)	a > 300g
			Hemisphere	150 (1st impact) 110 (2nd impact)	
			Edge	150	
DoT 218(rev. 1988)	Magnesium alloy	A (3.5), C (5.0), D (6.1)	Flat (2 impacts per site) Hemisphere (2 impacts per site)	60 - 110 size dependent 47 - 82 size dependent	a > 400g and t@200g, > 2msec t@150g, > 4msec
BS 6658 (a) Competition	BS 6489	5.0	Flat (2 impacts per site) Hemisphere (2 impacts per site)	140 (1st impact) 76 (2nd impact) 123 (1st impact) 63 (2nd impact)	a > 300g
ECE Reg. 22 (05)	Metal (EN 960)	A (3.1), E(4.1), J(4.7), M(5.6), O(6.1)	Steel flat, curbstone	87 – 172 size dependent	a > 275g and HIC > 2,400
Skiing/Snowboarding					
Snell S98	Metal (ISO)	A, E, J, M, O (5)	Flat Hemisphere, edge anvil	120 100	a > 300g
Snell RS98	Metal (ISO)	A, E, J, M, O (5)	Flat Hemisphere, edge anvil	100 80	a > 300g
CEN 1077	Metal (EN 960)	3.1 – 6.1	Flat	47 – 95	a > 250g
ASTM F-2040	Metal (ISO)	A, E, J, M, O (5)	Flat Hemisphere, edge anvil	100 80	a > 300g

Glossary of Terms:

ASTM	American Society for Testing Materials
BS	British Standard Institute.
CPSC	Consumer Product Safety Commission
CSA	Canadian Standards Association
DoT	US Department of Transportation
ECE	Economic Community of Europe
EN	European Norm (std)
FIA	Federation Internationale de l'Automobile
HIC	Head Injury Criterion
ISO	International Standards Organization
NOCSAE	National Operating Committee on Standards for Athletic Equipment
SI	Severity Index
	Snell Snell Memorial Foundation
a	acceleration
t	time

Endnotes

[1] The use of the term ISO in this column denotes that the test headform geometry complies with the specifications of ISO DIS 6220-1983.

[2] The Snell N-94 standard for *multi-sport* helmets has the same requirements but in addition stipulates four *conditioning* impacts of 40J to the rear aspect of the helmet.

[3] NOCSAE hockey and lacrosse helmet standards differ mainly in regard to an additional projectile test. In the case of hockey helmets, it's a puck. For lacrosse, the projectile is a hard rubber lacrosse ball. NOCSAE022-03m04 standard for baseball and softball helmets employs just a projectile impact test. In this case a baseball. In all three cases, a stationary NOCAE headform is mounted on linear bearings and the failure criterion is as elsewhere, SI > 1200.

[4] Though strictly a *road helmet* standard, it is an acceptable alternative in AMA sanctioned competition events.

In the 1950s, it was known that when tested according to the BSI protocol, some helmets transmitted higher forces than did others. The test involved placing a sample of the helmet on the wooden headform facing upwards and dropping a ten pound wooden block (presumably also free from dote) onto the front of the helmet. Then the helmet was turned backwards on the headform and the same test was run on the rear of the helmet. For each impact, the force transmitted through the headform to its base was measured by a rudimentary load cell transducer. The transmitted force of some of those early helmets that didn't pass the standard must have been really high as the failure level was set at 5000 pounds force. If you consider this in terms of inertia loading to a free headform, we're talking nearly 500Gs acceleration — a value that most in the business nowadays would regard as being fatal.

In the US, the first foray into the sports helmet standard issue was pioneered by Snively. Following up on his *skull busting* work, in 1959 he virtually single handedly published the first North American standard for racing crash helmets. His approach was to measure acceleration directly using a moving 12 pound headform. Using the BSI standard as a guide, the failure criterion was set at 400G (equivalent to 4800pounds force) — again, probably a fatal level.

Substantiating what would now be considered a high failure criterion, 400G, Snively with Chichester supplemented the data with a groundbreaking analysis of accident-involved helmets[33]. By replicating the damage to 10 helmets worn by racing drivers who had survived a crash, they deduced that "*Survival limits of localized head acceleration of brief duration in man have been shown to exceed 450G.*" Many years later, investigators in England[34] using a similar helmet damage replication technique, found otherwise. In fact they determined that "Current helmets are too strong, and their design is optimized for an impact severity that gives little chance of survival." That is, 400Gs is too high.

In 1966, ASA published its first standard for *Vehicular Users*. The test procedures were essentially as Snively had devised but some additional consideration of biomechanical tolerance levels was implemented. The WSU tolerance curve had now been published and, notwithstanding other shortcomings, it pointed out that there should perhaps be *time limits* on acceleration exposure. The ASA standard retained the 400G maximum limit but set time duration limits at lower levels. These so-called *dwell times*, required that acceleration in excess of 200G not persist for longer than 2msec and at 150Gs for no longer than 4msec. Though these seem to make sense, there has never been any biomechanical validation of these dwell time criteria.

In 1970, Snell upgraded its standard permitting only 300Gs maximum but without dwell times limits. In fact, Snell continues to upgrade its helmet standards on a regular five year basis, something no one else has been doing.

An important advancement in the evaluation of football helmets was to employ the Severity Index as a measure of helmet performance. The failure limit, in keeping with Gadd's view was initially set to SI=1000. This turned out to be too severe for helmets being produced at the time and the criterion value was moved upward to 1500. In 1973 NOCSAE published its *Standard Method of Impact Test and Performance Requirements for Football Helmets*. Since about 1980, virtually every football helmet sold and used in the United States has had to meet the NOCSAE standard. The failure criterion has since been lowered to SI=1200.

The CSA standard for hockey helmets allows a maximum acceleration of 300Gs but also limits the value of SI.

In Europe, the motorcycle helmet standard ECE Reg 22-05 sets the maximum allowable headform acceleration at 275Gs and requires that HIC not exceed 2400. As previously mentioned this standard method allows the helmeted headform to freely go on its way after the impact occurs. That is, it is not restrained by guide wires of any kind.

A newly published standard for Formula 1 race car drivers, FIA 8860-2004, also employs maximum acceleration and HIC as failure criteria even though it employs the Snell-like guided free fall methodology.

One area that continues to frustrate the evolution of better helmet performance standards, and thus perhaps better helmets, is the rotation issue. Biomechanically, there is little argument today that it is rotational motion that dominates the nature and extent of brain injury *not* simply linear translational acceleration. Indeed, several years ago, tolerance curves relating various types of brain injuries to rotational motion of the head have been proposed[35].

In 1986, the author introduced a head injury assessment function that endeavored to take into account both translational and rotational acceleration.[36] This function, the

Generalized Acceleration Model for Brain Injury Tolerance, GAMBIT, has recently been employed in an effort to better understand the nature of protective headgear for soccer.[37]

Several years ago, the author with colleagues Shewchenko and Welbourne[38] introduced a more general head injury assessment function, the Head Impact Power, HIP. This function, which considers the maximum rate of translational and rotational energy transfer to be the controlling element in inertially induced brain injury, has been successfully used in the development of a new North American football helmet (The Riddell Revolution). HIP is also currently being employed to help quantify head injury threats in soccer.[39]

Still, the failure criteria for every published helmet performance standard in the world continue to be based solely on linear acceleration of a test headform. How we will reconcile this conundrum remains to be seen. One thing is certain, helmets are better than they were 50 years ago and this is partially due to the recognition of certain basic biomechanical concepts.

5.2 Penetration Resistance

As pointed out earlier, sharp and pointy objects do not often show up in sports. However, the ability of a helmet to prevent intrusion by some sharp object can be important.

Motorcycle and auto racing helmets are the only ones now subject to penetration testing as such. Other helmet standards do have a jig that limits the size of ventilation holes, which, in a round about way, is meant to be a measure of penetration resistance. Also some standards, Snell B95 for bicycle helmets for example, continue to use a hemispherical impactor. When impacted directly onto a vent hole by this anvil, the headform acceleration must still be limited and that would not happen if the anvil made contact with the headform.



Penetration test apparatus. *Photographed by Stephen Fenn courtesy of Biokinetics and Associates Ltd.*

In the auto and motorcycle racing category, a penetrator whose shape somehow typifies the expected threat, is dropped onto the stationary test helmeted headform from a predetermined height. If penetration of the shell occurs, or more precisely if the headform is touched by the penetrator, the helmet fails the test. In the early days of helmet specs, the sharp steel penetrator weighed 4lb and was dropped from 3ft. In 1974 when the DoT standard was introduced, the penetration energy requirement had increased by a factor of 5 times! Probably nothing has contributed more to the excessive weight of modern motorcycle racing helmets than this exceedingly high demand. ECE Reg 22 for motorcycle helmets took the almost heretical approach and *deleted* completely a penetration test requirement. Much better helmets have since resulted. Again Europe moves on....

Equestrian helmet standards are one of the few that measure and require shock attenuation when struck with a penetrating object. A very aggressive anvil is intended to represent the threat from a horse's shod hoof. The hoof must not make contact with the headform and the headform acceleration is also limited as with any anvil.

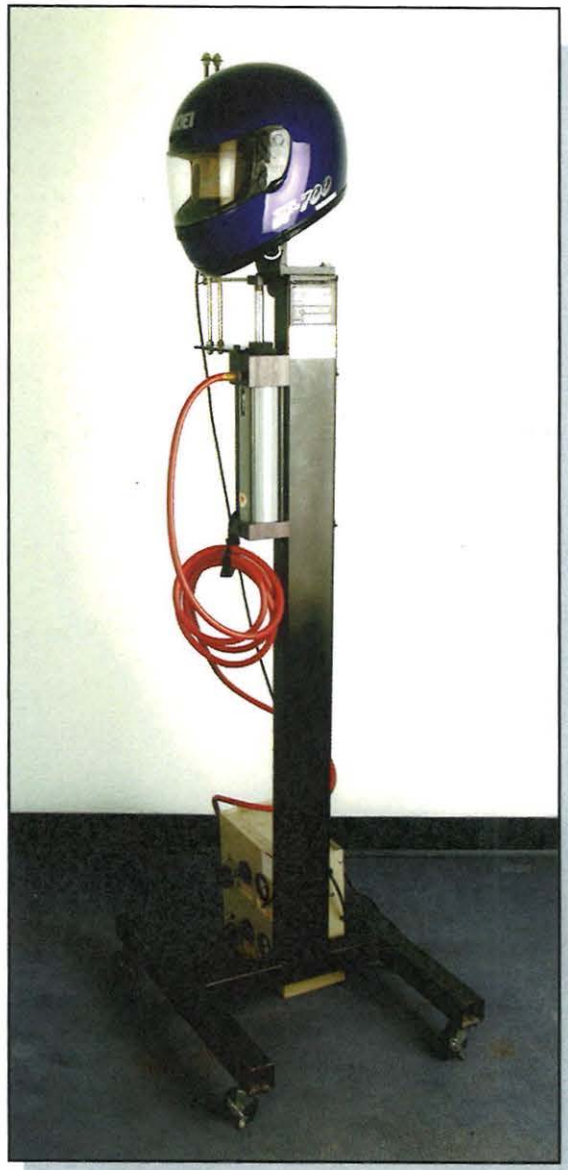
5.3 Retention Testing

Retention system testing at its simplest (and most common) measures the elasticity of the chin strap assembly. The chin strap is fitted around a set of rollers simulating the jaw and a force is applied to the fastened strap. The force may be statically or dynamically applied (depending on the standard). The strap must not break and must not stretch more than a certain amount.

Another more rigorous test involves trying to pull the fastened helmet off a headform by rolling it forward and backward on the head. If the helmet shifts too much or comes off the headform completely, the helmet fails the test.

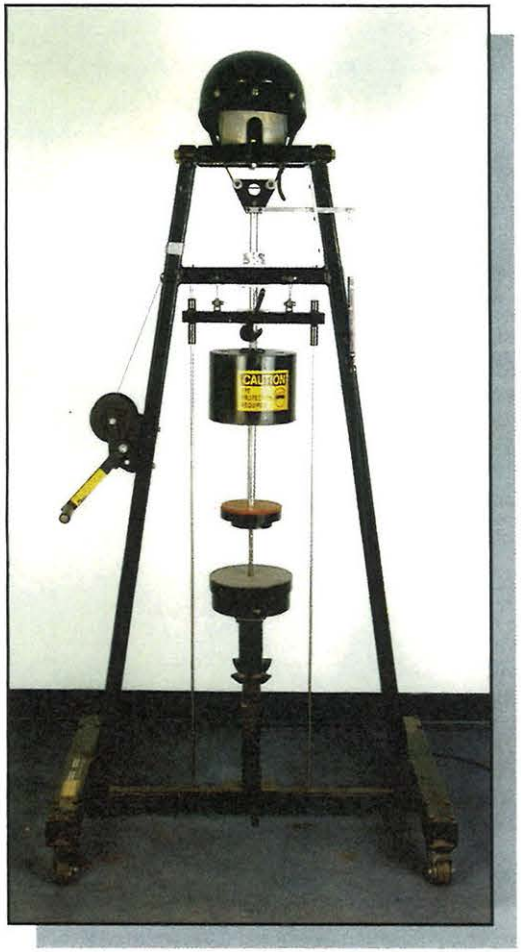


This illustrates how the strap is passed around a pair of metal rollers simulating the jaw. The roller assembly is used to apply a steadily increasing load to the chin strap. *Photographed by Stephen Fenn courtesy of Biokinetics and Associates Ltd.*



This is a typical motorcycle helmet *quasi-static* loading test such as used in the US DoT standard. A hydraulic cylinder pulls down on the fastened strap and the amount of stretch is measured electronically. *Photographed by Stephen Fenn courtesy of Biokinetics and Associates Ltd.*

Curiously, perhaps because the designs tend to be historically good, there is no standard requirement or testing for retention capability for football helmets. And though there is a retention system requirement for hockey helmets, it is apparent that players wear the strap so loose that the helmet can easily be removed without unfastening it. (Though perhaps few would admit it, tradition suggests that one could not engage in a fight with the helmet in place. Thus it must be easily and quickly removed from the combatants' heads should the need arise!)



A more modern type of chin strap test is conducted with this type of equipment. A weight is released onto a catch plate and the maximum *dynamic* stretch is recorded. *Photographed by Stephen Fenn courtesy of Biokinetics and Associates Ltd.*



Many modern helmet standards now use a *roll-off* test. Here a weight is dropped onto a catch plate and the degree to which the helmet may be pulled out of place on the head is measured. *Photographed by Stephen Fenn courtesy of Biokinetics and Associates Ltd.*

5.4 Summary

In a nutshell (yet another shell), helmet standards testing principally entails taking a helmet, whacking it, yanking it, and stabbing it. If it can tolerate all this it could be certified to a particular standard. There may, however, be additional requirements involving stiffness of the helmet and its ability to withstand certain chemicals, sunlight, and extreme temperature exposures. There may be requirements for visual conspicuity, coverage, field of view, and the characteristics of projections, outside and inside the helmet.

In general, standards performance testing insures that a helmet design meets some *minimal* requirements regarding the protection of the wearer. If one of these standards could talk, it might say something like *Look, I don't care how you make this helmet, how pretty it is, how big it is or what it weighs, or how you plan to get people to wear it. I don't care what it's made of, where you plan to sell it, or for how much. All I care about is that the helmet performs to* ***at least*** *these minimum levels of* ***protection.***

It is appropriate to design a helmet that exceeds these minimums somewhat as certainly some safety margin should be built in to account for various unknowns. It is always possible, too, to greatly exceed the specified performance levels, i.e. make it *safer.* But that would not be a successful design as so many other features may have to be compromised. The perfect helmet design is one which optimizes all the user related issues while just barely meeting the performance standards.

6. The Art of Helmet Design

In the design of any product, be it an aircraft or a pop-up toaster, art and science are mixed in differing proportions — and sports helmets are no exception. However, the proportions of each are dependent on the type of helmet.

Crash helmet designs of the car and motorcycle racing variety have been dominated by *art,* since the science has changed so little in the past fifty years. Furthermore, the standards for these helmets, first published in the 1950s, leave little leeway for technical ingenuity. Product design variations are usually subtle improvements in ventilation systems or aerodynamic characteristics. Trying to make them lighter and more comfortable will always be a technical objective for these helmets too. However, the only real opportunity for the creative soul is in the exterior appearance of the helmet. As we'll see, the auto/motorcycle helmet has become a vivid visual statement of the wearer.

It is difficult to chronicle the entire history of this part of the industry as it changed drastically starting in the late seventies. Manufacturers such as Vetter, Vector, Grant, Griffin, Ranger, Roper, Lear Seigler, Land Tool, American Safety, and American Sports, as well as KRW, Electrofilm, McHal, Buco, and, yes, even Bell literally disappeared from the North American scene. Once the largest helmet producer in the world, Bieffe in Italy (that for a few years produced the Bell helmet line) doesn't even exist anymore. By 2000, Bell, Simpson, and a few newcomers were gradually getting back into the North American business. Now however the largest producers of auto and motorcycling racing helmets are in Europe and the Far East.

Helmets for bicyclists have evolved from a somewhat different perspective. Since the modern helmet was introduced in 1975, competing manufacturers have tried to make their products look different — but not just with different graphics. Standards, such as those of the American National Standards Institute ANSI Z90.4 and The Snell B84 did emerge in the mid-1980s and designs changed accordingly. While the *science* of bicycle helmet design is the same as that of the auto crash helmet (the materials employed, the manufacturing processes, and the basic performance requirements were the same.) the shape of the device, its weight and coverage, as well as how it was to be attached to the wearer's head, were all very much part of the *art* of bicycle helmet design. In fact, four types of cycling sports helmets have been created: The road helmet, the mountain bike (full and open face), the BMX *bucket* style (often also used by the skateboard crowd), and *aerodynamic* time trials variety. By the turn of the new millennium, all that was left was for the graphic specialists to attack was the exterior appearance of the helmet. Today, though there are literally thousands of different designs in the marketplace, a bicycle helmet is usually recognized as such.



They're off at the Mountain Bike World Championship, Belgium 2005. Their helmets are all different, yet, at the same time, all the same. *Rob Jones photograph courtesy of Canadian Cyclist Magazine.*

The industry that produces bicycle helmets is enormous. Mainly made in the Far East, there are at least 45 companies in the People's Republic of China alone, not to mention the nearly two dozen in Europe in addition to those in North America. Too complicate matters, many producers make helmets for secondary markets who sell under their own brand name. For a thorough overview of bicycling helmets currently in the marketplace, check out Randy Swart's HSRI website[40]. Here he reviews the products of over 100 bicycle helmet manufacturers. From a few thousand sold in 1975, tens of millions of bicycle helmets of thousands of different designs are made and sold every year now.

On the equestrian side of things, the adage about getting back on the horse if you fall off is fine so long as you haven't sustained a head injury in the falling off part of the adage. In the early days of equestrian competition (and to a great extent today), style was everything. You could not go to a horse jumping event and not see the riders in their black velvet caps. Jockeys in thoroughbred racing wore a cap that was not much better performance-wise but colorful *silk* covers usually adorned the outside of their headgear, identifying the rider in a very fashionable way. And in that most western of all horse sports, the rodeo, riders aboard bucking broncos usually wore no more than the standard cowboy hat — again a fashion statement. In the US, ASTM published its first equestrian helmet standard in the late 1990s following the lead of the EN standard in Europe. The Snell Foundation published its own helmet standards for harness racing drivers in 2000. Eventually, helmets that recognized these traditions emerged and today equestrian helmets that actually provide a decent level of protection are available. Relative to the other categories, it is a small market and served mainly by a few manufactures in North America and Europe.

Athletic helmets such as those for hockey and football followed similar trends but with different emphases on the science and art. The shape of the American football helmet became essentially fixed around 1950. Even with the introduction of new science and the publication of the first performance standard by the National Operating Committee on Standards for Athletic Equipment (NOCSAE) in the mid-1970s, the shape had become iconic. All that was left artistically was to provide different exterior features and colors leaving plenty of room for often outrageous team graphics. In the latter quarter of the last century, the industry was decimated largely by litigation costs. Names like Maynard-Draper, Hutch and Goldsmith, then Spalding, Wilson, McGregor, and Rawlings all disappeared from the football helmet scene. Riddell and Schutt were the only ones to stay in the business. The market for these helmets is limited essentially to North America and is currently supported by Riddell and two other US manufacturers.

Hockey helmets were never *uniform*. Every manufacturer, and there were quite a few in Canada and the US, tried to produce a helmet different from its competition — and from its prior models. New models were issued with almost the same frequency that car manufacturers introduced new models. How well they performed however was essentially unknown. Helmet performance started to become more dependable when the first Canadian Standards Association CSA standard for hockey helmets was published in 1975. Toward the end of the 20th century a consistent appearance also started to become evident. But even today, there are not-so-subtle differences in the appearance of different manufacturer's hockey helmets. The market for these devices is principally North America and Europe. The design and manufacturing base for these helmets comprises essentially three companies in one province of Canada, Quebec.

Winter sports such as skiing and snowboarding are difficult to characterize head protection-wise. Are they athletic activities like hockey and lacrosse or an inherently dangerous activity like say BMX bicycle racing? Until the late 1990s, only competitive skiers wore any form of head protection. And, in the absence of any accepted performance standards, designs were not particularly good. In the 1980s, the only available ski helmets were made in Europe by companies like Uvex, Boeri, and Carrera. But recreational snow sport is also a fashion conscious activity. Skiing apparel is a huge industry and it was only a matter of time, and perhaps a few highly publicized skiing fatalities, before fashionable protective head wear became commonplace. Many ski helmets today look a lot like today's bicycle helmets — because they are made by the same industry or have been copied from bicycle helmet technology. With the publication of a new ASTM ski helmet standard in 2000, the Americans have caught up with designs that rival those of Europe.

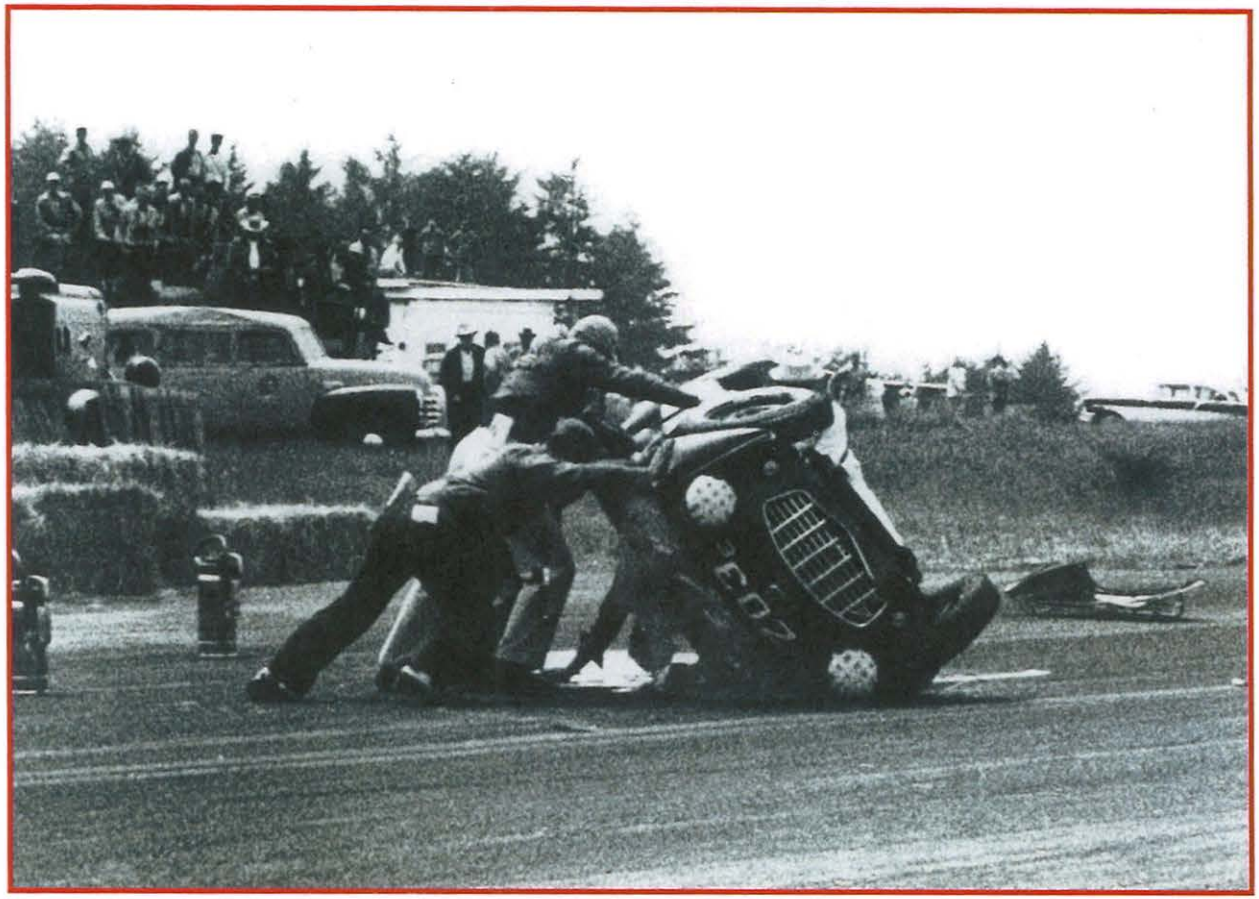
6.1 Auto and Motorcycle Racing Helmets

The use of helmets by motorcycle racers is based on the easily-grasped concept that if you crash and fall off at speed, your head may make rather violent contact with the track surface (or perhaps some other motorcycle behind you). Drivers of open cockpit race cars began using helmets for similar reasons. Restraint systems were nonexistent or ineffective and ejection from the vehicle was not uncommon. Not that *all* ejections were accidental. One of the more famous racers of the late 1950s, Maston Gregory, was known to jump from his car if a collision was imminent on the assumption that he'd be better off outside the car than in it.[41]

Even if the driver was not ejected thanks to a seat belt, roll cage structures were not typically used and the driver's head could readily make contact with the roadway during a roll over. Pete Snell, for whom the Snell Memorial Foundation was established, died from head injuries sustained during a race. It has long been held that his helmet was not effective. However, examination of the details of his roll-over accident shows that the lack of a roll cage on his car allowed his head to impact with the track surface. It is not certain that, even with a modern helmet, he could have survived this kind of crash.

The driver's head in early racing car crashes was exposed to impact much the same as that of an ejected motorcyclist for whom such headgear was principally developed. In any crash scenario in the past, the driver's head could be struck by flying debris, including car parts such as wheels, suspension, engine components, etc. Such threats are best dealt with by providing a shield between the environment and the driver's head. To this day, notwithstanding the publication of automobile racing helmet standards, auto and motorcycle racing helmets are functionally the same.

The way race cars are designed today, the current threats to drivers are likely not best dealt with by a *motorcycle helmet* at all. But more on that later.



Rescuers help upright Pete Snell's sports car after it rolled, 1957. *Photo courtesy of the Snell Memorial Foundation.*

When this photo was taken in 1958 at the French Grand Prix, Fangio was in fact the reigning World Champion. Many consider him to be the greatest driver of all time (at least until one Michael Schumacher arrived on the scene). In seven full Formula 1 seasons he was World Champion five times (with four different teams) and runner-up twice. In his 51 championship Grand Prix races he started from the front row 48 times (including 29 pole positions) and set 23 fastest race laps en route to 35 podium finishes, 24 of them victories. His superlative track record was achieved by some of the greatest displays of skill and daring ever seen. However, on this occasion, British born Hawthorne achieved his only F1 win of the year. With the points he had accumulated over the season, he finished one point ahead of Stirling Moss to become the first British World Champion. Yes, the flamboyant Hawthorne did in fact become Number 1 later in 1958. Regrettably, next year he was killed in a road traffic accident driving his own car.

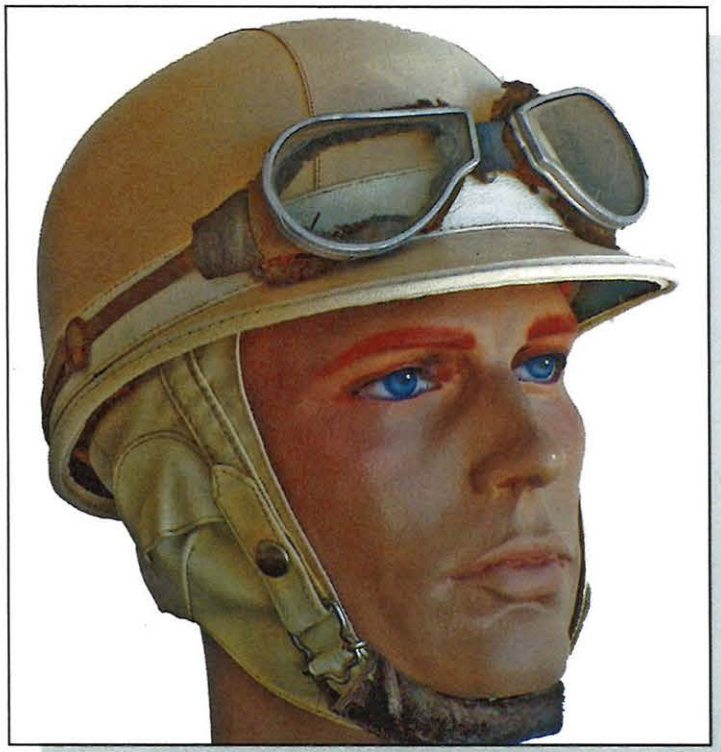


Juan Fangio and Mike Hawthorne seem to be discussing who's *Number 1*? Both are seen wearing the classic pudding basin helmet of the time. Fangio preferred the customary goggles while Hawthorne adopted the less popular flat face shield. *Photo from the Cahier Archive.*

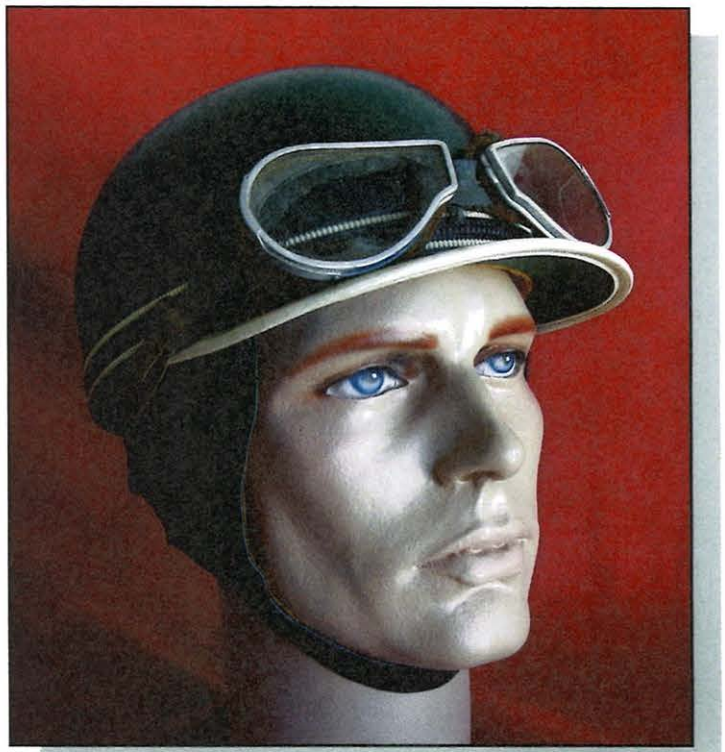


Stirling Moss at the Grand Prix of Monaco in 1959. It has been said that Moss was the most celebrated driver of his day to have never won a World Driving Championship. Moss won 16 of 66 Grand Prix starts and in all major events, his record is listed as 194 wins in 466 starts. For four consecutive years, 1955-58, Moss finished second in the World Driving Championship and was third in successive years, 1959-61. *Photo from Cahier Archive.*

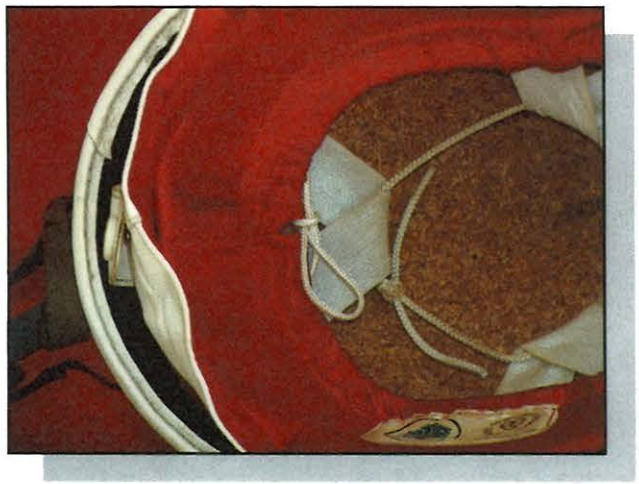
Moss's pudding basin was nearly always off-white and was in some ways his *signature* helmet. Even today, when Sir Stirling shows up at vintage events, he'll often wear this classic style of headgear. The Everoak helmet was made in England and comprised a hard outer shell covered with a leather-like vinyl fabric. The energy management interior was nothing more than a thin layer of cork. Size adjustment was accomplished with a nylon lace around an interior fabric hat band as seen in the following pictures.



The classic Everoak helmet worn by car and motor-cycle racers in Europe during the fifties and sixties. *Author's collection.*



An Italian made AGV pudding basin. *Author's collection.*



The draw string, fabric, cork interior of the Everoak.



One of the most recognizable labels of all time in Europe. The BSI *kite mark.*

Graham Hill, yet another Englishman, first entered Formula 1 racing in 1958. His first victory did not come until 1962 when he also became World Champion. He repeated the feat in 1968 after winning the Indianapolis 500 in 1966. At a time when helmet *decoration* was virtually unheard of, his dark blue helmet with the white *rowing stripes* became one of the most recognizable elements in 60s motor racing. Apparently the design was to acknowledge his earlier participation in the London Rowing Club. In fact, according to Richard Phillips of the London Rowing Club, "Before taking up motor racing as a full time profession, Graham Hill rowed at London RC in the 1950s. He was in the club's top boat and raced in the Grand at HRR. He met his wife Bette through rowing as she was a member of either Aurial or Kensington (pre-merger days). Both he and son Damon therefore felt that they owed the sport a great deal and in particular LRC. I believe the helmet design is the same as London boating caps."



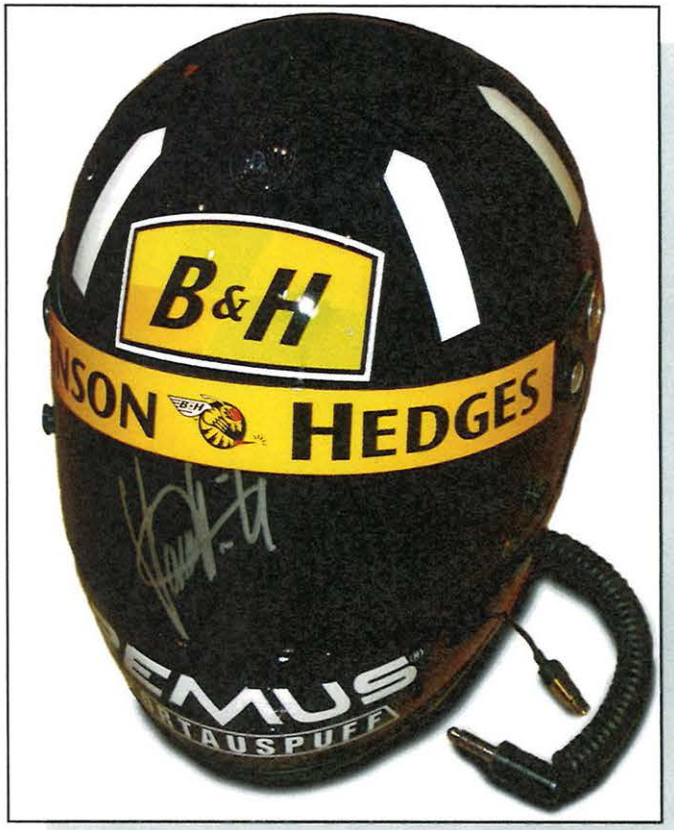
Graham Hill at the 1963 German GP. *Photo from the Cahier Archives.*

In 1975 Graham, was killed when the airplane he was piloting crashed in fog. This iconic design was not to be seen again in auto racing until 1993 when his son Damon, who later became Formula 1 World champion himself in 1996, reintroduced it on his own helmet.

Another distinguishing feature of Graham's headgear was the bandana he often used to filter the air getting to his nose and mouth. Damon had the benefit of a more modern approach to this problem.



Graham Hill's Bell 500TX replica c. 1964 helmet. *Author's collection.*



Damon Hill Arai replica (1997) helmet. *Photo courtesy Collector Studio.*



Jim Clark seen here is wearing an un-adorned Bell 500TX as he prepares for the 1965 German Grand Prix at Nuerburgring. *The Flying Scot* was considered by many to be the most natural driver of all time. All in all, he won 25 Grand Prix races, more than any other driver at the time. He was in 1965, the first Briton to win the Indianapolis 500. Clark was twice World Champion in 1963 and 1965. *Photo from Cahier Archive*).

On April 7, 1968, Clark lost his life in a violent accident in the forest at Hockenheim in a Formula 2 race. He was but 1 of over 100 international racing drivers killed in action between 1958 and 1968. Many no doubt died from head injuries. When this photo was taken in 1965, rudimentary roll bars were being used in Formula 1. Clearly the need for good impact protection was still required since the roll bar did not extend very high and, even if restrained by seatbelts, roll-over accidents exposed the driver's head to road impact.



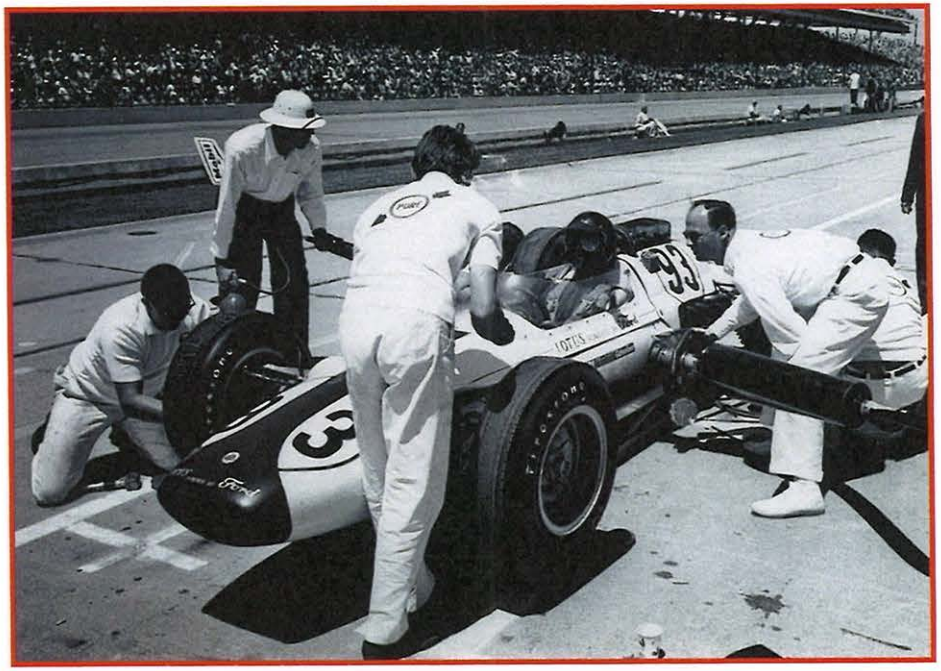
Another Scotsman, and another of the world's finest drivers, Jackie Stewart, had his own way of dressing up his Buco helmet with the Stewart tartan. This stylistic treatment would continue on every helmet he wore throughout his racing career. World Champion in 1969, 1971 and 1973, he remains one of the sports greatest safety advocates.

Sir Jackie shown here before the Dutch Grand Prix in 1968. His Buco helmet sports a band of the Stewart tartan. Stewart also favored the silk bandana approach to face protection. He used a plastic chin cup to help secure his Buco helmet, a practice that has been discontinued for 30 years. *Photo courtesy of Artemis Images.*

In 1963, the famous American driver Dan Gurney arrived at the Indianapolis 500 wearing an innovation not seen before — a self-made black leather face mask, the forerunner of the full-face helmet. According to Mrs. Evi Gurney, "He did not wear it again for a few years — maybe it was too uncomfortable?"



In off-road/dirt-track motorcycle racing, open face helmets like that worn by Stewart, were often modified to incorporate a mouth guard such as shown here. There were no published performance specs for such devices and it is not clear that they ever actually helped. The author is seen here in period headgear used in dirt-track/motocross motorcycle racing, c. 1975.



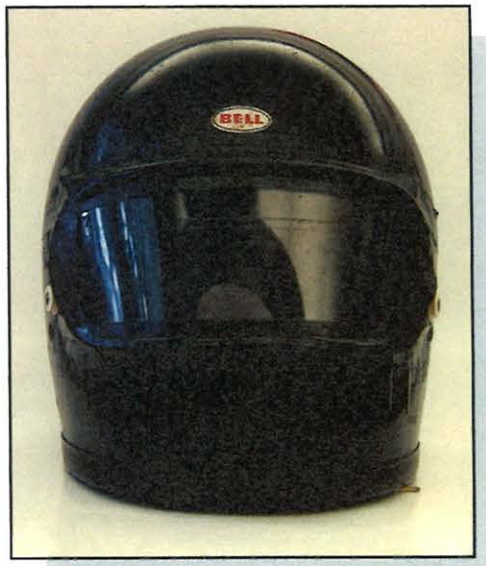
Seen here in the Lotus Ford, leather masked Dan Gurney makes a pit stop during the 1963 Indianapolis 500. At this time, like F1, roll bar requirements were minimal and the driver's head was still dangerously exposed. *Photo courtesy AAR and the Gurney family.*

The first genuine full-face helmet was developed for off-road motorcycle racing in about 1964. As it turns out, Gurney had been observing competitors in dirt track motorcycle racing. One such competitor, Swede Savage, was one of the first to adopt the Bell Star. Later, Savage joined the Gurney All American Racing Team and coincidentally or otherwise, Dan showed up at the 1968 Indianapolis 500 wearing a Bell Star, the first auto racer to do so. Later that year, as he put it, "Because of the appalling conditions, the German Grand Prix was the perfect place to try out my full-face Bell helmet." He wore the same model in the British Grand Prix later that same year. This type of helmet was soon adopted by the entire European F1 community. Today, drivers of virtually every race car and motorcycle wear a full facial coverage helmet. Some closed cockpit race/rally car drivers continue with open face designs but they are certainly among the minority.

By the time he retired from active driving in 1970, Gurney had raced in 303 events in 20 countries with 25 different makes of cars winning 48 races and finishing on the podium an additional 41 times! His victories included 7 F1, 7 Indy Car and 5 NASCAR races. Additionally he captured wins in Trans-Am, Can-Am, and sports car races including the endurance classics at Nuerburgring, Daytona, Sebring, and Le Mans. He remains the only US citizen to win a Grand Prix in a car of his own construction. The actual helmet worn by Gurney is shown in the next two figures. As was his custom throughout his career, his helmet was plain black, the only *adornment* being his name. At this time, the face shield was not movable and remained in the shut/down position. In fact it was supposed to be permanently fixed this way. However Dan found it leaked air which created annoying wind noise — hence the liberal application of electrical tape all around the face port area.



Dan Gurney, the first car driver to adopt the full facial coverage helmet, is shown here as he prepares to practice at the Nuerburgring in 1968. *Photo by Dave Friedman courtesy All American Racing and the Gurney family.*



Dan Gurney's original Bell Star, front view.



Dan Gurney's original Bell Star, side view *Photos courtesy AAR and the Gurney family.*



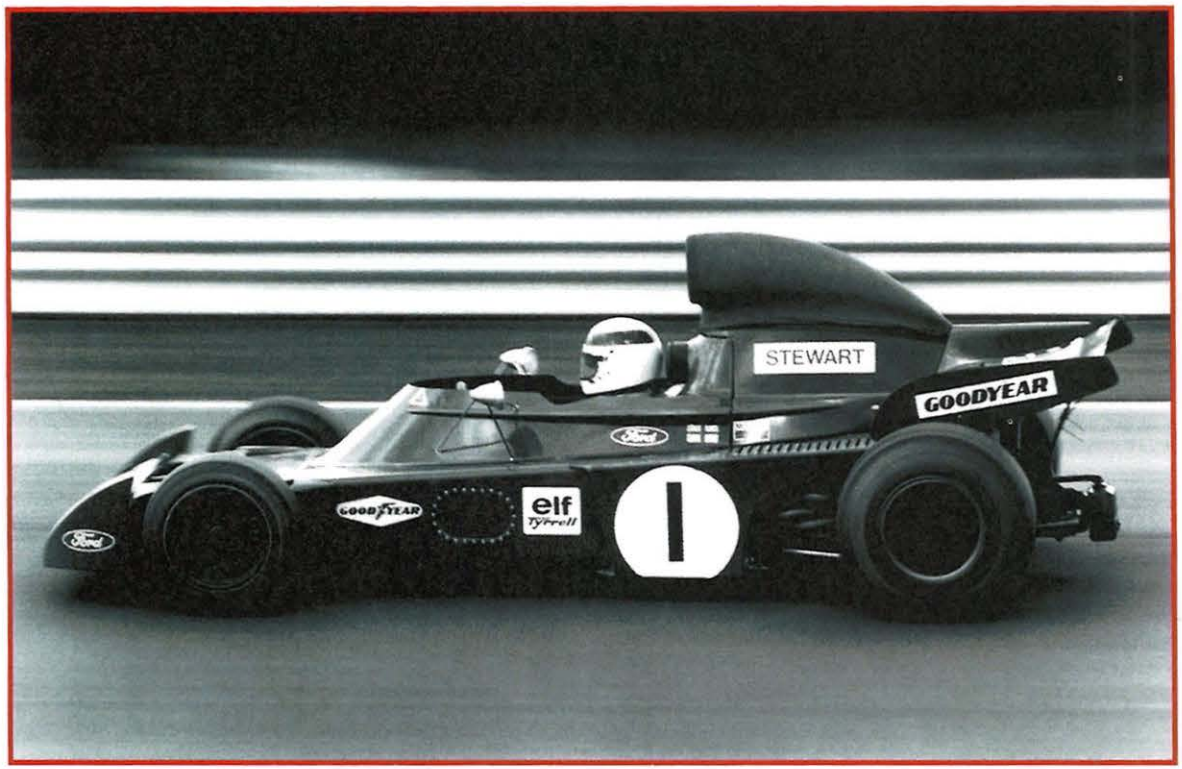
Dan Gurney at the 1969 Indianapolis 500 race wearing the same helmet. Since this is, after all, a motorcycle helmet, this time the black sticky tape over the face piece was applied to also reduce the upward field of view more suitable for car racing. *Photo courtesy of Artemis Images.*

Jackie Stewart practicing for the 1968 United States Grand Prix Formula One race at Watkins Glen with a prototype faceplate attached to his open face Buco helmet. Realizing perhaps that the full facial protection was the way to go, several manufacturers tried their hand at coming up with competing designs. Buco, working with Jackie Stewart, tried out this novel faceplate approach. It seems to have not survived beyond this practice session. *Photo courtesy of Artemis Images.*

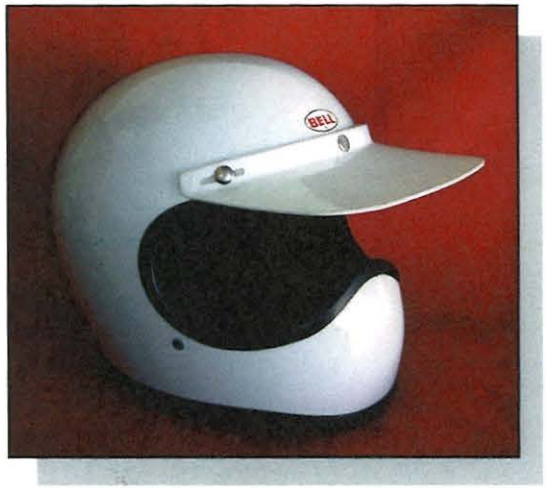
As was the case with the Bell Star in open cockpit car racing, this style soon was the predominant choice among off-road motorcycle competitors. Variations of the design were later introduced by Bell and by the rest of the helmet industry.



By 1969, Stewart too had graduated to a more typical full-face design — tartan intact. He's seen here in action at the Dutch Grand Prix that year. (*Cahier Archives photo.*



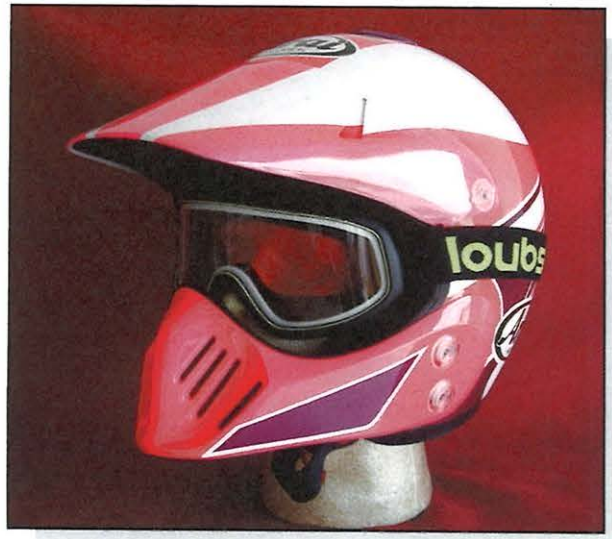
Sir Jackie racing to a second place finish at the 1971 U.S. Grand Prix. He had already clinced his second world title. His Tyrell teammate, Francois Cevert, won the race.



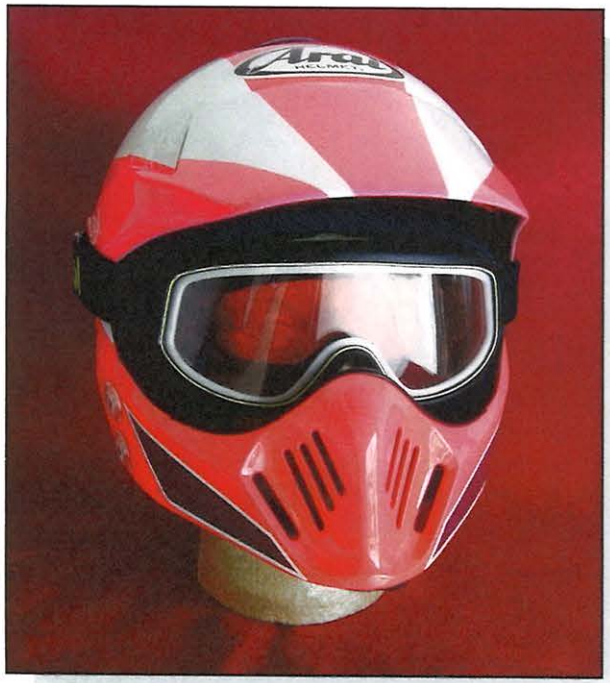
In 1975, Bell Helmets introduced the Motostar, a variation of the Star worn by Gurney and others, for the off-road motorcycle crowd. The biggest change was to increase the eyeport area to accommodate goggles. The chin bar shape was also changed to increase protection to the nose area. A transparent faceshield was not provided and the main accessory was a peak that could be snapped onto the brim of the helmet. *Author's collection.*



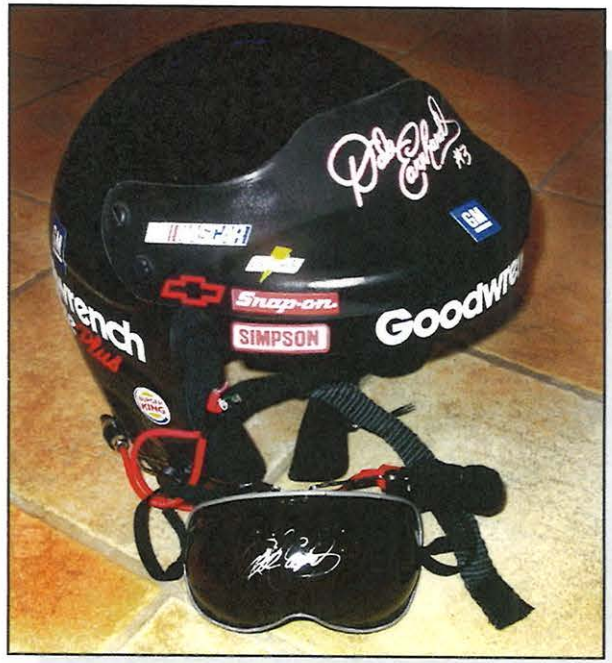
Jacky Ickx on his way to victory with co-driver Mario Andretti in the Ferrari 312PB at Watkins Glen during the 1972 Watkins Glen 6-hour race.



Pretty in Pink. This 1990s style off road helmet by Arai has a removable/adjustable chin bar. *Author's collection.*



Of course the need for facial protection appeared minimal for drivers of closed cockpit cars and open face helmets were the prevailing form of headgear in stock car racing. In time however, more and more drivers began to adopt the full-face design. In 2001 NASCAR Champion Dale Earnhardt was one of the few remaining drivers to be wearing an open face helmet. After his fatal crash on the second last lap of the 2001 Daytona 500, every driver adopted the full-face design. Dale died from massive head injuries.



A replica of Dale Earnhardt's open face Simpson helmet. *Photo courtesy of Collector Studio.*



This is Tom Sneva's helmet after he crashed in the 1975 Indy 500. The eyeport opening was specially modified to the narrow opening seen here. The graphic design is limited to typical automotive pin striping of the day. *Ryan Parks photo courtesy Bell Sports.*

By the mid-1970s, the *art* of helmet design was becoming no more apparent than in auto and motorcycle racing headgear. Technically, not too much was happening but the outer helmet shells were becoming canvases for the creative types. Sponsor's logos were about to be married to some pretty wild helmet designs.

In fact, tobacco sponsorship was the very first commercial sponsorship in Grand Prix racing, arriving at the Monaco Grand Prix of 1968, when Team Lotus drivers Graham Hill and F1 rookie Jackie Oliver ran in Gold Leaf-sponsored cars. In 1972 Philip Morris joined the fray with its Marlboro brand and in the years that followed Gitanes, Camel, Rothmans, Mild Seven, Benson & Hedges, West, and Lucky Strike all became major players.[42]

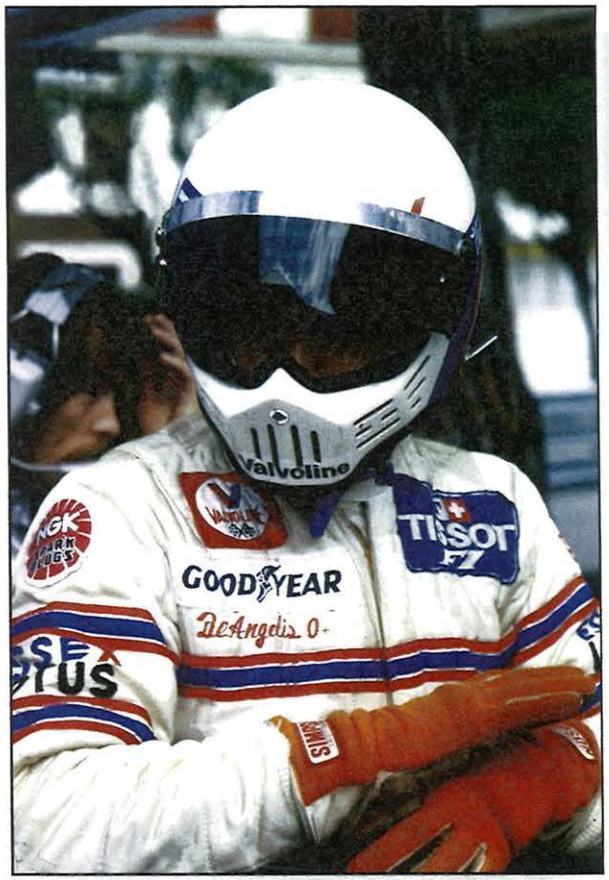


Emerson Fittipaldi was twice F1 World Champion (1972, 1974), twice winner of the Indy 500 (the second being 21 years after his first F1 Championship), and once CART series champion (1989). *Emmo's* helmet, rather staid by today's standards, is seen here at the 1974 Grand Prix of Monaco. Gasoline and cigarettes might seem like an odd combination but the oil and tobacco industries would become big sponsors of this sport and their logos would appear dominantly on many driver's cars, suits, and helmets. *Photo from Cahier Archives.*

Ten years later, Niki Lauda's helmet carries similar *livery* and now includes sponsors from the dairy and fashion industries. Marlboro would remain a dominant sponsor for all types of auto racing for over 30 years



Niki Lauda prepares for the 1984 French Grand Prix. Lauda was 3 times F1 World Champion. He first won it in 1975 and then, despite having suffered terrible burns to his face, scalp, and lungs (his helmet came off during a crash in 1976 at Nuerburgring when his Ferrari caught fire), he regained the Championship in 1977 and 1984. *Photo from Cahier Archives.*



Elios de Angelis at the 1980 Monaco Grand Prix. This helmet by Simpson, affectionately called the Ms. Piggy or the *Darth Vader*, was most popular as a motorcycle helmet and worn very seldom as here in Grand Prix racing. The Bandit continues as a popular Simpson racing helmet. *Courtesy LAT Photography.*



Another legend in his own time, and in his sport of motorcycle road racing, is *Fast* Freddie Spencer. In 1983, he was youngest ever at 21 to win the World GP Championship in motorcycle racing. He would go on to win both the 250 and 500cc World Championships in 1985. (*Kibiki photo courtesy of Arai Helmets.)*

During the 1980s, Arai issued several replica helmets of motorcycle racing greats including these honoring Kevin Schwantz and Randy Mamola.



Arai's Fast Freddy replica helmet. *Photo courtesy of Arai Helmets.*

Joey Dunlop, MBE, OBE, at Parliament Square, Ramsey, Isle of Man Tourist Trophy Race, 2000. Five times World F1 TT Motorcycle Champion, Sir Joey started racing in 1969 and first came to the Isle of Man TT races in 1976. He won his first TT in 1977 and was to go on to win twenty six TT's races in a 25 year TT career. He was made a Member of the British Empire for his contribution to motorcycle racing and admitted to the Order of the British Empire, not for his racing prowess, but for his charitable work throughout Eastern Europe. He was killed in a motorcycle race in Estonia in 2000 shortly after this picture was taken. Joey nearly always wore an Arai helmet and in his honor, Arai issued a limited series of Joey Dunlop replica helmets for riders who might like to think they could emulate him. *Photo courtesy Richard Radcliffe, Isle of Mann.*





Bell Helmet's Eddie Lawson replica. One of the winningest US motorcyclists, Eddie Lawson followed his 250cc AMA championships in 1980 and 1981 and the AMA Superbike championships in 1981 and 1982, by winning the World GP Championship four times in the 500cc category. He retired in the early 1990s and took up Indy car racing for a couple of years. Though he didn't always wear a Bell, Bell Helmets did produce a Lawson replica for budding racers. (*Ryan Parks photo courtesy of Bell Sports.*



Arai replica of helmet worn by Joey Dunlop in many Isle of Mann TT races. *Photo courtesy of Arai Helmets.*



Kevin Schwantz replica of Arai helmet worn in many GP races. *Courtesy Arai Helmets.*



Shoei RF200 motorcycle helmet. *Photographed by Stephen Fenn.*

The other big helmet producer in Japan was Shoei. By the early 1990s they were routinely producing motorcycle helmets with quite elaborate graphics like those shown here. It must be noted these are not special, custom-painted helmets, but rather mass produced units with the graphics installed at the factory.



Arai replica of Randy Mamola helmet worn in many GP races. *Courtesy Arai Helmets.*



Shoei RF200 motorcycle helmet, c. 1992. *Photographed by Stephen Fenn.*

A close look at Dismore's helmet shows how the auto racing helmet begins to differ from that of the motorcycle racer. Many drivers covered the upper portion of the faceshield with duct tape or something similar (with logos if you had a sponsor) since the upward field of view required by a biker, was not required for the car driver. Also plumbing for air supply and, occasionally, for something to drink, were added. Other chaacteristics of an auto racing helmet that differed from its motorcycling cousin included a different interior fabric. In anticipation of fire in a crash, the interior and the chin straps were lined with fire resistant fabric such as Nomex®. Some helmets (particularly those used in drag racing) also make provision for a fire resistant neck skirt as seen here on this 2004 photo of Jeff Gordon.



Not all helmets had elaborate decoration and their performance was what made them stand out. This modestly adorned Bell AFX1 was worn by Mark Dismore when he crashed during practice for the 1991 Indianapolis 500. The 180 mph crash has been described as horrific as any in history. Dismore broke both feet and both knees, two vertebrae, and a wrist. Though he clearly struck the left side of his head, he sustained no head injury and went on to compete for many more years. *Ryan Parks photo courtesy Bell Sports.*



Jeff Gordon, NASCAR's Winston Cup Champion in 1995, 1997, 1998, and 2001, celebrates after winning the 2004 Brickyard 400 NASCAR race at the Indianapolis Motor Speedway. Attached to his helmet is a fire retardant neck skirt. *Photo courtesy Arai Helmets.*

One other difference was that auto racing faceshields were generally a little thicker than the motorcycle counterparts and also the faceshield could be raised with either or both hands. (One hand only — the left, for bikers, right?) The other modification was to include a 2-way radio within the helmet so the driver could talk and listen to his crew.

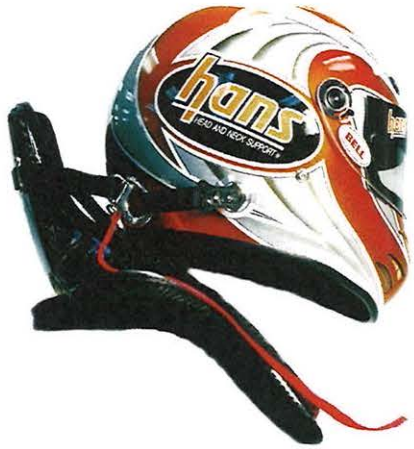
By 1993, Ayrton Senna's headgear had adopted a multicolored style that was immediately recognized. In 1994, on the second lap of the San Marino Grand Prix at Imola, Senna, then 34 years of age, crashed into an unprotected concrete wall at around 135mph. Post-crash examination of his helmet showed that his faceshield had been pierced by a suspension component. In addition, there was evidence of major direct impact to the region of the helmet above the eyeport. He sustained massive skull and brain injuries and was pronounced dead several hours later.



Ayrton Senna, World Champion in 1988, 1990, and 1991 is shown here competing at the 1993 Grand Prix of Monaco. *Cahier Archive photo.*

This tragedy, perhaps more than anything in recent history, caused FIA to take another serious look at driver protection. The most obvious result of these deliberations was the raising of the sides of the cockpit to better shield the driver's head and, to some extent more importantly, to provide lateral support and energy absorption for the head in a side-on collision. The cockpit surround today is probably more of a factor in controlling head injuries than the helmet itself.

Jump ahead to the Grand Prix of China in 2005 and look at how well Juan Pablo Montoya's head is ensconced within the cockpit.



The HANS device is shown here attached to the driver's helmet by way of strap tethers. A quick release is provided in case it is necessary to remove the helmet while the driver is still strapped in his car. *Photo courtesy Hans Performance Products.*



Juan Pablo Montoya at the 2005 Grand Prix of China. *Photo from the Cahier Archive.*

Formula 1 was not the only racing body to adopt these new open cockpit design changes. IRL, CHAMP as well as Formula Atlantic, Formula 3000, etc. adopted the padded cockpit surround in one form or another. Even *low budget* racing like SCCA Spec and Formula Vee now have lateral head support as part of the roll cage structure. Even NASCAR adopted a similar trend by installing lateral supports on both sides of the driver's head within the closed cockpit stock cars. The nature of the head injury threats to the auto driver and the motorcyclist were beginning to be substantially different. But yet further changes were to occur to improve head protection beyond that of a simple motorcycle helmet: the HANS® device.

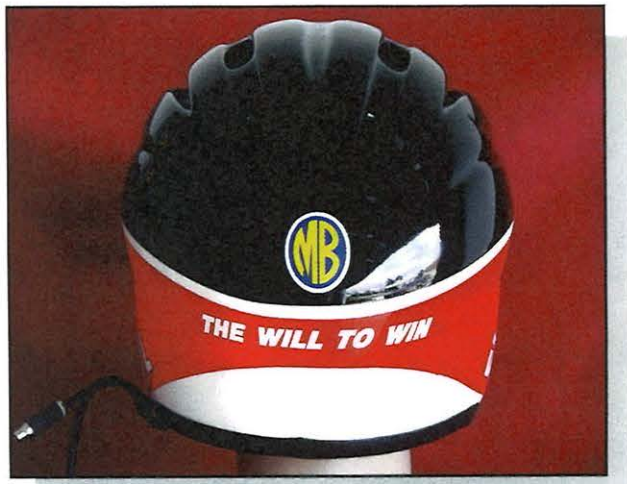
By the time Head and Neck Support (HANS) was introduced, the head was pretty well protected for lateral and rear impacts. However, impacts with a substantial frontal component were still a problem. In such cases the helmeted head was free to rotate forward on the neck creating dangerously high neck forces and permitting the front of the helmet to crash into the steering wheel/column. HANS prevented that. A brilliant adaptation of the vehicle restraint harness belt and the helmet by Robert Hubbard of Michigan State University, HANS improved yet again on the lowly motorcycle helmet by making it work better in car crashes. HANS was first adopted by CART for oval racing in 2000 and has subsequently been adopted by virtually every racing organization.



The helmet of Mark Blundell of Great Britain, seen here at the 2000 Bosch CART Grand Prix in Nazareth, Pennsylvania, typifies the way in which custom decor and advertising was being placed on driver's helmets. On the very top of Blundell's helmet is the stylized MB which is also seen on the crew member helmet. *Michael Levitt photo courtesy of LAT Photography.*



A CART PPG Bell Helmet, used by PacWest Racing Group crew chief Daryl Fox during the 1999 CART FedEx Championship Series season. During races, Fox could exchange key information with team driver Mark Blundell via the built-in headset. The helmet is in fact simply a BMX helmet made by Bell and painted to look differently. *Author's collection.*



Back of crew helmet with slogan and insignia.



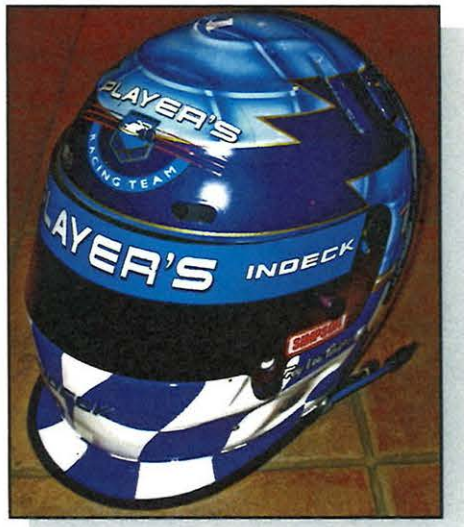
Simpson auto racing helmet. The tether ring on the left side of the helmet is set up for typical counter-clockwise oval racing *Author's collection.*



1996 World Champion Damon Hill is congratulated by the yet to be World Champion for 1997, Jacques Villeneuve, at the 1996 Argentina Grand Prix. Hill's helmet retains the simple oar motif while Jacques' sports a modern design. Both have the same sponsors' logos. *Photo courtesy of LAT Photography.*



The ripple effect on the shell has been an aerodynamic trade mark of Simpson for some years.



Simpson Greg Moore replica. *Courtesy Collector Studio.*

Before HANS, and the high cockpit lateral support or, in racing where neither of these are available (such as Kart racing), other efforts to tether the helmet can be employed. Attaching the helmet to the cockpit or to the driver's shoulder helps to counter the *G forces* during high speed cornering. The 1990s style Simpson auto racing helmet seen here features all the things you would have wanted at the time in a car helmet, a small eyeport, a robust chin bar, good ventilation, reasonable aerodynamics, a thick faceshield that could be opened with either hand and a fitting to which a tether strap could be attached. The Greg Moore logo was to acknowledge and celebrate the incredible young Canadian racer, not to mourn his fatal crash at Fontana in 1999.

As you can see from the helmet on the left, by the late 1990s the graphic artists were having a ball. With many big name drivers having a new helmet practically weekly, the opportunities to be creative were wide open.

The FIA adopted a policy to ban tobacco sponsorship in international motor sport when, in October 2000, the World Motor Sport Council adopted a resolution to introduce a world-wide ban on tobacco advertising and sponsorship in international motor sport by the end of the 2006 season. In fact the ban began to be effective sooner as individual countries adopted their own regulations regarding tobacco advertising. Such sponsorship was banned from all forms of racing in Canada, for example, beginning in 2004.



Seven times F1 World Champion, Michael Schumacher's *comin' atcha*. With 91 wins, 154 podiums in 250 races over a 15 year career, here he stays ahead of Fernando Alonso to win the San Marino GP at Imola in 2006. Note that the Marlborough logo is no longer in evidence on his helmet — or anyplace else. Michael, arguably the greatest race car driver of all-time, retired at the end of the 2006 season. *Photo from the Cahier Archives.*



The design on Michael Schumacher's 1999 Ferrari Bell Fueler replica helmet here is quite complex yet it retains adequate space for plenty of sponsor logos. Note for how long Marlborough has been a part of racing. (*Ryan Parks photo courtesy Bell Sports.*

Today, auto racing helmets are typically provided in simple plain colors to allow the creative types some space to work on. Examples of modern racing helmets are shown here.



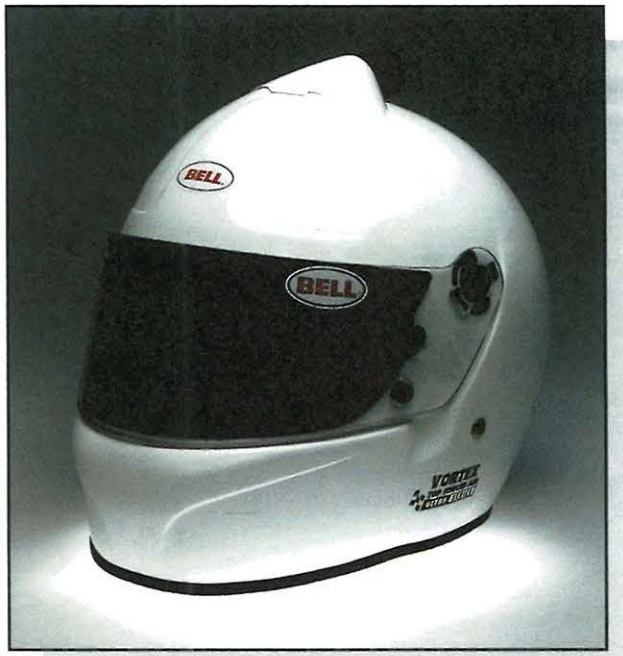
Arai GP5RC F1 racing helmet. Recognizing the trend to custom paint jobs, this popular model, like most auto racing helmets comes in one single color or another — no fancy graphics on these guys. The shell is fabricated from carbon fiber (*RC* standing for Racing Carbon).

Fernando Alonso's Arai GP5 RC helmet all dressed up for the 2006 Grand Prix of Turkey. Later that year, Alonso became World champion for the second consecutive time. *Charles Coates photo courtesy LAT photography.*





The Bell Auto Racing's M4 Pro. This lightweight helmet is designed for drivers who prefer the full range of vision of an extra large eyeport. It features a new friction shield system which has a mechanism that allows the driver to adjust the tension on the shield allowing for multiple opening positions. Bell's top end helmets all have a shell laminated with carbon fiber, Kevlar, and fiberglass.



Bell Vortex TFA (Top Forced Air) features a pipe on the top of the helmet that channels airflow from an external system and circulates it around the top of the head. Locating the pipe on the top of the helmet instead of the side allows for increased driver head movement because the pipe does not interfere with the protective head surround of the latest safety seats.



Bell GTX features a front lip and rear aerodynamic spoiler and is an ideal choice for open cockpit forms of racing including formula cars, sprint cars and karting. The helmet's recessed side chin bar vents provide ventilation while not allowing dirt to enter into the helmet.

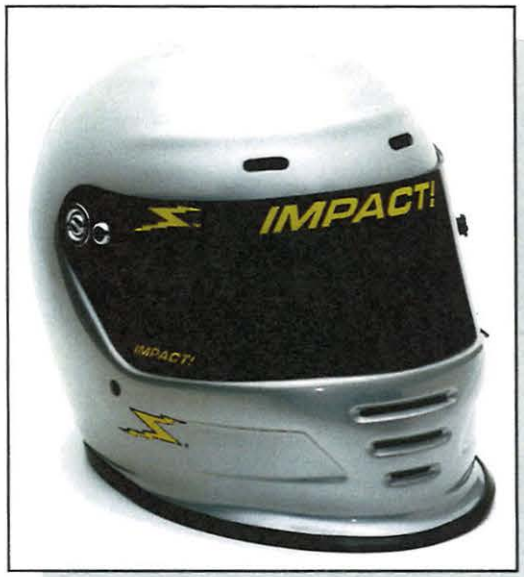


Bell's DBX is a special aerodynamic helmet designed for motorcycle drag racing. The front chin bar is angled to match the tuck of the tank when the rider is in the crouched position.



Impact Racing's Super Cyclone is available in white, black, or silver. This is specifically built for the drag bike and sport bike racer. It is designed to maximize field of view when riding in full race position: body forward, head down, and chin up or down. The high-brow eyeport with arched back fits better around the back of the neck. The shell is described as being of advanced composites and the liner of *intelligent* single piece variable density. This helmet also has interchangeable cheek pads for improving fit.



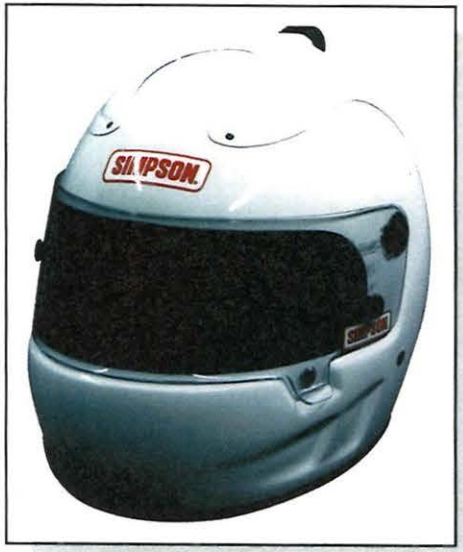


Impact Racing's Draft. This auto racing helmet is *handmade of American space age composites* and has a high-bypass air induction system that circulates air around the head and face. *Ripple Effect* boundary layer aerodynamic features incorporated in the shell construction stabilize the helmet in high speed airflow.



The Simpson Diamondback has been described by Simpson as "Aggressive and Mean." Certainly the Diamondback's futuristic design elements command attention with a unique diamond pattern crown design and contrasting vent screens in the chin air ram ducts.

Simpson Speedway Shark aerodynamic system consists of a *wicker bill* and a *downforce chime* that works in conjunction with Simpson's built-in BLD (Boundary Layer Design) and *gill vents* to add helmet stability at high velocities in open cockpit cars.



Simpson Shark Air Inforcer features an innovative top-forced air system for directing air to the face designed for in-car fresh air systems where seat and head room are at a premium. It has a carbon/Kevlar/fiberglass composite shell with an EPSB liner with form fitting CarbonX® lining. The chin flap creates positive pressure to eliminate contaminated air and to control fogging.



Simpson Bandit.



Simpson Vudo. The Speedway Vudo is the lightest, high technology helmet ever manufactured by Simpson. Like all Simpson helmets, it too is made in the US.



Zamp RZ- HP3 Super Helmet comes just as you see it. Zamp claims this to be the first helmet to meet the FIA-8860 standard which is mandatory in Formula 1. The full autoclave carbon shell and *specific expanded carbon polystyrene energy-absorbing liner* comes with preinstalled HANS clips. The helmet weighs in at a remarkably low 1300 grams. It is not known how many have been sold at its suggested retail price of $3000.00.



Zamp's RZ-3 Elite Helmet. An auto racing helmet of the same shell design as HP3 but with a hand laid carbon/Kevlar shell which is pre-drilled for HANS post clips.

Helmet painting has become an art form unto itself and there are many artists out there competing with each other. Motorcycle racers, particularly the professionals have elaborate decorative schemes that can change weekly. The motorcycle helmet industry will go a long way to reproduce replicas of famous riders' headgear so Joe Average can have one to wear. Amateur automobile racers will have to find their own artist.

What follows is something of a montage of modern auto and motorcycle racing helmets. We'll emphasize the art but not ignore the science (when something worthwhile deserves comment).

As would be expected, every manufacturer claims his model to be better in some way or another than its competitor. All meet the relevant performance standards and everyone claims to have superior ventilation and aerodynamics — and, of course, light weight and outstanding comfort. The art however is different and in many cases quite captivating.



One of the most recognizable helmets already attached to its HANS is about to go on one of the world's great F1 drivers, Jenson Button, at the 2006 Grand Prix of Turkey. The stylistic union Jack leaves no doubt about his origins. *Steve Etherington photo courtesy LAT Photography.*



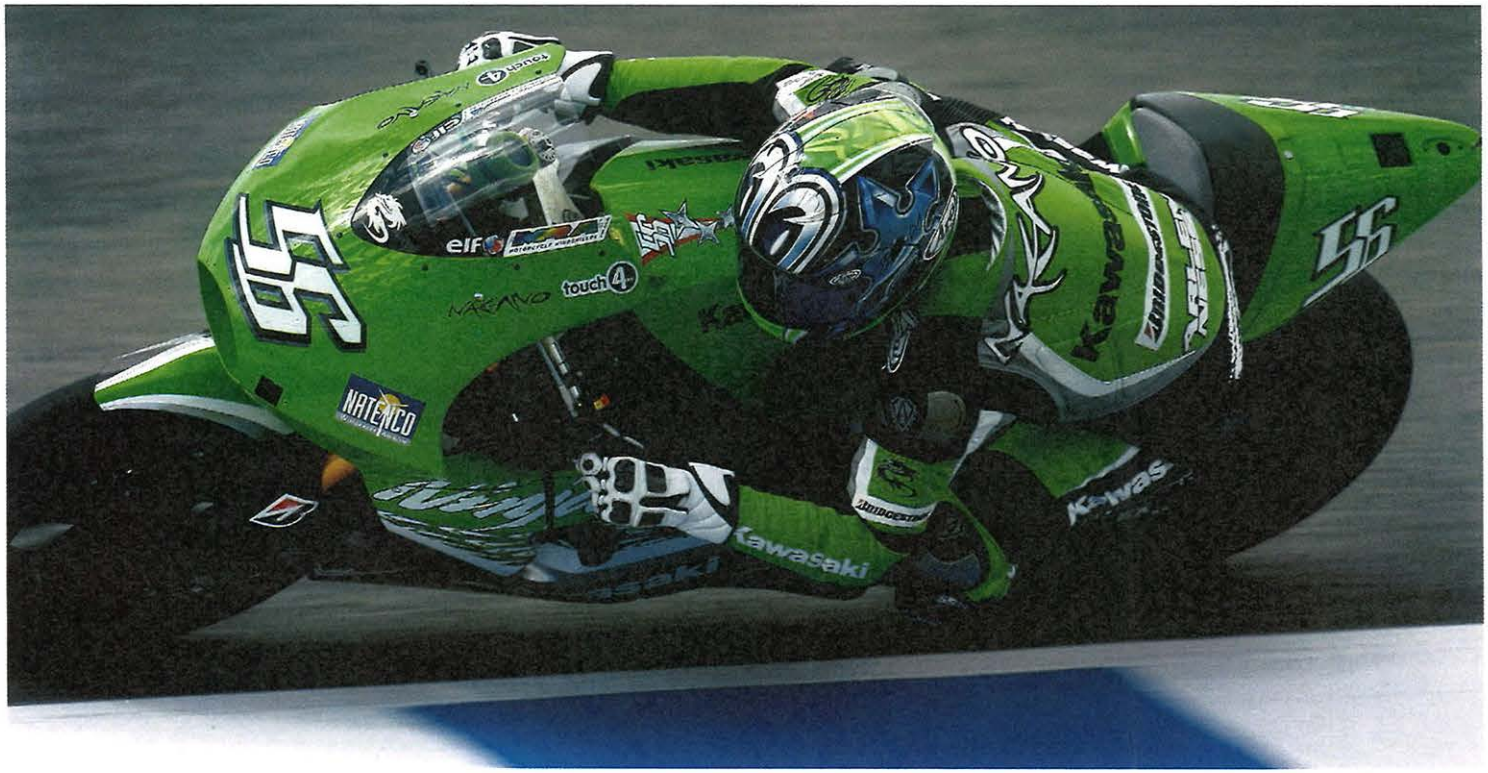
The Arai RX7 Corsair Kitagawa, one of several RX7 Corsair models. Probably the most interesting technical feature of this helmet is the way Arai has redistributed the shell weight by thinning out the crown region and thickening the shell around the lower periphery. This has the effect of lowering the center of gravity of the helmet making it more comfortable to wear. It has a triple density liner as well as a removable skull cap and cheek pads. As with the other RX7s, artistically there's something of a coup here. The design on the visor hardware cover plates has been cleverly integrated with the design of the rest of the helmet.

This is the helmet of Canadian driver Paul Tracy that he wore at the 2004 Long Beach CHAMP Grand Prix. The naked ladies theme, more often seen on truck mud flaps, has been part of his helmet design for some time. *Michael Levitt photo courtesy LAT Photography.*



Popular Japanese rider Keiichi Kitigawa. *Courtesy of Arai Helmets.*





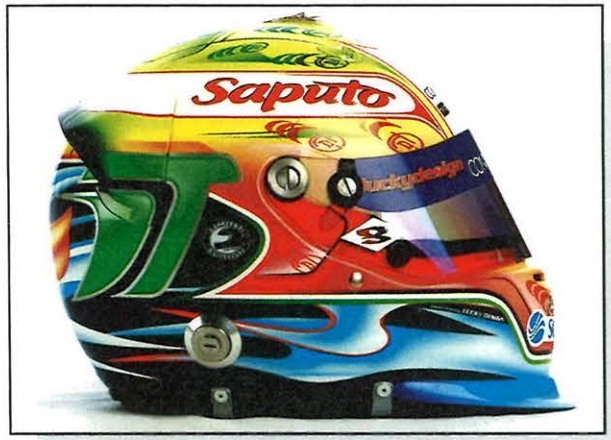
Shinya Nakano Spanish GP 2006. *The eyes have it. Courtesy of Arai Helmets.*

Arai Profile Carr Freedom model road racing helmet. Chris Carr, after whom this road helmet is named, was 7 times AMA Grand National *dirt track* champion from 1999 to 2005. Like all Arai motorcycle helmets, the shell is fabricated using what Arai calls its "Super Complex Laminate Construction." Employing strictly fiberglass based materials, Arai eschews the use of what it refers to as "trendy materials which may not be properly suited for use in helmet applications."





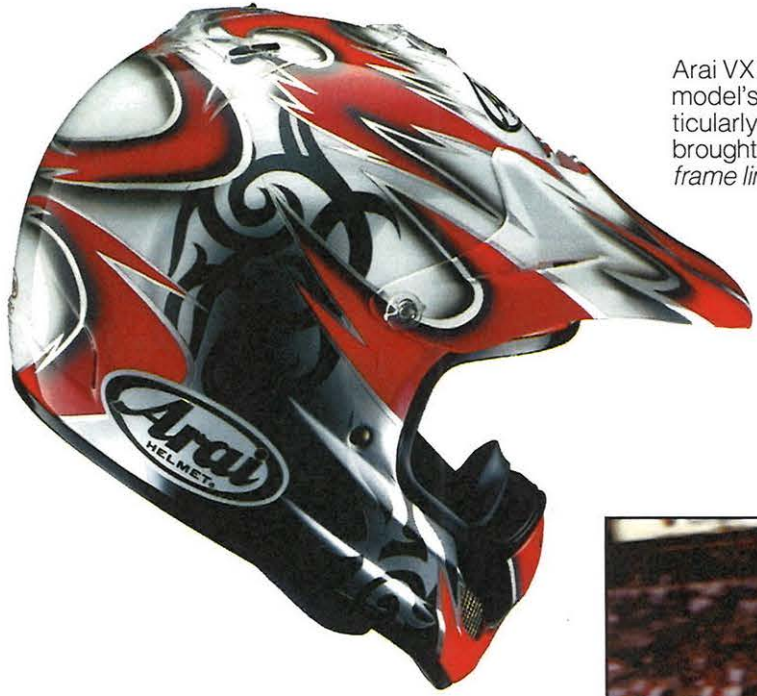
Arai's VX Pro Windham. This helmet is named after Kevin Windham, professional motocross racer.



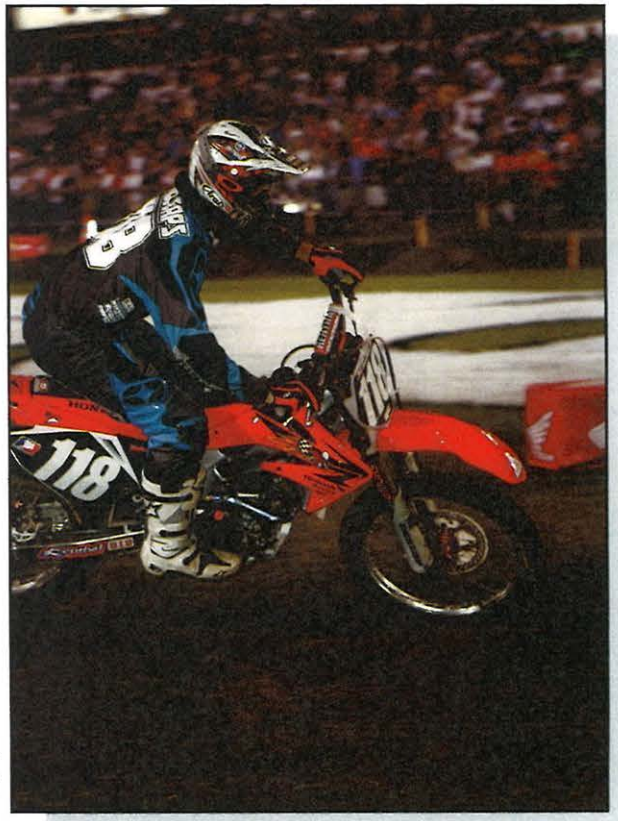
The right side of Alex Tagliani's helmet as worn at the CHAMP Long Beach Grand Prix in 2004. *Michael Levitt photo courtesy LAT Photography.*



The left side of Tag's helmet looks like a different helmet. Who said both sides have to look the same anyway? *Michael Levitt photo courtesy LAT Photography.*



Arai VX Pro Atomic model. This model's claim to fame is its particularly good ventilation system brought about by its *open space frame liner construction.*



18 year old Davi Millsaps wins 3 of 4 heats at the 2006 Daytona AMA Super Cross Lites. *Photo by Rick Menapace.*

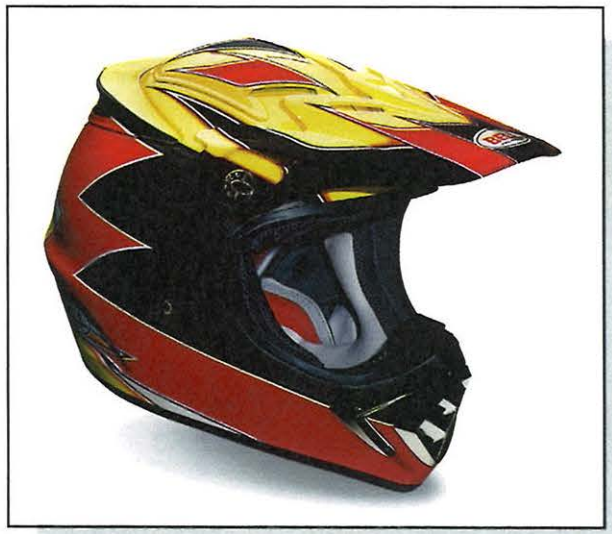


The Bell Moto 7-R off-road helmet has a shell made of a Kevlar/carbon/glass composite. This is the Rude Boy design. The graphics are available in several different base colors.





Moto 7-R Bone Yard.



The Bell Moto 8 is the descendant of the Moto Star series. The helmet features a fiberglass/Kevlar/carbon composite shell — and pretty spiffy graphics too. It weighs a mere 1350 grams.



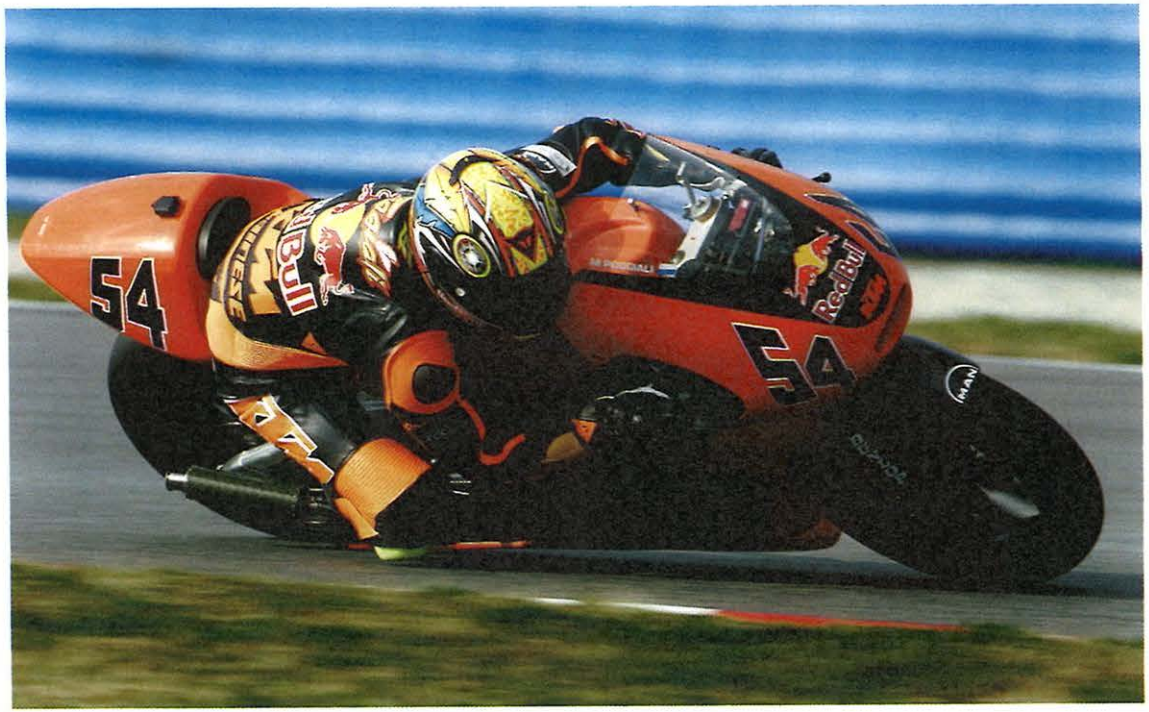
Bell SCX in Ripper Red.



The Bell Sprint is a basic road/racing helmet with attractive graphics. The shell is of fiber glass construction and the unit weighs about 1600 grams.



Dainese Airstream Course Mugello. This is one of several models by the Italian firm Dainese. The shell is constructed of layers of fiber glass, carbon, and aramide fibers which is compression/bag molded. The liner is ESPB foam with a low density insert at the crown. Interchangeable cheek pads allow for custom fitting.

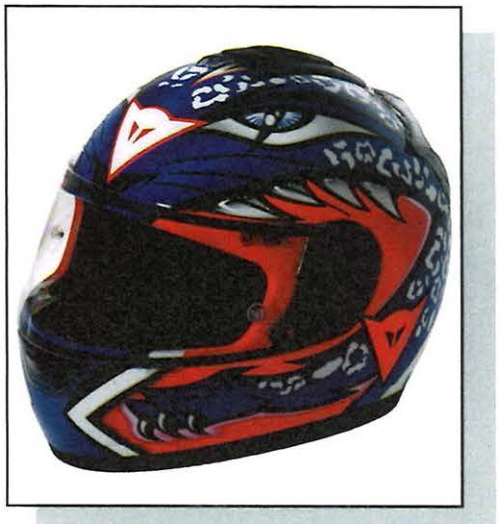


Manuel Poggiali, Spanish GP 2006. 125cc World Champion in 2001 and 250cc in 2006. *Photo courtesy of Dainese.*



Marco Simoncelli leads a pack at the 2006 Spanish GP at Jerez. He was 125cc World Champion in 2002, 2003 and 2004 *Photo courtesy of Dainese.*

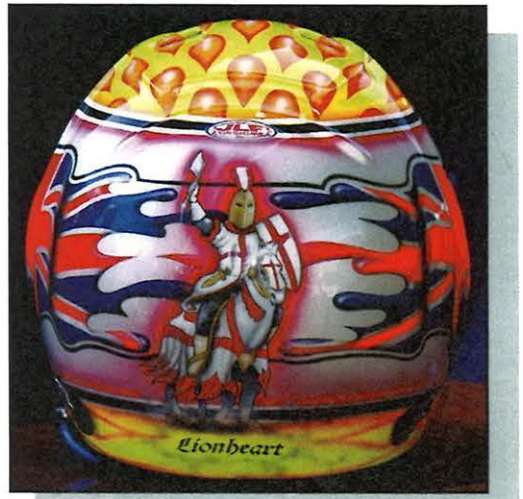
The rear of Dan Wheldon's helmet as worn at the IRL Delphi 300 September 2002. Wheldon, an obviously proud Englishman, won the Indianapolis 500 in 2005. He was the first Brit to do that since Graham Hill did it in 1966. That same year, he was the IRL Series Champion. *Paul Webb photo courtesy of LAT Photography.*



Dainese D180 Simoncelli replica. This has a thermoplastic shell, otherwise it's the same as the Airstream Course.

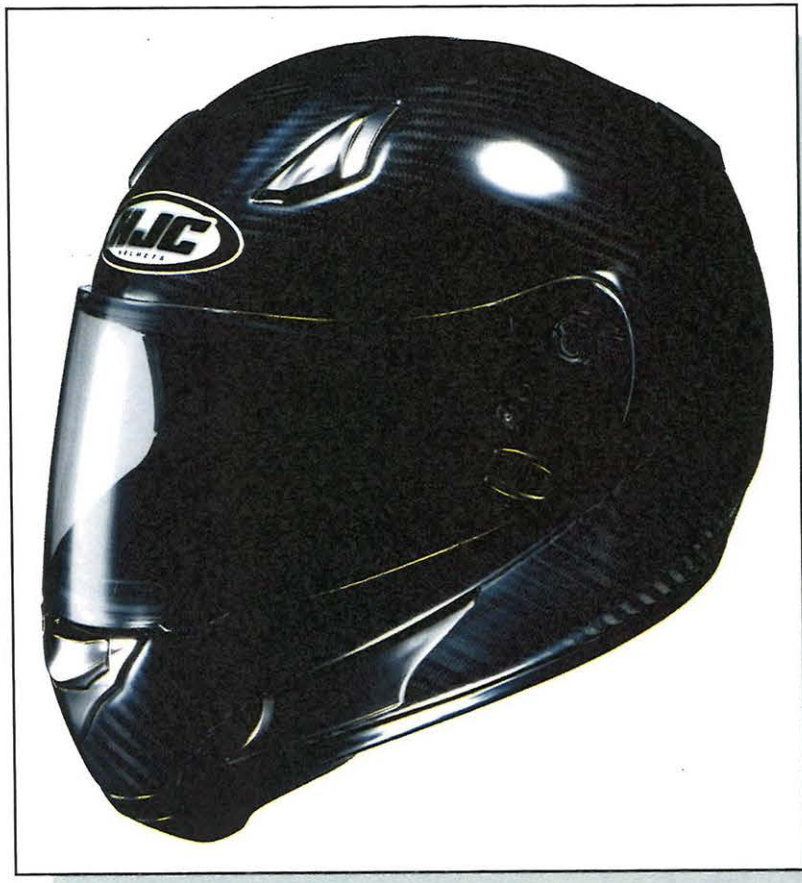


Dainese Airstream Course Simoncelli replica. The fact that this replica appears different from the former replica illustrates how often these designs change.





Marco Andretti's equally patriotic helmet. Marco, Michael's son and the grandson of a racing legend Mario, became the youngest driver in history to win in a major open wheel race at the IRL Indy Grand Prix of Sonoma, California on August 27, 2006. *Michael Levitt photo courtesy of LAT Photography.*



HJC AC12 Carbon. The AC12 features a true full shell application carbon fiber, offering the maximum benefits of this technology. With a dual density EPS liner and removable comfort liner, the medium size unit weighs only 1420 grams.



HJC's AC12 Carbon Elbowz. Here's a decorated version of the above as worn by Ben Spies.

2006 AMA Superbike Champion, Ben Spies. *Photo courtesy HJC.*

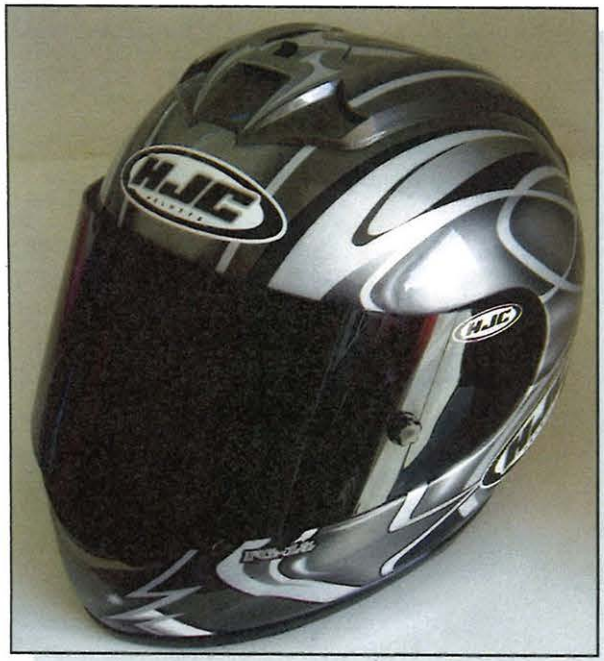
HJC's AC12 Yikes helmet. This one of several AC12 models which has a shell construction that HJC calls Advanced Composite Material ACM. In fact the fiber used in the shell is a composite weave of fiberglass and Spectra®. The liner is a two-piece dual density assembly. The helmet also employs a removable liner and cheek pads for cleaning and custom fitting. A medium size AC12 weighs about 1600 grams.





HJC AC12 Axis helmet.

HJC's FG-14. With a Kevlar-Spectra fiberglass shell, this helmet, available in Europe only, represents the apex of modern motorcycle road racing helmet design. Like other helmets certified solely to EC22-05, it is lightweight, 1440 grams, yet has outstanding impact capability. Perhaps one day, it and its contemporaries will be available to North American riders too. *Author's collection.*

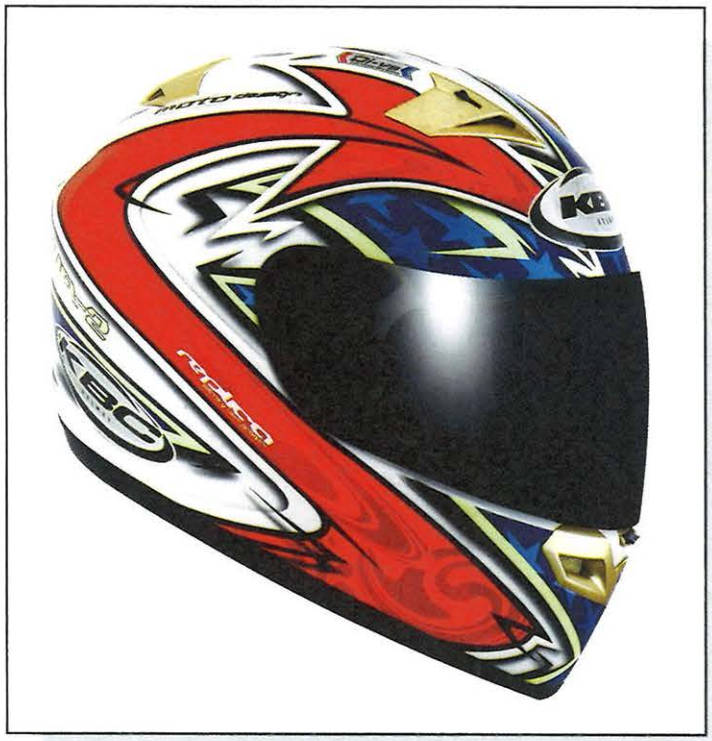




FG-14 vent detail.



FG-14 breath guard.



KBC Dragon Racer.



The KBC Moto X6 with the heart motif. Pretty in pink.



Invoking images from World War II aircraft, this is the KBC Airborne.



The KBC V2 Gunslinger.



KBC's rather sinister looking Super Gun.



The Zombie, another edgy design from KBC.



Ernesto Fonseca, born in San Jose, Costa Rica, was named the 1999 AMA *Rookie of the Year* following his success in supercross racing. Sadly, in March of 2006, he crashed and sustained a fractured neck leaving him paralyzed from the neck down.[43]

Shoei VFX-DT Fonseca. The VFX-DT model has a very rigid and light weight outer shell which is made from AIM+ (Advanced Integrated Matrix Plus Multi-fibers). A remarkable size range and comfortable fit can be achieved due to the availability of four outer shell sizes and four sizes of EPS liners. It also employs what Shoei refers to as its 3-D Max-Dry Interior System.

Shoei X-Eleven Kayagama. The X-Eleven model line also employs Shoei's AIM+ technology for its shell design. In addition to an array of ventilation and aerodynamic features, it has a quick release base plate and a dual liner system. This model is named after the young Japanese superbike rider, Yujio Kayagama.



IRL driver Patrick Carpentier's helmet worn at the 2004 Grand Prix of Long Beach. *Michael Levitt photo courtesy LAT Photography.*





Shoei X-Eleven Kayagama rear view.



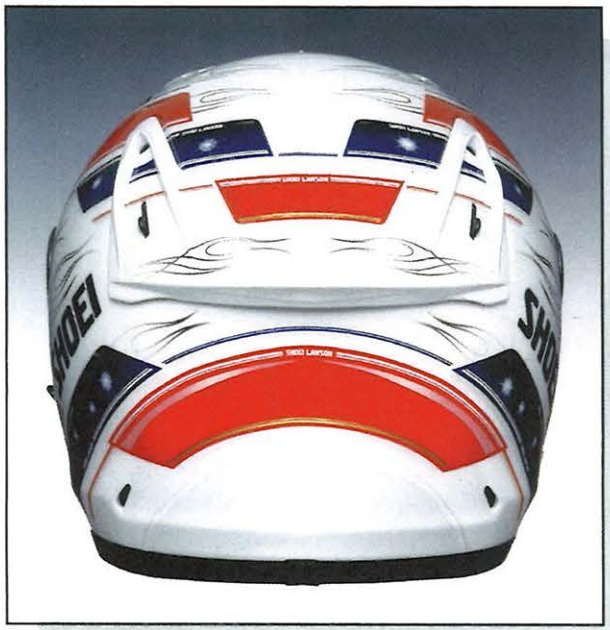
Australian racer Chris Vermeulen on his Rizla Suzuki Moto GP bike, 2006. *Photo courtesy Shoei Helmets.*



Shoei X-Eleven Lawson. Though he retired from GP motorcycle racing in the early 1990s, his fame still warrants a helmet with his name attached.



Zamp RZ 10 motorcycle racing helmet. This lightweight fiberglass helmet has an adjustable rear wing/spoiler. The graphics are probably not everyone's cup of tea but we'll leave you to make your own decision on that.



Shoei X-Eleven Lawson, rear view.

The Zamp RZ-2 shell is hand lay-up construction from a carbon/Kevlar/glass composite. The Ferrari theme is presumably aimed at the Ferrari or *would be* Ferrari race car driver.



Racing on a motorcycle or racing in a car, the chances of getting a head injury seems to have been taken into consideration over the years — and nowadays with substantial style. But what about the lowly bicycle and head injury attached to that sport? Check out the next chapter.

6.2 Bicycling Helmets

Falling off a bicycle at speed represents a threat not at all unlike that of crashing on your motorcycle. You'll fall from about the same height and the pavement hurts just as much. Studies undertaken all over the world have documented the nature of head injuries associated with bicycle use.

Randy Swart is the Director of the Bicycle Safety Helmet Institute in Washington, D.C. He had the following to say about the evolution helmets for bicyclists.

> *In the beginning, there were injuries. From cycling's earliest days there were head injuries. As more roads were paved it is likely that the head injuries increased, since macadam and asphalt are completely unforgiving as crash surfaces. In the 1880's high-wheel users in clubs saw that head injuries were a problem and began using pith helmets*
>
> *Around the turn of the century racing cyclists began using helmets made of strips of leather-covered padding, initially with a ring of leather around the head and a wool ring above that. Then the style evolved and the ring of leather around the head was supplemented by strips of leather arranged longitudinally on the head. When I started racing in the 70's we called them hairnets and the nicest ones were made in Italy of beautiful soft leather.*



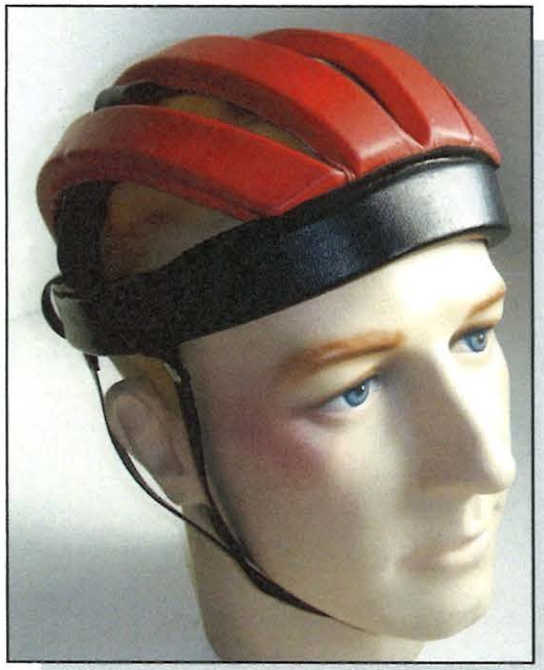
The classic Italian *leather hairnet* developed in the 1940s and still available in Europe even into the 1990s. *Ryan Parks photo courtesy Bell Sports.*).



A slightly more modern design is the Italian Cinelli shown here. Though the degree of protection afforded was minimal, such designs remained around for a long time even after the introduction of more modern cycling headwear. *Author's collection.*

In North America in the early 1970s, concern about head injuries, especially among competition riders, led to interest in wearing some better form of headgear. One could always wear a motorcycle helmet but as Randy Swart had pointed out, even the lightest available unit was two pounds of unvented helmet. The absence of any meaningful standards meant there was no way to determine the merits of what was out there.

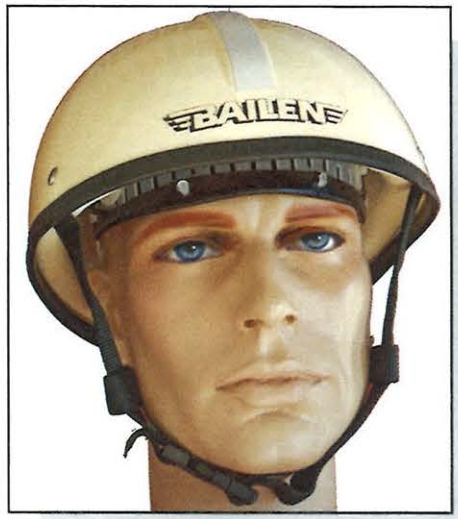
According to Swart, in 1974 the Washington Area Bicyclist Association had despaired of finding information on the relative protection of available helmet brands and formed a helmet committee to collect data from ride testing. WABA procured helmets from many sources and began a series of ride tests. At that time it was found that the helmets on the market mostly had some kind of shell with a *squishy* foam liner. Three companies responded almost immediately to this situation. Mountain Safety Research made a pretty good climbing helmet as did a company by the name of Bailen. Both companies offered their products to the cycling community. These helmets had strong exterior shells and decent energy management systems and were far better at protecting riders than any leather hairnet.



Leather hairnet from unknown manufacturer.
Author's collection.

Mountain Safety Research climbing/cycling helmet.
Ryan Parks photo courtesy Bell Sports.





Bailen climbing/cycling helmet.
Author's collection.

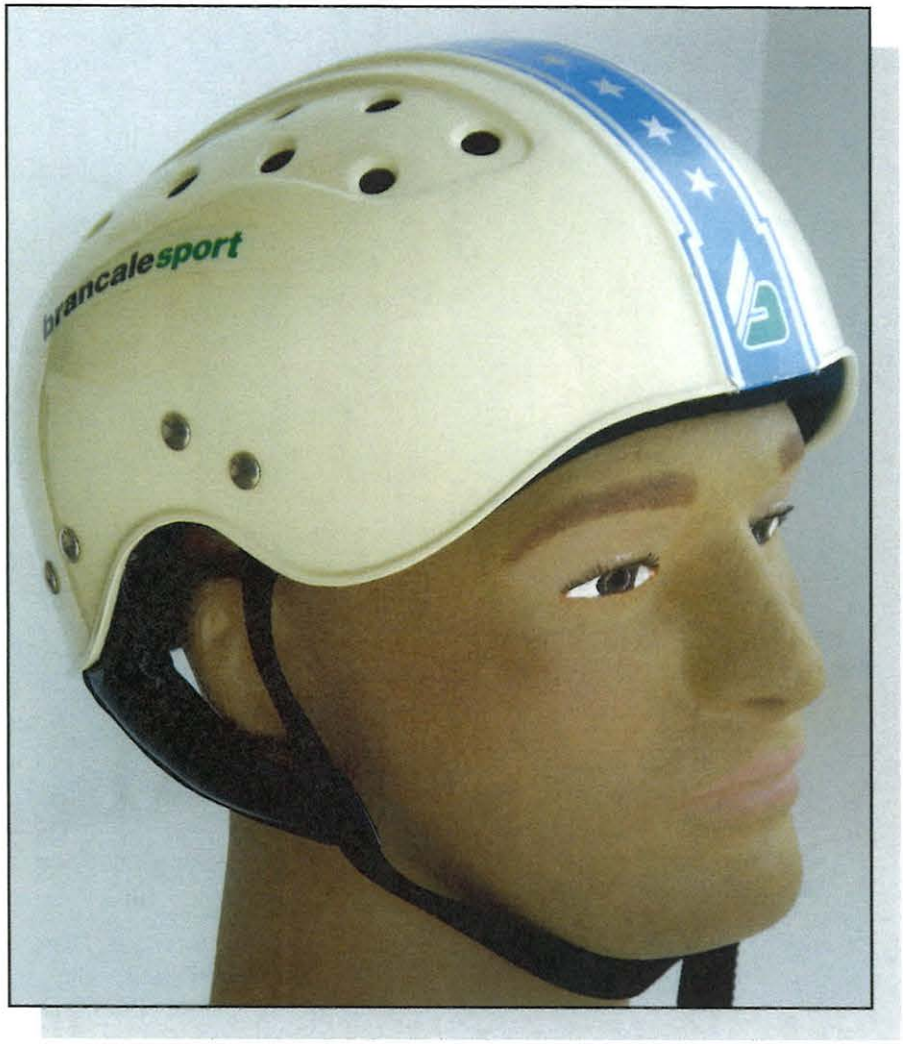


Bailen, side view.



Bailen, interior view.

In Europe, things were progressing less quickly. Brancale in Italy, for example, introduced a hard shell bicycling helmet but it had virtually no impact management capability.



Brancale hard shell helmet. *Author's collection.*



Brancale, top-rear view. No shortage of vent holes.



Brancale, interior view.

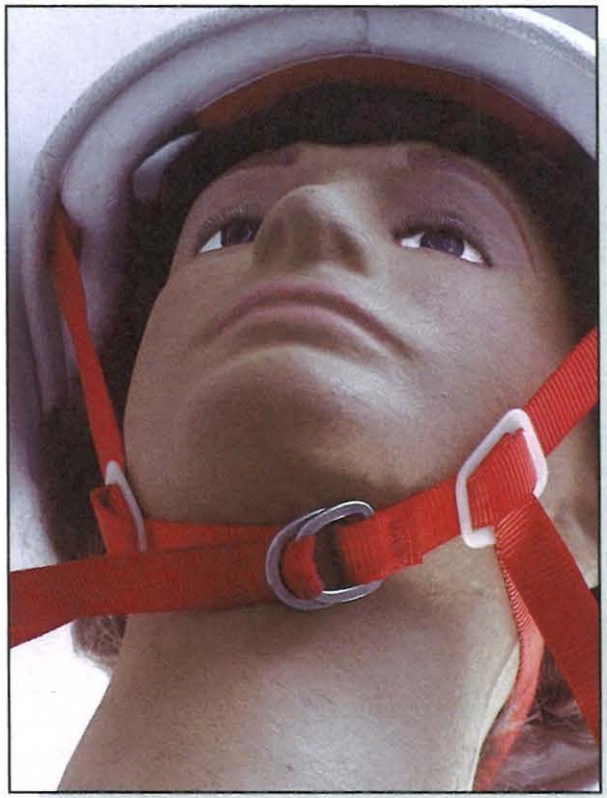
It was Bell Helmets that changed the complexion of the bicycle helmet business when, in 1975, it introduced the first Biker helmet.



The Bell Biker, 1975-1982. *Ryan Parks photo courtesy Bell Sports.*



Biker, rear view. This particular model was manufactured in July 1977. *Author's collection.*

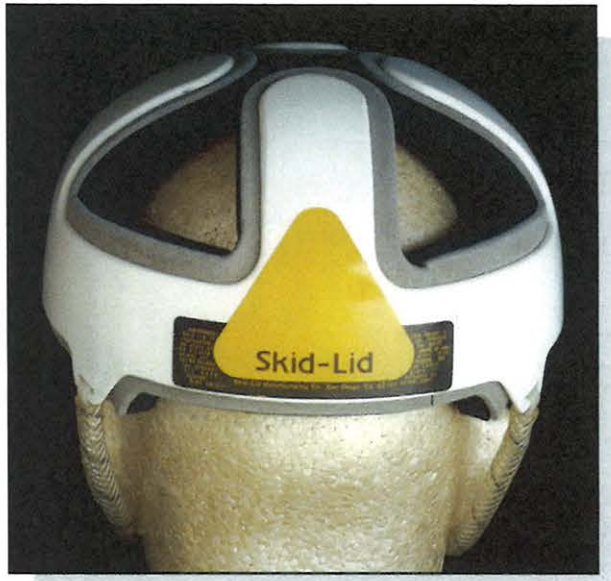


Biker retention system initially used the same D rings as on Bell's motorcycle helmets.

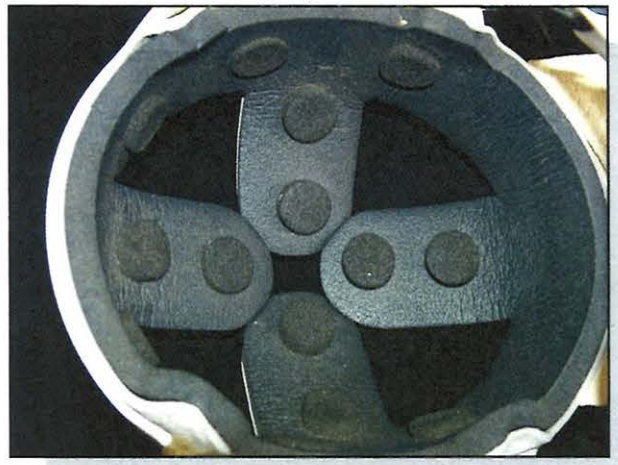
When first produced it was not at all certain that this market would explode as it has since done. The first year of production of the Biker was limited to 6,000 units. In keeping with this modest production level, the shell was *vacuum- formed* from polycarbonate sheet stock. (The customary injection molding tooling would have been too expensive for such a low number of parts). All those vent holes were individually cut by people using small grinding tools. About 20 to 30 shells a day were hand finished this way. This helmet did, however, become the most popular helmet of its time and production of it, and of variations, as well as knock-offs, continued for at least the next ten years. By that time, the quantities of helmets being sold were of such magnitude that other manufacturing methods were being employed — and many more manufacturers were showing up. Bell dominated the market for at least the next two decades, as year after year it introduced new models.



The once popular Skid-Lid, c. 1975-1985. *Author's collection.*



Retro reflective label on back of Skid-Lid.



Skid-Lid interior. The circular pads were stick-on foam buttons deployed to adjust fit.

Skid-Lid HELMET FITTING INSTRUCTIONS

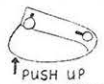
Congratulations! You are now the proud (we hope) owner of the best bicycling helmet in the world. In order to obtain all the protection built into your SKID-LID, it must be properly fitted. The FIT KIT included with your helmet provides an infinite variety of unique adjustments, allowing you to custom fit SKID-LID to any size head. The stand-off foam buttons permit almost total ventilation and maximum comfort.

BEFORE YOU START

Make sure your SKID-LID is large enough for you. There should be at least 1/16" clearance all around between your head and the helmet lining when the sweatband is pressed very gently against your forehead. Even 3/8" clearance is not too much. If your helmet is not large enough, exchange it for one that is.

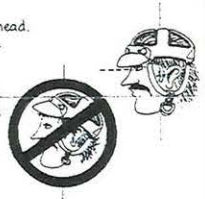


FITTING THE SKID-LID

① 

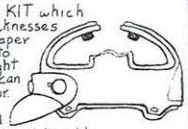
Push visor into its upper position. The center snap slides along a vertical slot in the visor.

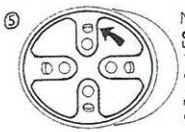
② Now put the SKID-LID on your head. Hold head in riding position. Move SKID-LID so that visor doesn't interfere with forward vision. Fitting your SKID-LID is no time for vanity, so don't wear it tilted on the back of your head. Helmet should sit approximately 3/4" above the eyebrows and cover forehead in area above your temples. This region needs the most protection in a crash.



③ 
Reach up and slide your finger between top of head and the four individual helmet tangs near their tips. Measure each gap with your finger. Don't be surprised if these measurements are all different. Most heads are asymmetrical by nature. SKID-LID recognizes this fact, and includes a variety of fit buttons so you can achieve a perfect fit for your "imperfect" head.

④ Select four buttons from FIT KIT which correspond to individual thicknesses of measured gaps. Remove paper backing and gently press into position. This establishes height of helmet on your head so you can comfortably look out under visor. If individual buttons are not tall enough, they can be stacked atop one another to achieve desired height.



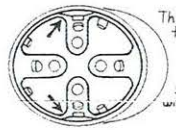
⑤ 
Measure gaps approximately halfway down the tangs. Select additional 4 buttons and press into position. Their placement should roughly correspond with "flat spots" in these areas common to most heads. These buttons will contribute to lateral stability.

⑥ 

Now measure gap on each side of back of helmet. Select buttons and place in position. Sweatband should exert very gentle pressure on forehead; if buttons are uncomfortable, move them in small increments until a comfortable position is found.

⑦ Measure gaps between each side of head and SKID-LID. Find points where gaps are greatest, usually right above or slightly aft of temple areas. Position buttons to fill gaps. If gaps are greater than 5/8", write the factory for special double wedge side fillers.


DOUBLE WEDGE SIDE FILLER

⑧ 
This is how interior of a typical SKID-LID looks after installation of FIT KIT buttons. Note placement of double wedge side fillers, if utilized, with their appropriate buttons.

⑨ At this point, your SKID-LID should now be stable on your head and settle into the same position each time you place it on your head.



REARVIEW MIRROR

The rearview mirror clips onto the visor. Some riders like it off to the side, while others like it well into the field of view. Avoid moving the clip around on the visor so you won't scratch the visor. The mirror can be adjusted in one of three ways: (1) rotating the mirror in the clip, (2) changing the angle in the clip, or (3) bending the wire clip itself. We recommend that you include some portion of your head or helmet in your field of view, so you can be assured that what you are seeing is really behind you and not off to the side.




Don't get discouraged if using your mirror seems awkward at first. Its use requires a mental adjustment much like that demanded of a rearview mirror in an automobile. It will soon be second nature to you, and you'll never want to ride without it. The contribution it makes to your safety is worth the effort.

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One page of the artfully hand drawn fitting instructions for the Skid-Lid which accompanied every helmet. *Compliments to the unknown artist.*



The Top-Hat by Monarch Helmets. *Author's collection.*



Everything you'd want to know about the Top-Hat.

Bell also produced the Tourlite during this time, which was essentially a Biker II with revised graphics, but that wasn't enough to save the overall design.

Some manufacturers continued to produce helmets with substantial shells but in the absence of published impact performance standards, chose to use softer more comfortable (*squishy* as Swart, most appropriately, would say) liners.



The Bell Biker II, c. 1983-1985. This was Bell's effort to retain the looks of the Biker, but with an injection molded shell. However the *look* was starting to fade shortly after its introduction. *Author's collection.*



Biker II from behind. The red stripes were now retro-reflective, shining in the dark when struck by light.



The Biker II box, c. 1980.



The Ranger marketed by Schwinn. *Author's collection.*



A Canadian made Ranger cycling helmet. *Author's collection.*



The less squishy, but still squishy, interior of the Schwinn helmet.



The Ranger's *squishy* interior.

While the left hand of Bell was trying to sustain the *Biker* look, the right hand reverted to a traditional leather hairnet look with the Prime and Mk1 helmets seen here. In fact, Bell marketed the Biker now as a *recreational* helmet and the new-age plastic hairnets for competition use.



The Bell Helmets V1Pro (not the golf ball), manufactured between 1983 and 1992. *Ryan Parks photo courtesy Bell Sports.*



Bell Prime Mk1 and Bell Prime. Manufactured from 1976 to 1982, these were the first helmets from Bell with injection molded shells. The Prime was meant to convey the image of the old style leather hairnet. The Mark 1 used the same shell but with substantial openings for cooling purposes. It was the predecessor to the V1Pro. *Randy Swart photo courtesy BHSI.*



A V1Pro when you're trying to hide.

The US Cycling Federation mandated the use of certified protective headgear in 1988 for all competition riding. However, it was not until 2003, that the Union Cycliste Internationale, Europe's professional cycling organization, first began to require helmets for all riders in all races it sanctioned. The ruling followed the death of Kazakh rider Andrei Kivilev in 2002. Kivilev died of a head injury after crashing without a helmet. The impetus for the ruling had grown due to other head injuries and deaths in races.

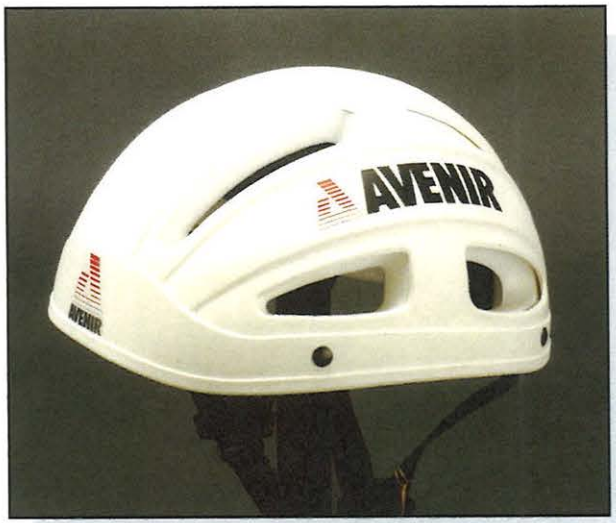
By 2003, the peloton (the main body or pack of riders) were wearing helmets in UCI-sanctioned races all over Europe. Riders can be fined, lose UCI points, or even be expelled for failure to do so. Helmets were the rule for most of the European events, but riders were permitted to jettison them for particularly hard climbs.[44]

By 2005 helmets were obligatory in all UCI races including the Tour de France.

The first *modern* helmet used in the Tour de France was the V1 Pro in 1983. According to Dean Fisher, then Vice President of Bell Helmets:

> *I got a call from a member of the Colombian Embassy. I was asked if we would furnish helmets for their team. Tammy* (his daughter) *happened to be in France at the time going to school. We shipped helmets to her and she fit the team in Paris. They used them in a particular rough cobble stone area and then took them off.*

Neither the Biker nor the V1 Pro look were precursors of what was to come. Neither presumed the disappearance of a penetration requirement in prevailing standards. Soon other manufacturers (as well as Bell) began introducing more *streamlined* designs. One such company in California, the Troxel Corporation, produced several million bicycle helmets during the period 1989 to 2000. However their helmets were usually produced for others under a different name so you'd be hard pressed to find any evidence today of a *Troxel* bicycle helmet. The company has since moved onto the production of equestrian helmets — but more about that later. Another big time producer of the eighties and nineties was the Canadian firm *Denrich.* It produced hundreds of thousands helmets for the mass market every year. Today, there's nary a Denrich helmet to be seen. Many other companies entered and left the field during this time period and it is not possible here to discuss all of their products.



The Avenir cycling helmet c. 1990. *Photographed by Stephen Fenn*).



Snell B84 certification sticker in an Avenir. Certification to the Snell standard implied that the helmet was a cut above the norm. Unfortunately by now nearly every manufacturer was so certified.

In the industry in Japan and in Europe, the market for more protection in cycling headgear was becoming evident and companies who made motorcycle helmets tried their hand at the business. Arai in Japan and Kiwi in Switzerland both fielded entries into this market. Both however were not much more than somewhat ventilated light weight motorcycle helmets with a hard injection molded shell with a thick polystyrene liner.



Bell Brava, c. 1987. *Author's collection.*



One of the few attempts in the industry to dress up the interior by painting it.



The Edge helmet, produced by the now defunct Edge Helmet Company of California, with Troy Lee graphics, c. 1995. *Author's collection.*



The Edge interior.



The Swiss (not New Zealander) Kiwi cycling helmet, c. 1990. *Author's collection.*



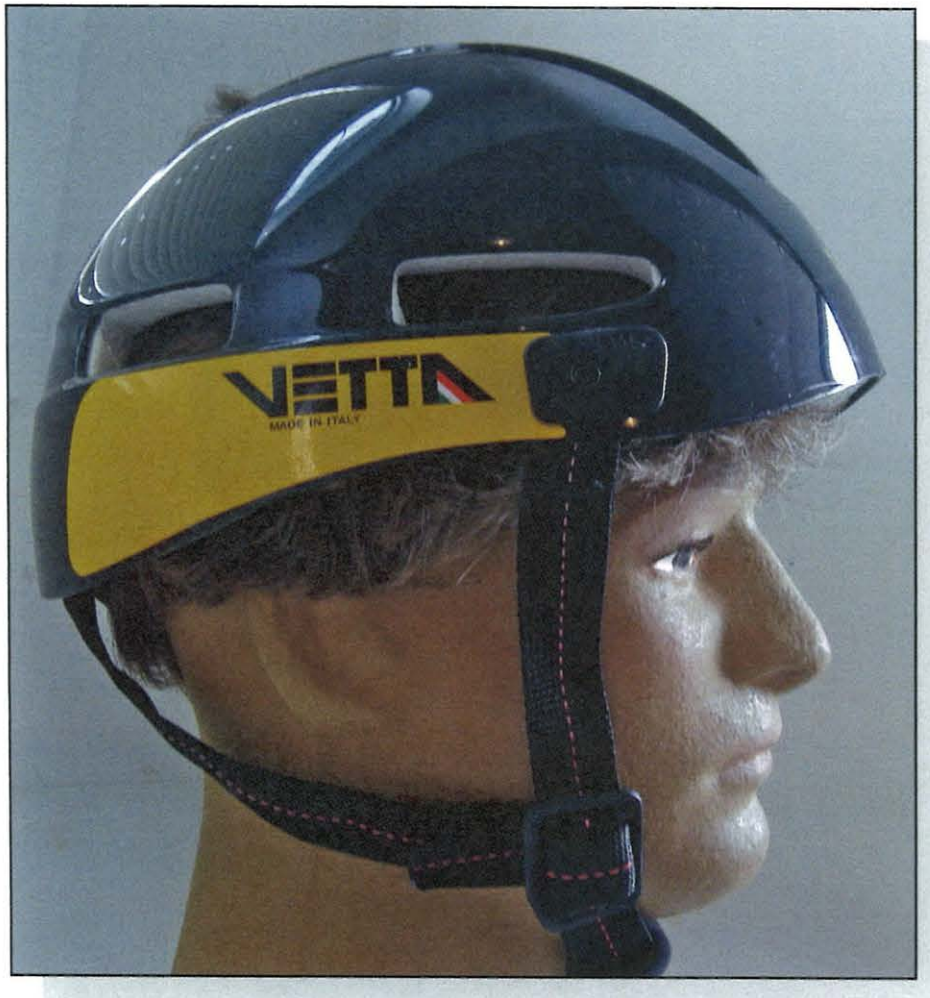
Who would have thought it?.



The Kiwi retention system, tidy, comfortable, and effective.



This Kiwi label needs no words.



The Italian Vetta was a popular design, but it too, like the Avenir, the Brava, the Kiwi, and the Edge, had a thick heavy outer shell based largely on motorcycle helmet experience. C. 1990. *Author's collection.*



Vetta interior, a two-piece EPSB liner with soft rubber comfort pads.

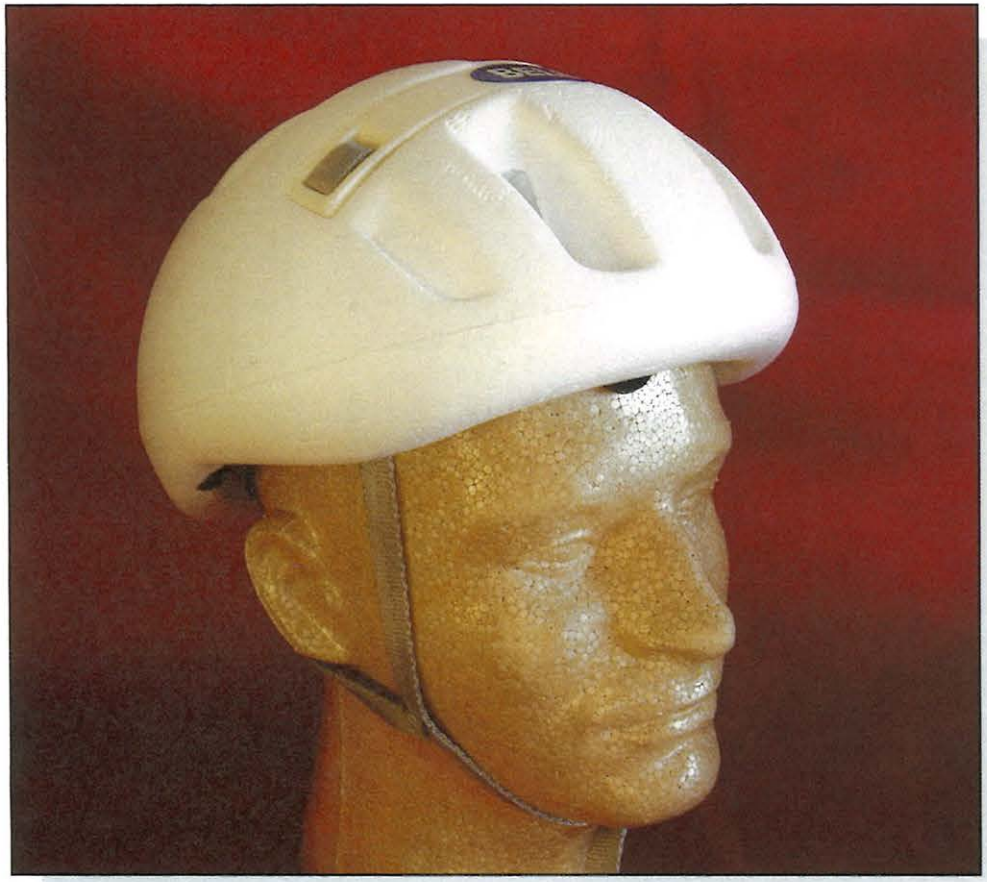
In the early 1980s Bell was approached to produce extremely lightweight helmets for infants who had undergone brain surgery. They experimented with a helmet that was entirely comprised of EPSB foam having no hard outer shell whatever. If thick enough and of the right density, impact testing showed it actually met the proposed standard for bicycle helmets. Bell introduced their *L'il Bell Shell* infant-toddler bicycle helmet design shortly thereafter. Adult helmets without outer shells soon followed.



The original L'il Bell Shell, c. 1983. *Ryan Parks photo courtesy Bell Sports.*



The Bell Quest, c. 1992. *Author's collection.*



The naked Bell Quest. The fact that the fabric covers were sometimes lost did not affect the helmet performance significantly, but certainly lowered the already pretty low aesthetic quality of the helmet.



Quest interior. Unadorned EPSB foam with stick-on sizing pads.



Label shows a change in performance specifications.

At about the same time, a designer named Jim Gentes designed an adult bike helmet with no outer shell and formed Giro to market the concept. The lighter weight was an instant hit, and Giro began selling large quantities of the helmets to bicycle racers.



The vintage Giro for track events. *Photographed by Stephen Fenn.*



One of the first of hundreds of Giro models.
Photographed by Stephen Fenn.

In the case of the PET, after the micro shell is vacuum formed, the shell edges and vent holes are die-cut. The shell is then simply glued/taped to the underlying liner, as with the Quest and Leader helmets shown here. Polycarbonate micro shells are processed the same way but are placed directly in the mold with the polystyrene beads. During the hot expansion process, the polycarbonate sheet bonds directly to the polystyrene material. This has been called co-molding. In the early 2000s, the co-molding of polycarbonate micro shells with the base liner had became common practice on many helmets.

Another unique feature of these newer designs, which also became fairly common practice, was the inclusion of an internal reinforcement ring or cage. This plastic *armature* buried within the liner serves to help keep the pieces of foam together when an impact occurs.



The Bell Ovation. One of the first bicycle helmets to employ the micro shell approach, vacuum formed, cut to shape, and taped to the underlying EPSB liner. This helmet was made in November 1989. *Author's collection.*



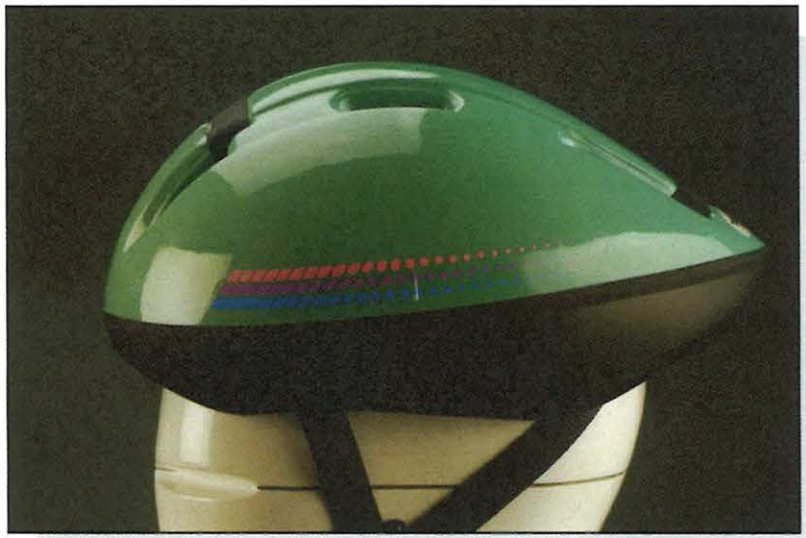
The Canadian Leader cycling helmet. Micro shells were cleverly taped to the top and bottom portions of the liner. *Photographed by Stephen Fenn.*



The Lumina front view. A fairly ordinary looking modern road helmet. *Photographed by Stephen Fenn.*



The rear view of the Lumina shows the built-in *tail light.* A battery inside the liner at the rear of the helmet powered a bright red LED light that, at the push of a button, could easily be seen at night.



The Variflex Street Heat. A typical road helmet from the Far East made almost entirely in one-piece from molded polyurethane foam. *Photographed by Stephen Fenn.*



A Trek Vapor with bonded shell above and below, c. 2003. *Photographed by Stephen Fenn.*



A Trek bicycle helmet. The modern style of the bicycle helmet is typified by this helmet marketed by Trek Bicycle Corporation in the early 2000s. A decorative PET vacuum-formed micro shell is taped to an EPSB foam liner. The snap-on plastic peak was a stylish addition that caught on. What did not last, at least on upper end helmets, was the sticky tape that held the upper shell to the rest of the helmet. *Photographed by Stephen Fenn.*



Vigor Pro Lightning from VSI. The co-molded shell embodies the entire polyurethane helmet.



This Louis Garneau Wings helmet made in 2003 has a co-molded upper shell only. *Author's collection.*



These top views of the Wings illustrates the rather exquisite surface sculpting that can be achieved with this technique.



Giro has become a major supplier to the marketplace of bicycle helmets in North America and Europe. It sells its helmets in several categories, road, sport, mountain and pursuit. Needless to say, the first two are the largest. In the sport category, the following are representative samples.

In the road racing category, here are a few examples of Giro's products.



Giro Atlas. A vacuum formed PET micro shell, taped to an EPSB Liner.



Remove the visor, co-mold a polycarbonate shell in place, and you have the Giro Transit. Well, not quite. The Transit also employs a somewhat more sophisticated way of attaching the harness to the helmet body.



Put the visor back on and it's now the Torrent.



Change the shell color and pattern and it becomes the ladies' version of the Torrrent, the Venus.

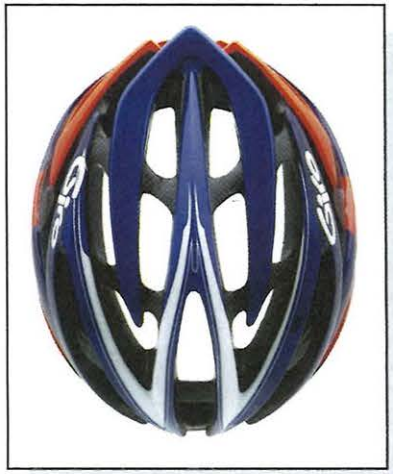


Giro Encinal.



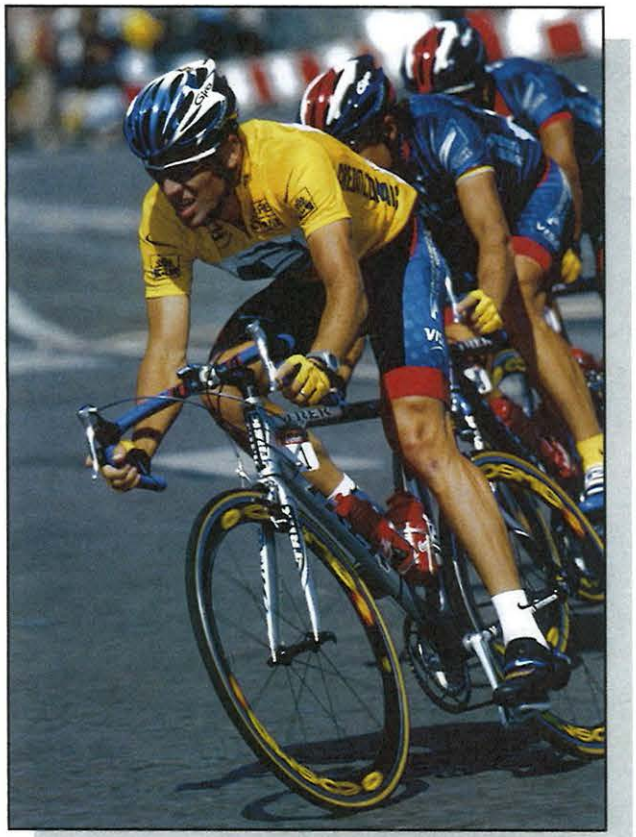


Atmos USPS, rear view.



Atmos USPS, top view.

Giro Atmos USPS. This is a replica of the helmet worn by Lance Armstrong during the 2001 Tour de France. Vents? You say you want more vents?.



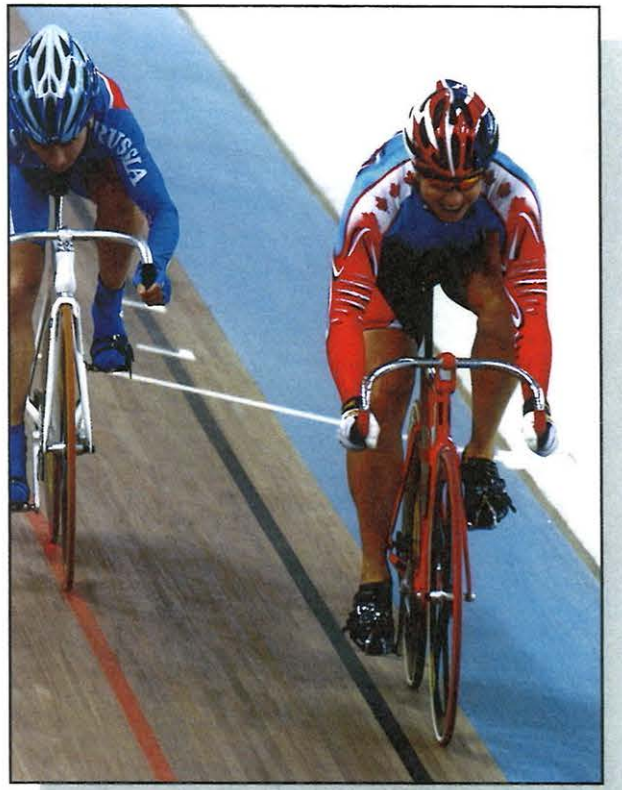
Lance Armstrong on his way to 7 championships — Tour de France 2001. *Graham Watson photo courtesy Bell Sports.*



Atmos Lone Star by Giro. A limited edition helmet celebrating Armstrong's six (at the time) Tour Championships.



Giro Pneumo, rear view.



Canadian Lori-Ann Meunzer, in her Giro Pneumo helmet, edges out Tarana Abbasova to win the gold medal in the bicycle sprints at the Summer Olympic Games, Athens 2004. *Rob Jones photograph courtesy of Canadian Cyclist Magazine.*

Giro's sister company, Bell, also markets a range of sports cycling helmets of which these are representative.



Bell Ghisallo.



Bell X-Ray.



Bell Furio.

As the sport of cycling continued to evolve beyond road racing to BMX , mountain biking, and other *extreme sports*, variations of headgear began to appear. Some helmets were now being marketed as skateboard helmets — an activity where the hazards are not unlike that of cycling. Mountain bike helmets usually have slightly extended coverage at the back of the head but some models incorporat a chin guard as well — much like motocross helmet.



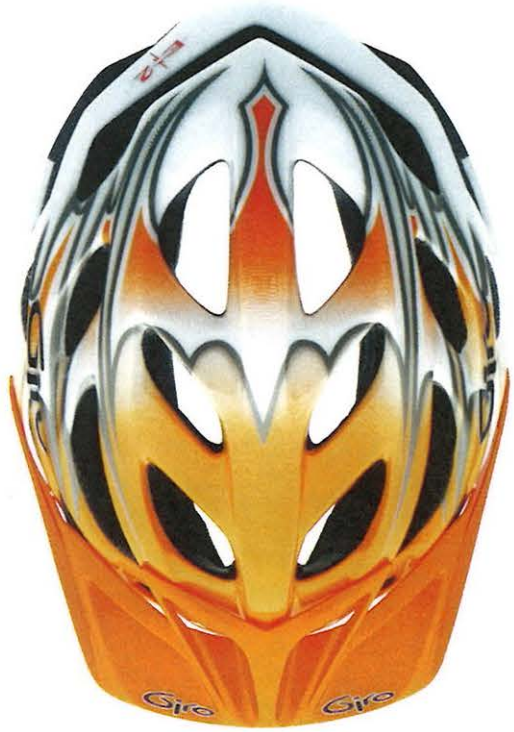
Giro Animas Mountain bike helmet .



Giro E2 .



Giro Animas, top view.



Giro E2, top view.



Mad Max mountain bike helmet by Giro.



Mad Max front view.



French competitor Mickael Pascal in the downhill race at the World Cup competition in Mont St. Anne, Quebec 2006, looking very fast in his Giro *Mad Max*. *Rob Jones photograph courtesy, Canadian Cyclist Magazine.*



Giro Switchblade, a typical mountain bike helmet to which has been added a chin guard structure. As radical looking as this helmet is, it is no longer being sold by Giro.

Youngsters may also go for the somewhat *edgy* graphics that Vigor makes available such as those, of the many available, shown here.



Giro Xen, the less pointed, more rounded look at the rear.

Early Youth BMX helmet.





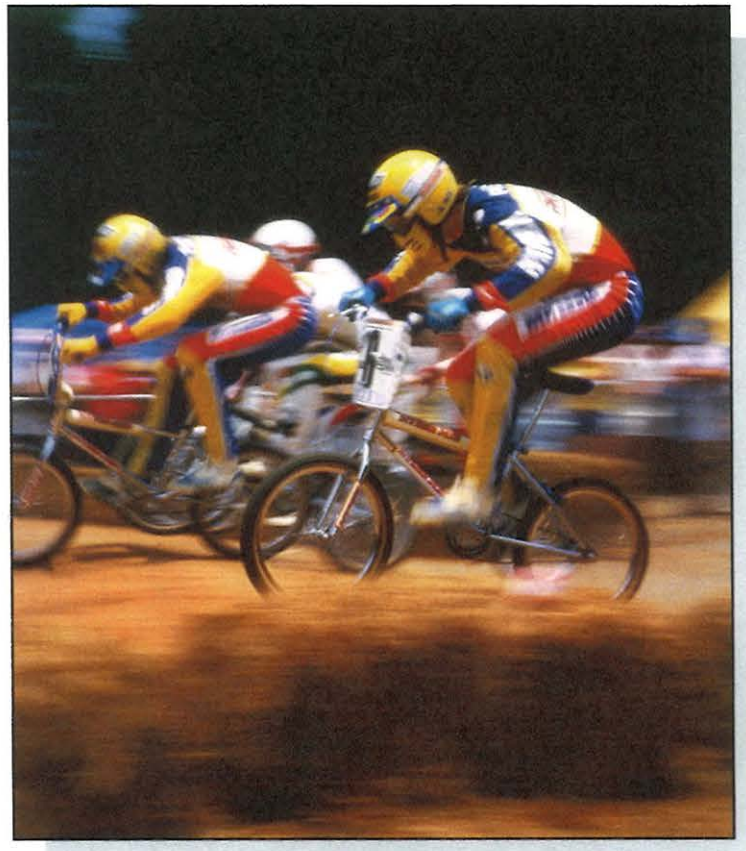
A modern Louis Garneau BMX helmet, the Buzz-2.



Bellistic helmet worn by Leigh Donovan. Nine times US National Champion and gold medalist in the 1995 Mountain Bike World Championship, she is one of the most successful down-hill mountain bike riders in US history. *Ryan Parks photo courtesy Bell Sports.*



Moto 6 worn by Dave Mirra. A professional BMX rider he dominated the sport for 15 years. In the X Games, he is the most decorated of all participants having won 20 medals, 14 of which were gold. *Ryan Parks photo courtesy of Bell Sports.*



Dixieland Nationals in Nashville, TN, early 1980s





The ONE, rear view.

The ONE, by THE Industries. With a strong and light-weight hand laid carbon fiber shell, this unit weighs less than 1,000 grams. It is one of the few BMX helmets to use a dual density EPSB liner.



The F-14 helmet, by THE Industries. This mountain bike helmet has 24 vent openings and extended coverage to the back of the head.



Chris Jongewaard of Australia competes in the 2006 Commonwealth Games in Melbourne. He wears a Specialized Decibel helmet in this mountain bike competition. *Rob Jones photograph courtesy Canadian Cyclist Magazine.*



Specialized Chamonix mountain bike helmet.



Specialized Telluride mountain bike helmet.



Specialized Decibel DV Team helmet.



Bellistic.



Italian Dainese Raptor mountain bike helmet. A high tech unit with a dual density EPSB liner under a carbon/glass fiber shell. The adjustable visor is molded from polycarbonate and the vents screens are aluminum fiber mesh.



The Vigor X5 BMX helmet. This is one of the few helmets certified to Snell N94, the standard for Use in Non-Motorized Activities.



Vigor Vamoose BMX helmet. This helmet has a shell of Kevlar, Spectra, and fiberglass composite. The chin bar is said to be an I-beam construction.



Youngsters engaged in BMX-like sports tend to disdain the flashy road or sport bicycle helmet and go more for the *bucket* style like this Vigor 1080 model.



Vigor 1080 skull and crossed bones.



Vigor 1080 web cross bucket helmet.



Vigor Royal clown bucket helmet.



Vigor Royal pinstripe.

So there you have it: a thumbnail sketch of the bicycle helmet, where it came from and where it is now. Where it's going we'll have to wait and see. Frankly, the most difficult job for the creative types in the future will be to come up with yet more new *names* for all the new models.

6.3 Equestrian Helmets

Riders of horses have of course worn a variety of headgear over the years from cowboy hats to velvet caps. In most cases these were considered part of the uniform or, simply, the fashion than for any kind of head protection (except perhaps in some cases, from the sun and rain).



Derby with hard shell and no liner. A cord at the back attaches to coat loop so it won't be lost when it is (inevitably) blown backward. *Photographed by David Crystal.*



The classic top hat. It's still used in that most formal of equestrian competitions, dressage. *Photographed by David Crystal.*

In thoroughbred horse racing LeRoy Nelson was killed in a horse race at Caliente in Mexico. Coincidentally, perhaps, this occurred in 1956, the same year Pete Snell's death precipitated the development of better auto racing helmets. Following Nelson's fatality, John Alessio, president of the Caliente racetrack, prompted development and acceptance of a helmet for jockeys during racing. Proponents of the helmet were seemingly vindicated when Eddie Arcaro, wearing the Caliente helmet, had a spill in the 1959 Belmont Stakes. He survived even though he was clipped in the head by a passing horse — an incident which earned the helmet worldwide acclaim and acceptance.[45] The *Caliente Safety Helmet,* which was in fact no more than a simple adaptation of the British pudding bowl helmet, and even by then current standards, a poor crash helmet, became the regulation *approved* headgear anytime someone took a horse onto a racetrack. Eventually, the shell of this helmet received the much better EPSB liner and performance improved.



The classic black velvet show jumper's cap. In the early days it had minimal interior padding and no retention system. Other than a simple draw string arrangement at the crown, there was also no way to adjust the size or fit. The purpose of the ubiquitous knob on top is lost in history. *Author's collection.*



The classic show jumping hat showing the obligatory satin bow at the rear.

In the late 1960s and early 1970s several members of the U.S. Pony Clubs Inc., became concerned about head injuries being reported by the member clubs and began to address the problem of inadequate helmets on the market. Manufacturers all over the world were contacted looking for better protection. In 1978 Drusilla Malavase who had been acting as the First Aid person at competitions noted,

> *I was horrified at what our son was wearing when riding and was seeing too many injuries to the head. There was interest in the horse community as a whole since one of our top riders had just suffered serious head damage after losing her unsecured helmet during a major competition and then being hit by a falling stadium jump rail.*

Malavase took the bull (horse) by the horns (ears?) and assembled about 40 people, equestrian sports leaders of all kinds, manufacturers, lawyers, doctors, insurance people, competition managers, etc. The upshot of that meeting was that helmets were collected from various countries and with the help of the NOCSAE football standard and the U.S. Polo Federation's new standard, new prototype helmets were developed and tested. Eventually a list of the *approved* helmets was published. The USPC required its members to use only helmets on the list, which remained in effect until the development of the ASTM standard.

The first ASTM equestrian helmet committee meeting was held in August of 1984 and Ms. Malavase was elected Chairman. She continued in that capacity until the standard was completed in 1988. Ten years after she had started the process, helmets that no longer horrified her started to become available.

Two of the major producers in North America are featured here. Both International Riding Helmets and Troxel Performance Headgear have been around for some time and each make a wide variety of modern ASTM F1163 certified helmets for the equestrian athlete. Some examples are shown here.



Vintage jockey's helmet with colorful cover in place. *Author's collection.*



The upgraded Caliente style jockey helmet. The flock on the outer surface was to help keep the outer colored cap, which distinguished individual riders, in place. *Photographed by Stephen Fenn.*



Vintage cork lined polo helmet, c. 1930. *Photographed by David Crystal.*



Buco riding helmet from the 1970s. Too heavy and top heavy. *Photographed by David Crystal.*



ATH by International Riding Helmets.



IRH Pro Rider model 1066, a classic show helmet with modern protection.



IRH Pro Rider.



The Equilite has nine vents and weighs a mere 340 grams.

Falling from one's horse has never been a happy event and, in competition, can be most distressing as well as dangerous. Head protection for riders has come a long way in the past few years and it will continue to improve as more and more participants *get back on*.



Developed jointly with Biokinetics, the Prolite, with 12 large vents, is one of the coolest equestrian helmets around. Suitable for everyday riding, camp programs, trail rides, etc., it comes, as do all IRH models, with their *Dial-Fit* size adjustment system.



Soft Touch by IRH. Available in a range of muted colors to match one's wardrobe.



The IRH Carbon ATH with brown trim, a very modern lightweight eventing helmet.



Troxel's Grand Prix Classic. All the classic features but with modern impact protection and a functional retention system.



Dakota Duratec by Troxel, a western-trail rider look. Visor is extended and integrated with shell. The silver conchos add to the Western-like appearance of the helmet. To adjust the width or the length of the helmet, it employs what Troxel calls its *Flip Fold* system whereby interior tabs can be folded over to increase the pad thickness. It also, as with the vast majority of their models, features an occipital adjustment system (The GPS III), as well as a removable washable liner.



The Orion by Troxel. This helmet has a co-molded polycarbonate microshell over an EPS liner.



The Troxel Derby helmet, a classically shaped hat cleverly fitted over a helmet.



The Troxel Sierra. This all-terrain helmet has been designed exclusively with the Western rider in mind. It features an in-molded polycarbonate top and bottom shell, permanent Cordura® and suede covering and an integrated soft visor.

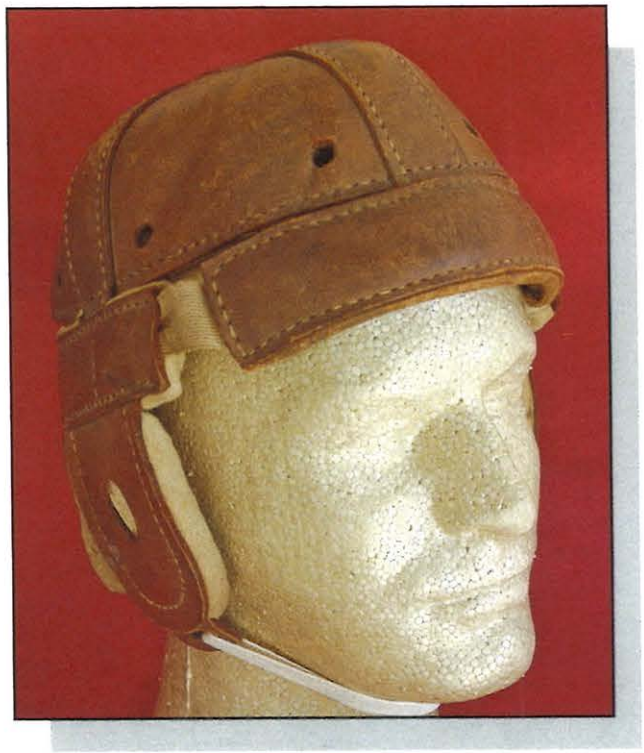
6.4 Football Helmets

It is said that the first football game, a combination of soccer and rugby, was played in November 1869 between teams representing Rutgers and Princeton Universities.[46] Initially no running was allowed; the ball was kicked, dribbled, and hit with the player's fists. In 1888 below-the-belt tackling was first permitted. Soon thereafter the incidence of head injuries among players created the need for protective headgear.

The leather football helmet has its origin well over100 years ago being first worn in an 1893 Army-Navy game. An Annapolis shoemaker created the first helmet for Admiral Joseph Mason Reeves, who had been advised by a Navy doctor that he would be risking death or *instant insanity* if he took another kick to the head. Later in 1896 Lafayette College halfback George Barclay so feared the fabled cauliflower ear on his *hearing organs*, which he felt was a direct cause of playing bare-headed, that he had a playing hat made. His design was a special headgear which was held to his head by three heavy leather straps fashioned by a harness maker, thus giving the first football helmets the nomenclature *head-harness*.[47] Around 1917, the interior suspension was introduced and the first real football helmet was introduced.

In the early 1900s, it was not uncommon for some players to wear helmets and others not. Up until the 1940s, these leather bonnets were completely unadorned. However, as team uniforms developed, players began to hand paint their helmets with school colors and logos. In 1948, the first NFL team logo, the Ram's horns, appeared on a leather helmet. Soon after in the 1950s, every school and professional team put logos and mascots on their plastic helmets. The *art* of football helmet design has since been pretty much confined to who can make the most dramatic team logo.

The football helmet industry was once populated by many competing manufactures. Some, such as Draper and Hutch, have long since passed away. Others like MacGregor, Spalding, and Wilson continue in the sporting goods business but not with football helmets. Nowadays there are but three manufacturers. Riddell, the official suppler to the National Football League has remained a leader in this field since 1929. Schutt Sports and relative newcomer, Adams USA, are the other two.



The classic *dog ears* soft leather helmet of the 1930s. Unknown manufacturer. *Author's collection.*



1930s soft leather football helmet rear view.



Interior view showing felt padding throughout.



The great Bronko Nagurski in period headgear, c. 1935. Born in the small Ontario town of Rainy River in 1908, he led his Chicago Bears to several national championships during the 1930 to 1943 period. Bronko, arguably the greatest American football player of all time, died in 1990. *Photo from the George Brace Collection.*



Replica of 1940s style leather football helmet. *Author's collection.*



Interior view showing first generation suspension design.



1941 advertisement for Spalding helmets and other football gear.



Hi Sport hard leather football helmet.
Author's collection.

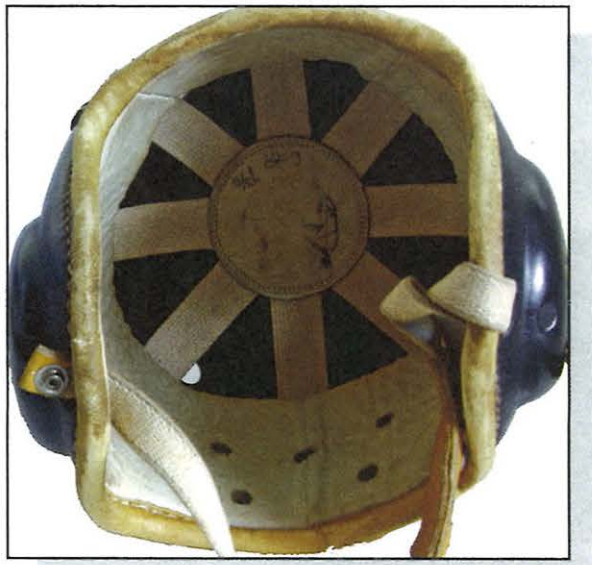






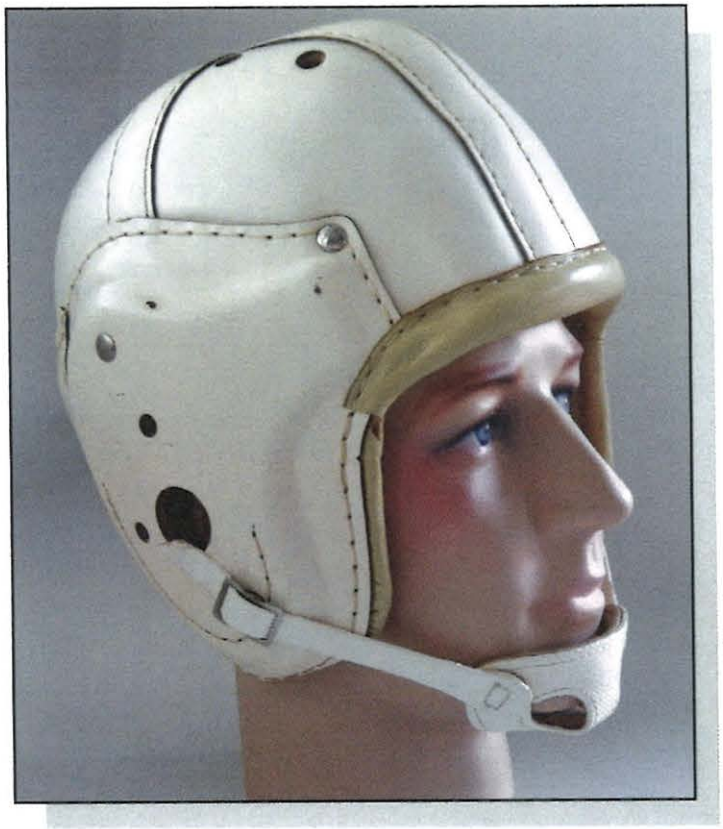


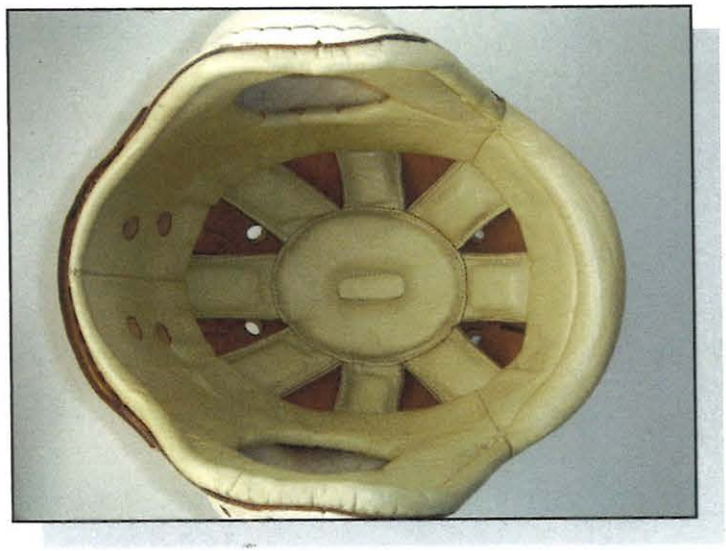
Hard leather football helmet. Unknown manufacturer. *Author's collection.*



As football helmet design moved into the 1950s, leather headgear such as the MacGregor model shown here became quite sophisticated. With its padded crown suspension, its then novel chin cup/strap, and with soft leather beautifully stitched to a substantial interior padding, the H612 is an example of how good a leather helmet could be.







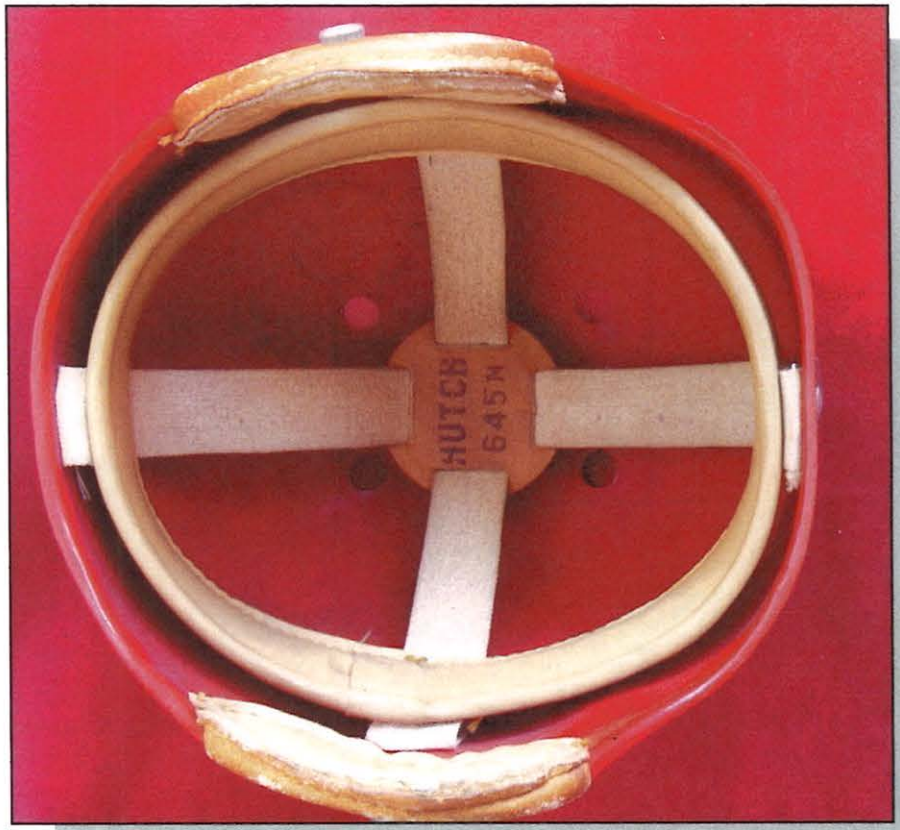
MacGregor H612 front view.
Author's collection.



With the inevitable introduction of the plastic shelled helmet, models such as the Hutch 645 began to appear. Vestiges of leather remained around the ear sections but the crown suspension was quite rudimentary. The older leather MacGregor probably provided more protection.

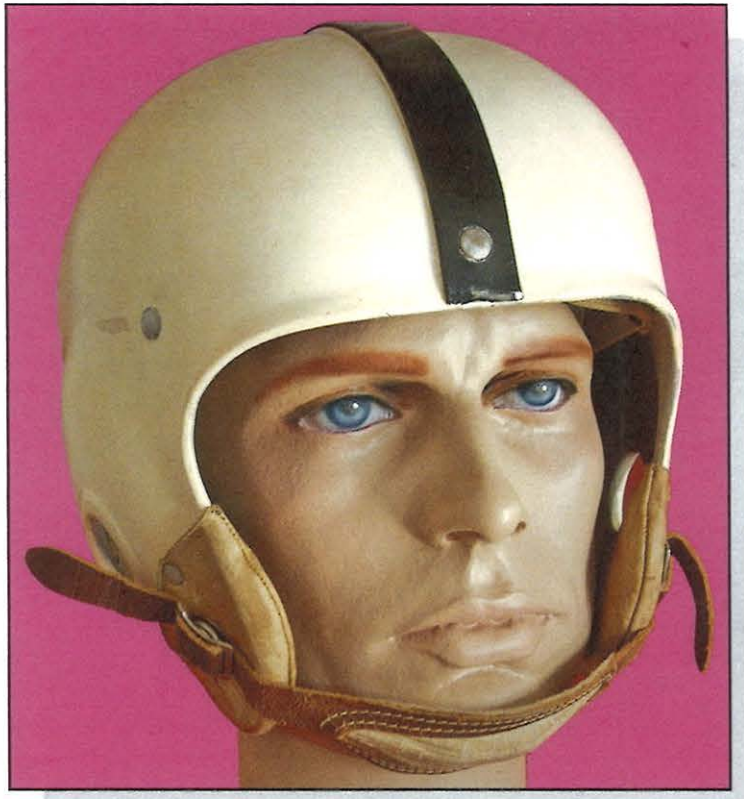


Hutch 645 plastic shell football helmet endorsed by the 1953 Heisman Trophy winner Johnny Lattner. *Author's collection.*



Hutch interior.

The original Riddell football helmet. This model, the RK style, was superseded by the one-piece shell helmet, the TK style, in 1965. *Courtesy Riddell Helmets.*



When Riddell introduced its truly functional suspension system, it did so in a plastic shell that was actually made in two pieces. These were bonded together along the midline producing a thick ridge down the center. For many years, this appearance in subsequent one-piece shell helmets was retained as it had become such a recognizable feature of the Riddell helmets.

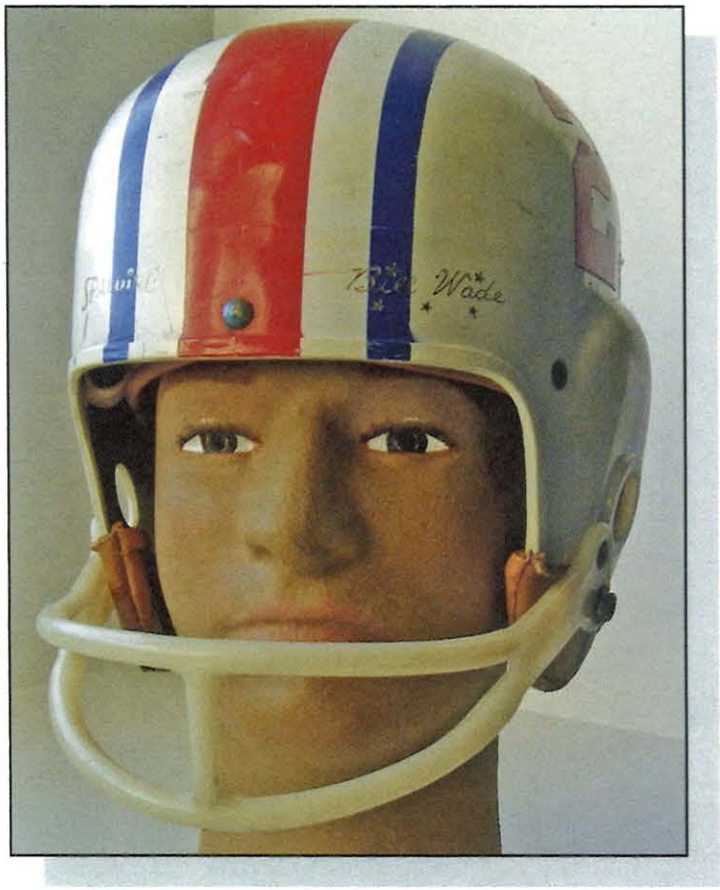


As discussed in the History chapter, the introduction of Riddell's football helmet was delayed by World War II. That did not stop the marketing folks though from making sure no one forget about the product. This ad appeared sometime in June, 1941.

Advertisement for Riddell football/paratrooper helmet, c. 1941.

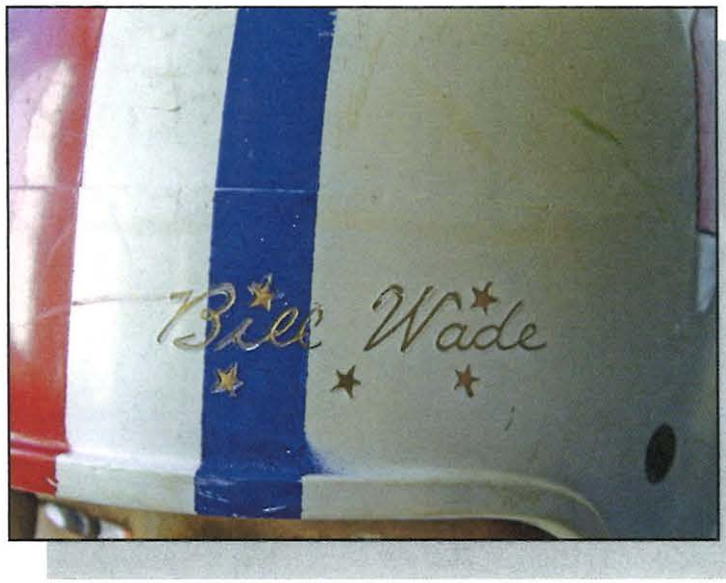


Riddell web suspension interior.



Spalding football helmet c.1960. *Author's collection.*





Endorsement by Bill Wade. Wade was quarterback of the Los Angeles Rams from 1954 to 1960, then for the Chicago Bears from 1961 to 1966. He was among several football stars who endorsed helmets with their signature.

Marketing probably also had a hand in securing endorsements from well known athletes, such as in the case of this Spalding youth helmet.

At least one very famous player lent his name in support of the plastic industry itself as seen in this advertisement.



Advertisement extolling the virtues of ABS plastic for helmets, c. 1965.



The Wilson fully padded helmet. *Photographed by Stephen Fenn.*



Wilson interior.

Wilson Sporting Goods was founded in 1914 and by 1917 was selling football helmets. It developed and sold several different models over the years. Its most significant model, the first fully padded model, is shown here. Like most of its competitors, Wilson stopped selling football helmets in 1979 due to litigation pressures.