Airflow Sciences Corporation

Racing Helmet Design

Case Study

By James C. Paul, P.E.
Airflow Sciences Corporation

*(734) 525-0300
www.airflowsciences.com*

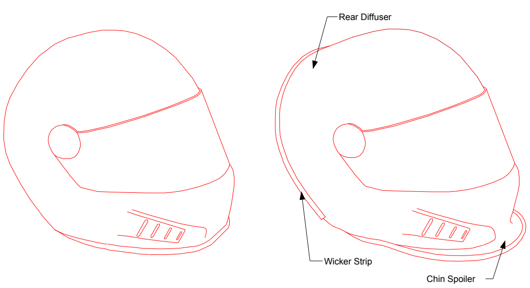
Document A-27

Race car designers continually strive to balance the effects of aerodynamic forces on their vehicles. Increasing downward force allows higher cornering speed but tends to increase drag force, thus limiting straight away speed. During 1993, the cowls and upper surfaces of Lola T90/00 Indy Cars were reduced in profile area. These changes improved the aerodynamics of the vehicles but adversely affected the comfort and safety of the drivers. At high speeds, track testing showed that a large lifting force was acting on the driver's helmets. At speeds of 220 MPH (354 km/h) the driver could feel an upward pull in excess of 50 lbs (222 N). In addition, the helmets were subject to violent side-to-side buffeting. These forces strain and fatigue the driver's necks as well as blurring their vision.

Figure 1 - Visualization of flow field around new helmet design

Airflow Sciences Corporation (ASC) teamed with Bell Sports, Incorporated, a motor racing helmet manufacturer, to help resolve these problems. Aerodynamic forces on Indy car helmets were studied in the University of Michigan's 5' x 7' Wind Tunnel in Ann Arbor, Michigan. A full scale model of the upper surfaces and wheels of a 1993 Lola T90/00 was fabricated and mounted in the tunnel. A helmet was strapped on a simple headform which, in turn, was connected to the wind tunnel 'balance'. The balance accurately measured both the aerodynamic lift and drag forces exerted on the helmet.

In order to measure the side-to-side forces (buffeting), the simple headform was replaced with a special crash test mannequin head and neck assembly. The mannequin correctly simulates the dynamics of the human head and neck. By instrumenting the head assembly with accelerometers, the buffeting forces acting on the helmet were determined.



Original Design **New Design**

Figure 2 - Helmet modifications improve aerodynamic characteristics

During the wind tunnel tests, a number of helmet designs were evaluated using these two methods. Lift, drag and buffeting forces were recorded for each design. In addition, visualization of the flow was accomplished (Figure 1) through yarn tufts taped to the helmet and car body as well as the use of a smoke generator.

The design with the best combination of low lift, drag, and buffeting forces was identified. That helmet was then further-modified and refined to achieve optimal performance. The resulting design is shown in Figure 2. It incorporates an extension or 'rear diffuser' on the back side of the helmet. The rear diffuser is rimmed by a small projection called a 'wicker strip'.

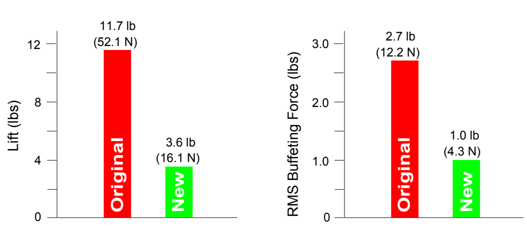


Figure 3 - Wind tunnel data shows dramatic improvement (150 mph)

On the front of the helmet, a 'chin spoiler' has also been added. An aerodynamically neutral condition can be obtained for each individual driver through minor adjustments in size of the spoiler and wicker.

Figure 4 - Emerson Fittipaldi wins the 1993 Indianapolis 500 race

Wind tunnel test results for the new helmet are presented in Figure 3. Lifting forces were 72% lower, and side-to-side buffeting forces were 58% lower than for the original design.

High expectations following the wind tunnel tests were met at the race track. Indy drivers confirmed that forces on the new helmet were greatly reduced - neck fatigue and blurred vision were no longer a problem. Many drivers on the Indy Car Circuit wear the new helmet (designated the 'Vortex SS' by Bell) including Emerson Fittipaldi, winner of the 1993 Indianapolis 500 Mile Race.