

**“I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Thermal – Fluids)”**

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**EFFECTIVENESS IN COOLING OF CYCLIST'S HELMET**

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**A report submitted in partial fulfillment of the requirements for the award of the  
degree of Bachelor of Mechanical Engineering (Thermal – Fluids)**

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**May 2006**

**I declare that report entitled “Effectiveness in Cooling of Cyclist’s Helmet” is the result of my own research except as cited in the references.**

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## ABSTRACT

Coolness, ventilation, fit and sweat control are the most critical comfort needs in providing effective headwear for bicycle riders. The helmets should be protective and at the same time provide effectiveness cooling to the head. This research project is to measure the relative cooling of bicycle helmets by studying and comparing riders wearing standard-approved helmets to investigate their effectiveness in cooling of cyclist's helmet. Variables for a good and efficient helmet include materials used, shell construction, thickness, ventilation, weight and shape of helmet. Some helmet brands claim that having more vents meant more ventilation, but it was shown by this investigation that it is not that simple. It is found that the size of the vents, they locations and how they work with other vents and internal channels would provide more ventilation.

## ABSTRAK

Kesejukan, pengudaraan, keselesaan dan kawalan perpeluhan antara yang sangat kritikal dalam menentukan keselesaan dan memberi keberkesanan pemakaian kepala bagi penunggang basikal. Helmet mestilah memberi perlindungan dan dalam masa yang sama memberi keberkesanan kesejukan pada kepala. Projek penyelidikan ini adalah untuk mengukur hubungan kesejukan helmet basikal melalui kajian perbandingan penunggang yang memakai piawai helmet bagi menyelidik keberkesanan kesejukan helmet basikal. Pembolehubah helmet yang baik dan cekap termasuklah bahan gunaan, pembinaan tempurung helmet, ketebalan, pengudaraan, berat dan rupa bentuk sebuah helmet. Sesetengah model helmet mendakwa helmet yang mempunyai ruang pengudaraan yang banyak mempunyai system pengudaraan yang lebih baik tetapi hasil kajian mendapati ianya tidaklah semudah itu. Kajian menunjukkan saiz ukuran pengudaraan, kedudukan, bagaimana proses pengudaraan berlaku diantara ruang pengudaraan dan saluran dalaman dalam memberikan pengudaraan yang baik dan secukupnya.

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## CHAPTER 1

### INTRODUCTION

#### 1.1 Introduction overview

The primary function of bicycle helmets is to provide effective protection of the head against impacts. The increasing demand for more comfortable helmets has stimulated investigations to determine their ventilation characteristics to optimize thermal comfort and avoid thermal strain to a cyclist's head. Bicycle helmets are passive devices, which provide thermal resistance to the cooling of a head. Indeed, helmets inherently represent barriers to forced convection over a head and act as a cooling impediment.

The poor ventilation of bicycle helmet is often cited as one of the major barriers to helmet use. Studies are required to understand the characteristic of cyclist's helmet in order to define cyclist's comfort performance. Helmet is made of foam that holds heat well. Human bodies use the head to radiate excess heat during exercise. Only a flow of air over the head can carry that heat out of the helmet, so ventilation becomes critical in hot weather and is needed even in cold weather to carry moisture away. The human head is designed to release heat, cooling the body and maintaining a constant temperature. A helmet traps the heat emitted from the head, which may result in overheating leading to increased fatigue.

## **1.2 Statement of Problem**

There are many advantages of wearing a helmet. Most importantly of all, it protects the head in an accident and shields from rain and hailstorms. The rider will feel confident on the road. One of the most common reasons adult cyclists give for not wearing a helmet is the heat. When the head temperature is higher, the body will easy to get exhausted and being uncomfortable. Helmets can get very hot, because they fit tightly around the head and the foam traps heat in. This is typically caused by restricted blood flow to head. The restricted blood flow can caused pain or a feeling of heat on head. It is usually because the head needs to release heat out with better ventilation. It is important that to decide a suitable helmet designed with the ventilation slots and linear cooling paths, which are conduits for forced air movement through the helmet.

### **1.2.1 Purpose of the Study**

The purpose of this study is to find the optimum on bicycle helmets in term of safety, and thermal comfort. It's also to determine the degree to which helmet exceed safety perimeters set by Consumer Product Safety Commission (CPSC), along with important factors such as secure straps, venting and construction. From this research, the dynamics of ventilation, cooling and heating systems in order to defined riders comfort performance will be analyzed. Observation and data given, can help to design an excellent helmet which will keep the head coolness. It also to propose a selection of various design alternatives based on suitable conditions.



### **1.2.2 Objectives of the study**

The objectives of this researches are to evaluate the effectiveness of the cyclist's helmet in allow adequate cooling and to study and gather data for currently commercially available helmet.

### **1.2.3 Scope of the study**

Several currently available helmets will be evaluated for effectiveness of cooling of the cyclist's head. Comparison will be made based on different helmets and also between different cyclists.

## **1.3 Importance of the Study**

This research is permitted focus on assessing the degree to which is the best helmets can provide the maximum advantages and keeping their head cool enough to prevent heatstroke. Helmet use reduces airflow over the head and this has led to speculation that individuals who routinely wear safety helmets may be prone to heat related stress and tasks requiring a high degree of attention can be more affected by this. This project is to collect and review information for keeping cyclist's head cool and comfortable inside a helmet, how to select the right helmet for cycling in hot weather. A helmet should be comfortable to wear, cool, light, unobtrusive to the rider and fashionable in appearance. Helmet should not be too heavy and provide adequate ventilation, because cycling can be an intense aerobic form of exercise which significantly raises body temperature. A review of related literature and an analysis of data collection will make it possible to design the best prototype of helmet that can keep enough cooling of head.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter reviews some of helmet currently available commercially so that justification can be made on which helmets to be taken as case studies. Information about the currently commercially available helmet characteristics regarding of materials, structural, ventilation system, weight considerations and construction is important to evaluate the heat flow and cooling of a cyclist helmet. The effectiveness of the vent system relies on the air flow around the edges for keeping head cool enough and comfortable inside the helmet.

#### **2.2 A Healthy Human Body Prior to Cycling Event**

Based on study of a healthy human body temperature prior to cycling event, the normal range of human body temperature varies due to an individual's metabolism rate. The normal core body temperature of a healthy, resting adult human being is stated to be at 98.6 degrees Fahrenheit or 37.0 degrees Celsius. Though the body temperature measured on an individual can vary, a healthy human body can maintain a fairly consistent body temperature that is around the mark of 37.0 degrees Celsius.



**Table 2.1: A temperature of healthy human body**

<b>Author name</b>	<b>Result (w/surrounding text)</b>	<b>Standardized Result</b>
Benjamin Cummings 1987: 790	"... a human can maintain its 'internal pond' at a constant temperature of 37 °C"	37.0 °C
World Book Encyclopedia. 1996.	"... a healthy, resting adult human being is 98.6 °F (37.0 °C)"	37.0 °C
Simmers 1988: 150-151.	"... the normal range for body temperature is 97 to 100 degrees Fahrenheit or 36.1 to 37.8 degrees Celsius"	36.1 - 37.8 °C
Eisman 1972: 125.	"... fairly constant temperature of 98.6 degrees"	37.0 °C
McGovern 1994: 2	"... core body temperature... the normal 37 °C"	37.0 °C

The normal range of human body temperature varies due to an individual's metabolism rate; the higher (faster) it is the higher the normal body temperature or the slower the metabolic rate the lower the normal body temperature. Other factors that might affect the body temperature of an individual may be the time of day or the part of the body in which the temperature is measured at. This research is to have to determine the temperature of riders head before and after cycling activities to compare with atmosphere temperature and also to evaluate helmet effectiveness by studying and compared the relative cooling ability of a riders uncovered head and the one with the helmet.

### **2.3 Currently Available Helmet**

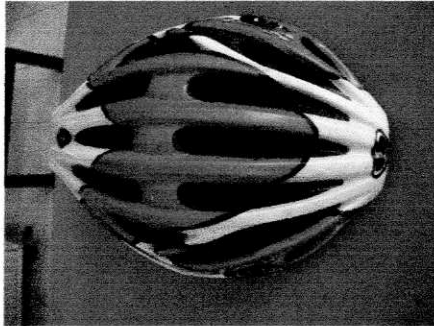
Most current available helmet have adequate cooling for most riders look for a good combination of front vent that cool, and rear vents that allow exit flow of that ventilation. V-shaped vents are most effective. More vents tend to mean more cooling. The differences each type of helmet is in quality of construction, ventilation, retention system and weight. The focus of study is to determine which helmet can get the fast cooling when wearing.

This experiment was selected the different shape and model of a sport helmet. The typical helmet listed below is made of EPS foam with a thin plastic shell taped or glued onto the foam. It has at least some vents, nylon or polypro straps, a plastic buckle, no reflective trim and either a ring fit ("one size fits all) or squishy foam fitting pads inside. If no contrary information is in the write-up for each brand or model, those features are assumed. Many have a rear stabilizer wrapping around the back of the head, which note only if it has some unusual feature. This is limitation types of helmet user, in junior team of Malacca Cyclist Association, which is the better helmet that has in market.

The helmets are suitable in this research. They are:

- a) Selev helmet
- b) Rudy Project
- c) Las helmet
- d) Giro Pneumo
- e) Mango helmet

### 2.3.1 Selev helmet

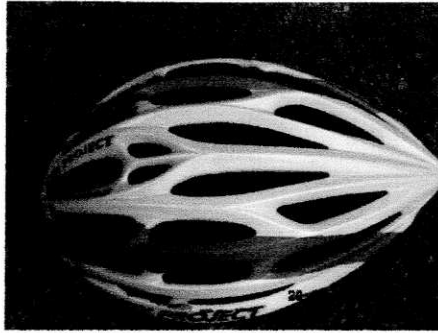


**Figure 2.1: Selev helmet**

(Courtesy: <http://www.bike-x-perts.com> )

Selev is an Italian company with models mostly for the upscale road rider market. They will distribute in 2005 through Trialtir in the US, assuming their helmets pass CPSC certification. Their helmets are all molded in the shell. The manufacturer fit rounder Asian heads better than others. These helmets have optimum ventilation with 23 ventilation holes, compactness and high comfort preferred by the pro riders. The new system to regulate size allows fitting safe and perfectly this helmet.

### 2.3.2 Rudy project



**Figure 2.2: Rudy Project helmet**

(Courtesy: Rudy Project Aryon+ Helmet - GearReview\_com.htm)

In general their models have the usual rear snag points and external strap anchors. As move toward the lower end of the line the shapes improve to rounder, smoother designs. Some are molded in the shell. Visors are attached with hook-and-loop. Rudy Project has some interesting innovations, and perhaps they will find wider US distribution at some point. Their use RSR 3 retention system, which allows the straps to be tightened as one with a small dial in the back to accommodate a snug fit. It fits well, is well ventilated and looks great and has some features not found on other helmets, like the option to run mesh in the vents or not.

### 2.3.3 LAS helmet



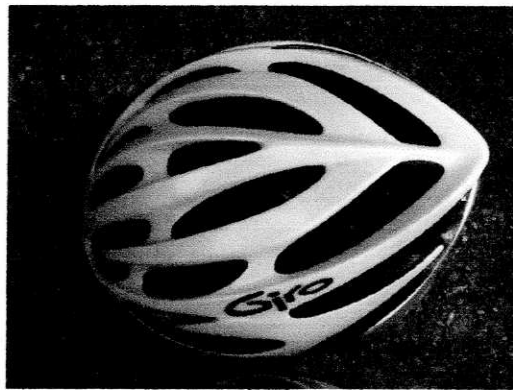
**Figure 2.3: Las helmet**

(Courtesy: <http://www.lashelmets.com>)



The innovative design links aesthetics and aerodynamics in an Italian style. Size adjustment with PREFIX SYSTEM® that allows the helmet to adapt to maximum comfort. The excellent aeration system guarantee a special air conditioning with 20 ventilation holes. Most of them have moderate snag points in the rear. Internal padding made with AIRTEK, removable and washable lining. Insect repelling cotton net for optimum air circulation. There are some nice bright colors available.

#### 2.3.4 Giro Pneumo helmet

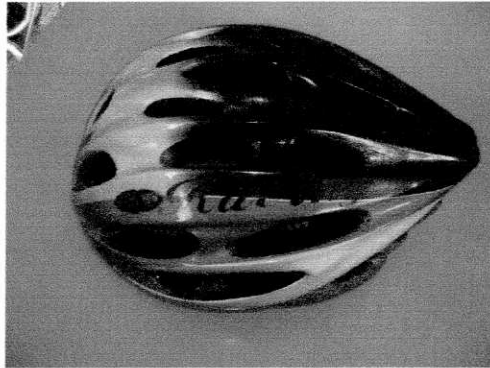


**Figure 2.4: Giro Pneumo helmet**  
(Courtesy: Giro Pneumo Helmet.htm)

Giro and other manufacturers have hyper-ventilated models produced for the European market that meet the CEN standard but are not certified to meet the tougher US CPSC standard. The Pneumo sets the standard for professional protection and ventilation. It boasts Roll Cage reinforcement and In-mold construction for sturdy protection no matter what speed will be going. 19 massive vents scoop air and channel it around your head for icy ventilation. And, the sculpted fit and Roc Loc 4 will have wondering if head wasn't the mold Giro used to design the helmet. In fact, the ventilation and fit are so good might wonder if wearing a helmet at all. The Giro Pneumo is light at 284 grams (10 ounces) and has 19 huge vents to allow air to flow through the helmet. The Pneumo's vents were actually wind tunnel designed to "channel" air to the rider's head to

allow maximum cooling. The padding inside the Pneumo is made of moisture-wicking Coolmax material to further aid in the evaporation of sweat and to better aid in cooling.

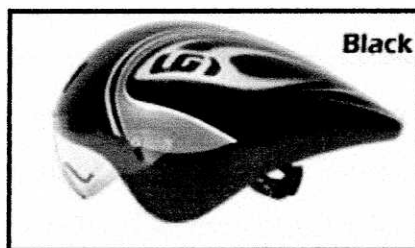
### 2.3.5 Mango helmet



**Figure 2.5: Mango helmet**  
(Courtesy: Mango Helmet.htm.)

This Italian company has a line fitted with a single band fitting device. The size is adjusted with a dial in the back where the band drops down to become a stabilizer, and the device is claimed to end fitting problems. There are even some bright colors. It has good ventilation. Better good and comfortable. The helmet has 14 ventilation holes, including the three very large ones at the front to keep head cool. The moulding construction keeps the weight down to 260g.

### 2.3.6 Prologue helmet



**Figure 2.6: Prologue helmet**  
(Courtesy: <http://www.all3sports.com>)

The fit was good with the spider lock dial on the back. The prologue came with a clear visor. The visor can be rotated upward without sacrificing much of the “aero ness” of the helmet. This comes in handy on hot days or when climbing. It allows a bit more air circulation into the helmet. The three vents on the front of the helmet provide a minimal amount of air flow. The air circulation is less of a consideration. Prologue is the only approved aero helmet (CPSC and ASTM) and as the only aero helmet, it’s by far the best aero helmet. The prologue is a head fairing, and a protective helmet, Air-dry Fusion pads keep comfortable and wick away the sweat.

### 2.3.7 Louis Garneau



**Figure 2.7: Louis Garneau helmet**

(Courtesy: <http://www.trivillage.com/helmets.html>)

The Spiderlock retention system is fairly easy to adjust but lacks the comfort some of its contemporaries offer. The only other downside of the T-Bone is a lack of large vents in its arsenal of 33 air intakes. A nice collection of vents keeps the helmet cool, and the pads are well placed so that the helmet is a comfortable fit. A ridiculous amount of cooling ventilation, combined with the security of patent-pending U-BAR technology.



### 2.3.8 Briko



**Figure 2.8: Briko helmet**

(Courtesy: Briko 2002 Spark Road - ATB Bike Helmet.htm)

The Briko use the Venturi Effect when designing the vents on their top two helmets. “The Venturi Effect accelerates air out above the head, thus creating a cooling effect.” The last major layer is the fabric and padding that come closest to the skin. Since the loose most of the body heat through the head this is a key layer when it comes to comfort. The wicking fabrics offer quick drying comfort in a lightweight, hypoallergenic fabric. Double supporting cap structure – Air thru technology the another revolutionary element of Briko helmets is the double supporting cap structure, a device that is able to offer greater safety in addition to decidedly superior lightness, aerodynamics and ventilation.

### 2.3.9 Giant Bell

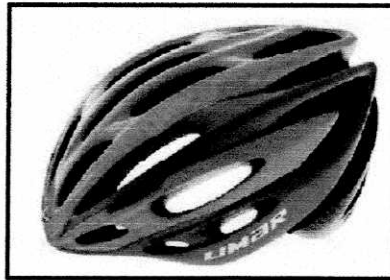


**Figure 2.9: Giant Bell helmet**

(Courtesy: <http://www.silentsports.com>)

Giant Bell also utilizes the in –mold technology as well as using many cooling vents and exhaust ports to keep the riders head cool. Specially designed ventilation channels on the interior of the helmet’s linear bring cool air in through the front and over the head while flushing warm air out through the rear ports. For the comfort, the bicycle helmet includes 20-channeled vents that are specially designed to force cool, fresh air in through the front and around rider’s head, while flushing warm air out of the rear ports.

### 2.3.10 Limar 907 helmet



**Figure 2.10: Limar 907 helmet**

(Courtesy: <http://www.bike24.net/p24312.html>)

Limar 907 helmet includes 29 air vents to allow helmet air flow thus creating a cooling affect. Micrometric retention Pro System 2 Retention System developed for demanding cyclist. Extra light, compact and the fit is easily adjusted with one hand, even while riding. Soft and cool pads specially designed for the internal structure of a helmet, which offers the wearer superior comfort and excellent sweat absorbing capacity. Double In-Mold Production Process which fuses the external micro shell to the polystyrene lining of the helmet, which guarantees a higher level of safety and optimum quality.