National College of Art & Design

Industrial Design

"The Evolution of the Motor Car in the Changing Environment of the 1990's".

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INTRODUCTION

It seems that the world has a collective obsession with the motor car. It cannot be classed simply as a method of transport, that allows us to travel from one destination to another, it is an extension of humanity, of human form. The motor car represents the image that the individual wants to convey to the world. As Walter J. Boyne states;

> ***The automobile, the ultimate mechanical love object, has been with us for just over 100 years. In that time it has served as both the symbol and the instrument of some of the most profound changes in history.*** **(Boyne, 1988, pg. 8).**

When Ford introduced the concept of mass production into the car industry, he initiated a precedent that has remained unchanged to the present day. He sought to make the automobile affordable to the vast majority of the worlds population, and he succeeded.

In this thesis we will examine how the motor car is evolving in the changing environment of the 1990's. The world has become aware of the damage being done to its environment and cars have been recognised as one of the prime contributors. This is hard to accept when we consider how the motor car has become such an integral component of our everyday lives. It is indisputable that the automobile is partly responsible for diminishing the earth's natural resources, at an unacceptable rate. The emissions from car exhausts are contributing to air pollution and the destruction of the ozone layer, along with the increasing problems associated with traffic congestion. We have realised the importance of high safety standards in automobiles, as the rate of car accidents and the worlds vehicle population increases each year. This thesis will endeavour to discuss the advances have been made and the changes that have yet to be realised as regards the motor car in our environment. I will also

discuss why there is some hesitation by both the general public and car industries in making some of these changes.

Chapter 1 will examine the recycling of car components, in order to minimise the waste of the earth's diminishing resources. It also deals with the tasks facing the car industry, as regards designing automobiles for both assembly, and disassembly for recycling.

Chapter 2 discusses the quest for alternative fuels and alternative forms of propulsion. We have become more aware of the harm car emissions cause to the ozone layer, and realise the need for change. Some of the proposed alternatives are discussed and examined, in view of quality and acceptance.

Chapter 3 deals with public transport systems, as another proposed solution to both air pollution and traffic congestion. I will discuss how they compare to personal transport systems and what is required of them in order to compete successfully with the motor car.

Chapter 4 deals with car safety. Many of the new additions to car safety will be discussed and examined. The car industries attitude towards safety standards will also be discussed.

In conclusion, I will discuss the reaction of both the consumer and the manufacturer, to the major changes that are required in the composition of the modern automobile, in order to aid the salvation of the environment. Finally, what is required of the motor car of the future is discussed.

CHAPTER ONE
RECYCLING CARS

Forty years ago, the motor car was comprised of very basic materials, i.e. metal, glass, wood, leather, and paint. Now, in the 1990's, no fewer than eight hundred different materials are used to manufacture the modern motor car. To the vast majority of today's society this may signify the great technological leaps that have been made in the motor industry, but to others it signifies a decade of unnecessary wastage of natural resources.

The average car is made up of a large variety of materials, each of which has either to be mined or manufactured, through combining other mined materials. These actions require a lot of energy, energy that would have to have been supplied by a generator or a power station, both of which release pollutants, i.e. carbon monoxide, hydrocarbons, nitrogen oxide etc. From this it becomes evident that even the mining of materials for car production contributes to global warming and the deterioration of the ozone layer.

When a motor car reaches the end of its service life, it is scrapped. It is in the scrap yard, where all vehicles are destined, that these components and liquids become a glut of worthless waste. As raw materials become more scarce and more expensive, the motor industry has begun to realise that the contribution they are required to make to the environment should not just be confined to lower emissions.

The recycling of car components has become an important issue in the motor industry. While the person purchasing a car may not be concerned with how many components of the car can be recycled, for the car

manufacturers it is a requirement that should be met before certain materials are used in production. In mainland Europe legislation has been passed that will classify car shredder waste as hazardous, making it five times more expensive to place in land fills. This bill also states that car manufacturers will have to accept the return of cars, without incurring a charge from the owners.

By the end of the 1990's, German car manufacturers will be required to recycle 25% of all the plastics within their fleets, use 'uniform plastics' for all vehicle construction and design all cars for disassembly in automotive development. Other countries have begun to follow Germany's lead, but are these manufacturers recycling simply as a token gesture? Designing cars for assembly and disassembly is an arduous task, designing materials that are easy to recycle is also difficult, but if car components are not designed with recycling as a main priority the motor industry will pay dearly. The motor industry has finally begun to accept the scarcity of supply and the abundance of demand. Companies that supply car parts have had to become more responsible for the development and design of components. From 1965 to 1990 the steel content of the motor car has been reduced from 76 percent to 66 percent. Of the steel content in a modern motor car all is recyclable, provided that all excess fluid is properly drained from the vehicle. Yet, it is not steel that poses a problem when recycling the motor car, it is the numerous other synthetic materials that contribute to the manufacture of a vehicle.

Between 1965 and 1985 the percentage of synthetic components utilised in car production escalated from two to ten percent. **Gert-Dieter**

Werner, who manages the research division for non-metallic materials at BMW, predicts that this rise will continue through the 1990's, he says;

> ***I see plastics going to no more than 12 to 15 percent of cars content by 1995. The current euphoria relating to plastic composites is totally unjustified because their disposal still causes plenty of problems.*** **(Werner Interview).**

Yet, are companies or consumers really concerned about the disposal of these plastics? After all the use of plastics in the manufacture of cars is more viable to the industry.

The underlying problem with recycling these products is the vast amount of different materials used in production. The materials used in the production of cars may also be altered during the course of various face-lifts. Increasing pressure is now being put on the car industry to reduce the wide variety of materials utilised in production.

Some companies, including BMW have stated that they would like to centre attention on the use of only three to four materials in production, with reinforced polypropylene as a possible choice to fulfil several new functions. This company have also favoured the use of thermoplastics over thermosets, although they cannot be ruled out entirely because thermosets are easily recycled.

However, resin suppliers view the problem differently. **Eugene Geurts**, a polymer recycling manager at D.S.M., says he favours;

> ***A narrowing of the current wide range of specifications from all the various car companies in order to get a more recyclable product.*** He says; ***There is no reason why for instance low-temperature performance specifications for bumpers should vary as much as they do.*** **(Guerts Interview).**

Even at this present time, the recycled plastic from bumpers is being utilised in several different areas, even as new bumpers. Bumper claddings for the new 911 model Porsche are produced entirely from bumper scrap.

Mercedes Benz are also carrying out extensive bumper recycling, which involves the sorting of the various bumper components, i.e. polyester elastomer mounting elements, polyurethane foam energy absorbers, polycarbonate bumper claddings, in addition to the polypropylene bumper itself.

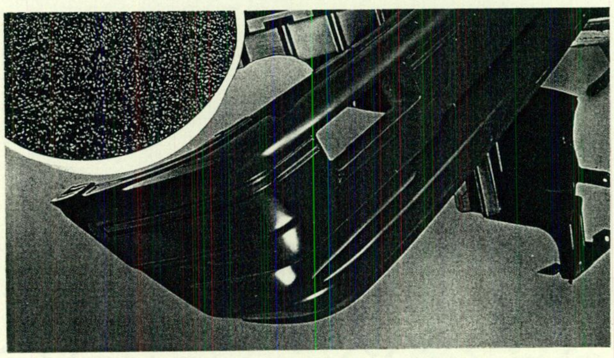


Fig. 1.1 A bumper and its possible regrind.

The company is also investigating the possibility of putting these materials to other use, i.e. air ducts and wheel covers. The instrument panels of its 1991 S class are also being experimented with for possible recycling.

BMW currently recycles painted bumpers that have been moulded from polycarbonate/polyester blends, taken from scrapped Series 3, 5 and 7

cars. The latest series 3 version has six components that have been designed and moulded in recycled materials. These components include the luggage compartment liner and the wheel arch lines. Also, the vast majority of polyethylene petrol tanks in production, now incorporate a plastic regrind of at least 30 percent, that is taken from the scrap which results from the original manufacture of these items. It seems that the detailed designers of today's petrol tanks create such a high level of scrap at production level, that they in turn make recycling a necessity.

Fig. 1.2 Fuel tanks taken from scrapped cars are suitable for recycling.

Bernd Waite, director of plastics development at BMW, says that;

> ***We have produced prototypes using 70 percent regrind taken from used petrol tanks and the results have been impressive. This is technically possible today, but because we only started installing plastic tanks in 1986, short supplies could mean it could be well into the late '90's before we see this in the series levels.* (Waite, World News, 12 October 1994).**

Audi have produced tanks made of 100 percent recycled HDPE from used tanks, some of which were ten years old. They have also been involved in the production of completely recycled bumpers, made from elastomer modified propylene.

GE, Bergen Op Zoom, Netherlands, formed a joint venture company, Polymer Recovery, with industrial recycler, Ravago Arendointe, Belgium, to recycle engineering thermoplastics from wrecked cars (as well as from products such as telephones). This company is now co-operating with Ford to recycle old Xenoy modified polycarbonate bumpers. Much of this recycled material will be sold back to Ford as well as being used for battery covers on Audi 80's and 90's. At a recent recycling conference in Davos, Switzerland, the vice president of Automotive Materials, cited that;

> ***Developing post-consumer recycling is at an earlier development stage for thermosets than for thermoplastics, the technical reality is significantly in advance of popular perception.***
> **(World News, 12 October 1994).**

He pointed out that the re-ground thermoset scrap from car fenders is being tested as a filler in mudguard's made by Polrim, France, and in sight shields moulded by Pfeba, Germany for Jaguar cars.

Aluminium, like plastics, has only recently been introduced into the manufacture of the motor car. This metal alloy is of great benefit to the car industry, due to its corrosion resistance and its saving in the weight of the car. Also, unlike some of the other synthetic materials, light alloys are easily recycled.

The only disadvantage of using aluminium however, is that it costs three times more than steel. Yet it is expected that the popularity of this alloy will increase over the next five years. BMW is currently experimenting with a steel structure that would be clad in aluminium body panels, and while the impact strength of the combination of these two materials is surprisingly good, the union of these materials is still in its infancy.

Despite its cost, aluminium is very popular among car manufacturers. The next generation of the Audi V8 will possess an alloy body, produced in conjunction with Aloca.

It was discovered that this lightweight material can also reduce consumption by up to 15 percent. At BMW, engineers have developed aluminium suspension components for all existing models. Should there be another energy crisis, these components could be in production within six months.

Although the introduction of extensive usage of aluminium in the car industry, would increase the overall expense of a motor car, it appears that consumers can only benefit from a higher aluminium content. BMW's **Jurgen Ziese** says that; ***"the owner could get money back in the shape of a scrap voucher, which would be redeemable for cash when he turns in the old vehicle".*** **(Ziese Interview).** This only goes to show the saving that could be made by using aluminium in the long run.

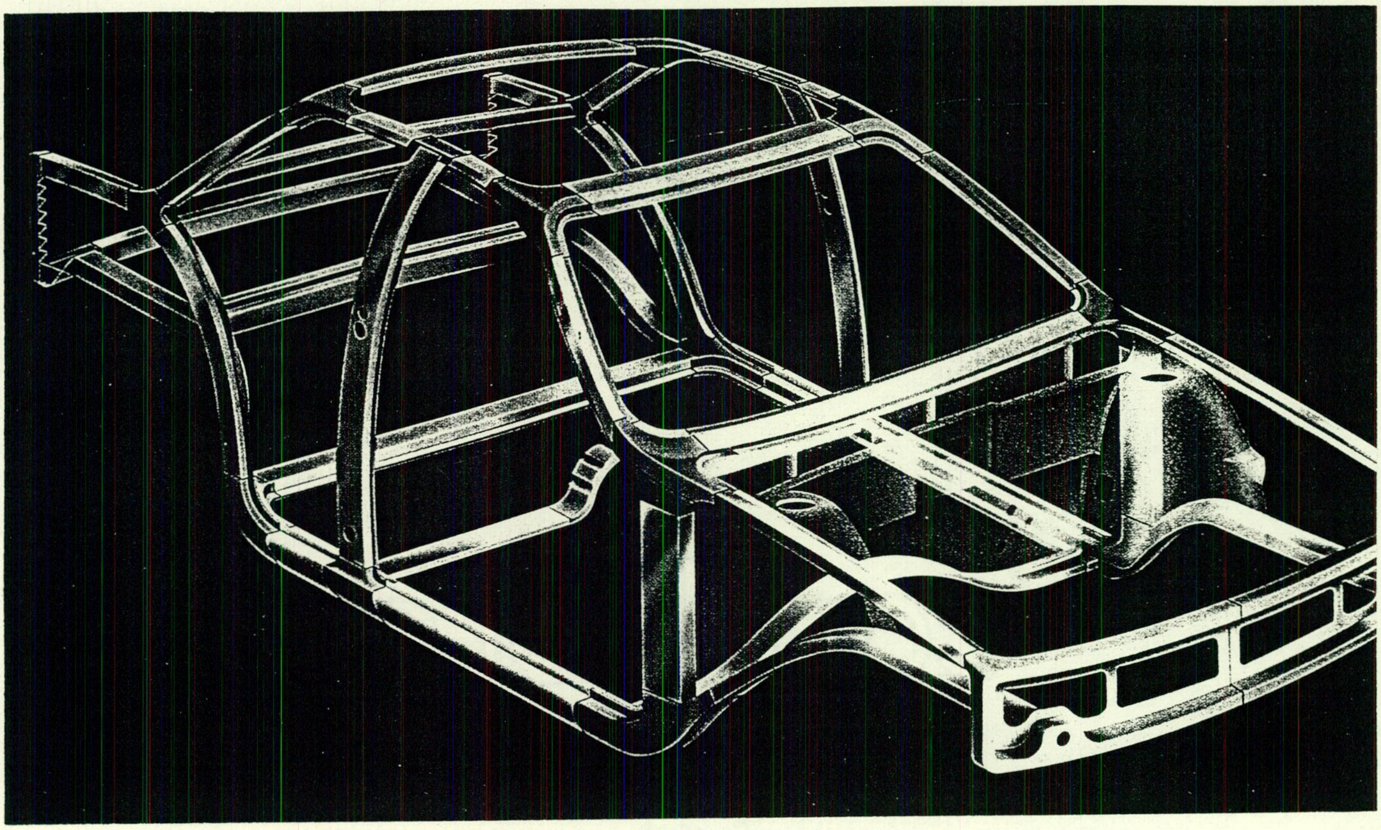


Fig. 1.3 Audi's concept aluminium space frame.

In addition to steel, aluminium and plastics there are also other materials contained in the motor car that are very suited to the recycling process. Both the lead used in car batteries and the platinum which is contained in catalytic converters is suitable for recycling. While you may only get approximately four pounds in weight of this precious metal out of a tonne of scrap catalysts, it is reasonable when you consider that a tonne of ore will only yield three ounces.

Some car and recycling experts have also recommended salvaging the anti-lock brake systems from automobiles, as they predict that the

technology currently in use will not alter in the near future. This will allow these systems to be utilised further.

Natural materials are still widely in use in car production where the aesthetic appeal of the product is a crucial selling point, these materials appeal to the senses of the consumer. This of course only applies to luxury models whose cabins are crammed with wood, leather and wool. Of these three, leather is the only material not suitable for straight forward recycling. Yet, it is possible for it to be processed into sound-dreading material, for use in door panels and glove box lids. Glass is another material that is ideal for recycling, there is no explanation why windscreens and backlights should be used only once.

One of the main problems with car recycling, is the collection of the components to be recycled. During the automotive conference which was held in Germany, in March of 1992, engineers from BMW, Mercedes Benz, Porsche and Volkswagen/Audi, had a suggestion that could rectify this problem. They all proposed a scheme which suggested that the automobile breakers (those who dismantle cars and sell them for scrap), should play a central role in providing processors with the materials for recycling. **Peter Mast** of Porsche's R&D states that;

> ***We do not envisage car breakers becoming full-scale dismantling centres, but we do expect to see them increase their current functions. We envisage 20,000 to 40,000 dismantled vehicles per year in Germany as attainable.***
> **(Mast Interview).**

Car manufacturers have already made detailed plans for a network of disassembling points around Germany, eventually to reach the continent. By the end of 1995, it is hoped that there will be approximately ten

disassembly plants in full operation. These plants would be operated by independent companies certified to a minimum level of confidence, by the car producers.

At these plants car parts would be removed from the vehicles and stored manually. If recycling is to develop on a world wide scale it would eventually be necessary to introduce automated machinery into the entire process and of course, cars would have to be designed with both assembly and disassembly in mind. This eventuality may be a long way off, but companies like Ford are already developing a system that utilises environmental stress that causes cracking in plastics. Many car parts are now held in place by plastic clips that are kept under constant stress. The design of these clips is such, that during lifetime of the car, stress can be accommodated.

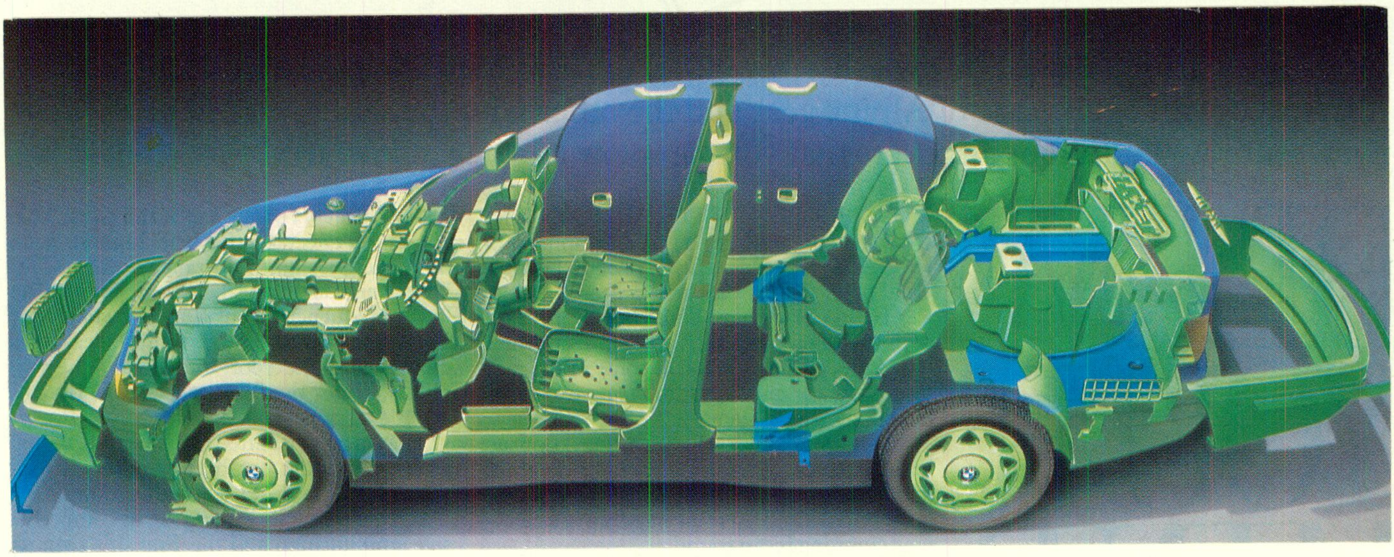


Fig. 1.4 **Possible recyclable parts of the modern motor car.**
The blue areas are parts that are currently recycled by car manufacturers. The green areas are parts that could also be recycled.

In the disassembly plant of the future, the car would be placed on a conveyor belt that passes through a spray of powerful solvents, that would attack the plastic clips and induce catastrophic stress cracking. This would eventually cause the clips to fall from the vehicle. The clips would be made of various materials that would be susceptible to different solvents, which would vary according to which component they held. While on the conveyor belt the car would pass through various spray zones, and within each zone only certain components would fall off. Thus resulting in automatic pre-sorting.

The real issue when it comes to recycling is how serious both car manufacturers and the public are about 'greening' the motor car. Recycling as already discussed involves a total 're-think' of the entire design process, in terms of manufacturing and technology. This is a time consuming and expensive task. In order for it to be successful total commitment is required from both manufacturers and the consumer, this is the only way a totally recyclable automobile can be produced on a global scale. Otherwise, the recycling of a minority of car components will be of no great benefit to the environment.

CHAPTER TWO
ALTERNATIVE FUELS

In recent times the demand for a more environmentally friendly car has become stronger than ever, this is largely due to recent legislation and increased public awareness of the environment. This is understandable when you consider the various problems that car emissions cause, i.e. global warming, depletion of the ozone layer and general pollution.

The gas most harmful to the environment is carbon monoxide. In Ireland nearly twenty percent of carbon monoxide comes from road transport and it is the same or higher in other industrialised countries. Every car produces almost four times its own body weight in carbon monoxide every year, and this is contributing to the current high levels of air pollution in urban areas. The use of petrol is being rejected and the search for more environmentally ‘friendly’ fuels has begun. The success or failure of these alternatives has yet to be realised. Car manufacturers have also become increasingly aware, as a time may arrive when the earth’s supply of fossil fuels may be exhausted.

Some improvements have already been made in the fuelling process, but their success is questionable. The introduction of the catalytic converter as standard on most cars, allows for a reduction in the levels of carbon monoxide, hydro-carbons and oxides of nitrogen, emitted from automobiles. A two way converter can reduce emissions by up to fifty percent, a three way by up to ninety percent. There are however, many conditions that must be met in order for a catalytic converter to function successfully. Firstly, if the car does not possess a sensor, (as with some older cars who have the converter fitted), there is no control between the ratio of air to fuel. Converters can take up to five minutes to reach the

operating temperature required, rendering them useless for short journeys. They can also increase fuel consumption, leading to an increase in carbon monoxide emissions. The converter can be easily damaged and costly to replace. Converters seem to be a temporary solution to a much larger problem.

Another consideration for the immediate future is the design of a compact two stroke engine, which allows the vehicle to be both smaller and lighter. It would also use less fuel and therefore emit less pollutants. These engines may also reduce cost as compared to the four stroke engine, because of the reduction in parts (up to 50%). These engines are expected to be in production in the immediate future.

As both of these solutions appear to be temporary, the real issue that needs to be addressed is, what form of car propulsion will be used in the future and will be successful? There is no simple solution to this problem. Experts in this field have many different opinions. **Lindsey Halstead,** Chairman of Ford Europe, has said that people are willing to pay more for a 'green' engine than a 'brown' one. He also predicts that the pollution-free car of the 21st Century will be powered by electricity, charged by on board solar cells, and proposed hydrogen powered cars as a possibility. **(Halstead, The Greener Machine).** **Ulrich Seiffert,** Director of R&D Volkswagen, predicts that in the next century people will be filling their cars with methanol, not petrol. He states; ***"Methanol, manufactured from natural gas, has great promise, it is cleaner-burning than petrol, and conventional engines can run on it very easily".*** **(Seiffert Interview).** Seiffert also foresees other alternative fuel sources, or

engines being developed within the next decade. He believes that the hybrid vehicle has a great future. Seiffert says of the hybrid; ***"This may be a vehicle using either a combination of diesel and electric power, or one using both petrol and electric power***. **(Seiffert Interview).** In the immediate future Seiffert sees diesel as the fuel to use. He says;

> ***The greater fuel efficiency of the diesel engine, as compared with petrol power, gives it an immediate advantage of producing less carbon monoxide***. **(Seiffert Interview).**

Toyota have a different opinion. They predict a more lean burning engine for the future. It is believed it will reduce fuel consumption and therefore cut carbon monoxide emissions. Toyota are also eager to promote two-stroke engines, it is hoped that their compact size would mean tremendous all-round benefits, the vehicle would be smaller and much lighter, greatly helping fuel economy. They also predict the use of a 'gas turbine engine' in fifteen to twenty years. These are just some of the numerous opinions that have been given by people in the motor industry. From all of these views it is difficult to ascertain which alternative will be of real benefit to the environment. If the industry that manufactures the motor car is divided in its opinions how can the consumer possibly decide. In this chapter some of the alternatives for a 'greener' form of fuelling will be discussed as regards performance, practicability and cost.

It seems that in order to predict the fuel of the future, two factors have to be taken into consideration, one is political and the other technological.
The political impetus originally began in California, USA, and here the struggle continues with the air pollution problems of the Los Angeles basin. Here the fumes of nine million vehicles are trapped in peculiar, local atmospheric conditions. The huge reductions in vehicle exhaust

emission levels, which have been enforced since the early 1970's, have certainly lead to an improvement in air quality, but Californians are demanding more reductions. It seems that the only way that these demands can be met, is through an expeditious enforcement of the existing legislation, plus the introduction of some further standardised requirements. One such requirement is that from 1998 onwards, two percent of all cars produced for the Californian market must be ZEW's or 'Zero Emission Vehicles', and that seems to entail the use of electric or hydrogen powered cars.

The Electric Car

The concept of the electric powered car has been in existence for the last hundred years. Then, as now, it was obvious that the concept would never be viable with the use of heavy lead acid batteries.

In the late 1970's the shock of the fuel crisis inspired a massive world-wide programme of research into alternative forms of propulsion. British ministers for transport 'wheeled out' some of these ancient prototypes, including a converted Mini. This vehicle was barely capable of carrying along the tonne or more of lead acid batteries it contained, which were compressing its spring flat. It was at this time that numerous forms of electrical generation or storage were being researched, i.e. the fuel cell, the zinc air cell, the lithium-chlorine cell and many others.

In recent times, a variety of actions have been taken by manufacturers as regards electric cars. BMW have built one, IAD have built two.

Fig. 2.1 The BMW 'EZ' Electric Vehicle.

Peugeot have also declared their interest and Volkswagen are known to be negotiating with the Swiss SMH company, to produce a joint venture electric car. Once again people are talking optimistically about at least one alternative to the lead acid battery, the sodium-sulphur cell. Yet there are still surprisingly few electric cars on the road, although Fiat have made themselves the first major manufacturer to offer an electric car to the public, the Panda-based Eletta.

Fig. 2.2 Recharging a Concept Peugeot Electric Car.

Contrary to popular belief, it must be stressed most emphatically the electric car is not a zero-emission vehicle. That is unless the electricity comes from a renewable source, i.e. falling water. Otherwise, it is simply a vehicle which transfers the pollution from a small local source to a large remote one, the power station.

It may be less complicated to clear up the flue gases of a large and highly efficient power station, than the exhaust gases from an individual car, but there are other losses to consider. Pollution is caused by losses in the power lines, in the battery charger, in the battery and even in the electric motor itself. Therefore, it is unlikely that an electric car system (from power source to road), will achieve an efficiency greater than 15 percent or so, when compared with a petrol driven vehicle which has been fitted with a good quality three-way catalyst. This form of propulsion does not present itself as the solution to reducing the amount of carbon monoxide emissions. There is another disadvantage of the electric car and that is the

distance it can travel without being recharged, as recharging can take up to six hours. Also as the battery becomes older, its storage capacity is reduced.

These concerns about the electric car would be dismissed by GM who have produced an electric car called the Impact. It has a battery range of about 120 miles after one charge and is no slower than the average petrol driven car.

Fig. 2.3 GM's Electric Car, the Impact.

The primary reason for this cars performance is that unlike previous electric cars, the Impact was designed from the outset to be an electric car. The Impacts designers sought to keep weight to a minimum. GM also insist that,

> ***Charging the batteries overnight simply uses the surplus energy generated by power stations out of peak hours. Even if the majority of cars in London were electrically powered there would be no need to boost electricity production.***
> **(Car Magazine, Jan. 1993, pg. 21).**

However, these are not the only factors that have to be considered, the initial cost for an electric car would be 20 to 40 percent higher than the cost of existing motor cars on the market. As the cost of a car is already quite high this would make one question the demand for these cars. How many consumers would be willing to pay the extra money to own one of these vehicles?

Solar Power

Some environmental experts have yet to be convinced of the benefits of the electric vehicle, they believe such a car would have to be powered by another source. **Jonathan Porritt**, of Friends of the Earth, states;

> ***For any environmental benefit to be derived, electric cars will have to be powered by the sun, through the use of photovoltasic cells.***
> **(Environmental Bulletin, April/June 1992, pg. 3).**

Solar power is at the present moment in time an underdeveloped technology. The main disadvantage of this concept being that solar powered cars can only be operated in daylight hours (unless the power is stored), with an expected speed of 65 miles per hour. A very large surface area is also required to obtain enough energy to power these vehicles. There is also a minimal weight required to improve the vehicles performance and this could prove itself lethal, if such a car was to collide with a heavier vehicle. It seems that at present it would not be economically viable to produce this type of vehicle.

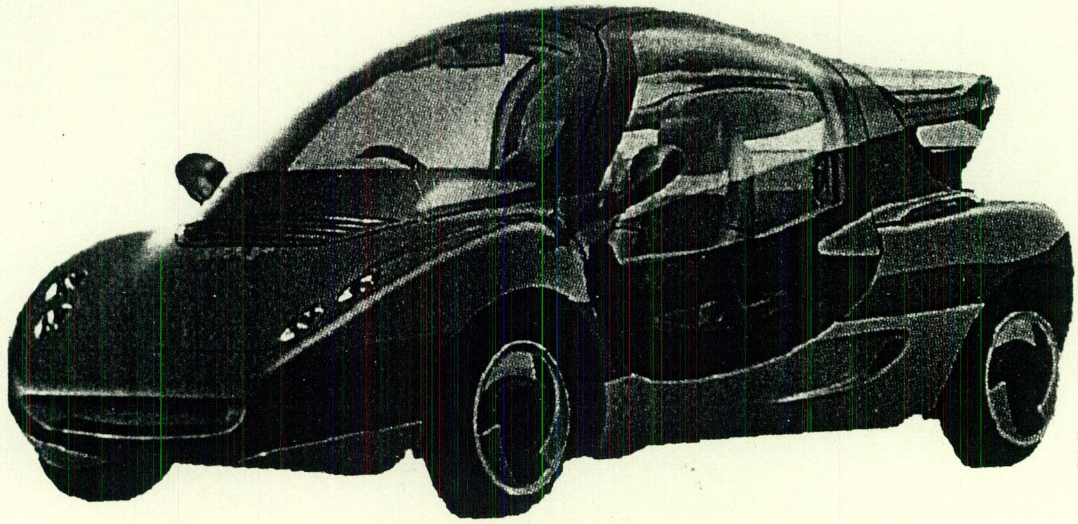
The Hydrogen Car

This is another possible solution in the search for a 'greener' car. Hydrogen is already known as a highly dangerous fuel. One cubic centimetre of this substance, has the explosive power of two kilograms of 'TNT'. The great Hindenburg airship was destroyed in a fireball of hydrogen, and space ships are blasted to the moon by it. It is little wonder that the publics perception of hydrogen is that it would not be a suitable fuel substitute for petrol.

Yet, some believe that if handled carefully it could be the fuel of the future. **Wolfgang Strobb**, a research engineer at BMW, has said, ***"when oil runs out or becomes too expensive to extract, perhaps in fifty years, hydrogen could be the fuel to replace it. For a start, it is inexhaustible".*** **(Strobb Interview).** Two thirds of the globes surface is covered by the substance, that is two parts hydrogen and one part oxygen/ water, and the only resource needed to produce hydrogen is primary electrical energy, the sun. There is said to be one benefit of this fuel from an environmental point of view, that is that hydrogen is the perfect fuel for the road, as it creates neither noxious pollutants nor carbon monoxide. This may be true, but it requires large amounts of generated electricity to divide water into hydrogen and oxygen, for this fuel.

The fact that it can be harnessed for use in a conventional internal combustion engine is an unquestionable advantage of this fuel. One of its main disadvantages however, is that it is hard to transfer it to the engine, and at the moment it would be ridiculously expensive to utilise as an

everyday fuel. It's production, distribution, storage and transfer involves great expense.



HR-X2

Fig. 2.4 Concept Mazda HR-X, - Hydrogen fuelled and the HRX 2 below.

Another problem with the use of hydrogen as a fuel is it's tank design for use in a car. This has to be designed to a high degree of precision. Hydrogen must be kept at a temperature of 253 degrees centigrade. Therefore the tank must be designed specifically to maintain the fuel at

this temperature. The design of a refuelling system, which was fool-proof, would also be of great importance, in order for this fuel to be viable. At present, it would take skilled technicians an hour to fill a 20 gallon tank. Due to these problems, it seems that hydrogen is decades away from becoming a global solution to the problem of alternative fuelling.

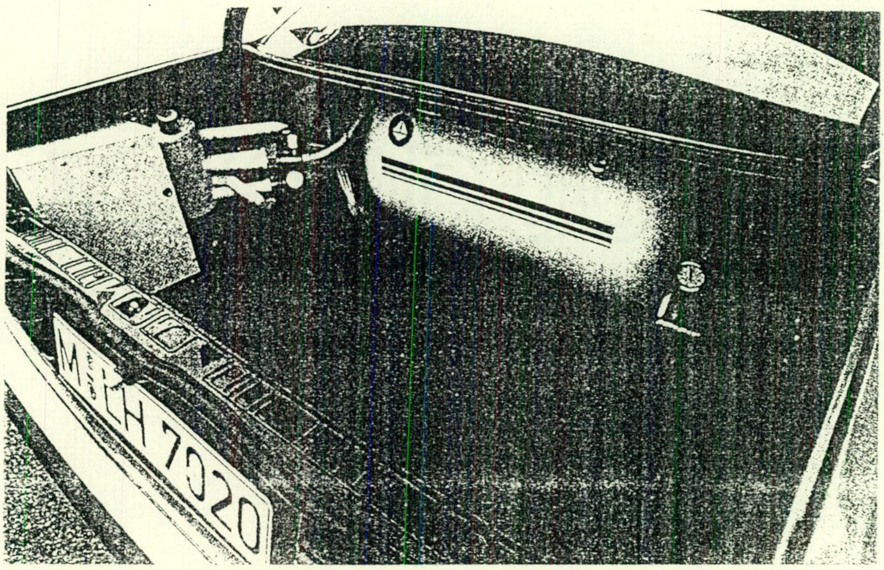


Fig. 2.5 A prototype of the hydrogen tank.

Methanol

Methanol has been given great consideration as a possible alternative fuel, especially in the USA. Here a fuel has been developed that combines petrol with methanol. In this form methanol would reduce hydro-carbons (low level ozone producer) by thirty percent, but it would produce the same amount of carbon monoxide and carbon dioxide. Methanol has also been found to be corrosive to steel and this could limit its manufacturing

abilities. This fuel can also limit the performance and range of the car, which would not make it very acceptable to the consumer.

Bio-fuels

Many experiments have been conducted with the use of rapeseed oil in diesel engines. The results of these experiments have shown that the level of toxic emissions was similar, if not greater in variety than those of petrol. Also to provide enough fuel to supply a countries needs, would require vast acreage of land that is required for agricultural needs.

The Hybrid

It appears that at present the best solution for a more 'environmentally friendly' car is that of a hybrid. The most likely hybrid being a combination of a petrol/electric or diesel/electric car. This simply means the combination of an internal combustion engine with a battery. It may be possible that an intelligently designed hybrid could be sufficiently practical, allowing it to be commercially viable and sufficiently 'clean' for environmentalists.

A number of companies are researching the idea of a hybrid car design for the near future. The most advanced company in the hybrid race is Volkswagen, who have produced a diesel/electric car. It incorporates two engines, one diesel and the other electric. The beauty of this system is that it addresses several environmental problems at once. Energy consumption for example, is significantly reduced. On a single gallon of

diesel you could expect to travel about 100 miles, supplemented by energy taken from the batteries. Yet some dispute that the problem with these cars is that because there are two engines are in use, the cars weight is increased and can considerably reduce the cars performance and fuel efficiency.

It seems that pollution is dramatically reduced also. While driving in urban areas the electric motor is used and while driving in rural areas the diesel engine is used. A major advantage of the hybrid however, is that when using the diesel or petrol engine the electric motor is being charged, which does not transfer pollution to a power station like the concept of an electric car.

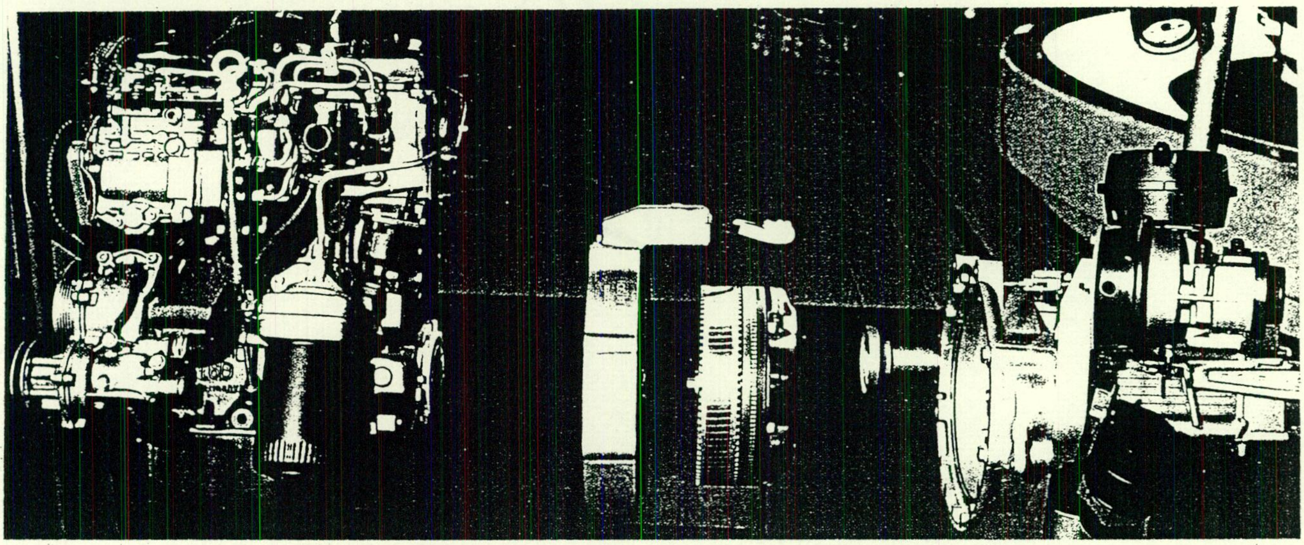


Fig. 2.6 The engine of a concept hybrid diesel/electric car. The electric motor and clutch (centre) are sandwiched by the engine and gearbox.

A hybrid car whose petrol or diesel engine is fitted with a good three-way catalytic converter, would reduce carbon dioxide and other emissions by 50 percent. Thus making the hybrid car a step in the right direction for the future. This is especially true when we consider how important public

acceptance is. A hybrid engine can be fitted into the body shells of existing models on the market, so it would not change the public perception of the motor car in today's society. Yet, somehow there seems to be no immediate solution to this manmade problem.

CHAPTER THREE

MORE CARS, MORE POLLUTION

The Irish **'Department for Transport'** predicts that car traffic alone, will increase from between 27 and 47 percent, by the year 2000. It is predicted that by the year 2025 there will be a further increase of between 83 and 142 percent. Although Ireland has one of the lowest car ownership levels in the world (220 per 1,000 population as compared with 552 in the US), saturation will occur once these levels reach 550. At present growth rates, this level will be attained by the year 2025, but the flow of traffic could come to a 'grinding halt' sooner than is expected. **(Dept. Of Transport, 1991, pg. 4).**

The foreseen explosion of car usage in the near future, will undoubtedly erase any benefits, as regards new technology and improved design for the reduction of car pollution, as discussed in previous chapters.

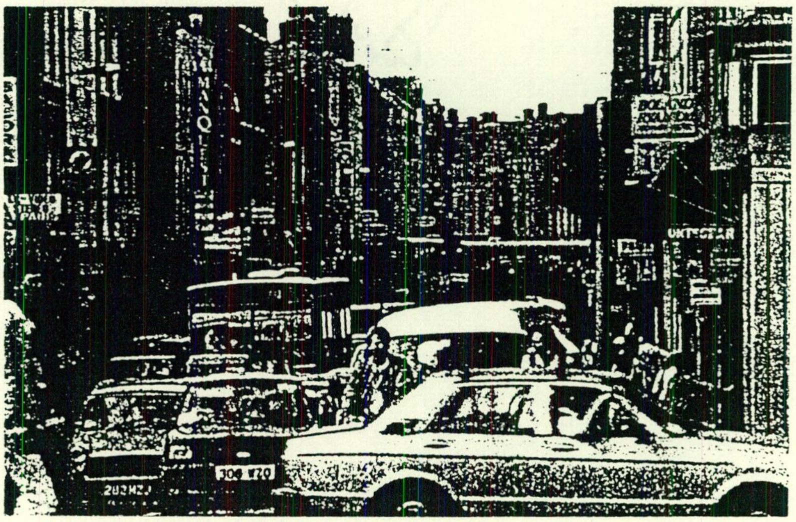


Fig. 3.1 A typical city street.

Contrary to popular belief, the Confederation of Irish Industry concludes in its report, **'Trade Routes to the Future'**, that the flexibility afforded by roadways will continue to make it the preferred mode of transport for

the vast majority of business traffic, well into the next century. As a result, the movement of vehicles, particularly private ones, will have to be severely restricted in towns and city centres. This concept is not one that will be widely accepted by the public, as cars afford the individual the freedom of travel.

The Irish Labour Party have many proposals for urban areas, where traffic congestion is at its worst. It is suggested that access should only be allowed for 'essential' vehicles (i.e. business vehicles and emergency services etc.) at peak hours. Tougher penalties for illegal parking and more effective enforcement of the traffic laws are also included. It is believed that this would also encourage local and regional authorities to develop 'traffic-calming' measures in residential areas. These measures would be similar to those that already exist in Cologne, Germany and other European cities, such as reduced speed limits and road ramps.

Other schemes that aim to ration scarce road space include the **AVI** toll system, already in use in the US, and recently endorsed by the British Chartered Institute of Transport. It comprises of vehicle-borne tags, roadside reader units and a computer system that bills users on a monthly basis. Already, the **SCOOT** policy (Split Cycle and Offset Optimisation Technique) is being utilised in many European cities. This involves the use of traffic lights that will change automatically, according to traffic density.

From a public point of view, it is believed that the solution to this problem is to simply build more roads. The director of the 'Transport 2000' group believes that,

> ***The roads of the future will largely be those of today. Consequently, traffic congestion cannot be dealt with solely by road construction. New roads actually generate more traffic and the suppressed demand for road space is almost infinite.* (Transport 2000, 1990).**

Although the public are keen to reduce road congestion, they are not prepared to carry out the measures necessary for road decongestion. A nation-wide survey carried out by AA, addressed some of these issues. It was suggested in this survey that no persons without a garage could own a car, unless they parked it either off the highway or on certain roads in defined areas. This proposal was met with 74 percent disagreement. The suggestion that households should only be allowed to own one car, met with 70 percent disagreement. This is hardly surprising.

Yet, ultimately drivers may be forced to alter their driving habits. The most favoured method for the reduction of road congestion, and thus pollution, is to reduce the amount of road space allotted for vehicles. This could allow for the reallocation of road space for other forms of public transport, including pedestrians and cyclists.

By decreasing the number of cars on the streets a whole new set of problems can occur. For one, businesses on a particular street may lose a lot of custom due to a reduced flow of potential customers, due to the sub-standard forms of public transport in Ireland. On the other hand, a pedestrianised street may become a 'trendy' place to 'hang-out'. A prime

example of this would be Grafton Street in Dublin. This highly fashionable street has become a meeting place for many. Such a large congregation of pedestrians can lead to an increase in crime, i.e. 'pick-pocketing' and drug related offences. An increase in pedestrianisation could eventually lead to an explosion in crime, if present trends continue.

It would be more advantageous to divert the flow of traffic from city centres to 'ring roads', that encompassed these areas, allowing the city centres to be served more efficiently by public transport systems. In order for this to be effective public transport would have to be upgraded on a nation-wide scale.

Fig. 3.2 An articulated bus from Holland.

Many believe that only improvements to public transport systems will result in improved in road speeds. A view shared by the Department of Transports document, **'Moving Ireland into the 1990's'**, which stresses that, ***"a good public transport system can play a major role in relieving congestion".*** **(Dept. Of Transport,1991, pg. 2)**.

It appears that public transport may be the only solution to traffic congestion. Public transport also seems to address the environmental problem far better than the modern motor car. Firstly, it has a greater capacity to carry passengers when you consider the amount of car journeys made by a sole driver. Also, a train or bus has an expected service life of twenty five to forty years, whereas a regularly serviced car has a life expectancy of ten years. A greater investment in road construction in Ireland (e.g. the recently completed Kilcullen by-pass), can only lead to the inevitable chaos that will be caused by road congestion.

However, the Irish public transport system requires a total transformation in order for it to be acceptable on a nation-wide scale. The present system is insufficient. Public transport is potentially a more comfortable, efficient and 'greener' way of conveying the public into and around cities, or on long-haul journeys. The Irish system seems to have failed in this regard.

Big improvements are required in the maintenance, appeal, frequency and efficiency of public transport services. Greater government expenditure is also desirable, in fact essential. Public transport should be a state service, not a government money spinner. Some of the existing modes of transport have been purchased (already used), from countries such as Britain and Japan. Second hand transport hardly suffices in a densely populated, developed country.

The form of public transport eventually chosen could incorporate anything from buses to guided trams, to light or heavy rail, or perhaps a futuristic mono rail system. Although, the use of one particular system would be of more benefit to the environment, than a combination of the above.

Fig. 3.3 London's dockland railway.

Yet, it will take more than the improvement of public transport systems to dissuade people from commuting in their cars. Such is the appeal of the motor car, it symbolises the freedom of the individual, the freedom of choice. In order to ensure less road congestion, some of the aforementioned solutions, will have to be strictly enforced, i.e. banning cars in some areas, high road and fuel taxes and high tolls for entering big conurbation's.

CHAPTER FOUR

DESIGNING FOR SAFETY

In discussing the motor car and its environment, designing for safety is of vital importance. There is an increasing awareness among the general public of the standards of safety that are required, and a realisation that these standards are not being met. The motor industry has placed a greater emphasis on designing cars that are safe, but is this another advertising ploy to sell these products or are their reasons genuine? This chapter will deal with and discuss, both future and current safety measures in the automobile industry.

The private motor car is the worlds largest killing machine. In America, the National Safety Council claim that on average 18,000 Americans are killed and a further 250,000 maimed each year. With the utilisation of standardised designs for car safety and the enforcement of stricter safety laws, this outrageous number of deaths could be reduced dramatically.

The safety of a car is said to be the sum total of the cars ability to aid the driver in avoiding accidents (which is described as 'active safety'), and its ability to protect those in the automobile when an accident situation is unavoidable (which is described as 'passive safety'). The most productive of these is 'active safety', as preventing an accident is of far greater benefit than the provision for safety measures that could reduce the extent of injury if an accident occurs.

Initially, the most effective method of preventing possible accidents is by relieving the driver of all routine chores while driving, allowing him/her to focus all their attention on the road in front of them. This seems possible when you consider the technology that is currently available to designers

and manufacturers. Interfaces (otherwise known as dashboards) coupled with the principles of human factors engineering, offers great scope for development in the area of road safety. Yet, the application of new technologies, without taking human factors (ergonomics) into consideration, could prove detrimental.

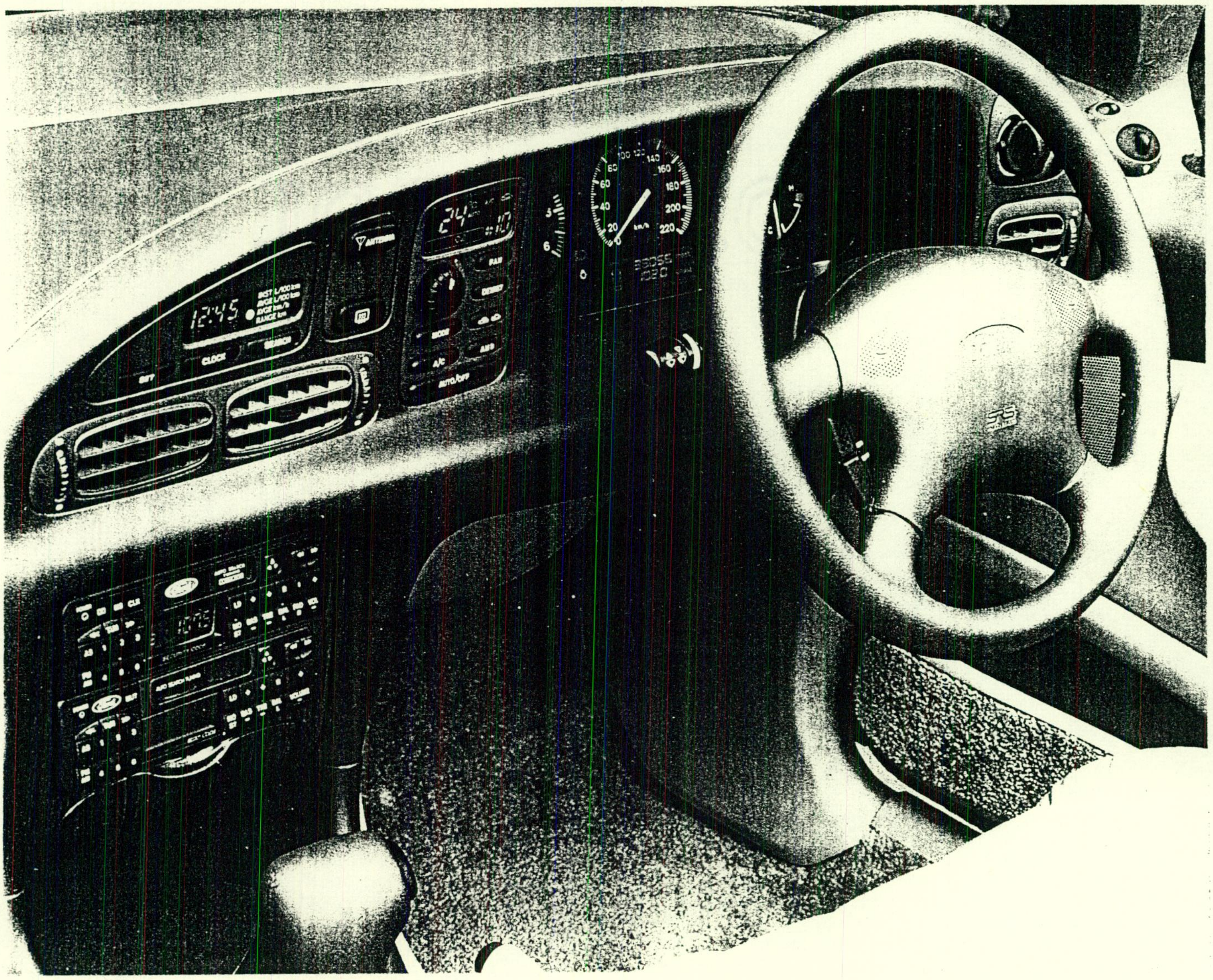


Fig. 4.1 An example of an over complicated car interface.

The inclusion of a vast number of features to car interfaces, without any consideration for how they affect the driver is known as 'creeping futurism'. The real danger when installing these new advanced systems, is that they bombard the driver with a mass of information. Driver's are then given the arduous task of trying to ascertain which information is useful, while being presented with a stream of redundant information.

With the introduction of advanced car interfaces, there is a strong possibility that while eliminating many current problems, they may also create many new ones, resulting in a stale-mate situation. For example, a recent study discovered that presenting too much information on head-up displays, could cause a disruption in the drivers line of vision.

When the matter of safety arises, the measures of safety that usually come to mind are items such as safety belt usage and the driver protection afforded by a vehicle, in the event of an accident. Important as these issues may be (and will be referred to later), it is the in-car interface that has a major effect upon driving safely. This is due to the attention that is required of the driver while using the interface.

Typically, while driving, a person performs two types of tasks. Primary driving tasks are to do with control of the vehicle, e.g. steering, braking or accelerating. Secondary driving tasks are concerned with the monitoring and management of the vehicle, e.g. monitoring the vehicle would include checking things such as speed and fuel levels, while managing the vehicle could include anything from setting the air-conditioning to a suitable level,

to ensuring a steady flow of music from a stereo. The driver performs both primary and secondary tasks via the car interface.

The interface is the medium through which the driver receives information regarding to the vehicle (e.g. information about speed from the speedometer), and controls the vehicle (e.g. depressing the brake to slow the vehicle or turning a knob to adjust the volume of the stereo). So, if the interface is poorly designed from an ergonomic point of view, secondary driving tasks can often lead to unnecessary demands being placed upon the driver. These in turn can distract the driver from primary driving tasks, and consequently result in errors being made, which could eventually lead to a serious accident. This is understandable when we consider that 95% of all road accidents have a component of human error. From this it is evident that car safety relies heavily upon the concise design of in-car interfaces. So, the question that needs to be addressed is, how can those responsible for the design of these interfaces and the components they are composed of, reduce the demands placed upon the driver in performing secondary driving tasks?

One solution to this problem, and perhaps the most straight forward one, would be to reduce the number of potential secondary tasks required of the driver. For example, instead of fitting a car with a state-of-the-art, multi-feature stereo (which includes a radio, cassette and CD player), a mono radio with frontal push buttons, could be installed. This would enable the driver to change channels with greater ease. Of course, the likelihood of the acceptance of this proposition is remote, as drivers feel they have achieved a certain level of status through the possession of a

high powered stereo. Drivers want state-of-the-art equipment installed in their vehicles, and car manufacturers realise that the provision of multi-feature in-car facilities is a major selling point for their cars.

If the number of features and forthcoming secondary tasks are not reduced, then the only foreseeable alternative is to reduce the demand associated with each task. The creation of new technology, along with growing ergonomic research (regarding how to utilise these technologies more favourably), could be beneficially applied to a reduction of the emphasis placed upon these tasks.

One of the prototype interfaces that could prove successful as regards safety, is the voice controlled interface. It is hoped that these interfaces would eventually control the secondary functions of the car, by matching the wave pattern of the drivers voice to stored templates. However, the prototypes that have been produced up to now are notoriously unreliable. These systems are easily confused by slight variations in the drivers voice and the noise of background traffic. The main advantage of the speech interface is that it places no visual demands upon the driver, enabling him/her to keep both hands on the steering wheel during interaction, which is a commonly recognised requirement for safe driving.

Touchscreens are another type of interface being developed for future use. These would offer display and input facilities on one screen, with the utility of the hierarchical menu system. Touchscreens offer two main advantages when compared with conventional interfaces. Firstly, they allow all information to be inputted and received in one place. This in

turn saves the driver of having to visually scan the dashboard, or reach out for controls. The compact size of these interfaces also means that they can be positioned on top of the dashboard, beside the steering wheel, placing them directly in the drivers line of vision and within easy reach. Secondly, they could allow for a degree of consistency in the manner of which tasks are performed, making these tasks less demanding from an ergonomic point of view.

Both the use of touchscreens and speech interfaces allows for a striking contrast when compared with conventional interfaces. In using a conventional interface the driver is presented with an array of knobs, sliding and push buttons, all of which control different functions and require different modes of operation. Both touchscreens and speech interfaces dispose with the inconvenience associated with these conventional interfaces.

The principle of the touchscreen could also prove beneficial in other forms. By incorporating buttons into the cars steering wheel, a solution to this problem could be found. The display of all interface information on the windscreen of the vehicle could also be utilised, as this system is already successful with aircraft. This would allow the driver the freedom to read all the information he requires without taking his eyes off the road. If this safety measure is met, by the utility of any of the aforementioned systems, a drivers vision could remained undistracted in daylight and on well lit roads at night.

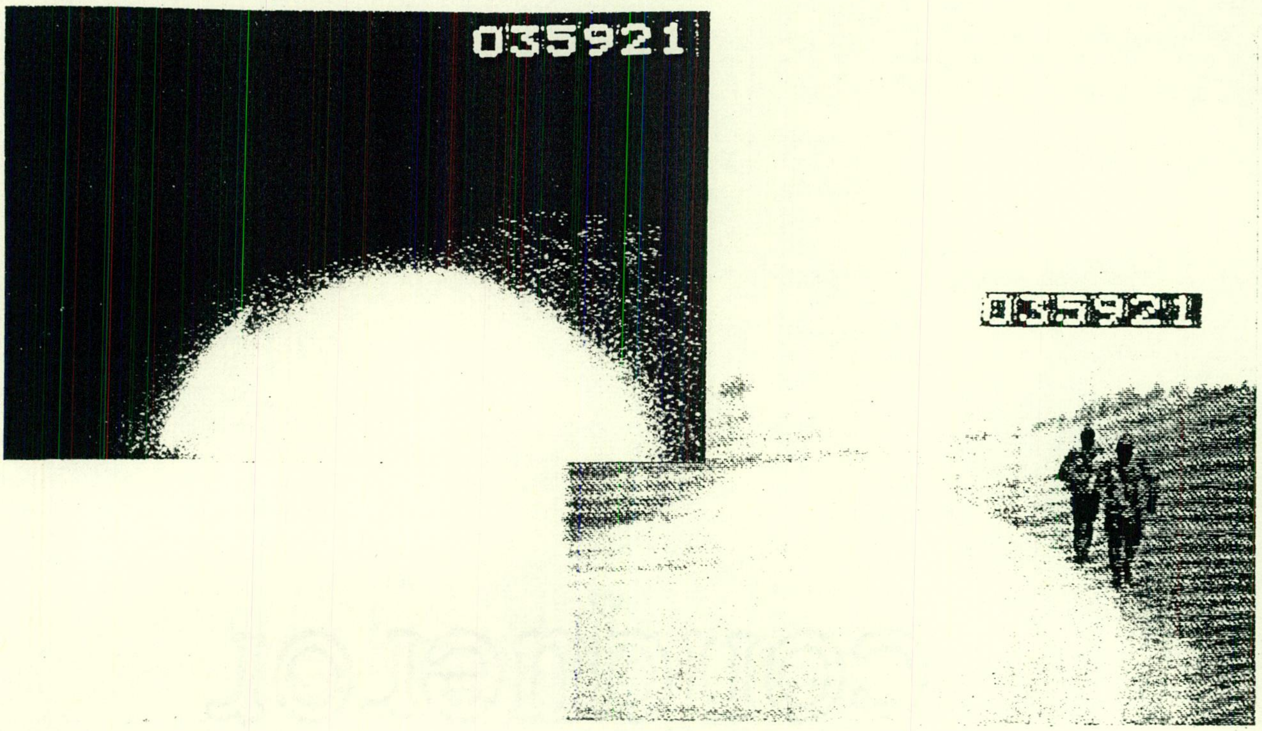


Fig. 4.2 Night vision using infra-red cameras to turn night into day.

Night vision is another problem that has to be addressed. This is currently being investigated by some car manufacturers, with future production in mind. The night vision enhancement system of the future will most probably be an infra-red camera system. However, the problem with this system is how to present the information to the driver, combining infra-red with a touchscreen could prove successful.

After discussing possible safety measures for the future it is also necessary to discuss those currently in use, the most important of these being electronic anti-lock braking (ABS). This was a breakthrough in braking systems when it was introduced. It allows the driver to break in a potential accident situation, while keeping control (the car will not skid) of the car.

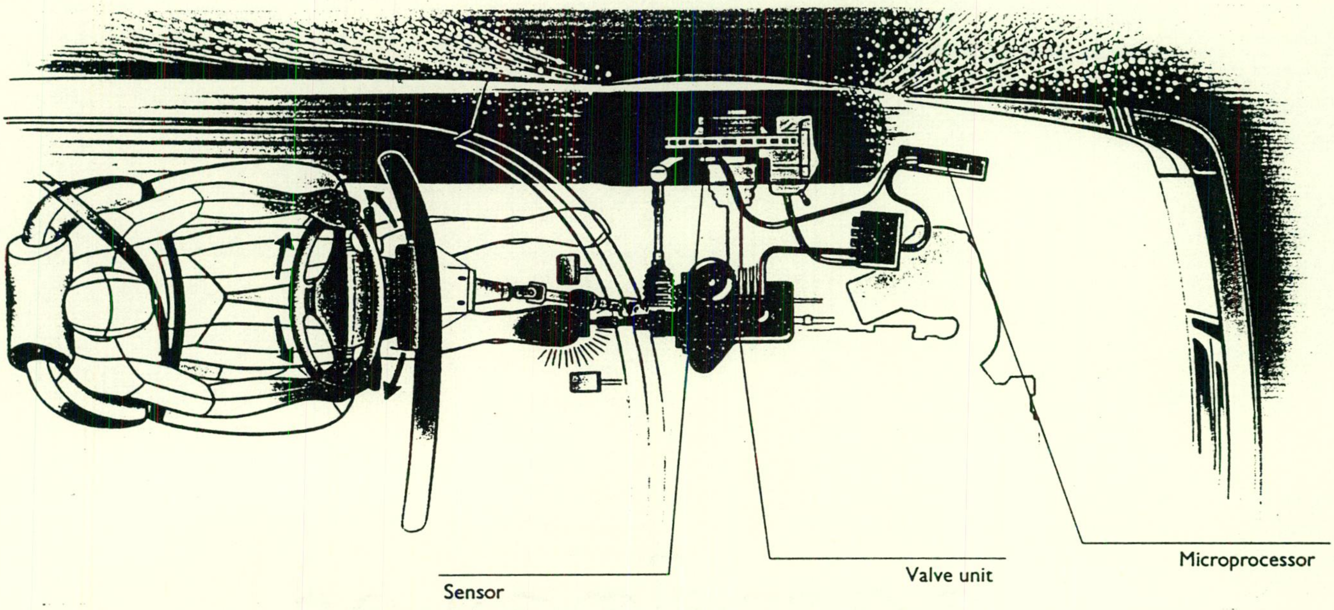


Fig. 4.3 The anti-lock braking system.

Another highly effective, safety device is the third rear brake light, which is fitted by some manufacturers. The National Safety Association in America carried out an experiment whereby a total of 12,000 taxies in New York City, Philadelphia, Boston and San Francisco, were fitted with the third brake light. It was discovered from this experiment, after three months, that there were 54 percent fewer collisions than expected on an annual basis. They also determined that the installation of an extra brake light, located at the eye level of other drivers, would only increase the overall cost of a car by four to six dollars. Yet, car manufacturers claim that they do not install them as they are an unsightly and unnecessary design accessory, that would add hundreds of dollars to the cost of each automobile, and are impracticable. Car manufacturers always insinuate the possibility of higher cost in trying to dissuade the public from demanding certain safety measures. So, until such a time when the public

demand the installation of such accessories or laws are passed to make them standard, lives will be lost unnecessarily.

In the unfortunate event that none of these measures are able to prevent an accident, then the 'passive' elements of car design are required to prevent serious injury. However, there are still no integrated safety regulations in Europe, that cover all vehicles. It is still possible for manufacturers to avoid the whole issue of car safety, by satisfying various individual specifications, many of which are considered to be nonsensical by safety experts themselves. Only manufacturers supplying vehicles to the USA for example, must comply with the relevant American safety regulations. To pass current safety regulations all that is required of the car, is that it passes a crash test, in which the car must hit a flat wall at 30 miles per hour. This test is in no way realistic, since the majority of all frontal collisions take the form of offset crashes, and only part of the body structure is subjected to load. Yet, car manufacturers would lead us to believe that their cars are the safest, despite the fact that they do not comply with minimum safety requirements.

The most crucial component of a cars passive safety elements (although they all work together), is the 'safety cell'. The 'safety cell' is the part of the car where both the driver and passengers are seated. This area is surrounded both front and rear by crumpling zones, which are designed to deform in a crash, absorbing the energy. On either side of the cars occupants, are side impact protection bars. Manufacturers claim that these bars will stay secure if hit by 1.3 tonnes in weight, travelling at 34

miles per hour. All of this is surrounded by a high impact steel frame, which will stay intact, even if the car rolls over a number of times.

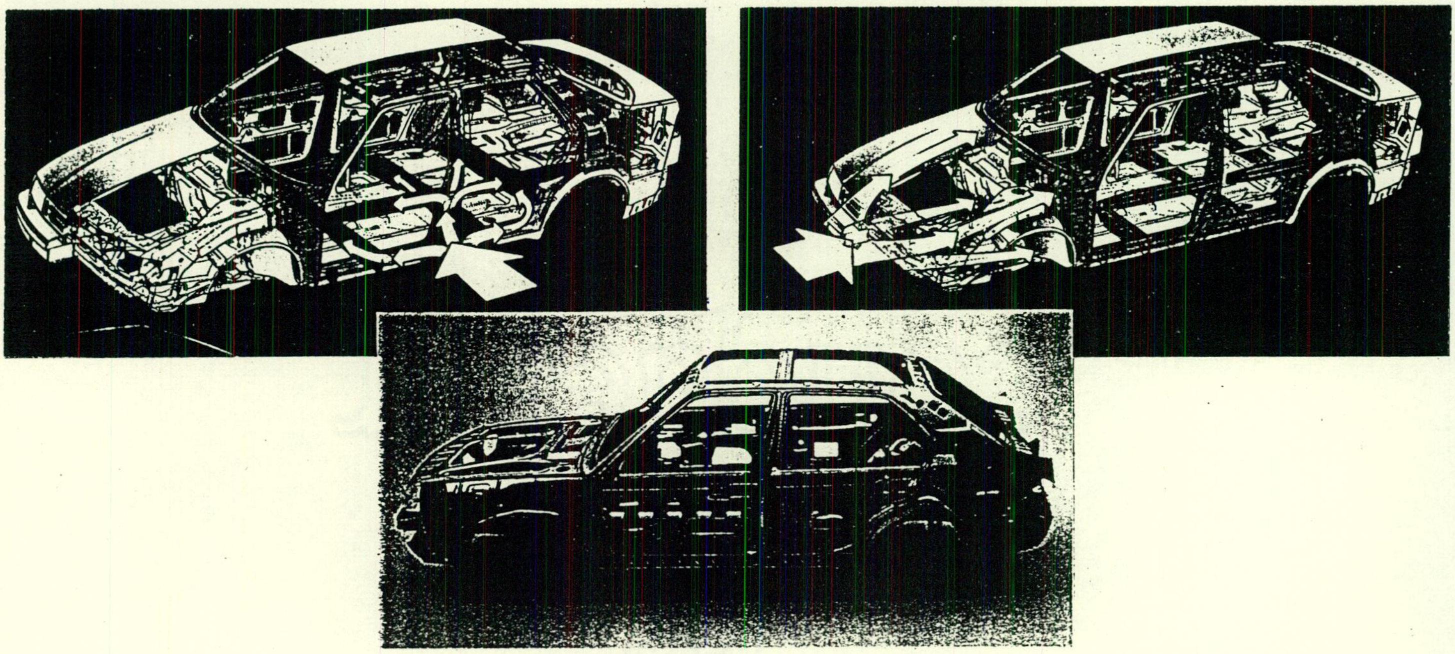


Fig. 4.4 The safety cage gives its occupants a good survival cell.

In more expensive cars an aluminium honeycomb structure is used, which is lighter and stronger than the traditional steel frame. This was pioneered by Jaguar and Audi and will become standard on all cars. Currently, most cars are fitted with hydraulic impact bumpers, which will also absorb minor collisions.

In 1996, America is expected to be the first country to enact stipulations for a safety cage around the passenger cell, paying particular attention to side impact bars. The passenger\safety cell of course contains seat belts, which are fitted with tensioners and pretensioners. Pretensioners do

exactly what you would expect, they pretension any slack from the seat belt. The tensioners, in theory, hugely reduce injury the risk of injury in the event of collision. Upon impact, a small explosive charge tightens the belt in milliseconds, reducing forward movement.

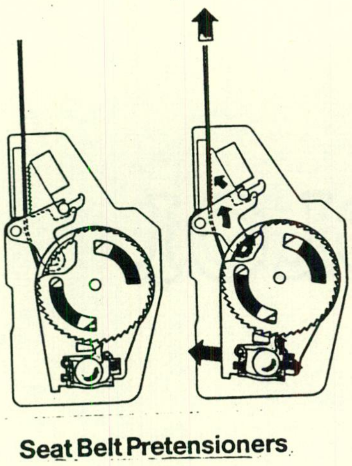


Fig. 4.5 Seat belt pretensioners and tensioners.

The recent inclusion of seat belts in the rear seats of cars was also a huge progression in the extent of safety in cars. Some car models have at present an excellently designed seat belt system, with automatic height adjustment. This allows passengers of different sizes to fit the belt comfortably.

The addition of the air bag to cars has probably been the biggest improvement in passive car safety in recent times, although it has had a long and chequered past. It was first introduced some twenty years ago, to a public reaction of both derision and disbelief. It has now re-

emerged, significantly improved and has finally been accepted by many manufacturers. The air bag system is composed of one or more sensors, which react to collision. An igniter or chemical charge, which generates nitrogen gas and the bag itself, inflates like a balloon in front of the occupant.

Fig. 4.6 An air bag is vital for survival in head on collisions.

In the first stages of operation the airbag inflates very rapidly, in approximately 40 milliseconds. By distributing the load of impact over a large area of the occupants body, the airbag fulfils the first requirement of injury protection. The latter part of its task, is to reduce the declaration acting upon the person involved. This the airbag does through controlled deflation, via holes of carefully chosen size. The whole sequence of events, from inflation to deflation takes place in little more than 0.1 seconds.

The airbags biggest drawback is that it is only effective in frontal collisions. Such collisions account for a high proportion of accidents, but not all of them. There are all kinds of accidents, i.e. rollovers, side impacts etc., for which airbags can provide no protection whatsoever. Therefore, European accident experts remain unanimous in their view, that the standard lap and diagonal seatbelt is still the most effective safety device to be devised so far. However, they do agree that the airbag used in conjunction with the seat belt, would reduce the extent of injury in accidents, by about 40%.

CONCLUSION

Throughout this thesis the requirements the modern motor car must meet as regards the changing needs of the environment, have been discussed. These include issues such as reducing the waste of natural resources through recycling, lessening air pollution through the use of cleaner fuel or alternative propulsion, increased use of public transport in order to ease both traffic congestion and pollution and finally, ensuring maximum safety precautions and standards are met by all car manufacturers. We, the public are fully aware of the damage that car usage inflicts upon the environment. Yet, both the general public and car manufacturers seem less than eager to alter the form of the modern motor car, for a more environmentally aware counterpart. In concluding this thesis the questions that need to be addressed are why the world seems so reluctant to take action to protect the environment and what does the future hold in store for the motor car?

Take for example the recyclable components of a vehicle, as discussed in chapter one. While in the process of deciding which model of car to purchase, the recyclability of the vehicle is not high on the consumers list of priorities. However, if a large amount of recyclable components in a vehicle reduced the overall cost, it would become a priority. Yet, at present recycling seems to incur an increase in the cost of many products, not a reduction. Companies, including car manufacturers, have used recycled products as a marketing ploy or gimmick, playing on peoples fears. They are aware that in purchasing these goods consumers feel that they have played a part in protecting the environment. Companies then sell these goods at a higher price, than the less environmentally 'friendly' equivalent. Car manufacturers are also reluctant to increase the amount of

recycled components in their vehicles, as the initial designing of cars for assembly and disassembly would incur further costs. This however, would eventually reach equilibrium as manufacturers would cut costs by recycling large amounts of components, proving less expensive in the long run, to both the manufacturer and the consumer. It must be realised that with the further depletion of the earth's natural resources recycling will be a necessity, it will no longer be an option.

In considering alternative fuels and forms of propulsion, as discussed in chapter two, both the public and car manufacturers must deal with much stronger issues. The use of alternative fuels does not solve the emissions problem, though they may reduce them. They are an immediate solution to the problem, not the ultimate one. However, alternative fuels do not threaten to alter the structure of the modern motor car, making them more acceptable to the worlds population. The use of other forms of propulsion however, dose pose a threat. After all, some of the concept cars produced as a solution to the environmental problems totally erode our perception of the automobile. The proposed alternatives cannot compete with the existing models on the market. For example, concept models, i.e. the electric or the hydrogen car, these may not be able to reach the same speeds, evoke the same feeling acquired in the revving of an engine or have the aesthetic values of existing cars. Also, they may be less economical and devoid of all technological prowess. It is all the aforementioned qualities that make the motor car the most desirable of all products. As Stephen Bayley writes; ***".....unless a car is carrying a load of effective imagery, it is unlikely to enjoy genuine popular success".*** **(Bayley, 1986, pg. 109).** Car manufacturers are well aware of this and

have invested a lot of time and finance in conditioning our senses. They do not want our world-wide obsession with the motor car destroyed. Research into hoped solutions to these problems is often suppressed by both oil companies and motor companies, in order to stunt any major developments. It seems that these powers are more concerned with portraying an illusion of the 'greener' product, rather than seeking a solution.

Public transport, as discussed in chapter three, is another proposed solution to the reduction of traffic congestion and air pollution. In some countries it may prove somewhat successful. Unfortunately many countries public transport systems are severely under funded and in need of vast transformations. They can be unreliable and time consuming, allowing the user little flexibility. By owning a car the individual can travel to varied destinations when he/she desires. Public transport limits this independence. Yet, it is not just a question of independence, as Walter J. Boyne wrote; ***"A curious aspect of the automobile has been the manner in which men and women of all countries view it not in terms of need, but of desire".*** **(Boyne, 1988, pg. 9)**.

Also, some of the solutions discussed in chapter three (i.e. only allowing business vehicles in urban areas during peak hours or only allowing one car per family), will never be fully acceptable to the general public. One car per family may be acceptable to lower income families who cannot afford two or more cars, but to those in a higher income bracket it will never be acceptable.

In recent times, the safety of the cars environment has become a very important issue. This is understandable when we consider how many people are involved or killed in car accidents each year. Also, the amount of safety features a car possesses has become a major selling point for the automobile, as people have become increasingly concerned for their safety and the safety of others. Some people seek these facilities in a car and then become lackadaisical in their use, e.g. relying on the air bag instead of wearing a seat belt. Car interfaces as already discussed, place large demands upon the attention span of the driver but companies are slow in changing their design, as they help to market an automobiles image. It seems that a lot of the safety features of current cars are merely token gestures, which we accept because subconciously we are indifferent to them. The provision for speed is also of importance. We are all aware of speed limits within our countries, yet all cars are designed with the ability to exceed these limits. If car manufacturers were to reduce their cars capacity for speed we would probably reject them. As Stephen Bayley wrote; ***"A fast car demonstrates professional success and suggests sexual prowess".*** **(Bayley, 1988, pg. 31)**. We crave speed and the power it gives us.

The world faces a dilemma as regards the motor car. Countries car population throughout the world are growing fast, draining more and more of the earth's energy and causing great harm to the environment. Yet, there is little being done to halt this steady progression. We are brainwashed by advertising and the image the motor car portrays. Man has destroyed his environment in his need for transport and independence.

What is needed is a system which meets all the aforementioned requirements, without compromising on performance, image and cost.

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