The Effect of Car Mass on (Internal and External) Safety with A Case Study on Concept Family Car

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ABSTRACT

Transportation means are always of importance to people due to their functions. Originally, a vehicle in terms of a means of transportation has been thought as only a device what takes people from one place to another point. But with considering both occupant being transported and vehicle means of transportation since their inextricable relations, vehicle has become significantly considerable within its design.

Prodded by industrial revolution, especially after introducing the first mechanized mode of vehicle in 1769, the technological advantages have highly intensely been used in automotive, and also now. Primarily, within that advantages, even all efforts providing for retention of vehicle during a crash to protect occupants from the injury risk have been zeroed in on for only the one objective: to design vehicles with a high capability of safety.

In this thesis, We consider that people in scale unit as family for vehicle design of the need. Environment for the family vehicle is thought a place encircling metropolis wherein the people as grouped lives out and wishing that it was so pleasant place, just a few miles away from the city, taking advantages of working at home.

Moreover, we are in making a think of vehicle design for family that ought to contain the conventional signs more within global perceptiveness as small, but not compressed down since the generation becomes huger in size by years, and finally has enough space of interior regarding ergonomical and anatomical requirements. Under the definitions for creating the concept family vehicle within limits, the project aims to present most apropos model, and assumes to allow the person to drive and to move on it in safest position.

In this paper, in the light of above, we will set out to clarify the safety features of vehicle structure for **Family Vehicle,** and with respect to that each connective parameter in the boundary of freedom will be clarified.

ÖZ

Ulaşım araçları işlevlerinden ötürü insanlar için daima önemli olagelmişlerdir. Önceleri, araba ulaşım aracı olarak sadece insanları bir yerden diğer bir noktaya götüren basit bir düzenek olarak düşünülürdü. Fakat, taşınılan yolcu ve de ulaşım aracı arasındaki güçlü ilişki dikkate alındığında araba, tasarımı ile birlikte hayli önem kazandı.

Endüstriyel devrimin verdiği dürtü , özellikle de 1769 yılında arabanın makinalaştırılmış ilk modelinin çıkmasından sonra, teknolojik olanaklar şimdi de olduğu gibi otomotiv sektöründe hayli yoğun olarak kullanıldı. Öncelikle kaza süresince arabanın direncini artırmaya yönelik, yolcuları yaralanma riskinden koruyacak olan bütün çabalar teknolojik olanakları da kullanarak yalnızca bir amaç için dikkate alındı: yüksek güvenlik kabiliyetine sahip bir araba tasarlamak.

Bu tezde, araç tasarımı için insanların aile ölçeğinde olacağını kabul ediyoruz. Aile arabası için düşünülen çevre; ana şehri çevreleyen, insanların gruplar halinde yaşadığı alandır ve şehirden birkaç mil uzakta evde çalışmanın avantajlarını taşıyan öyle bir alanın sempatik olacağını umuyoruz.

Üstelik, aile için kültürel, yöresel, yaşam biçimi izleri taşıyan, küçük fakat, insanların bedenen yıllara göre daha da gelişeceği tezi ile basık olmayan, ergonomik ve anatomik ihtiyaçları karşılayacak yeterli iç hacime sahip, genel kabullere dayalı araba tasarımı düşüncesini kurgulamaktayız. Kavramsal aile arabasının oluşturulmasi için gerçekci tanımlamalara dayanarak, proje en uygun modeli sunmayı amaçlar, ve insanlarin en emniyetli şekilde sürmesini ve seyahat etmesini sağlayacağını varsayar.

Bu tezde, yukarıdakilerin ışığında, aile arabasına yonelik araç yapısının güvenlik özelliklerini netleştireceğiz, ve bu çerçevede irdelenen her bağlayıcı faktöre belli bir esneklik payı içerisinde açıklık kazandıracağız.

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INTRODUCTION

Going down in history, human beings have been intervened with unexpected technologies to achieve the controlling of the environmental factors. Curbing in the name of shifting the superiority of nature to the side of the human mass by processing the objects gotten from the raw sources and utilizing them for the use of specific neediness supports the convergence with the human kind and the environment. Shaping, forming, and functioning from first antecedence models to the modern designs, those have been assumed the credence of safety in forms, usages, symbols or adding the useability a livening up property.

Safety in vocabulary gathers the meanings of state of being safe from the harm and danger and for objects safety is out of unwilling properties (Dictionary of Collins Cobuild, 1995).

Designs for products on account of product risk preliminarily affix the requirements onto itself and in that process, the more requirements are in need, the more technological opportunities are used. The contradiction of much-to-much perceptiveness has lasted up past three decades. We think it is clearly wrong. The concept is resulted from the thought of the way in which the complexity requires great attention, as a result so much malfunctions in products. Barely, it could be thought as an equation. Raw equation supplied with concept, material, paradigm, function and form that all give properties as they are, but all directly effects the safety hardly enough or much. For such products, development period of transportation *means* could be counted as a peak example.

Starting with using the pure vehicle mechanizm around 3500 B.C. by ancient Sumerian Civilization using flat structures had been mounted on wheels, subsequently it had been followed by use of horses that remained till the mid of 18th century. In all uses since the means just for only carrying the loads the intense of safety requirements has stayed at a level not being considered in designs. Profoundly, utilizing the technological developments from a different perspective, approaching the nature hesitantly and the wars propelled the human being to provide the equipments with rough, vulgar, rigid geometry with heavy materials.

That thought has reflected transportation means in two significant eras of the car history could be defined as:

- Early Cars era between 1769-1885, and
- First Modern Cars era between 1885-1914.

a. Early Cars first introduced and designed were steam-propelled cars in terms of self - propelled concept. That period has nonetheless an important role of developing the modern car.

Very first known car designed and introduced by, a military engineer, Nicolas Cougnot in 1769, in France. It was fuelled the steam and could achieve the speed only up to 6 kilometres per hour, so far heavy design to practical use. After first experienced the same model produced in 1771, however the machine ran well made a crash to the wall because of driver's performance degradation. That event recorded as the first motorcar accident causing by human being.

Orderly, in 1807 Isaac de Rivaz designed the first internal combustion engine using the hydrogen and oxygen to generate the needy energy was a gas driven engine. And after completing development of the engine, it designed the first internal combustion car. Finally, the year 1813 it developed a car 6 meters long and about one ton weight.

Through the 1860 there was no considerable event, only Jean Etienne Lenoir patented very successful two-stroke gas engine capable of attaining the peak up to 3kmph, in Belgium.

In 1865, The Red Flag Act stated by manufacturers of horse-driven coaches and in the end, based on the evidence of its weight causing damage, especially for roads, the use of steam car gradually discarded and propelled to use the turnpikes. Eventually, development of those car modes completely discouraged, except some occasion experiences.

And finally, in 1876 patented four-stroke engine were developed by Nikolaus August Otto containing intake valve, piston, fuel-air mixture, cylinder, spark plug, compressed mixture, mixture ignites, exhaust valve, burned gases.

b. First Modern Cars

Second era in the car history begins with introducing the first petrol engine in 1885. Since the car were produced very congruent to the car being run, it is known as, and therefore backgrounds of some of nowadays best known car companies like Rennault and Ford leads to back in 1900.

In its historical development, after August Otto, Karl Benz improved and designed the first modern car implemented and stabled on the three-wheeled with four-stroke engine concept.

In 1886, Gotlieb Daimler fitting the four-stroke engine onto a horse-driven coach, and created the first four-wheeled motorcar.

The concept of the personal little-low-mass car at first began at first decade of the 20th century. Ransome Eli Olds introduced the assembly line concept for mass-produce of the car and the first little-low-mass car produced as its prototype name of Oldsmobile Gas Buggy.

After two important eras in car history, added family concept for small cars, The Miki City Car founded in the late of '50s by Rodolfo Bonetto could be accepted mid-outclass model.

If the historic trends considered, the one of aims of study is to make assembly of advantages of each era and to introduce all those in the concept of personal transportation system as Family Car.

In use of advantages, the study and project are directed in those ways:

a. Concept of study

After producing first car, a variety of designs are introduced to the user. Each all takes the different social concerns, different shapes in bodies, aesthetic proportions, safety, and so on. Almost all, out of safety, have so improved and designs became so close each other. Moreover, nowadays, since the technology in use very congruent on worldscale for producing a car, ability to innovate or create a completely different structure in car design is reduced. But, although the term safety is considered in designs, yet improved enough. So, it could be counted as a raw area for designers and, even by reason of annihilating the potentially impelled harms onto occupant as a result of smash hits, it could allow to do so much things in that area. Also, it could help the designers to shape the car in a completely different side of the innovation and directs the efforts to the property of the product safety.

b. Concept of project

Also accepting above, additionally designing a car instead of much-to-much act of seeing, **extreme in constant** for conceptual safety. It is marginal applying a new object for each safety requirement. But it resists the comfort, increase loaded weight and energy consumption, and so on. But in our criteria, if the result reflects the safety being efficient or not, it should gather and be define the portion of each factor. Thus, the different factors being coincided with each, the result or what it is expected from the safety gets the peak.

Reasons for choosing mean defined in the name of Family Car, cultural habits reflected to the project. Considering the strong bond in our nation in term of family structure, statistical results, and customer wishes accounted for the tendency of car model to be selected. It is considered to turn conceptual approaching of the safety to viability, applicability at the end. And the thoughts of compact but comfort, light gains frenetic, small but smart, simple but

means more, make something extra-special refute all blandness in innovation, quality and emotion will be the secondary aims for the project,

Criteria for Family Car study are as:

- **Compatibility,** in mass, structure, stiffness, performance and technological opportunities for safety, and

- **Useability,** the secondary aims of the project will be reflected to the criterion of useability, since thinking of utilizing all in terms of adding innovation to the design. Such as condensing the control buttons in size and numbers, or making the dashboard smaller but designing the buttons bigger signs the usability. Small but smart will obtain the advantages of being mobile system, especially in jammed area.

The project considered the system automation in the mid-point between car and driver. So, not the portion of use the car almost electronically, but with respect to touching gives feeling of being safety and restricts the degradation of harmony between them, the portion of driver-use is considered as primary gain. Rated electronic usage added system thinking of being more advantageous to the steering safety.

The term safety involved the design criteria to produce the solutions not just in technical proportions and also in human-based factors. And all actions gathered are named *vehicle safety.* So far, all the obligations, legislative regulations, and requirements have been put in a role of defining the vehicle safety reason in documents but, expect some successfully studies in worldscale, have not gotten more since those only present an cursory-look through the problem. We are making a think of constructing the problems around the criteria in order for us what we want the design to reply on conceptual project.

This thesis will be a research on Light-Dainty Vehicle with a case study of Family Car. Added general additives in first and second chapter thought to provide the people more

familiar the safety problem. Later on, in sequence chapters, by expressing the technical assessments concerning car structure on both inner and outer space of a car and spreading the project renderings into whole titles is to understand connection of design with related subjects. Referring new technologies and manufacturing techniques for producing of complete bodies in last chapter is to show the project suitable for producing by advanced methods and techniques.

Overall thesis, comparing and critisizing is to reach the solution to be able to undertake by putting in processing to show how promising is a structure or developed system aimed at its all components. To the end, by all considerations based on the technical assessments and society, We will imagine and outlook of all done so far.

In the thesis explainings and direction of the implementing subjects since so wide in its category, each explained case is accepted as source, and methods in complete car design. And therefore, all chapters would be the base to the last one.

CHAPTER 1

1.1. REVIEW OF TITLE

1.1.1. IDENTIFICATION OF FAMILY CAR

A car as very innovative product, in apple pie order, arrangement of about ten thousand individually separated articles as finite elements into a whole that runs. That best arrangement has taken place in our life as a result of the combination of technical stake with the need. Based upon that kind of view, we clarify a car to be a result of purely social requirements in paralleling technical achievements.

Pretended to see, the need for ingenuity of the car in which design process gains messages. If the designer treats as was user, stating the problem becomes familiar us, and touches much many aspects in our life.

Creating a car with the family concept results in one of model in category of personal transportation means. So, shaping, defining solid and voids on that, wishing reflecting the spirit in term of a car with feelings, expressing individuality differentiate from others. The individuality leaves, sharing common habits, properties of lifestyle of family and related habits become current. As mentioned, Turkish family lifestyle contains being together, living together for a prolonged time and creating the time to share coming from having strong kernel structure. If average number of family population of six reflected to the design, it needs much more space than the need of worldscale acceptance. The wind of change on world, global perceptiveness, and becoming the living much similar to the others by accepting the same technology everywhere also impel a car design to be congruent to its all class as in other.

According the worldscale inputs results on occupancy intensity have shown that about 87% of travels both including work related and just only for trips occur with two or fewer travellers (Nationwide Personal Transportation Study, 1991).

Considering the outcome average, size of family car is planned for less than four occupants. So, it offers an interior space available that can accommodate 2 to 4 passengers. It is designed for young family (thinking of Turkish generation age average as the design Peugeot 206 by Murat Günak (Figure 1.1. & Figure 1.2.) and weight and dimensions in Daewoo Matiz (Figure 1.3.)). The family car has the concept of urban theme. Essential characteristics of the concept are firstly being weak in weight and secondly small, or near to the mini category in content (3-door mini Dainty). Those add frenetic, frugal and dynamic performance to the car. Reflecting the family tradition onto the design would sign the category of the car.

Figure 1.1. A view of Peugeot 206 five-door model.

Figure 1.2. A view of Peugeot 206 three-door model.

Figure 1.3. A view of Daewoo Matiz.

Brand name as Dainty for the project is chosen since it gathers the meaning of weak in weight, small, delicate, pretty, and special. Hence, as thought one word was able to contain a number of meanings based the term of simple means more. Critisizing existing models like The Model T by Ford Company, first founded in 1908, We thought, it is an example for sourcing to design the car with the model Volvo S80 having the best safety properties in body as a stiff chassis. But, as 1963 Volkswagen Beetle literally means person's car, by Ragtop Sedan, could be base to the Dainty car as the luggage being mixed to the simple form, and its being compact. For that reason, it could be considered as outclass model in its category. Specialty of two-door term is reflected as countered of the wheel is not integrated to the side edge of front sided-doors. Optimal drag factor of the form is 0.21 (Chapter 4, 4.2.1.1.1. aerodynamics, page 80).

In many circumstances, the project is considered as an example the Beetle's exterior form in side with a deformation of front hood to the form being integrated with windshield in the view of a soft slope.

So, person's transportation means could be converted easily to the family car. The only thing is to make the luggage area rated enough to the store the occupants' equipments. For small ones it is difficult to set that property. To gain the alternative space secret luggage is thought under the each seating system. When occupant or driver hold up the cushion would take the advantage of placing the small things that makes untidy in interior side of the car

compartment. Also, it could save the laden luggage reducing by a third. In the project, the structure of the luggage area gains more space partly or completely foldable rear-bench seat. Design is thought up for travelling, shopping, bazaar, and for vacation.

Containing the small volume could be seen as disadvantage for those of car. But, shifting the rate of solid and void through the side of latter, the disadvantage is deflected and advantage may occur. That makes enough space of interior volume regarding ergonomical and anatomical requirements considering the occupants' persons. Also, being tightly in small area disturbs the comfort, but it gains comradely effects between each person. Why? Although the persons that have no strong relationship or friendship, the car provides them to get on with each other. Hence small size presents a long variety of advantages to the users, not only in technical properties but also in social concerns.

In our proposal, the concept not only for sale to the side of the family, it also based on offering and recovery service using a parking system by installing a genuine network of small parking stations. The stations would be under ground. To hire it, a subscription system curbed by a computerized network functioning using a smart card.

If all successfully done, the project could be also replaced and condensed all category of personal transportation means into one model, and therefore We would not be surprised to see the car fundamentally intensely express the concept of family in whole category in the next future.

By the way, all new achievements as well as innovations resulted for that otherwise conjured up ideal idea mentioned above takes the automobile industry to produce one upscale model as family car or its various types.

1.1.2. LIGHT CAR EVALUATION

Downsizing, especially in '70s, seemed to have been driven likely via changes in ownership and two-car families than economic factors. However, after the petroleum shortages emerged in relation to OPEC oil embargo, manufacturers are launched on foraging for developing more promising transportation systems. As a result, the low-mass car design became spreading on worldscale.

That kind of private car being mentioned as an alternative is known as the most effective transportation system on the land. All category of such vehicle imitated as LTV stands for Light Vehicle or LMV under the name of Low Mass Vehicle.

Ability to freely and individually move people is the precedence link in design for such category of that car. But the primary tradeoff for light, or low-mass car is impelled risk of harm in a collision. Thus, should those kinds of ramifications were able to be remedied by emphasizing innovative safety hallmarks such as visually impressive driver information systems, advanced car control and crash avoidance systems, and attractive car layouts and styling in combination with material extension, a car would be in ascendant as safe. Also, in that assumption the efficiency in level degree of safety simultaneously goes up. Such a study of car, conducted in the concept of hard shell is projected to our study. In the project, being weak in mass coincide with the wishes of less vibration, and also minimized noise problem.

It is important which limits enforce a car to be in the category of feather vehicle. Such as, from smaller to the biggest, Indy cars have the special weight of 400kgs for only one seating position on complete body, including tires and axes. The car "Hyundai Atos" has 800kgs in mass, and the model "Saab" constructed in 1900-1950kgs unloaded vehicle weight.

But, in general, weight of vehicle-groups are distributed in:

- **Mini Cars** (between 681kgs-907kgs),
- Lights (between 908kgs-1135kgs),
- Compact (between 1136kgs-1362kgs),
- Medium (between 1363kgs-1589kgs), and
- Heavy (between 1590kgs & over).

In dainty vehicle, the mass criteria considered between the unloaded weight of 400 and 900 kilograms, but rather near to the 700kgs (unloaded vehicle weight). Since material usage as the same as Indy cars, but its form completely different from one being wide and shallow, the advantages of applying the same weight portion could be dangerous to the vehicle in its rollover propensity. Choosing the criterion of engine is to be light, but enough (999cc) because of heavy engines in contradiction with light mass might be a factor of swerving at veering at curved parts of the road.

Considering average weight of the occupants (Figure 1.4.) in the number of four maximum loaded vehicle weight is assumed to be reach to 1068kgs (700+328+40kgs) (distributed as 60% in front, and 40% towards rear portion of the vehicle), including luggage loading.

	5th percen- tile adult	95th percentile adult
Weight	46.3 kg	97.5 kg.

Figure 1.4. Average weight of person considering height factor.

1.1.2.1. ECONOMIC PROVISIONS OF LOW MASS

Transportation now consumes more than %20 of the world's total energy. In next thirty years, transportation will need 2-1/2 times more energy since the number of cars will desperately soar from today's levels of four hundreds to the level one billion. If these trends are projected to year 2100, cars will consume 40% of 10 times more energy (Sviden, Ove, 1992, pp. ISBN 92-64-13752-1).

In the light of these data, term low-mass which is a centrepiece-part of the way in which reducing consumption of traditional energy stocks is very tenable. Nowadays, almost all engineering designers address those environmental concerns onto their project under the name as of environmentally friendly cars.

1.1.3. AN OVERVIEW OF FAMILY INCOME IN PARALLELING CAR OWNERSHIP

The exponential growth of car ownership and use relatively depends on economic well being in developing countries. As income drives a higher level, the population life standards relatively expand. Thus, purchasers individually purchase, maintain, and fuel the transportation device. That also provides investments on transportation network entail public funding in which transportation schedules and routes are tailored to public needs, as well as being inexpensive. By this individual needs car density per family is expected to reach twice more than it is.

CHAPTER 2

2.1. LIGHT CAR SAFETY IN PERSPECTIVE

Understanding reasons for dire injury conditions provide the requirements jointed as any system, part, or component within car. These varies of requirements generally emerge as a result of two important characteristics make drive fatalities of feather cars higher are rollover propensity and compatibility. It is cited that, in jeopardy of fatal impact light vehicles are twice as likely to have rolled over than other means. A rollover increases the likelihood of occupant ejection, fatality or injury (An Overview of Vehicle Compatibility, 1998).

Other significant characteristic involves differences in car distinctions between means and light cars, such as, weight, volume, or size, geometry, and stiffness. According the test results, gotten from FARS stands for Fatality Analysis Reporting System, crash statistics demonstrate that, in side impacts, light cars are more injurious as a striking one than passenger vehicles. For example, when LMVs (Low Mass Vehicles) ram on the left side, especially to passenger cars, the risk of lethality to the car driver can be about thirtyfold more than the danger to the LMVs occupants (An Overview of Vehicle Compatibility, 1998).

This issue shows that during development period of such category, both technology and material dimensions have been intensely focused on that vehicle group. Since utilizing advanced technology light vehicles become superior to other categories of cars.

2.1.1. MASS AND SIZE ENFORCEMENTS ON A CAR

Changing car's size and mass, one of the most considerable are orientated to the estimations in proportion to the consumer's broad social concerns. Hereby, energy conservation and emission sacrifice, both in the name of environmental health, are not primary gains.

In respect to nearly emphatic premises, we ought to come to an agreement to converging factors of energy conservation, emission, and consumer's concerns in order for a car to be designed that has a higher level of safety.

Even though both descending car mass and its size could dwindle the volumetric and manufacturing cost of car, they foment a respectable increase, for occupants are at perishing risk, in harm of injury more than twice in any collision, in rear ramming, side, or their various types. Profoundly accounting for the words being mentioned, it is anticipated that even after all changing in both mass and size reduction applied on a car there will effect reliability of the car.

The safety risk, or performance, for this kind of car become more considerable since one raises a number of very complex issues including the relationship between car design characteristics and crash trends. These design characteristics with extended respect to the standards, tests for *vehicle equipment* can adequately theorize human-body injury rates in car-to-car impact.

Overall this paper and its whole articles will be utilized the standard FMVSS stands for Federal Motor Vehicle Safety Standards whilst approaching each entailments to afford impact protection for occupants.

2.2. OCCUPANT CRASH PROTECTION

Considered as basis gain for occupant protection, is to mitigate frequency and risk of perishing and injury of occupant involved in collision. Most likelihood of encountering crashes generally result in moderate, more severe injuries, and lethality entails the best optimisation with requirements in both car and its use. The term are also subjected to FMVSS under the name of occupant crash protection aims to provide possible further developments of protection for occupant enmeshed with crash environment, and specifies, and also defines the limits, placements, measures of any instrument, system, or device

applied on car. Also, it is wishing that these all were capable of serving the needs and producing centerpiece alternative through car designed.

The need for occupant protection are required when a relative velocity at or about 19 kilometres per hour with an unloaded car weight of 2,495 kilograms equals nearly 5450 pounds and at any speed up to 48kmph, or 30mph (Federal Motor Vehicle Safety Standards, Standard No. 201, *Occupant Protection in Interior Impact*, 1998).

For more ability to understand, the term must be distributed in order for occupants to encumber injury risk into two bases:

- Identifying the pre-crash conditions or addressing the crash environment, and
- Occupant protection with high determination in interior impact via an exterior offset pulses through interior volume.

2.2.1. CRASH ENVIRONMENT AND INJURY

Crashes are likely to result in either environmental causes, for example road conditions, inclement and degraded weather, and other factors such as driver's behaviour, technical defects, compatibility and disparity with other cars, and roles of equipment being not sufficiently qualified. All of those factors predominate in a way for injuries of occupants.

Almost all crush trends by reason of causal factors from environment results in specific location deformation on car body itself.

2.2.2. DISTRIBUTION OF CRASH TYPES

Trajectory of impact shall be either in a vertical plane parallel to car longitudinal axis or in a plane normal to the surface at the point of contact. But, crash types or impact modes, to be

best simulated, are basically grouped by GAD stands for general area of damage and DOF based on direction of force into frontal offset impact crashes, offset, or side offset impacts, and rear impacts, and finally crashes as a result of rollover.

The categorization by object connected symbolize as OC is then divided into two types of crash modes as car to car and car to full barrier, or to fixed objects.

Frontal impacts are again branched into collinear and oblique (left or right) considering DOF, and by general area of damage into offset (left or right). The same distributing is available for other crash types just mentioned above (Stucki, Sheldon L. & Hollowell, William T., 1998).

Concerned with the research outcomes of statistical samples, most percentages of crashes causing high injury risk are the frontal. Related addressing alone is the primary objective in simulation together with analysing, comparing and testing of configurations of crash which will best represents the risk of impact severity for occupants as in real world crash environment (Figure 2.1.).

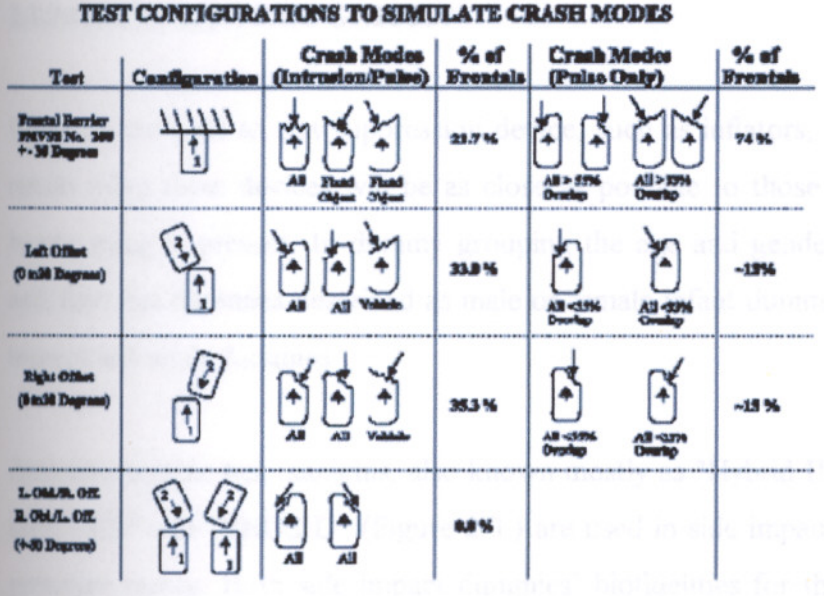

Figure 2.1. Test configurations to simulate crash modes.

2.2.3. SIMULATION OF CRASH ENVIRONMENT

Simulation in conjunction with addressing, configuration, testing, and analysing of crash environment which is subjected to occupant crash protection could be used to replicate the safety performance of cars currently in use.

In simulation of real world car collisions at laboratories, specific test devices are used. In respect to nearly emphatic premises, first group of test instruments of use in comparing and analysing to test data obtainable from performing of configurations. And, rests of them are fixed and movable objects as full barrier, dummies and out-of occupant simulators instead of drivers and side-seat occupants, and test cars in lieu of themselves. Tests are implemented for a specific equipment, for testing any system, or any other component or accessory equipped car so that whether they are successfully qualified or not.

Simulations are also done by the reason of developing prototypes of crash avoidance systems. As developing such systems in complete effectiveness and making their tasks in immense efficiency special hardware such as testbed cars are designed.

2.2.3.1. DUMMY RECOGNITION

Dummies are used to test suppression device, such as inflators, belts, and i.e., so that test results using these devices will be as close as possible to those that would occur when a human being is present. In dummy grouping the age and gender are primarily considered and, then test dummies described as male or female infant dummies, 3-year-old, 6-year-old, teenage and adult dummies.

Anthropomorphic test manikins, also known mostly as "Hybrid III" (Figure 2.2.) for frontal tests, "SID" and "BIOSID" (Figure 2.3.) are used in side impact tests under their product prototype names. Both side impact dummies' biofidelities for the responses measured are superior to other mannequins, especially for drivers, are extricable into three categories sized

by height are 5 percentile female, 50 percentile male, and 95 percentile male, respectively. Hereby, the average heights for each category are:

- 5 percentile population refers to ones less than 1640mm,
- 50 percentile refers height among 1640-1800mm, and
- 95 percentile equals to over 1800mm.

Should be denoted that the use of combination of those dummies is higher in Family Car other than cars.

As named above, although those two prototype dummies have their gradations to each other, biofidelity of them according to test results to *cadaver* assessed to a parameter called coefficient of variation as ***CV*** are analogous.

Dummy positioning differentiate according to testing purposes just the same as in a test in which the test car is, assumed, to be struck on its left side, each dummy is configured and instrumented to strike its left side for analysing being measured acceleration data to body parts from accelerometer mounted onto ribs, spine, femur and pelvis, or placed inside, coming mind skull cavity, and any other certain part of body of the dummy, and thus for specifying injury criteria and fatality risk.

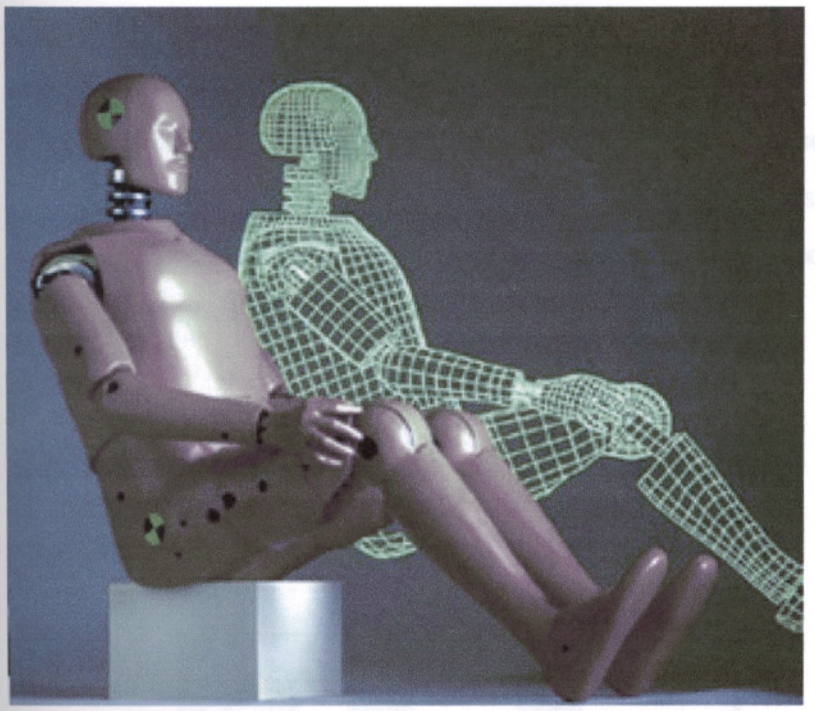

Figure 2.2. Schematic of Hybrid III Test Dummy.

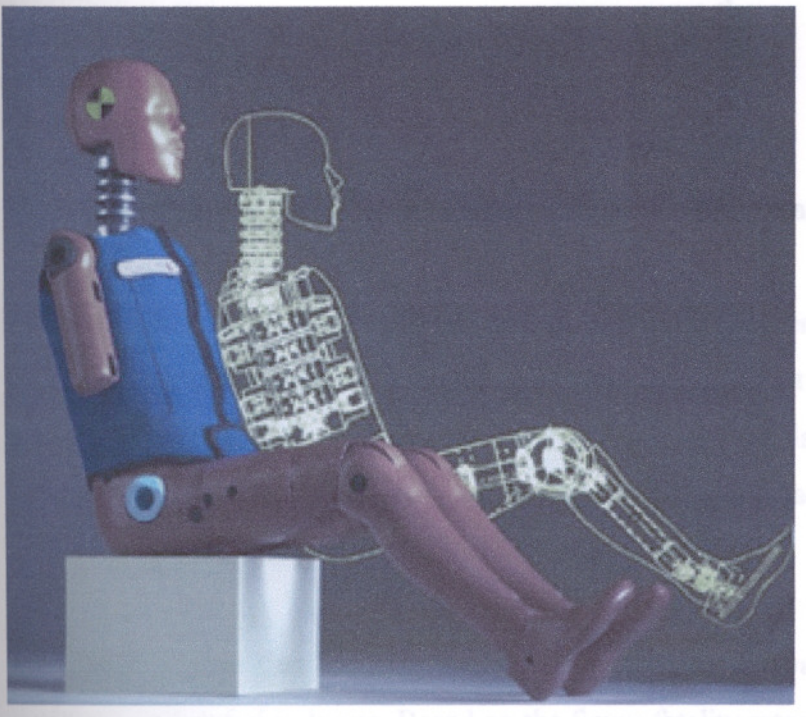

Figure 2.3. Schematic of Side Impact Test Dummy (BIOSID Dummy).

2.2.3.2. INJURY RISK BY SIMULATION

Simulation together with analysing, comparing and testing of configurations of crash shows that injuries should be taken under three-risk-level of injury as Moderate and More severe Injuries in symbol with MIS 2, serious and higher injuries in condense to MIS 3 as one-up level, and the Fatal Injuries.

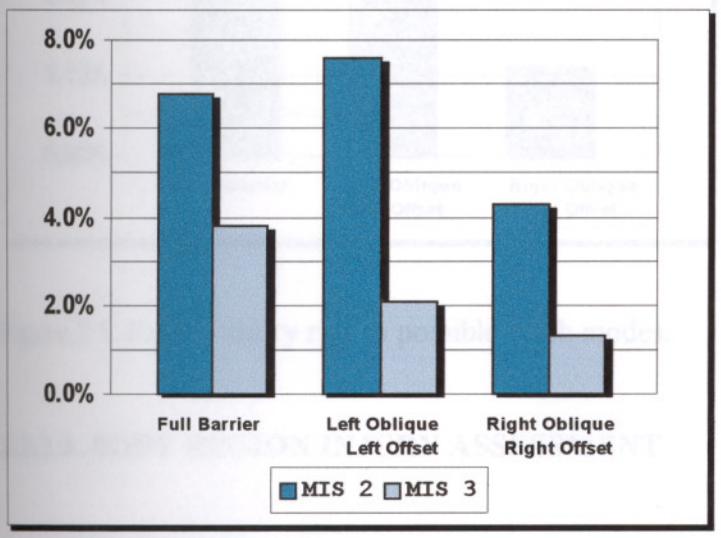

Figure 2.4. Moderate and more severe injury risk to possible crash modes.

As figured above, for MIS 2 the injury risk is, somewhat, higher for most majority of cars in crashes as identical as left offset in portion of about 7.6 percent than those described by full barrier at a relative 6.8 %. And also for MIS 3, serious injury risk has the highest rate of 3.8 percent through full barrier crashes, and thereon above, left offset and right offset groupings have lower serious injury rates of 2.1 and 1.3, respectively.

Just another figure that explains impelled fatality risk for various crash modes by test condition, are located to lower. Based on the figure fatality rates for left offset grouping (left offset and left oblique offset) result in higher fatality jeopardy at 0.43 percent than full barrier which is respectively about 0.25 percent. If all, given as figure 2.5., considered, the right

offset grouping (right offset and right oblique offset) are fourfold as likelihood of fatality risk than left offset modes.

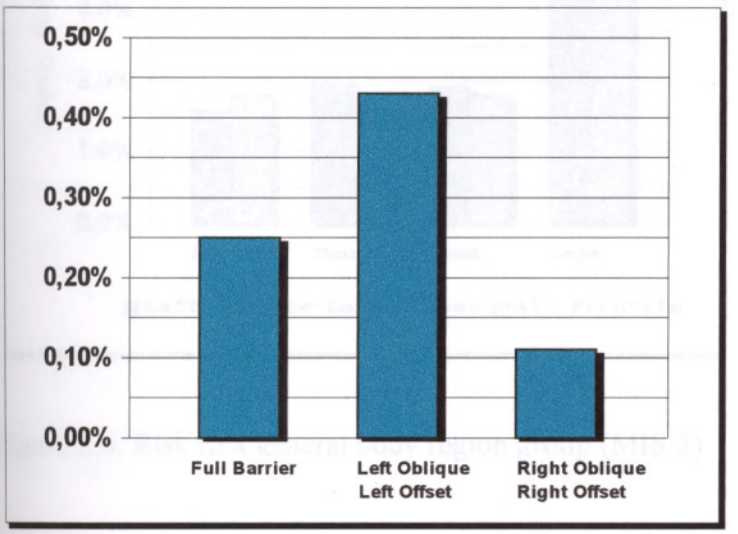

Figure 2.5. Fatality injury risk to possible crash modes.

2.2.3.3. BODY REGION INJURY ASSESSMENT

Inextricably above, injuries to specific body regions could also be separated into two-risk-level of injury as Moderate and More severe Injuries in symbol with MIS 2, serious and higher injuries in condense to MIS 3.

Risk to a general body region group, that head, chest, or thorax or torso, arms, and legs are branch of which, are figured as:

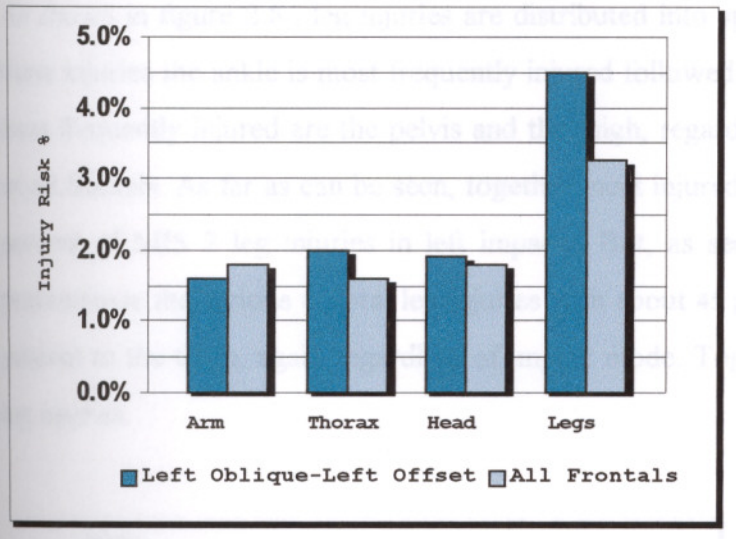

Figure 2.6. Risk to a general body region group (MIS 2).

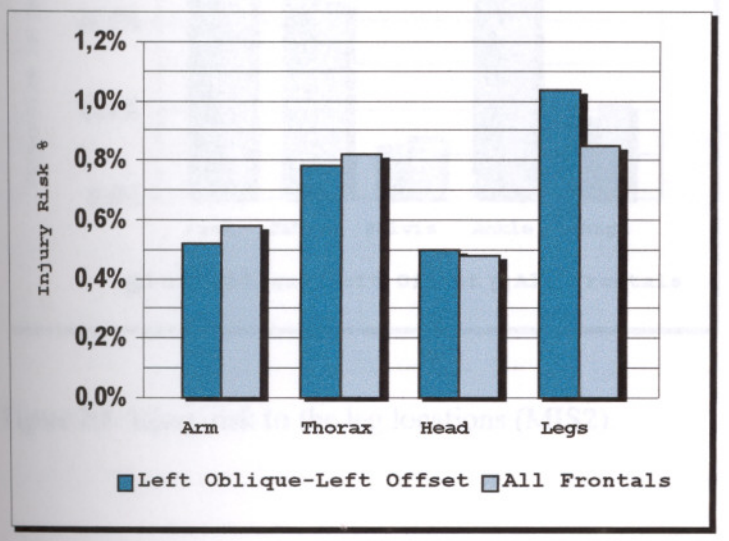

Figure 2.7. Risk to a general body region group (MIS3).

A comparison of figure 2.6. and figure 2.7. shows that potential MIS 2 and MIS 3 injury have a higher rates for legs in left frontal offset than all frontals with rested body regions having resemblances in both impact modes.

As shown in figure 2.8., leg injuries are distributed into specific injury location, and within these injuries the ankle is most frequently injured followed by the knee and tibia, and others least frequently injured are the pelvis and the thigh, regardless of whether the impact is left or all frontals. As far as can be seen, together most injured legs locations make up about 90 percent of MIS 2 leg injuries in left impacts. But, as seen in figure 2.9., tibia and thigh predominate the serious to fatal leg injuries with about 45 percent to the tibia and almost 43 percent to the thigh, again regardless of impact mode. Together form almost 88% of MIS 3 leg injuries.

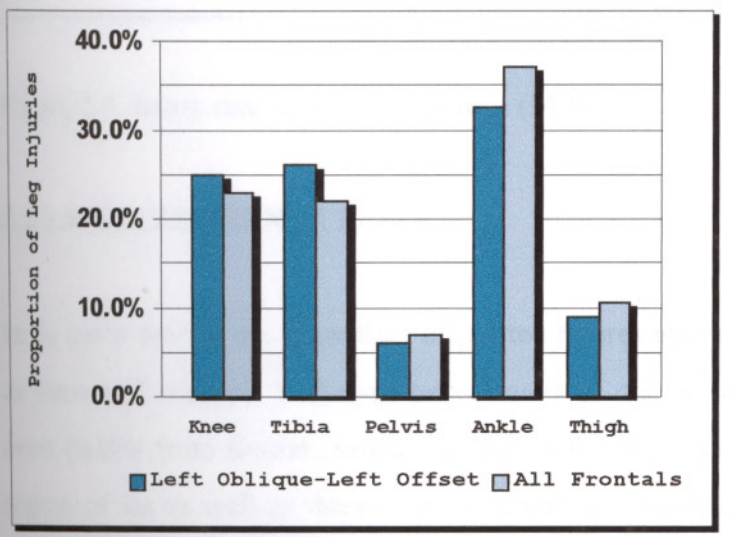

Figure 2.8. Injury risk to the leg locations (MIS2).

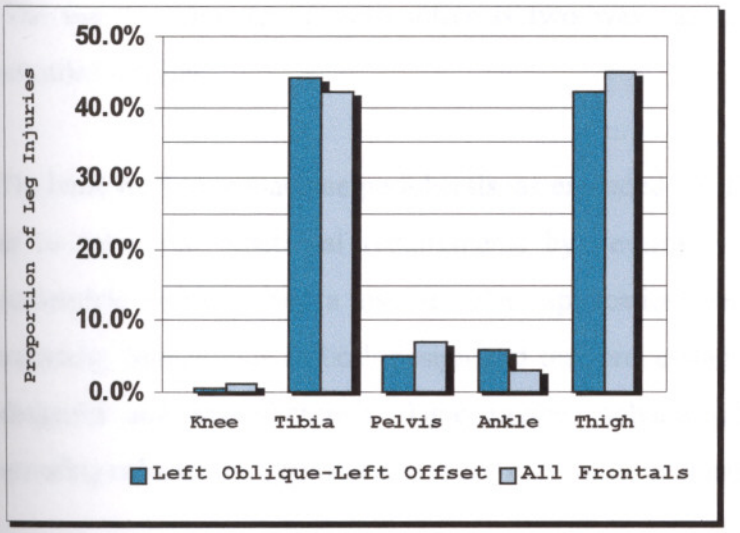

Figure 2.9. Injury risk to the leg locations (MIS3).

2.2.3.4. RECOMMENDATIONS

In so many words, not regardless of plotted figures above with making the word stationary as been said recently, that most percentages of crashes resulting in severity of injury and even fatality from frontal cuttings through left frontal has the highest effect in local body region of leg as well as thorax. So, to come to a conclusion, outcomes shows innovative designs through car styling should be stepped up attempts to innovative article designing, systems devising, equipment projecting, and so on, for helping to avend the dire consequences of accidents and alleviating them in frontal ramming.

2.2.4. SAFETY AND THE COMPUTER

Since the *bare machine,* and especially introducing the new atlas system as a part of product in 1972, computers have become essential to society on applications on new fields as in design of automobiles and its test processing. Moreover, in the period of being applied in such industry, because of a car equipped with a variety of structural elements and their complexity, exact measuring and implementing the process can be only hunched using the computer.

The use of computer in automotive is two ways as either simulation or operating the extended devices.

The basic hardware machine peripherals, as extended machine hardware, are complicated so as to solve the functional requirements by developing any number of packages. The automobile industry has a use for that application packages for simulating or circuit analysing. Simulations of both design and test processing give such many opportunities to designers and manufacturers. Time saving, solving exponential number of variables, revealing calculation, responsiveness are only some of them.

Those simulation packages are constructed with softwares consisting of predetermined programming codes.

Advantageous of computer, curbing the extended input and output devices successfully during testing, improves the production of a car prototype as lowest defect as possible. Since the computer allows designer to minimize unreasonable allegations, the product as well as its testing results in best method a car to be newly minted up.

Especially, in simulations the car collision behaviour can easily be progressed. In doing so, there can remain a rested time enough to achieve substantial improvement for other areas on car prototype.

Almost all simulations after innovating a device, or any system are attempted to measure its safety adequacy. Both simulation and performing the extended devices in planned configuration, the foremost portion of testing is aside body and restraint elements. Deformation tables, inertia loading on equipments, yawing moment or torque on body, aerodynamic stability with drag reducing and for other all a computer counteracts the unforeseeable corrupts.

For example, in any impact test, side or frontal, or rear, and has only time approximately 70 milliseconds for collide duration, just for the interrupting and capturing the wishing section at any certain graphic, and at a particular juncture, CAD systems (or CAS) are essentially used. Here, a configuration of computer-based measuring gives the advantageous of repeatability, simultaneously analysing, comparing, determining the factors of deformation ratio after first contact, and testing the stiffness of doors and door hinges for all longitudinal, transverse, and inertia load continuously at any level giving the proxy. Geometry, chassis, finite element thickness, yield strength, modulus of elasticity are set as input data or data sets. As a secondary way of using the computer in that measuring, capturing provides by an external devices as cameras, the rest of the job, completed by extended bare machine after batching the data sets into the computer. The tests for the deformation zone of the car on left side are significantly carried out.

Apart from those, dummy injury testing encompasses a wide range of computer use. For its simulation, biofidelity entailments and physical algebraic equations such as, mass, inertia moment and body temperature, are set in the program. The usefulness hinges on the parameters to be more encompassing and more detailed. In reality, whilst the car being decelerated, however, the occupant's jerking gathers speed. From that point of view, dummy injury testing for encumbered the lurching criteria could be separated the receding behaviour of the car. Then, the needy estimations calculated and the results combine with the each other. Restraints systems using so as to harmonize the occupant to the car slowing down also have the opportunity of testing in simulations.

Very complicated simulations are integrated with the mechanical devices. Simulator room is an essential member of such systems. Those constructed on a base with the ability to move in six axes and regarded as moving base simulator with the ability to represent antecedent events. It is used highly intensely in car road test simulation. Since the mechanical movement, the drivers provided to feel themselves as if they were in real world.

2.2.5. TESTS

Car tests at laboratories implemented in an isolated room, or in such areas for road test. After a test was done, the special working out disquisitions are ordered. Those orders don't oblige to, but for the certainty of the car reliability indubitably should be taken with all due care.

Majority of the test applied for a specified object, and the reliability of its results, others as verbose should be removed from the whole in case of affecting the load upon or the deflection of the car. Needless to say, negligible parts could be not.

Here, with all given knowledge, focal points of the test will contain:

Outer parts:

- Chassis, on lateral, frontal, and rear ramming,
- Doors, on lateral impact,
- A number of articles including hinge, latch, and windshield and windshield mounting, and
- Uppermost portion of the body, in the event of rollover.

And inner parts:

- Seats as outboard component and seats' anchorages.

a. Outer parts

a.1. Chassis

As infrastructure part of the car a chassis, conforms the stability of the body built on in probable junction collision. Therefore, related tests are just for realising to a need to evaluate the car's weakness points.

In the striking on each direction aside the car, the resist elements are provided to make the car physically stronger. The front part of the chassis already designed to be very effective, but in sides that is not what supposed to be. The probable trajectory of crushing is shown in the project model as figure 2.10. and supposed to be explanatory.

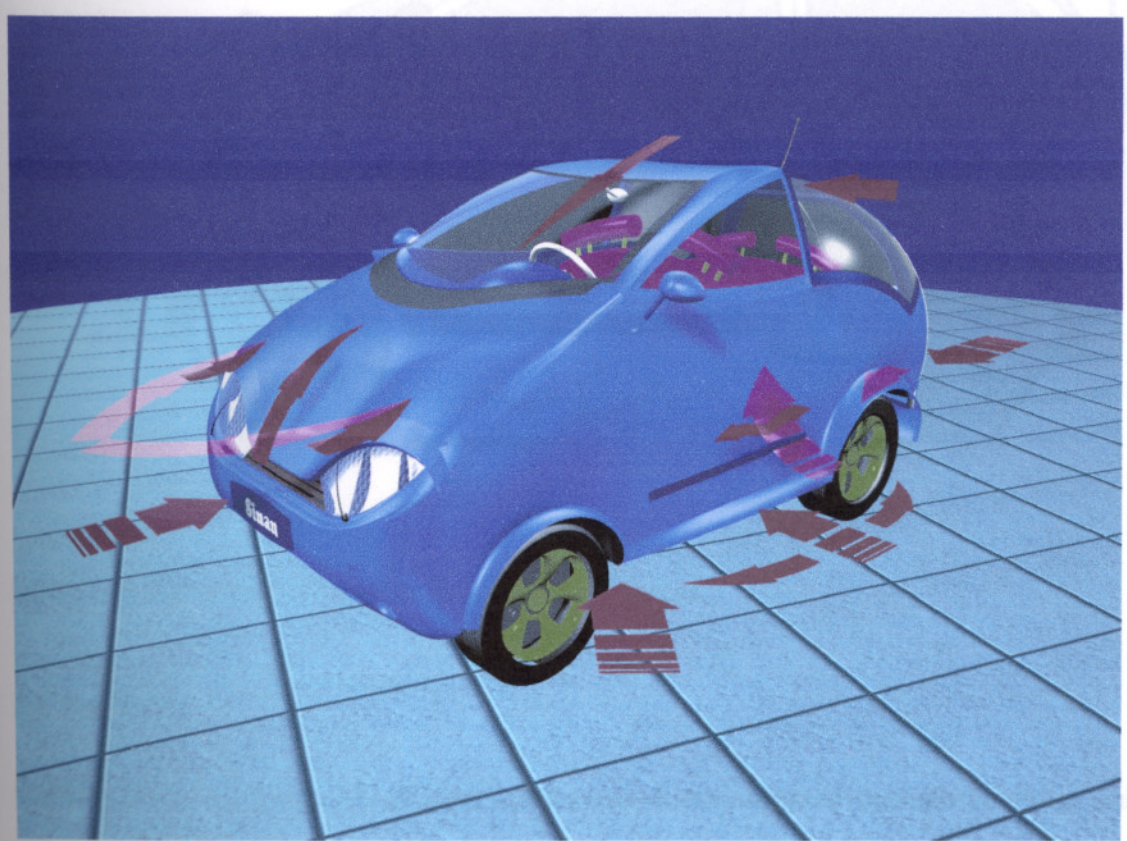

Figure 2.10. Schematic of the probable trajectory of crushing.

Chassis covered with a shape directs the impact forces off the inner compartment. Or, first it resists the forces, and then makes a flow direction parallel to the surface of the shape. For that reason, shape design with aerodynamic factors compounds with the characteristics of the chassis.

In our project rendering, the possible flow of impact forces are imitated, and the inner flow risk are thought to be able to catch in mind for shaping the chassis and finish elements (Figure 2.11.).

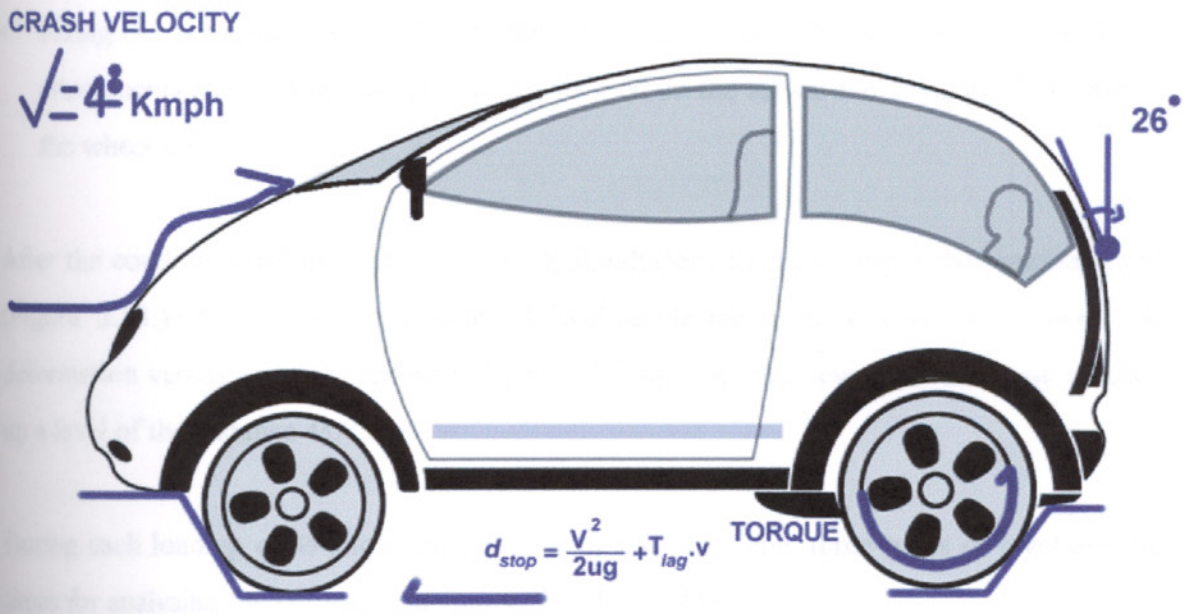

Figure 2.11. Schematic of possible flow of impact forces.

a.2. Side doors

Orientated to our project, the striking on the rear doors accepted through covering finish panels on each side integrated the body, since the design devised for a car with three-door including hatchback model.

Presets of the test in side collide, the procedures:

- Removing the seats,
- Placing the side windows in uppermost position,
- Keeping the door locked,
- Preparing and positioning the loading device, which is a rigid steel cylinder or semicylinder of 304.8mm diameter with an edge radius of 13 millimeters, its longitudinal axis as in parallel to car's vertical direction, and that direction laterally opposite to the midpoint of the junction line 127 millimeters above the outermost of the lowest point of the door, regardless of the any protective moulding as side fenders, and
- Fixing the car rigidly vertical to its transverse line or horizontal centerline by means of attachments between the wheel base line located on the forward and rearward portion of the wheel centerline.

After the conditions achieved (Figure 2.12.), simultaneously the configuration implemented (Figure 2.13.). So, using the positioned loading device a force-laden door takes the deformation versus as of 120 seconds of points in time until the device continuously reaches up a level of the distance 457.2mm.

During each loading of 55 kilograms per inch in specified time, three types of level are the times for analysing the deformation zone of the doors. These:

- The initial crash loading duration,
- The intermediate crash loading duration, and
- The peak crash loading duration.

For the first, the initial crash load is the average force deforms the doors over a third of the 457.2mm. The latter is required to deflect the doors in initial 304.8 millimeter of the crush. And, the last applied to those over entire level of 457.2 (Federal Motor Vehicle Safety Standards, *Side Impact Protection*, 1998).

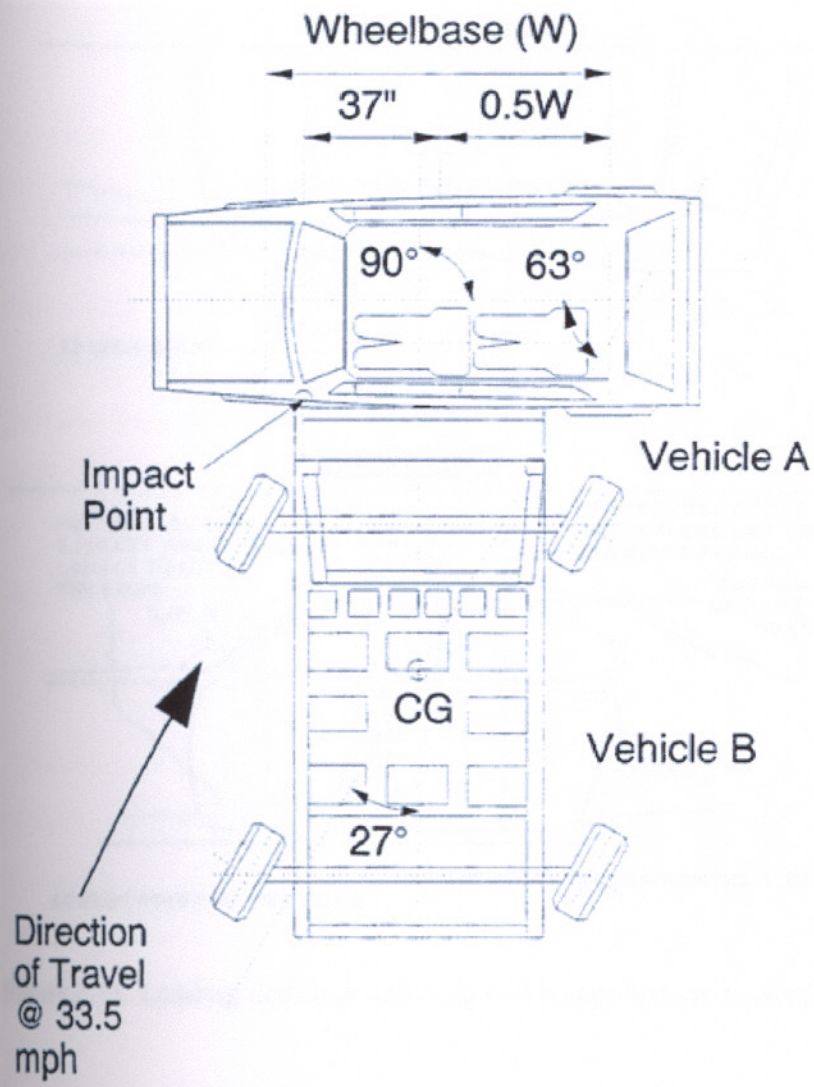

Figure 2.12. Test configuration of vehicle for side impact.

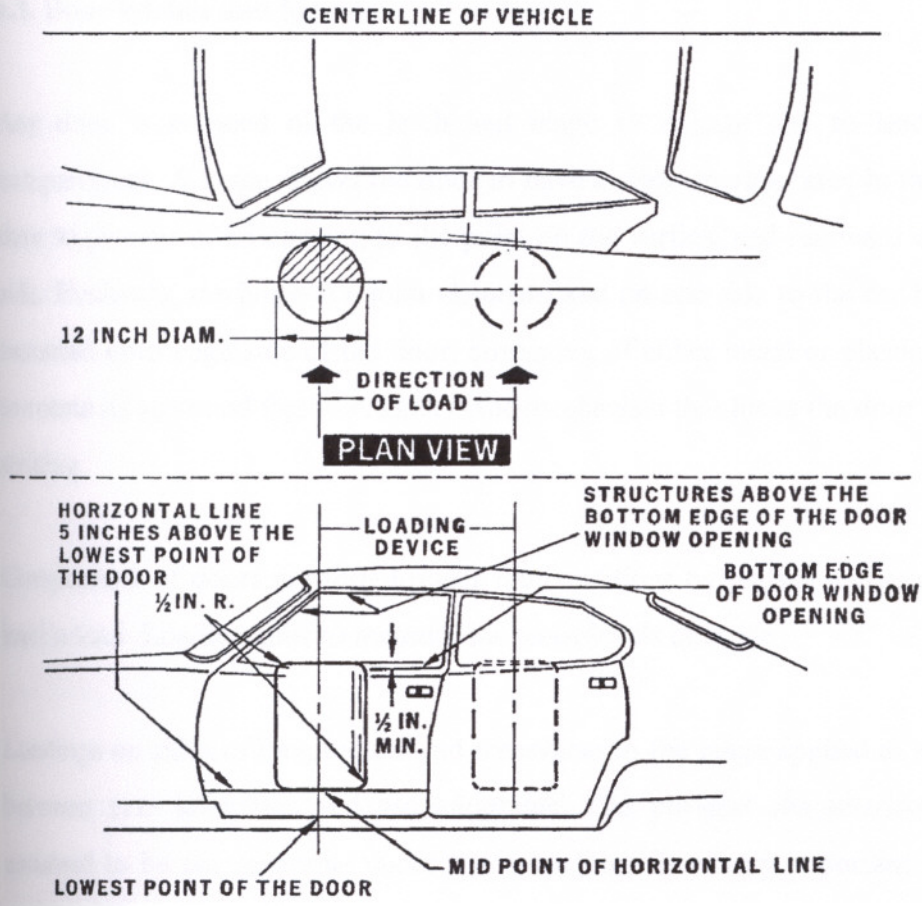

Figure 2.13. Loading device positioning and its application towards the doors.

In project, the doors since their importance of usability, such as easy opening-easy entry even by a child, at the off-peak times simply to egress the compartment, it has the properties of light, enough door- opening. The concept of being small in size also allowed to directly reduce the four-door concept to the use of two-door one. Especially, light-door enable both driver and occupants to better evaluate obstacles on off-road travelling.

The two-door is directly effected use of interior space. For instance, the seats are designed to allow the occupant to seat the rear within the function of folding and when required simply sliding forward.

a.3. Door latches and hinges

Any door is in need of the latch and hinge to engage and to lead to the occupant compartment. A hinge allows the door to have a *door-opening* area in the position of more than 50 percent of its opening to the point on the vertical and rearward of the seat on each side. Evidently, the hinge is a joint element fixed on one side to the car frame, on the other mounted onto edge-side of the door, consisting of either metal or plastic provides the door to rotate its surround freely. A latch is the mechanism that locks the door automatically after striking.

Components of doors are tested under the conditions by putting a charge of dynamics and inertia load. Loading aims to measure the resist levels of those.

Loadings on sides of longitudinal and transverse to the hinge applied at an amount of force between 1135 kilograms and 980 kilograms. The physical characteristic of the hinge is assumed to be not separable under those loadings. It is very important such that many of perishing have ensued after the doors had been separated and moved off from the body, especially in rollover crashes.

For the case of splitting, the role of latch is higher than supposed to. It helps by disengaging from the locked position due to its malfunction leading to design defects. For that reason, the same test are done for that component. In test, locking being functioned as in real world (such that open-close process is progressed in the number of twenty thousand times).

Inertia is a tendency of the latch and the hinges being in a position still. The inertia loads of both are implemented separately from the dynamic load. In tests, a car shall not free from its completely latched position under a particular loading of 30 grams (Federal Motor Vehicle Safety Standards, *Door Locks and Door Retention Components*, 1998).

a.5. Windshield and windshield mounting

Inefficient the restraint systems are the case for jolting through outer surface in a sudden brake or colliding. A windshield in its pre-modern models had been designated as a heeding element for airflow, onward steering controller. But, within many circumstances keeping its basic function, it is improved entirely in an abyss field. It is the field that aims to achieve protection for outing outward.

That is not the indictment of ejecting of the force-laden occupants toward innermost surface of the windshield in lieu of causing serious head injuries and being sheared by glass. To remedy cases, windshields are provided with a glazing material that additionally helps for spreading the forces more equally all around the windshield causing, thence the merest effect and being unscathed in case of splitting glass material.

For testing the improvements on windshield the following steps preset:

- Positioning the 50 percentile dummies at each front outboard designated seating locations,
- Specifying the protection zone area by affixing template onto windshield for both controller and occupant (Figure 2.14.),
- Loading the car in addition to its unloaded car weight up to an amount of 136kgs,
- Filling the canister with a solvent, less than up to the brim, between levels from 90 to 95 percent of its full capacity,
- Inflating tires and setting other even negligible parts.

Implementing the test, at a fixed speed relative to the 48kmph, accounts for and, therefore, entails the following optimisation on windshield:

- If the occupant with its belted seating position, the windshield supports preventing intrusion outward at least 50 percent of its periphery or mounting,

- If not, and the belt inefficient, should be protecting at the level three-fourth, and
- Both takes the width of at least 6 mm.

For any intrusion the mounting elements are of lead in importance. For stabling the mountings the fixing is considered to be not detachable around the temperatures between –9 and 43 degrees Celsius (Federal Motor Vehicle Safety Standards, *Windshield Zone Intrusion,* 1998).

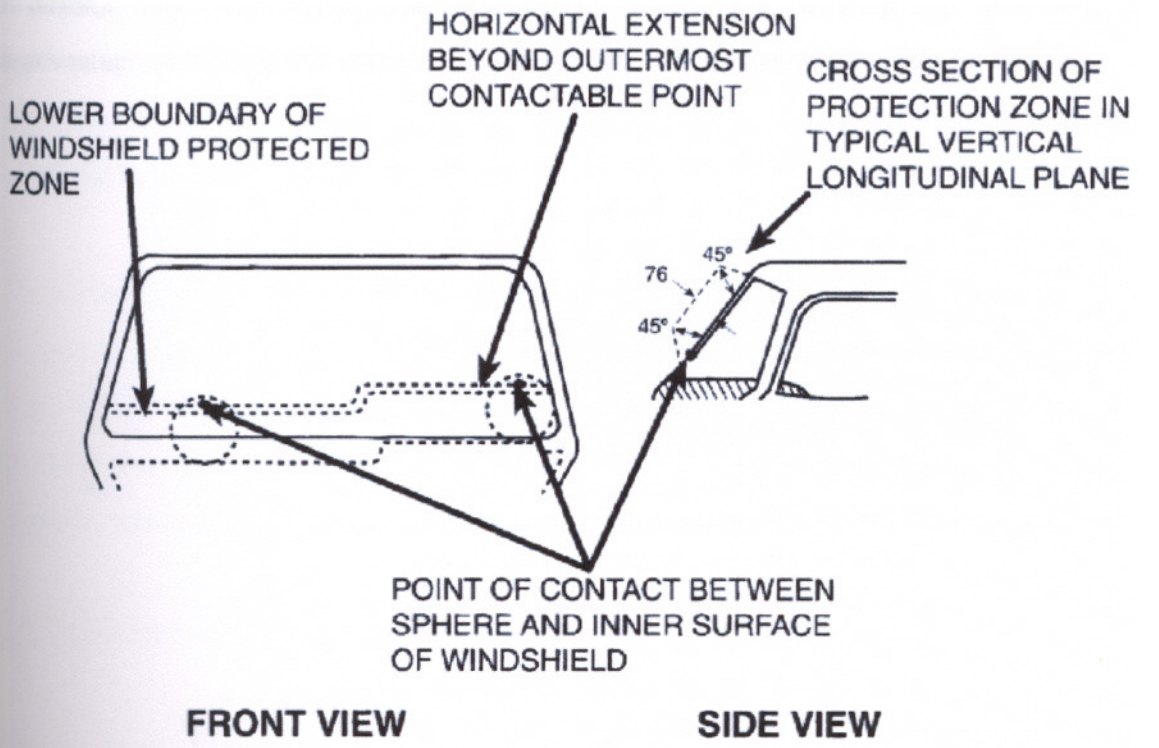

Figure 2.14. Windshield protection zone (All dimensions in mm).

In the project, windshield is glazed with the types of glass-plastic. It contains of from outer to inner, tempered glass, polyurethane film with energy absorbing capabilities and polyurethane film with abrasion resistance capabilities (Duffy, 1996). It reflects the aesthetical portion of the design. Forming it with body, in open-body cars, or on fully closed types with other windowpanes identify the shapes. Also, it provides to see the around and deflects the airflow to the side of the driver. Seeing around clearly is required the

windshields to provide with washing and wiper systems. Existing wiper models has mounted on, either by one or two points onto the hood edge side adjacent to the outer side of windshield. Although they have the period of 45 waving per minute, the system is still weakness to achieve full clearing. As a way, we thought that a rain sensible system may use so thin transparent elastic material that rolled up around a bar secured front roof edge, held by asides on path using the front pillar hole. The system functions manually or fully automatic options by winking like an eye as if it were scanning the surface. By doing that, whole system could be secured under finish elements and could be prevent the disadvantages of dusting. Since the system could clear more area at one winking and deflecting the disadvantage of waving that restricts steering safety, it becomes more viable for the car.

CHAPTER 3 SAFETY SYSTEMS

Any system that aids in hindering accidents and uses its ability to lessen or to moderate risky results from ram injurious, albeit at a mortal crash. According the search on crush rates per country Turkey has a population of 70% that had an experience with traffic related accidents at least one time in their lifetime while the other countries at an average of 50%. That also shows how utmost importance a restraint system for occupant, especially for our country.

Very innovative systems emerged as safe can primarily be distributed into two groups:

- Passive Protection Systems and,
- Active Protection Systems.

The discriminations of two to notice are rather more complex such that one member of group can become a member of another group or, can be designed as semi-active or passive systems in proportion to using of electronic components. Therefore hardware which is originally first founded and settled in which category, will be started explaining in that category, with respect to its other characteristics being assumed a part of it in that portion.

3.1. CONCEPT OF PASSIVE PROTECTION

Concept Passive Safety contains both structural and design features that require no action by occupant. Such systems could be put to use as in a wide spectrum of car structure. Originally, those systems forlornly designed to provide specific purposes. But, by the years it was realized that centerpiece arrangements of passive protection systems, although in complexity of both engineering and design, were multi connected or integrated system designs such that whole parts would work in a way in which the harmony reached up.

3.1.1. RESTRAINT SYSTEMS

Most likelihood of knowing as passive protection systems, are occupant restraint systems emerge as passive belts, knee bolsters, and head restraints with seats. The purpose of these equipments is to protect someone in case of ejecting through the interior surface. Such as through the windshield, instrument panel, pillars, or side window pans and doors of the car and to encumber their jerks to such deceleration levels as can be endured without externally and internally serious to fatal injurious.

a. Passive Belts

Primitive type of Passive Belts is knowing as sash belt now superfluous that was jettisoned as of 1960. As for first concepts of main passive belt were developed through the `70s and early `80s and cars outfitted with various types of passive belts around `83s by stationary regulations in relation to the requirement of passivity in car occupant protection systems. With adoption of passive belts and within its starting using in cars showed that the injury risk for occupants, first, significantly mitigated, even though those had produced unreasonable and unnecessary injury patterns.

Passive belt has three types of its configuration as:

- two-point shoulder belt, or torso belt,
- two-point and door-mounted belt, and
- three-point and door-mounted belt.

First produced model of passive belts two-point shoulder belt attached to a retractor at the console and contains a mouse as motorized buckle running along the roof rail. As front door opens, simultaneously the belt makes its forward movements to allow the occupant to ingress or to egress the car. When the doors close the belt goes back rearward to the window frame or pillar. But, although reducing the injury risk the belt foments essentially important three types of injury patterns due to the allegations in its design. These are:

- The risk of ejection, as well it might be ended with death,
- The risk of submarining emerged in frontal collisions as the lower portion of occupant's body forward and outward under the belt, results in spinal cord injury and even decapitation as a result of occupant to be restraint by his or her neck. To encumber abysmally high risk of injury and moderate an additional passive system concepts as knee bolster, and lap belts were introduced with this belt so as to allow femur bones to handle the occupant loading in a frontal collision and to provide the same pelvic restraint, and
- The risk of thoracic injuries, rupturing aortas, and lacerated livers as the forces applied from the belts to the torso.

The second model two-point and door-mounted belt assembly to the front doors by a permanently mounted shoulder belt, or torso belt. Once the door opens the belt recedes away from the occupant for making riding on and riding of position available. That systems is in need to be provided by knee bolster instead since the same injury patterns incur as in two-point shoulder belt, or torso belt, but additionally the occupant might be totally unprotected in event of opening doors.

The third and last is a combination of the door-mounted belt as well as two-point with a integrated lap belt, together all mounted and anchored in the door. The belt contains a buckle in order for occupants to use it as either a passive or manual use. Such that when the latch is disconnected and the door is its fully opened position the belt easily can hang on the car's door and once the door in its fully closed position the occupant can buckle the belt as in a manual use. The only risk of the belt is to leave occupants in their unprotected and fully unrestraint positions in case of door latch disengaging from locked position (Palmer, Robert M.N., *Passive Belt Litigation*).

Those signed product risks for belts break even the protection as a result, and all become insufficient to provide the occupant not to exceed the impact protection zone. But, should think that any car with any belt correctly placed in exercise of due care is counted as one and a half cars. Otherwise, a belt halves the unladen car weight. So if all considered, it is very

simple to correct that application defect. Missed anchoring system is there in synovial pillar, or B pillar, a very structural stiff area, next to the front door window frame where the door is formfitted to, just in stead of in the door. In doing so, the effectiveness is tied. But the easy way of getting out will be lost.

Giving a lead, we recommend both manually and automatically use that where a belt fixed on the seats (since the frame so rear to the driver, in project) and an automatic retractor embedded as close door locking point as possible, or integrated the latch system of the door itself. Therefore, once could mechanically sense a movement from inner door latch system it tautens the belt easily. The tightening aims to get body velocity slowing whilst car being decelerated as well as achieving the tension at the moment of ramming.

The softening rate for occupant deceleration shall meet the requirement of 20 gram per millisecond (Federal Motor Vehicle Safety Standards, *Seating Systems,* 1998).

In its manual use a switch button not a knob designated an area on the locus of the steering wheel that tightens or loose the belt tension. The button area very apropos due to also contacting the steering wheel cable with engine. It would very effective to be disengaged from the belting especially in the event of being side impact, and also for comfort in under weigh moment. Since its function it could so called horsewhip. And the system accompanied with the engine, as existing examples, by a contacting element as fibber optic cable since its beam flow is in very jiffy than others.

The standards at minimum provide the use of three-point attachment what are likely to even out two-point with lap belt. Therefore, and also with referring the consequences above, the type of belt determined in Family car to be three-point belt where one end of it attached the retractor, mounted on the door, one mounted on seat-recline near to openings of the car, and one side affixed the console right rearmost location to the driver's seat. For rearward and facing forward outboard seating position of family car is equipped with an integrated belt.

b. Head restraints

Head restraints are used to reduce the frequency and severity of neck injury in rear-end and other collisions.

Under the standard of FMVSS, a head restraint counts as a device that limits rearward angular displacement of the occupant's head relative to his torso line. The requirements applied weight of car not more than 4535 kilograms (Federal Motor Vehicle Safety Standards, *Head Restraints,* 1998).

Several types of head restraint could be counted as:

- Integral head restraint, and
- Adjustable head restraint which also regarded as vertically adjustable head restraint, head restraint in both vertical and angular adjustment, and self-aligning head restraint.

Integral head restraint contains an affixed pad merged to the seat back and has not any ability to jerk and round any direction.

Adjustable head restraint consists of a separate head restraint pad attached to the seat back by sliding metal shaft. The occupant, then, takes the advantages of adjusting the headrest by moving to top, bottom, and intermediate positions in conjunction with angular rotation so that angular fixing allows the occupant to set closer to the rearmost portion of the head in either fore or aft position. Self-aligning head restraint also named as automatic headrest which features two sensors located at the top of the pad that scan the occupant to determine how tall they are, then automatically position the restraint at a high entailed. Another additional hallmark using a seat belt attached to headrest by belt anchor performs the headrest so well to reach its forte adjustment.

Both are installed on split or bucket seats and bench seats inboard car with a loftiness at least 698.5 millimeter in their highest position referencing the occupant seating reference point or H-point, or SgRP, stands for seating reference point (Federal Motor Vehicle Safety Standards, *Head Restraints,* 1998).

Those systems are designed based for the occupants who involved in the category of 95 percentile equals an average height of 1800 millimeters or over and considered to be in 711.2mm above the seating reference point when adjusted to its fully extended design position. The effectiveness of those at reducing neck injuries in rear impact very successful such that both integral and adjustable head restraints in efficiency of 17 % and 10%. The difference is due to integrals primarily being higher in respect to the occupants' heads than adjustables (NTHSA, 1982).

Within their historical background, the forces to forage outcomes showed that in case of being 787.4 millimeter shallow from occupant reference point, headrest becomes more than twice as effective than a 711.2mm high restraint at a relative speed of 48kmph for car at reducing neck injury. Again with respect to outcomes, the head restraint should take the most considerable attributes for a better safety in its design as follows:

- Measuring either 63.5mm below the top of the head restraint or 635 millimeters above the seating reference point or H-point, the lateral width of the head restraint shall not be less than 254 millimeters for use with bench-type seats and 171.45mm with individual seats,
- Increasing recliner stiffness results in diminishing neck injury, but on the other hand, using plastic materials to a great extend in the seat recliner saves for occupant rebounding velocity,
- Contouring edges not more than 3.2 mm in radius precludes any possible neck injury as a result of static contact by a head, and
- Any headrest should be constructed with energy-absorbing material.

c. Seats

Seats placed either front or rear seating position, used as an outboard-seating element. Seat types in the car are bench and bucket with the options of adjustment, folding, and armrest for the front and back positioning. Seats are the snug elements and it is also the equipment for decreasing the forward sliding in any braking, and a device absorbing the rearward collide loading. Since their functions, a seat design required much attainment.

Design features of the seat, in the event of rear ramming, are considered to meet the following neediness:

- Stiffness,
- Containment and retention,
- Preventing whiplash, and
- Diminishing rebound velocity.

The recliner stiffness mitigates the neck injury or *whiplash injury* as well as a head restraint. The other factor of rebound velocity is met by using the plastic of energy absorbing material in the seat recliner. Rebound velocity also lessened over the surface of seat itself, and supported by means of bumpy texture with poring.

The construction of stiffness takes the trajectory of force as base. For an installation of bench seat in the rear, in a seat plane versus the vertical torso line, a stiff strut, as rigid cross member of the carcass in the horizontal plane of the seat's center of gravity, is placed in front of the seatback frame for forward loading. Just for rearward loading, a new one faced another already existed. Next, a diagonal member affixed on each side of the carcass from the horizontal centerline on the seating bar adjacent to the struts in the centre of the gravity to a point forward end of the seating anchorages. And then, the carcass with members fixed on the car chassis (Figure 3.1., Figure 3.2., Figure 3.3.).

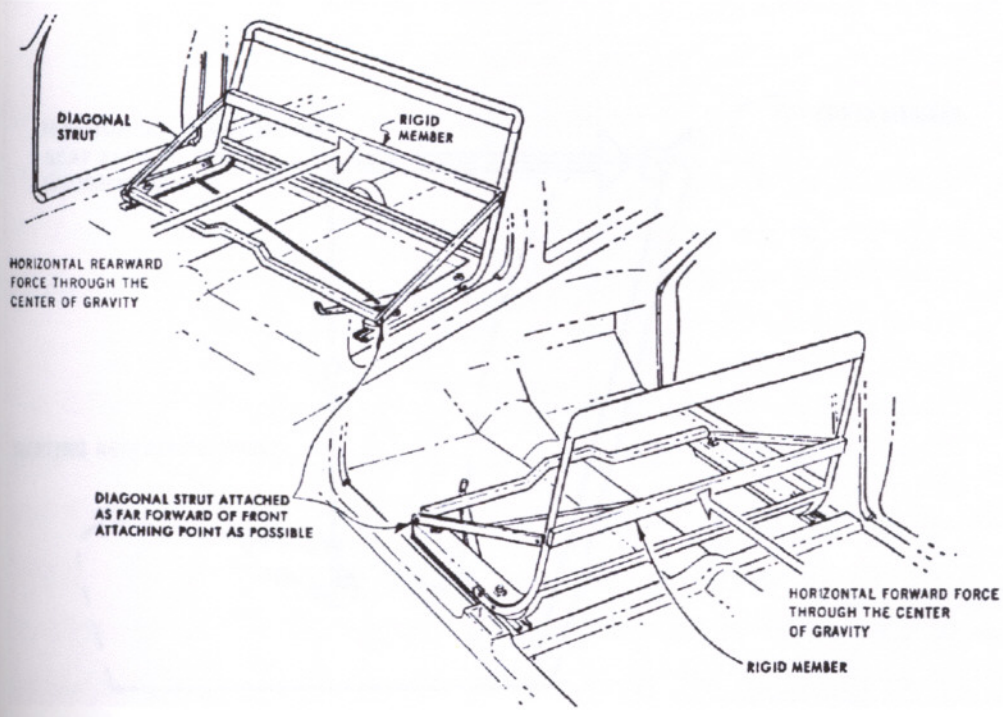

Figure 3.1. Constructing elements by direction of impact.

The installation of the bucket or individual split seats for the front outboard seating position required two rigid supports as one base to the chassis the other interval element among base and seat frame. An additional design hallmark as suspension is combined with the seating carcass.

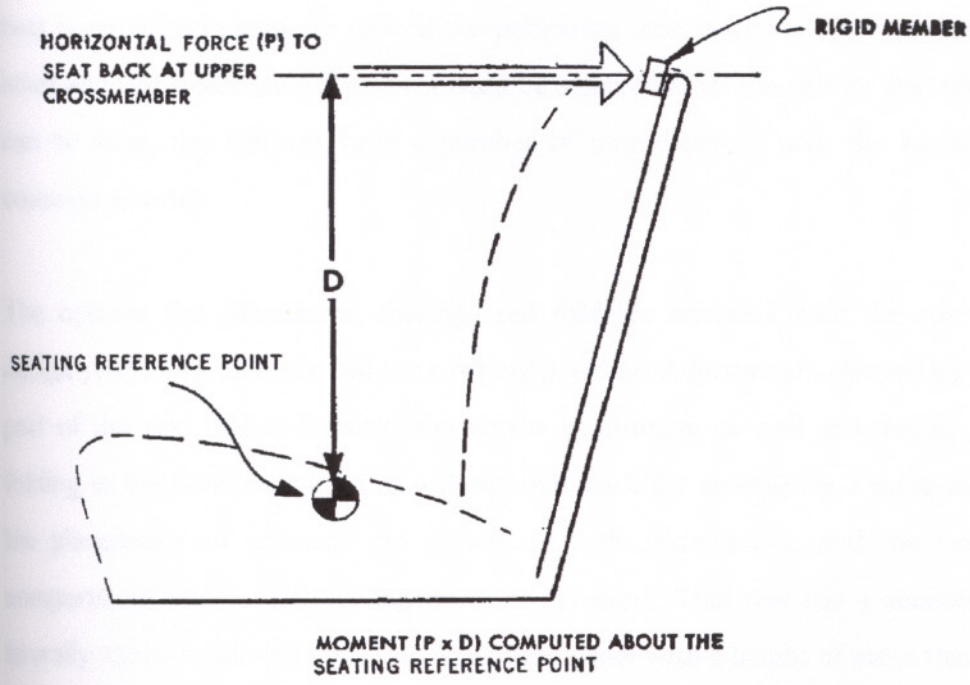

Figure 3.2. Front inertia load to the seating reference point.

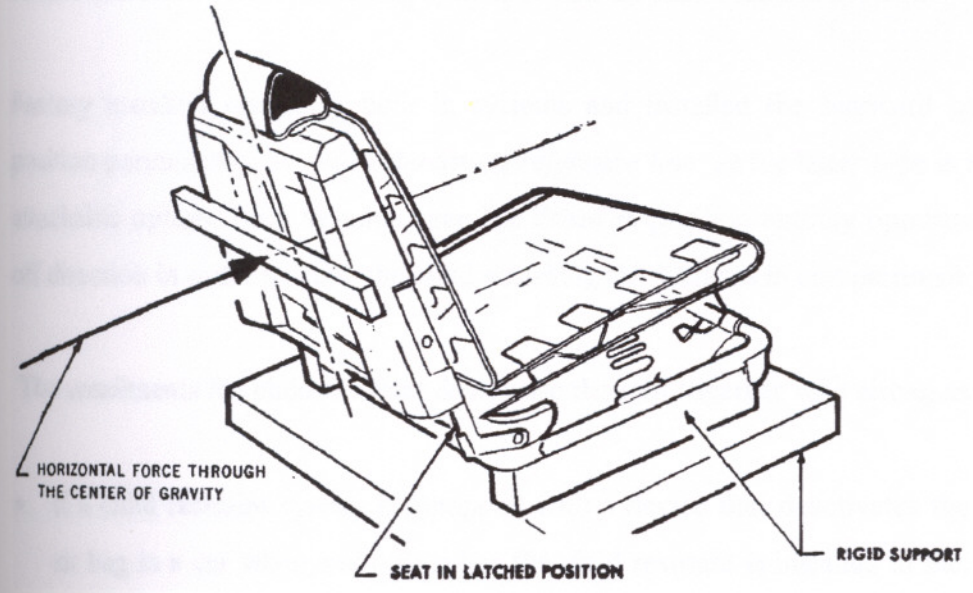

Figure 3.3. Rear inertia load to the seating reference point.

Here, for no sliding, a material, as gorix, can be used, which also immunises the film heat level and never change its temperature, and contributes the occupant by no absorbing the heat coming body so as to reduce the perspiring, and oppositely to increase the snug. The inner element underneath the cover need be selected from the energy absorbing material. As can be seen, the features have a number of convergences with the headrests since their common sharing.

The options for adjustment, folding, and foldable armrests with the seat presents some design properties on body and for a roomy position. Adjustment achieved by an adjuster as a part of the seat makes forward and versus positioning as well as rotating. The portion of folding in the family car used as a design hallmark for emergence a three-door model. And the placements of armrests are lashed onto the side doors, and the rearmost covered compartment panels with having no door-openings. That rest has a secured rigid member laterally 32mm inside the cover surface of the panel with a height of more than 25mm.

In respect to childrests as mini seats or restings, their design can be either factory installed-built in childrests with rear facing system or add-on child restraint systems.

Factory installed rests is a built in systems and installed the rearward outboard seating position permanently by *seat orientation reference line*, as for latter type is in a use with an attachable option. Both systems keep the infant in position entirely opposite to the moving off direction in order to keep the child smashing the surfaces in compartment impact zone.

The entailments for child restraint device are thought together with airbag as:

- If a child restraint system is equipped with a device that deactivates the passenger-side air bag in a car when and only when the child restraint is installed in the car and gains a signal, for at least 10 seconds after deactivation, and
- The child restraint system should be installed in the right front seating position with a continuous-loop lap shoulder belt.

In project seats designed rotatable from one point that together anchoring point is the same location with the belt anchor location. It is considered only for aesthetic proportions. By doing that, one biggest point on each seatback aesthetically is emphasized. And condensing adjustable restraint system together with seatbelt provides functioning together in the event of colliding (Figure 3.4.).

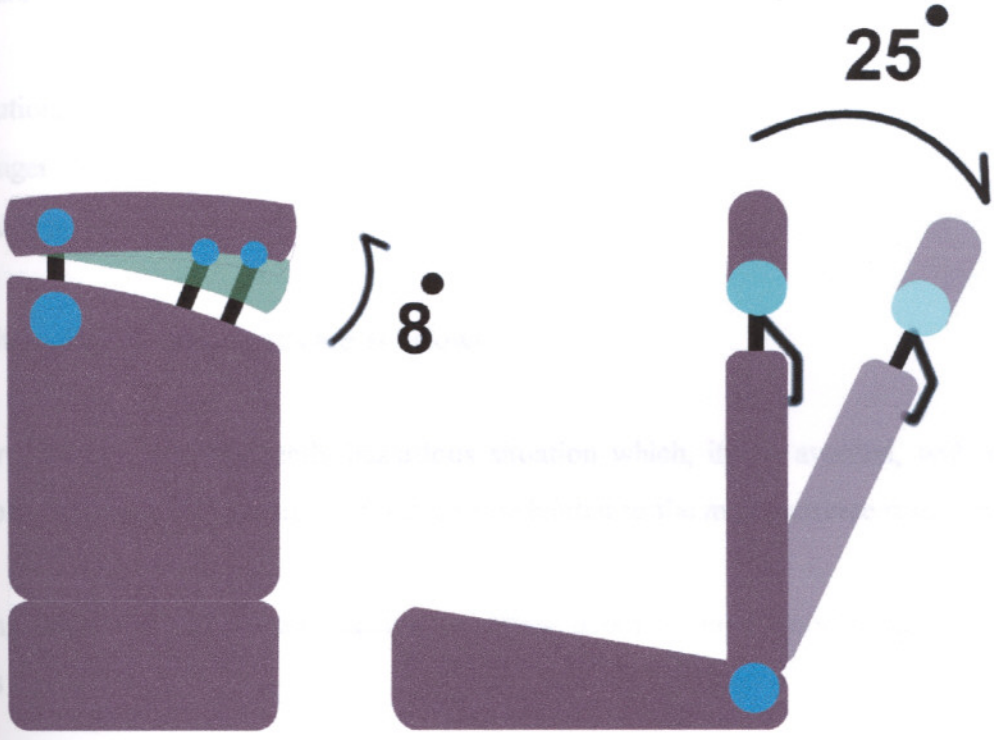

Figure 3.4. Schematics of seats of Dainty Vehicle.

3.1.2. SIGNALS

Majority of occupants is likely to have an experience with unreasonable accidents due to the defects of product's use or due to its complexity. Aiming above, for car's structural parts to draw occupants` attention adequately, the signals are required to meet the standards within its criteria, what are likely read, feasible, and capability to presage occupant effectively.

Depending on the standards, and in terms of letters, use of one of three signals is entailed. These are:

- Caution,
- Danger and,
- Warning.

The criteria for the three words are as belows:

Danger: Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

Warning: Indicates a potentially hazardous which, if not avoided, could result in death or serious injury.

Caution: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

The most apropos one of them for passive restraints is Warning.

Placement of signal words are assumed to able easily to see by occupants in front seating position of interior space, especially for steering controller. Most likelihood of placing these signal notes or design notes are high as labels permanently affixed to the sun visors in its

stowed position, placed in any position where one side of the visor is in contact with the car interior surface such as windshield, side rail, front header, roof, etc. Or could be placed onto the equipment itself.

Signal words plotted on where should be within black letters on an orange background. Any message or information area refers to the signals shall be white in 300 square millimetres with black text.

As for appliance this requirement many of car manufacturers were under the standards to be moved over to their new design, such as redesign of sun visors, just for pursuance of the standard. Nowadays, pictorial presaging are being highly used as well as signal or design notes. The pictogram in black with a red circle and circle on a white ground are considered to be no less than 30mm in diameter. Those are represented in the part of identification of controls and displays. And also signals are not bounded in this part when it comes in necessity would mention over all of thesis.

What we have said in terms of signals is pellucid as in two samples labeled on sun visor or dash, and child seat are figured belows:

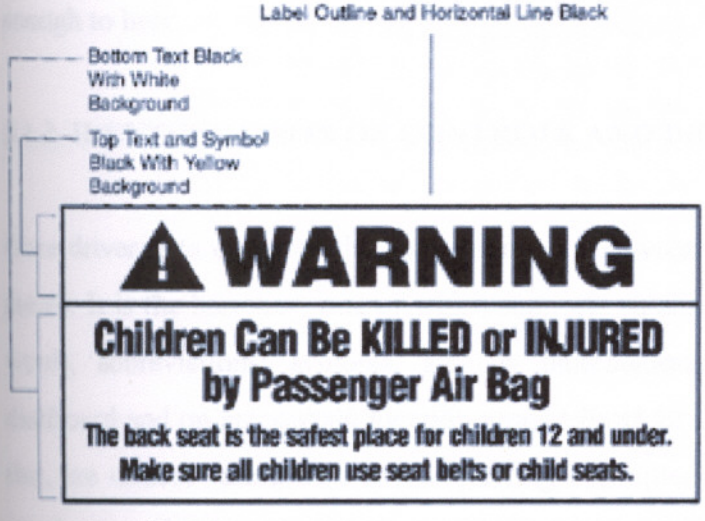

Figure 3.5. Removable label on dash or sun visor.

Figure 3.6. Label on child seat where child's head rests.

Just another signal is sounded as lights and buzzers or chimes. These audible signals are very innovative electronic systems connected to the passive restraints by a cable within a precautionary warning interlude between 8 to 12 seconds that activates a continuous or flashing presaging light alteringly with a period of time of 60 seconds, beginning when the car ignition switch is moved to on or in engine cranking position. The most considerable criterion for them are, sequencely, to be enlargedly enough to presage and lenghtenedly enough to hear.

3.1.3. IDENTIFICATION OF CONTROLS AND DISPLAYS

Once driver gets on a car the communication between each other provided by existing of means. It is the harmony, one of which supports auxiliary control and display means are by words, abbreviations, symbols, and by illuminations, whether they are mounted on dashboard and on any certain location around *head form* that those all facilitate selection of that, are utmost seriousness to the steering controller's attention. Or the others, such as *accelerator, clutch,* around seating position need not be identified.

Defined words or abbreviations, and illustrations of the means are presented in figure 3.7. and figure 3.8. would be helpfully useful for coming explainings:

Column 1	Column 2	Column 3	Column 4
Hand Operated Controls	*Identifying Words or Abbreviation*	*Identifying Symbol*	*Illumination*
Master Lighting Switch	Lights	5	———
Headlamps and Tail Lamps	(Manufacturer Option) [2]	(Manufacturer Option) [2]	———
Horn	Horn	4	———
Turn Signal	———	3 5	———
Hazard Warning Signal	Hazard	5	Yes
Windshield Wiping System	Wiper or Wipe		Yes
Windshield Washing System	Washer or Wash		Yes
Windshield Washing and Wiping Combined	Wash-Wipe or Washer-Wiper		Yes
Heating and or Air Conditioning Fan	Fan	or	Yes
Windshield Defrosting and Defogging System	Defrost, Defog or Def.		Yes
Rear Window Defrosting and Defogging System	Rear Defrost, Rear Defog, Rear Def., or R-Def.		Yes
Identification, Side Marker and or Clearance Lamps	Marker Lamps or MK Lps	2 5	Yes
Manual Choke	Choke	———	———
Engine Start	Engine Start[1]	———	———
Engine Stop	Engine Stop[1]	———	Yes
Hand Throttle	Throttle	———	———
Automatic Vehicle Speed	(Manufacturer Option)	———	Yes
Heating and Air Conditioning System	(Manufacturer Option)	(Manufacturer Option)	Yes

Figure 3.7. Identification and illustration of controls.

Column 1	Column 2	Column 3	Column 4	Column 5
Display	*Telltale Color*	*Identifying Words or Abbreviation*	*Identifying Symbol*	*Illumination*
Turn Signal Telltale	Green	Also see FMVSS 108	1 6	—
Hazard Warning Telltale		Also see FMVSS 108	2 6	—
Seat Belt Telltale	— 7	Fasten Belts or Fasten Seat Belts Also see FMVSS 208	or	—
Fuel Level Telltale		Fuel	or	—
Gauge	—			Yes
Oil Pressure Telltale		Oil		—
Gauge	—			Yes
Coolant Temperature Telltale		Temp		—
Gauge	—			Yes
Electrical Charge Telltale		Volts, Charge or Amp		—
Gauge	—			Yes
Highbeam Telltale	Blue or Green 4	Also see FMVSS 108	6	—
Brake System 8	Red 4	Brake, Also see FMVSS 105 and 135	—	—
Malfunction in Anti-Lock or	Yellow	Antilock, Anti-lock, or ABS. Also see FMVSS 105 and 135	—	—
Variable Brake Proportioning System 8	Yellow	Brake Proportioning, Also see FMVSS 135	—	—
Parking Brake Applied 8	Red 4	Park or Parking Brake. Also see FMVSS 105 and 135	—	—
Malfunction in Anti-Lock	Yellow	ABS, or Antilock; Trailer ABS, or Trailer Antilock. Also see FMVSS 121	—	—
Brake Air Pressure Position Telltale	—	Brake Air. Also see FMVSS 121	—	—
Speedometer	—	MPH and or km/h 5	—	Yes
Odometer	—	— 3	—	—
Automatic Gear Position	—	Also see FMVSS 102	—	Yes

Figure 3.8. Identification and illustration of displays.

- First off, any car hand-operated control listed in column 1 of figure 3.7. should identified either by a symbol or substantially congruent in form to that designated for it in column 3 of that figure or by the word or abbreviation shown in column 2.
- Each of some for which no illustration is shown should be identified by the word or abbreviation, and
- Any for which additional words or symbols should be specified by designer's discretion as "Dss. Option".

Those plotted symbols and others are settled in a position, they shall be either on or adjacent to controls and displays. Regarding visibility and accessibility, their perceptiveness may be upright or not to the driver. Identification of some hand-operated and all foot-operated controls need not appear to the driver perceptually upright, except include. This requirement are subjected to followings:

- A master lighting switch or headlamp and tail lamp control that adjusts control and display illumination by means of rotation, or any other rotating control that does not have an off position,
- A horn control,
- Turn signal control which is operated in a plane parallel to the face plane of the steering wheel in its normal steering position and which is located on the left side of the steering column. So that, it is the control on that side of the column nearest to the steering wheel face plane,
- Automatic car speed control located on the steering wheel, including the steering wheel hub and spokes.

Identification each function of any control, such as speed control, heating and any air conditioning system control, and for the extreme positions of any means operates a function over a quantitative range:

- Either in a word or abbreviation, or
- In colour coding.

Extreme examples for each are a switch has three adjustments for heat, defrost, and air-conditioning. Since each position regulates a different function must be identified. And a slide lever controls the temperature of the air in the car heating system over a continuous range from no heat to hot. Since the control regulates a single function only the extreme positions meet identification by means of words, or color in which hot extreme specified by the color red and the cold position by blue of colour.

On displays, as can be seen in the related document of figure 3.8., two definitions are available as *gauge* and *telltale*. Both are very functional when the telltale used in conjunction with a gauge such that it need not be any identified. The definition of any display are considered to be visible to the front left seating position and appear to that position perceptually upright.

Telltale gives away information that would not noticed by the driver positioned infront seating while travelling. If the information measured over an extreme level the system has a use for originating warning the driver. To warn a light emitted by tell-tale called as illumination. To be effective of both telltale and gauge displays shall be capable of being illuminated in a condition when any malfunction incurred.

Illumination of each gauge or telltale checked when the headlight or ignition switch is activated, or during the *bulb-check* upon car starting. This is a prerequisite safety step for controlling the means whether being successfully functioned or not. Source of illumination in the compartment of the car is forward of a transverse vertical plane 110.6 millimeters or 4.35 inches rearward driver seating reference point with the seat in its rearmost aligned position. The source has capable of illuminating while the car is going distance.

Any information from any source for telltales and gauges can be subjected into one common display also named readiness indicator in lieu of spreading to related means. In this concept, telltales for the brake, high beam, turn signal, tire pressure, radar distance warning in related to the automatic steering using image information, and safety belt except during its fastening may not be added on common space, but the others must be encompassed. Information printed on display seen as either repeated in sequence or indicated by visible of being selected by the steering controller for viewing as well as a function of abortion. For example an airbag, for both driver and occupant, deployed manually by an on-off switch system must monitoring and warning the occupant in an unilluminating visibility. And for belt once the ignition switch either on or start position, simultaneously, could emit the information like tautening seat belts.

3.1.4. FLAMMABILITY

Before case of any firing originating in the inboard car from sources such as overheating of interior compartment causing by sunlight, or the causes as cigarettes and matches, flammability of any material any components of car occupant compartment built up need to meet predefined requirements. Fulfillment of burn resistance to any flammability for a car is come to think of either interior or exterior components.

As first, in compartments of all motor cabin, trunk, and inner area of any place to which the occupant directly in contact or where statically contactable surfaces are obtained separately listed below:

Seat cushion, seatbacks, seatbelts, headlining, convertible tops, armrests, all trim panels including door, front, rear, and side panels, compartment shelves, headrests, floor coverings, sun visors, curtains, shades, wheel housing covers, engine compartment covers, mattress covers, and any interior materials, including padding and crash deployed elements that are designed to absorb the energy on contact by occupants in the event of a crushing.

For latter, finish elements or covering panels as well as used material to prevent from corroding and degradation of surface colour caused by sunlight.

3.2. CONCEPT OF ACTIVE PROTECTION

Dependable driving gets the car to go smoothly as well as minimising the defects by noticing the possibilities before case of occurrence of accident. Such protection involves systems with innovative safety features, such as visually impressive driver information systems, advanced car control and crash avoidance systems, for example, in terms of handling and braking abilities of the car and ergonomically correctly mounted controls. Those systems are always being significantly important as long as the cars are gradually getting merest in their size.

We are thinking of examining some parts of active protection systems in chapter 4 while explaining the project.

3.2.1. AIRBAGS

Air Bag Protection Concept applies on car as head-on protection systems also called Supplemental Restraint System. Originally, it has founded as a very innovative hardware to eliminate the need for seat belts. However, the requirement for belts is proved and stated under the enforcement of standards. Then, airbags became secondary effective protection systems that hinge on seatbelts. Normally, the airbag is secured in the steering wheel, entirely forward driver seating position, in the area so-called *forehead impact zone* as dynamically deployed protective system.

Or, in case of the passenger side, crash protection by inflatable restraints systems as airbag placed in a position rearward of the dashboard in which the dashboard upper surface more than 125 mm inboard from the junction of the panel attachment to the body side inner structure. Or, the surface not closer the windshield statically contactable by the head form (Federal Motor Vehicle Safety Standards, *Occupant Protection in Interior Impact,* 1998).

The modern airbags comprise of two elements as gas generator and the airbag itself. The generator encompasses sodiumazid tablets in a steel canister. The other container saves the airbag as folded. Once the system actuated, simultaneously a chemical reaction converts the tablets into nitrogen gas. Then, the gas leaks from the canister and inflates the airbag at a speed of about 300kmph. The needed time for this process is approximately a-half second.

Inflating with a speed of nearly 300kmph foments some several injury on occupant's head including neck with some portion of upper torso. For an occupant especially under the age of twelve, it is most likelihood of giving irreparable damage. For that reason, it is not permitted the occupants to sit front seating position not less twelve, including age twelve, unless the adjustable seat is receded as far as possible of its longitudinally rearmost position

with a child restraint device. Additionally, it is better not to place any objects over the airbag or between the airbag and the occupant, and not to sit or lean close the airbag.

In the project, use of airbags in both front and rear compartment side is on ten points to the vehicle. The rate of front shares the 60% of all and other is applied on four sides. For design criteria, successfully preventing occupants from sides and head-on acceleration, sides one could be applied on seats. Easy attachment, being nearest to the occupants and applicability gains effectiveness and maximum protection rather than the one secured in roof rail or frames.

3.2.2. CONTROLS AND DISPLAYS

Facilitator elements whereon correctly furnished is foremost importance of reducing the event of crushes that are likely to happen by diversion of the driver's attention from driver mammoth task and thereby faults in selecting controls.

For a human driver after sensing crash possibility, the time for both latency and response is as of 1.0 second. Considering that numeric aspect, the utmost neediness of placement of controls and displays is comprehended.

By the way, standardised controls are defined by use of body region as:

- Hand-operated controls,
- Foot-operated controls, and
- Displays.

Hand-operated controls counted as steering wheel, horn, ignition, headlamp, tail-lamp, turn signal, illumination intensity, windshield wiper, windshield washer, manual transmission shift lever, windshield defrosting and defogging system, rear window defrosting and

defogging system, manual choke, driver's sun visor, automatic car speed system, highbeam, hazard presaging signal, clearance lamps, hand throttle, identification lamps.

Service brake, accelerator, clutch, highbeam, windshield washer, windshield wiper are included into the controls by foot-operated.

As for **the displays,** placed onto dashboard are as speedometer, turn signal, gear position, brake failure warning, fuel, engine coolant temperature, oil, highbeam, electrical charge. For minimising goofs, or maximising the safety, of selecting controls and for a better watching the displays whilst steering position operative words for each are entailed as belows:

- Visibility, and
- Ease of accessibility.

Visibility not only procured by proper placing, and also it is obtained together with or alone symbols, words, abbreviations, and by illuminations that are all discussed in part as identification of controls and displays of chapter 3. Hence, here, the operative words are being mentioned.

Control means, for meeting the safety requirements are designed for providing at least two levels of brightness, one of which is pellucidly discernible to a driver who has adapted to dark ambient road conditions. Besides it, means are devised operable manually or automatically. If adjusting between two extreme levels are directed by automatically, then control equipped with a device to restore the visibility in the event of identification invisible to the driver.

3.2.3. ADVANCED SYSTEMS PROVIDING FOR CAR SAFETY

Before the car driving technology electronically was supported, the steering controllers must had been at vigilance only by their senses, and concentrations. But electronic elements

having stated to use in car technology, they started to dispense with their common steering habits. Nowadays, the advanced systems become so widespread that even for the engine the electronic circuits are being used. In numbers, the electronic components are at the level of a quarter portion on the total manufacturing in the last decade of the year 2000.

After the advanced systems have been envisioned, gathering needs to beam the solutions are intended to do. Prodded by those reasons, monitoring driver's own state of fitness, enhanced driver situational awareness, advance warning of potential danger, emergency control, for the occupants, to intervene and to assist the in a imminent crushing, and automated driving or automatic steering process systems, are the cars equipped with.

It is significant that monitoring state of fitness could be cared with the adjustable headrests and seating systems. Advanced warning of danger are thought to be able to monitor on common display as mentioned in same chapter of 3.1.3. identification of controls and displays.

3.2.3.1. I.T.S

The subject precisely represents two important issues in automotive technology: improvement in safety technology, more precisely dwindling in disturbances based on product risks, or its converse product safety, and giving rise to transportation efficiency.

In view of technological developments, there have been many efforts around to thame these problems by applying image information processing, traffic control management systems, crash avoidance systems, and automatic control technology on cars. This approach commonly known as I.T.S, standing by Intelligent Transportation Systems. Here, we are frequently concerned with the first portion of that under conjunction to automatic steering with image information process.

3.2.3.1.1. AUTOMATIC STEERING USING IMAGE INFORMATION

Envisaging a car to being designed with a property of a self-guided system, together with the driver, makes comprise of a two-tiered system. It is abundantly clear that both manual and automatic steering approach take the injury jeopardies down, which enable the fast and reliable acquisition in car technology. Hereby, it will make use in converse the technology more advantageous for human mass.

The application of automatic steering system onto a car mainly oriented to the two factors that is adjustment of steering or direction and speed control of a car, both based on the information processing. Since the extricable relationship between two things steering angle and lateral deviation of a car, it is necessary to control the direction using a proportional and differential element in order to follow the trajectory in a constraint manner. What we have presented that achieve this using optical flow and position of two lane partition lines on each side of the road.

So, each factor is implemented within depending on the algorithm, which uses solely the horizontal component of the optical flow. Wisely, for speed control, in straight parts of the road, a predetermined maximum speed control command is performed, and in curved parts the speed is controlled using an algorithm uses the image information. However, this in contrast to the algorithm used in the past, which were based on the things like lateral acceleration and lateral jerk concept.

That system is a great effective at night departure situations and inclement weather conditions. Since the systems sense subtle the boundary of the road on each edge which the driver normally can not perceive the system aid in perceiving and clearing road sides.

3.2.3.1.2. CRASH AVOIDENCE SYSTEMS

The processing of crash avoidance systems results in summoning up the awareness at the moment of sensing the crash possibility. In this sense is expected to make a close coordination between the controller and the car, increasing safety while phasing out negative influences, and to make reduce slow flowing from being tightly jammed.

First originating of the avoidance systems after many researches by testing, simulating on cars are achieved. And, in many circumstances, the concept of testing the conditions in real environment by applying either a data gleaner or data spooling systems reasoned basic model of such systems. Now, it is as used data acquisition system for assessing the environmental parameters, interpreting the consequences, and detecting abnormal situation, shocking up the faults on common display as a result. In common, such systems for making sure establish how to react for aware of being enmeshed used existence knowledge bases generated from the outcomes and must keep its developments carrying open-enhanced data itself in making of contemporary, and for the purpose of utilizing new functions.

Being effective and serve the need efficiently an avoidance system must be in exact interfaced with the driver. A wide range of zeroing in on identifying the driver behaviour at the juncture of colliding, optimizing the countermeasures for controller and being controlled, and over resulting on steering workload that are all put to design and to develop such systems. But, how great attention brought for enhancing those systems, first must be induce the driver to obey their responses.

For a car, two-tiered with using advanced presaging packed systems, are branched into:

- Driver Status and Performance Monitoring Systems,
- Intersection Collision Avoidance Systems,
- Lane Change or Merge Collision Avoidance Systems,
- Rear end Collision Avoidance Systems,

- Road departure Collision Avoidance Systems,
- Systems for Assessing The Car Motion Environment, and
- Vision Enhancement Systems for Night time and Inclement Weather.

Briefly for all,

Driver Status and Performance Monitoring Systems are carrying the concept of a car-based device. It peers at the controller performance while departure position, monitors the data of status and performance, and in the time of detecting any faults or driver performance degradation system provides a signal to warn to take over controlling from the steering controller.

Intersection Collision Avoidance Systems, as a conceptual system, is the gathering of knowledge based on the analysis of predominant-casual factors of intersection collision problem size.

Lane Change or Merge Collision Avoidance Systems, as a viable system with its all countermeasures, assists the driver with zero mistake for carrying out lane change, merging, and backing manoeuvres.

Rear end Collision Avoidance Systems set a response to requirements of both human and car, using backward elements contains sensor, processor, and visually impressive subsystems as driver warning, interface of system, and control elements. The system orientated to countermeasure systems being self-contained and, having ease of attachment within the car and capability of cruise control as other with the data sets.

Road departure Collision Avoidance Systems uses the sensor technology to detection of roadway or lane boundaries. And with gathers the information basis from the unpredicted swerving, somersaulting, and ejecting from road path.

Systems for Assessing the Car Motion Environment are one group of other avoidance system that quantifies the specific movement a car exhibits. Once the system senses objects and other driving environmental features, and then records their location in the field of view relative to lane boundaries. All abilities in conjunction with the reaction to other cars, backing and forward manoeuvre and, with lane changing trajectories enhance the driving performance, regarding outboard-element safety requirements.

Vision Enhancement Systems for Night time and Inclement Weather rates clearance of road, visibility of pedestrians, and make subtle objects be able to seen in unwishing road and weather conditions by supplementary components.

3.3. REQUIREMENTS IN COMPLIANCE WITH SAFETY

Safety term is only one of all requirements a car has to be equipped with. Therefore, the idea is that a car, which will produce up, must consider its interrelationship with performance and useable space, comfort, noise, fuel consumption, traffic in urban areas, and cost (Figure 3.9.). Since the subject "traffic in urban areas" has already examined in the chapter 3 of 3.2.3. advanced systems providing for car safety, will not mention.

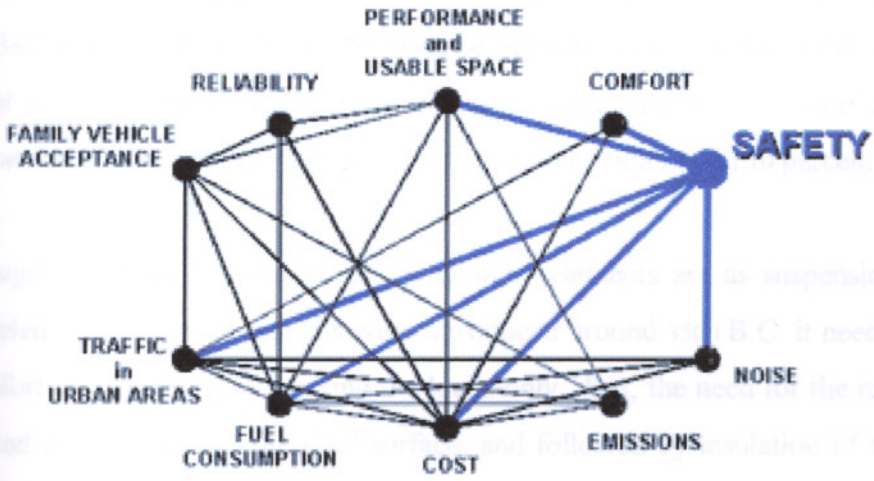

Figure 3.9. Interrelationship between requirements in compliance with safety.

3.3.1. COMFORT

A family car labelled with the premise safety it should meet requirements of comfort. Defined as physically relaxing and contenting that are not a feeling of pain or unpleasant sensation. Therefore, comfort partly hinges on space where the useability is optimum.

Occupant infront or rear sides of the car compartment, the factor comfort, or being in a snug position starts with its seating device. And going on the equipments exist around. Adjustable seating systems, covering materials, seat suspensions, car body form, occupant compartment

air space freshness, humidity, and the average heat temperature inside compartment, suspensions, and all other acceptable design features meet the anatomical neediness must be in exact conformity with occupant.

Since during travelling an occupant in touch with seating elements, and due to breathing, the inner area humidity and temperature rise up and rate of oxygen rises down. The film area among the hip and seat outer surface must be bounded in a constant level as nearly possible as between 19.0 and 26.0 degrees Celsius so that the occupants take their short or even long travel without felling any discomfort and ennui causing by perspiring. For the humidity and air freshness, the cooling system must be applied in occupant compartment on instrument panel either automatically or manually by rotating or pushing on-off switch button. The climate must allow the human body to be at any humidity from 10 percent to 70 percent.

As signed, one of importance of the comfort elements are as suspensions. When the first wheeled transportation systems were introduced around 3500 B.C. it need not contain a high comfort due to aiming at carrying the loads only. But, the need for the reducing the shaking started with smoothing the road surface, and followed by insulation of the bodywork from the road wheels. Then, in its development period, first examples appeared as a system that would base the modern springing systems being called suspension is just like an upturned table. And it functions only to move body and wheel separately. The concept was replaced by big C-shaped spring and it is phased out by powered car developments changing to elliptically shaped one.

Initially, the principles of the suspensions is to make keep the wheel adjacent to the ground, and to achieve extreme insulation from the vibrating resulting from irregular movements when hitting a bumpy surfaces. Shock pressures in those situations move the wheel directly upward or make the wheel sprung and then movement as momentum transferred to the chassis and the body. The movement upward turns back by the car body gravity so sharply. Therefore, springs are placed between the wheel and chassis since moving upward less rather than wheel. The utmost importance of the suspension is being designed considering its

movement frequency being coincided with the frequency of the wheel's vertical acceleration. But, significantly, in that acceleration together with wheel, the force could exceed the limits enough to lift the wheel off the road. So, the suspensions are not only made of springs but also it contains the damping device using the friction to dissipate the force or energy.

Struts as, used here, hydropneumatic suspension components are attached to the chassis by its upper end and affixed at the lowest to the carcass of the tire. To fix and not to swing the spring around strut used a heliozoan base. The conceptual design of the suspension system either active by adding an actuator, a pump, an accumulator and an electronic valve or passive ought to remove the verbose loads from the car at the shortest time as possible by tires. Hence, how important a suspension for driving stability, is realized especially in the event of inefficient of distributing and condensing load on each axis around tire (Figure 3.10.). Such that, it will make at least one side of the car collapse and probably will ensue a rollover crash with very a familiar consequences of jeopardy as a result of malfunction in veering a curve on the road.

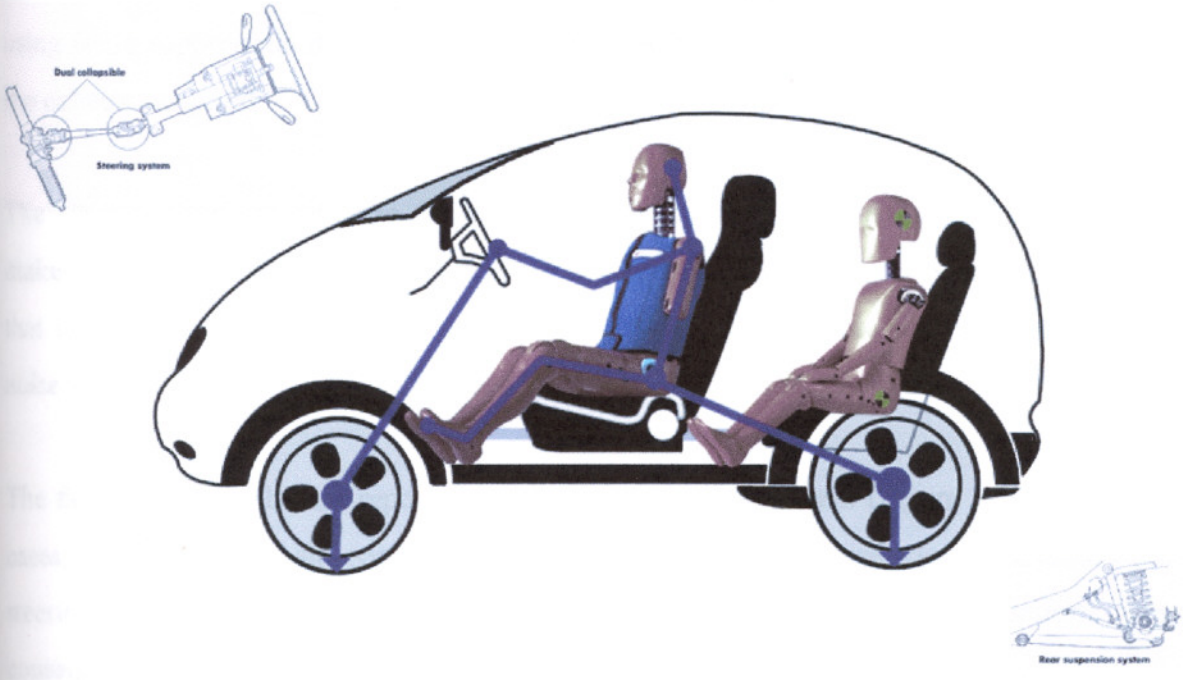

Figure 3.10. Schematic of effect of suspension system in Family Car in side-bisected view.

3.3.2. STREAMLININGS FOR NOISE, FUEL CONSUMPTION, AND COST

a. Noise

Noise through the inside the compartment depends on the body itself or the causes from environment. Husky noises and crash sounds emitting from the around, crackling coming from the motor cabin, wind noise from aerodynamic ineffectiveness, inefficient suspension, transmission, and noises of tires when moving at a cracking pace that almost all vibrate the body by creating a secondary sound source, disturb the driver, and may ensue to lose your driving concentration.

Additionally, the factor of comfort requires pulling down the noise to a negligible level.

The noise through the compartment of the driver radiates out either by window and door-openings or by connections so called bridges between compartment and car components. Since the noises radiate out from the motor cabin using the specified ways, scattering of the waving of the noises could be cut off via encapsulating engine itself, covering inward hood using noise suppression materials, and by placing a platform under body from the cabin to the exhaust manifold.

The other very effective way to get over the noise problem is to use a noise alternator that makes the negative copy of the sound from the area of noise field and then superimposes that negative wave onto the origin. In the end, the microelectronic signals pull down the noise zero, in conjunction with the accurately recreating the same noise area.

The factor vibration beams repeated small shakes and movements (Figure 3.11.). In most cases, emanating from air, road conditions, and also from the noise sources, it draws the steering controller's attention out of concentration and makes physical discomforts as a consequence.

For diminishing the vibration on car, the aerodynamic factors and the suspension system are required to have extremely solved. You could see the devised system for aerodynamic neediness to be informed peer into chapter 4 of 4.2.1.1. aerodynamics.

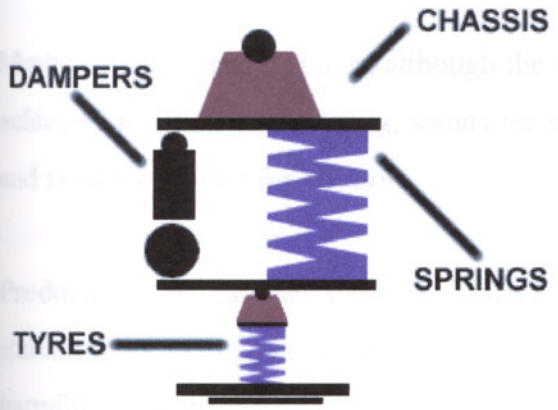

Figure 3.11. Schematic of vibration factor in the car.

b. Fuel Consumption

Once a car had emerged, simultaneously reams of fuel system have been developed, and also now. Most probable ones are regarded as oil and gasoline or benzine obtainable from petroleum, methanol from natural gas, corn as ethanol, water supply energy sources such as electricity, solar energy from sun, and hydrogen.

Gasoline a well learned fuel system around the world. Nowadays, almost all cars produced with an engine system uses that fuel as the energy source. But, use of such a source has cons as well as its pros.

First off, the role of gasoline in atmospheric pollution accounts for the portion of hydrocarbon at any amount of around 50 percent, carbon monoxide as close the range of 60-unit, and nitrogen oxide emission at the level between 40 percent and 60 percent in the air. Besides those, the continuously growing in the number of car using that fuel, especially in

the industries having least clean technologies, would make the *greenhouse effect* in the air as well as its life threatening effects. The physical and financial properties should compare with the other energy sources, the consumption level accurately seems lower, and the costs are par on with each (Mason, 1990, pp. SP-869).

Methanol and ethanol sources although the same cost with the gasoline, a car could be only achieved at the amount of mpg, stands for mile per ***gallon,*** a half times more for methanol, and twofold the fuel for ethanol.

Producing a car completely use of electric in the form of electricity, the pros added its profit statement as saving the energy around 30 percent of primary energy, although produces harmful emission.

And, as for the **hydrogen...** It is the most environmentally friendly energy source that has a careful consuming of the energy as of 2 with a half. The hydrogen reformed from methanol on-board using advanced fuel cell. That costly advanced systems would be the future energy source since the majority of solar energy as its biggest alternative is thought to be use in the agriculture.

You should look for more information to the chapter 4 of 4.3.1.3. engine.

CHAPTER 4 PORING OVER A CASE

4.1. AN OVERVIEW OF PROJECT

Under the definitions for creating the concept family car within limits, the project aims to present most appropriate model, and assumes to allow the person to drive it and to travel in safest position.

As introduced notable safety requirements for the car almost overall parts of the title, here, the project will be discussed with its design criteria, also benefiting from technical terms defining its meanings.

In the era leading up to Family Car Concept, naturally, there have been in an increase of variations of the sketches and the first renderings so that proportions of safety requirements could be correctly caught in shape. Therefore, the project would not eliminate the alternatives (Figure 4.6., Figure 4.7.), would make a way of briefing them, but will be focus on the basic model (Table 4.1., Table 4.2., Figure 4.1., Figure 4.2., Figure 4.3., Table 4.3., Figure 4.4., Figure 4.5.).

In design process, specified neediness is targeted the consumer as Turkish young family group and its common lifestyle regarding general structure of that. (Chapter 1 of 1.1.1. identification of Family Car, page 7-10). Here, it would be useful for discussing and briefing on what structural basis were thought of reflecting within and whilst projecting the title.

In the period of time starting 1923 and continuously leading up to now, having oriental culture has become aggressive one. Especially, the date in 1982, injecting and constructing new structure in commercial area directly aimed at revaluation the life of Turkish family. Additionally, constructing the idea on the concept as market economy which reaches every individual with a tremendous organization has been replaced and turned over to that of open market which serves the groups by reducing production cost on account of build-up

consumption, and increasing fiscal structure. That passion of commercialism, however, strictly effected the main kernel of family life and caused it to be more condensed and smaller in number.

Those all accumulation of experiences over changing in general marketing perceptiveness reflected on certain sectors. As a one of that, automotive sector, having a widen organisation scope, gradually used those way to the point for selecting targeting group for whom manufacturers produce the goods by intensely putting the technological advancements on current interest. Should we coincide each one, direction of future commercial region clearly will be directed to the side of group as family with supposition of making someone, or consumer as used here, induce or belong as much in any number by making a select on big portion on that unit.

Those commercial reasons are counted as only one of all criteria basis for selecting new structure, new manufacturing method, and a new one category. Using that databases as stated above, design features being used in converging with the Turkish young family social life in use within esthetical proportions and reflecting them through the form concept of the design encompasses following explanatory words:

- The concept for approaching the design has considered minimalism by using small components, but in highly efficiency, being able to do their tasks successfully. As for the car small in size, especially interior design simplified from its complexity for gaining acceptable space such that occupants will feel themselves snug, also with taking the advantages of sufficient cargo area in the luggage with a capacity of 72 kilograms, or 160pounds.

- Car designated as Dainty has established by volumetric size of 3100x1527x1590mm^3. The concept oriented towards emergence of side front doors with a hatchback (3-door bodystyle). The doors are designed to be easily detachable so that it would help for extricating the victim of an accident from the situation being in extremis.

- Form of the vehicle signs the personae of designer. While projecting it, as said, young family prototype was also thought of having an adapted lifestyle to the new commercial culture and its all necessity. Project is constructed on a way of mounting and placing devices such as front apron and front spoiler being smoothed with the surface of outside of the car, and even with body color. But, as headlamps, tail-lamps and signal lamps, the form was used to emphasize those only by reasons for making a complete opposite on formal congruence, and describing like an eye in symbolic meaning. So, the method of approaching external space of the car is based on the form concept as "from general to special", in contrary, in interior compartment design, tenably, on the concept as "from special to general".

We believe that the advantageous of contrast is always aside the small structures. So, even a headlamp may become dominating if others are only used to provide for condensing the perceptiveness onto the object. As here, hood surface, in a way, that covers the up-edge of front lamps in the sense of using counters as the tool of design trade, and whole.

Becoming narrower through the side of the rear portion of the vehicle is assumed to cause a unobstructed seeing, even at dark point. On countered side, the form remains to be done by a finish-element that would replace with rear side doors, in the concept of hatchback model. As based on safety and aesthetic concerns, barely rear occupants, children as here, is clear of dangerous position, and need not worry about thinking of the doors fully closed or not.

Especially, concave forms outward and convex forms inward are in extreme effectiveness for safer form construction. They contains compact concern, and would be a base for easily attachable, detachable, and even refuting blandness to the side of innovation so that a new design spots easily could be caught and could be redesigned. It is cited that form building is an action of taking pains over body. And that we are entirely seeing eye to eye with the theory of a car should be design and buildup onto a rectangle form near to square which provides to be correct in aspect to engineering concerns. Habits, such as using light but

decked and twisty contours on goods could be reflected the form criteria within esthetical concerns.

- The book written on cars in the title of "Araba Sevdası" by Recaizade Mahmut Ekrem basically tells our nation having the passion on cars as a decked device. Seeing that, fully embellished with reams of words or linen material, and accepting a car as a second home caused to a new type of mass transportation means under the name of shared taxi (dolmuş) that has not yet been done other countries. As it is, but more strictly configured a family car would response the family needs as private personal transportation mean. We recommended that the old type of those vehicles should be completely discarded and the use of family car should be phased in. So, there is no need for using alternative ones anymore.

The rules are the same as the world acceptance. But vehicles are required to be have body more off land in parallel to the road and geographic conditions, solving the complexity of aerodynamic efficiency with leveling devices.

As easily caught in name of the vehicle it should reply the requirements of children. As a way, we thought that how successfully cultural tendencies might be imitated within family car design. Coming in mind, stock characters of Turkish shadow theatre would have been echoed on a film display consisting of a bar that secures electric and electronic articles and a square flexible movie screen wrapped around the bar itself with the size of 300x300mm², and all system located at any side pane-frame with the property of one-point-rotating for easy controlling and folding property on convergence with advanced material and with its points. Another adjustable mini camera would superimpose the digital picture on that screen and will play the action. We think it would be very useful for children who really disturb psychologically in a long car travel, even at short distance, due to the feeling of being tautened in a covered compartment. Since the system controlled by the driver easily, being small in dimensions and stated rear seating position, it would not cause any driving degradation or any faults by system.

Other specifications (Table 4.1., Table 4.2.):

SPECS OF DAINTY VEHICLE			
Curb Weight kgs	700	HP	67
Torque	82/3100	Weight Distribution	60/40
Wheelbase, mm.	1946	Track f/r, mm.	55.6/58.8
Length-Width-Height, mm.	3100x1527x1590	Aero. Drag	.21
Engine	999 cc	Cylinder	4
Front Suspension	Struts,arc-shaped lower arms, coil springs, tube gas-pressure shocks, anti-roll bar	Rear Suspension	Semi-trailing arms, coil springs, twin-tube gas-pressure shocks, anti-roll bar
Steering	Rack&pinion, engine speed sensitive power assist	Steering Ratio/Turning circle ft.	15.4:1/32.8
Brakes	11.3" vented front/10.7" solid rear	Acceleration, 0-160 kmh, sec	11
Top Speed	162kph (limited, speedo says 160)	Fuel Capacity	60 litres (fuel tank under rear seat)
Transmission	ZF Type C, 5 speed	Ratios: 1st	4.21:1
2nd	2.49:1	3rd	1.66:1
4th	1.24:1	5th	1.00:1
Rev.	3.85:1	Final Drive	3.15:1

Table 4.1. Specifications of Dainty Car.

EXTERIOR FITMENTS OF DAINTY CAR	
Outside mirror case in car colours	White side indicator lights
Bumpers in car colours	Roof antenna
Steel 6½ J x 16 wheels with wheel covers, 205/55 R 16 tyres	Rear fog lamp
Central locking system	Open-door warning lights
Ready-to-drive spare wheel	Adjustable-range headlights
Activated carbon filter	Front windscreen wiper with 4-stage interrupt option
Central locking system remote control	"Monte Carlo" wheel pack: 4 light metal 6½ J x 16 wheels, 205/55 R 19 tyres, hub caps (for front)
"15" wheel pack 4 steel 6½ J x 16 wheels, 195/60 R 20 tyres, hub caps (for rear)	Anti-theft alarm system with interior surveillance
Fog lamp	Heatable front screen-wash jets
Remote opening system for luggage space and tank cap	

Table 4.2. Exterior fitments of Dainty Car.

Dainty Car presents high performance through road conditions within global perceptiveness as small which adds the car frenetic flexibility on curve parts of lane portion of the road for encumbering swerving, in parking areas, and in event of any traffic congestion in city. As not compressed down, and has enough space of interior with ergonomically enough components providing anatomical requirements, it provides relax travelling, easy drive, and maximum snug for occupants. Also the car supports the body by using hard shell as well as aerodynamic effectiveness for steering stability heeding jolts led on to by longitudinal, vertical, and lateral airflow forces. Inboard and outboard surface, the car is assumed to be outfitted with dependable driving accessories and hardware. Such as, automatically strengthened seat belts assembled to adjustable steering wheel, bucket seats with vertically and roundly self-aligning head restraints, a very unadorned dash board, gutsy designed chassis, leveling devices, an innovative windshield wiping system, redesigned sun visors, and others.

Figure 4.1. Color range of Dainty Car.

It uses an environmentally friendly small engine that fuels hydrogen as basic energy source, but easy adaptation for coming next the car will equipped with multi-fuel concept taking secondary fuel as gasoline.

4.2. STRUCTURE OF CAR

4.2.1. DISTRIBUTION OF CAR STRUCTURE

Very common car parts alone consists of the following categories:

- Body,
- Chassis,
- Engine,
- Front and rear axle,
- Master cylinder, reservoir and brake lines (will not be mentioned), and
- Transmission (will not be mentioned).

4.2.1.1. BODY

As first introduced above, body itself, should it is thought as a finish element with its interior of complete structure, combine the aerodynamic factors to aesthetic proportions into one. Originally, as body of car built up solely to protect the occupants from inclement weather was the case earlier with horsedrawn coaches. And also its design supposed to gain as much space as possible for occupant being under weigh condition. That is the reason how likely the body was to be changed over the period of one hundred years (Seiffert & Walzer, 1991).

After a while, since having increased serious to fatal injuries year by year as a result of accidents, car body became important factor for restricting damage of crash through interior compartment. Not only one factor, also paramount importance of reducing fuel consumption and the aerodynamic side of styling with aesthetic proportions that both have adequately predominate on body design. However, since designs become more productive via technical stakes, the factor of aesthetic has emerged as the most considerable to the consumer's broad social concerns. Hereby, energy conservation and others have not assumed as primary gains.

In Dainty car, body takes properties of the *mono-coque* hard shell concept (Chapter 4 of 4.2.1.1.2. structural concepts, page 83-84). The concept utilizes a rigid exterior as identical as rigid interior compartment of conventional cars. In case of a collision, the rigid concept of the smaller car causes the less rigid deformation zone of the larger one to yield and absorb the energy. It should be cited that Dainty hard shell concept contradicts others since traditionals support less rigid deformation zone outboard and rigid deformation area inboard car. It must do so, because front area of the Dainty car or boot portion outermost the car, since the motor became merest, has not enough deformation zones (Riley, 1994).

Dainty body basically consists of outboard elements as *hood, trunk, pillars, window frames, windshield, rear and side windowpanes, sunroof, and doors.* That all could be also counted as finish-elements including *front and rear apron, spoilers, and lamps.*

So, whole outboard element cover a content mostly discerned as belows:

- Either both outboard and outer side or exterior as finish-element.

All styling and compounding outboard elements in concept of mono-coque that are in compliance with each of all are required another study as aerodynamic.

4.2.1.1.1. AERODYNAMICS

Aerodynamics is the poring through the way in which the objects recede for a place against the air. The aim is to make the airflow off exterior surface of the car.

Aerodynamic design through the car body has been implemented via three factors. These are:

- Frontal area of the car,
- The square of the air velocity in the airflow direction, and

- The shape of the body with a specified coefficient of aerodynamic drag as CD.

First off, together of three factors directly influence the driving stability, handling, fuel consumption, and the speed of the car. The first of three factors is not supposed to effect aerodynamic ability of the car positively since car interior shape depends on the generation that becomes huger in size by years. But, the others have highly intense effectiveness as mentioned, in which the shape of the body with its design limits must be defeated or minimized the effects resulting from air forces.

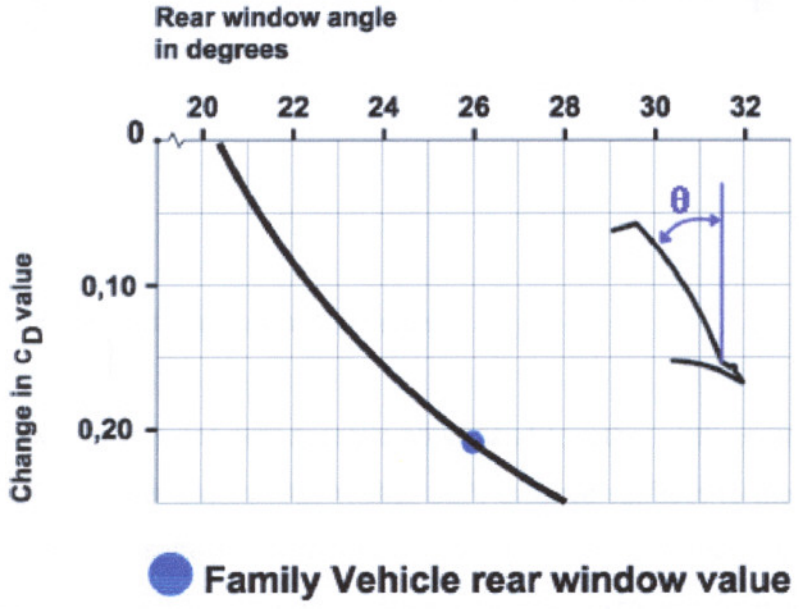

Figure 4.2. Graphic of Dainty Car rear window value.

As seen, figure 4.2. prepared utilizing from the test outcome tables for the project car. It shows the drag coefficient or CD value of nearly 0,21 is acceptable for aerodynamic efficiency and under the limits of 0.3 of CD. But, it is cited that especially after rear end degree of 62 the CD value does not make so respectable effect on car aerodynamic. If so and over, it should only reply the design criteria for aesthetical proportions as in figure 4.3.

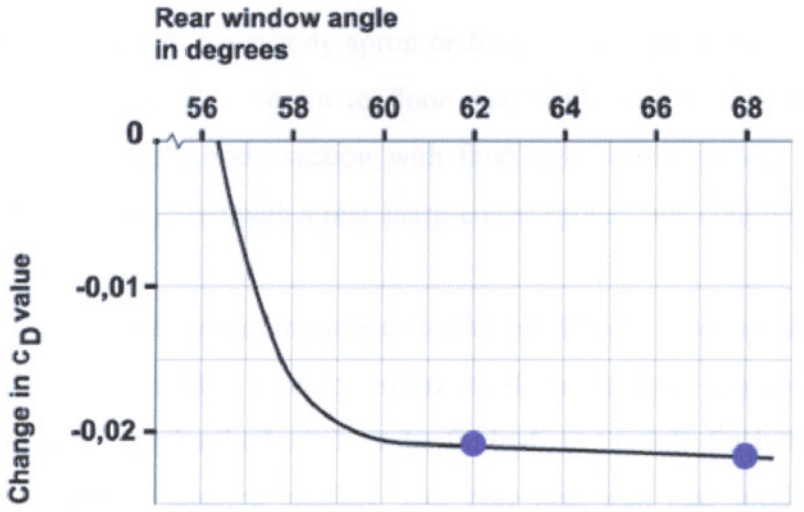

Figure 4.3. Graphic of Dainty Car CD value.

The contradiction between aerodynamic ability and together with comfort and useability of space is the form organisation. One wishes flatly inclined surfaces to the horizontal axis, but, in contrary, others make the forms in angular tendency towards outward. Such inclined windowpanes are probable to restrict inner side head area and to cause more heat to be transmitted due to choosing aerodynamic efficiency.

The limits have been reflected on the Dainty body by formfitting each edge of the car around its orthogonal axes. The first portion of the car that first faced with the air resistance is the hood. For the aerodynamic stability of the car although hood is an unforsaken component, very flat front onward restricts the driver visual performance and entail the feeling of roominess.

The rests are as follows:

Smooth-faced front end, front body apron or front fender with integral elastic spoiler, rear fender with aerodynamic transition to floor pan, windshield within shallow angle limits, elliptically shaped upper body section with flush side windowpanes, rounded-formfitting pillars, hatchback integrated with a rear sharp-edged spoiler, and countered top.

The spoilers are of paramount importance to the car. Barely, front spoiler supports heeding the airflow leaking parallel to trajectory of travel of the car or its longitudinal axis, to deflect any turning moment under the body in order for body not to jolt. Such that, unless it is used efficiently, it diminish steering stability. Not only one, also rear spoiler provides the car going the distance for lessening swerving.

Aerodynamic design directly effects the body shape. In this project, the tendency for rollover, resulting from shape with vertical length on several models is being considered. The own study for aerodynamic effectiveness versus rollover propensity basically quantified on each shape point that relatively trues the form of the family car.

4.2.1.1.2. STRUCTURAL CONCEPTS

A stiff infrastructure on which the bodies rested could be extricable into three different structural concepts to build a car as follows:

- Traditional Steel Concept,
- Space Frame, and
- Mono-coque.

Traditional Steel Concept discerned as Uni-body or Body-In-White that the structural elements consist of beams, columns, and inner and outer panels. The steel elements are deep drawn from cheap semi-finished plate material, and jointed together in a self-carrying body.

The technologies involved are well developed, and production costs are minimal. On the contrary, the concept with which car constructed takes the disadvantageous of:

- Requiring a lot of assembly operations,
- Structuring with full of discontinuities, and
- Being heavy in stead of opportunities and improvements coming in use for weight dwindling.

In another structural concept as **Space Frame,** the load carrying structure is separated from the exterior body panels. The body panels can therefore take the advantageous of:

- Being made in light weight materials,
- Designing differently from the load carrying space frame (as the model Audi), and
- Using profiles as semi finished parts since the space frame is independent from the design.

A big difference in this concept is the replacement of steel by composites in some of the panels. Such as, GMT in *wheel housing*s or bottom panels due to giving a smooth shape to it and SMC in outer panels because of attainability of a smooth surface.

Finally, In concept of **Mono-coque,** using of body panels and load carrying elements are integrated in one structural element. In condition of throwing weight of advanced composites for producing integrated elements, it is possible to save weight as well as highest structural effectiveness. Therefore, mono-coque as a triumph of ingenuity and experience of the designer using which manufacturing technique is well available for cars that are small in size as in Dainty body.

Mono-coque is a combination of carbon fibre and glass in epoxy matrix. Allowing the components with no sub frames gains easily removable parts for bodywork or in the event of a collision, less space, less parts, and incredibly strength efficiency (1816 ft kgs/degree), perfect weight distribution, and performance not at the cost of safety.

Strength efficiency when designed energy absorbing zones in passenger compartment, any damage to the monocoque zone could be limited to the visible areas of failure. Repair of the system needs specialist repair, but it does not require a difficulty of unduly expensive undertake.

Seat attachment to the mono-coque body as the same as evaluated in the chapter 3 of 3.1.1. restraint systems of seats. Additionally, the vertical and horizontal carcasses of the seat could be attached via same attachment or by using different attachments onto the fleet of the chassis.

4.2.1.1.3. BODY INBOARD

Whole content, enclosed via outboard elements, mostly regarded as described belows:

- Either both inboard and inner side or interior as occupant compartment.

Inboard of the whole car is the most essential part since comfort, enjoyable feelings, steering pleasure, and almost all driver and occupant needs must be met. To achieve this from infrastructure of design to the components that the user touch, seats, perceives, feels and sees. Design range for the latter since much pleasure to the designer, wide variety of products and solutions could be easily soared.

It is also the area that the form of out integrated to the inner side. Specifically, the essential criterion for the inner in design is to catch the idea of seeing each component soft, in form, material, texture, also in colour. Plastic materials inboard surfaces could easily achieve all requirements above. Nowadays the use of plastics or materials obtained from that has reached (up to 26 kilograms (Hürriyet Gazetesi, October 30th, 1998, pp. 20)).

For example, the seats are designed in the concept like baseball catcher's, as though it caught the energy and then draws it down.

In interior, front canopy, cockpit, front and rear bumpers, and all other interior fitments (Table 4.3.) rates reliability of car.

INTERIOR FITMENTS OF DAINTY CAR	
Front canopy storage compartment	2 storage pockets on reverse of front seats
2 cup-holders in cockpit	Flower vase
"Easy Entry" access for rear-seat passengers	Luggage space cover
Fleece carpeting in luggage space	Illuminated passenger-side glove compartment with lockable flap
Interior cloth decor in "Domino" or "Panama" design	Luxury steering wheel
Front frame headrests	Fold-down rear bench and backrest with 2 frame headrests
Textile footmats	Front door compartments with net bags
Vertically adjustable front seats	Master key with lamp
Adjustable blue instrument-panel illumination	1 front inside light with switch-off delay, 2 reading lamps in rear
Instrument-panel with speedometer, petrol gauge, rev. meter and re-settable kilometer display	Illuminated make-up mirror in driver and front passenger sunshade
"Gamma" radio system	Power-assisted steering
Electric socket in luggage space	Electric socket on central console
Alarm buzzer when lights are left on	Clock and outside temperature display in inside mirror
Heatable front seats	Front electronic window drive with comfort switch and anti-jam safeguard
Central armrest in front	Central seat upholstery panels, seat wings, fronts of headrests in New Beetle confection perforated leather
Leather steering wheel cover	Leather gear-stick knob / sleeve and handbrake grip
CD changer for 6 CDs in luggage space	Speed control system

Table 4.3. Interior fitments of Dainty Car.

In this project, installing a pneumatic roof entirely prevent the occupant from being injured. It is thought when an airbag activated, simultaneously sensors ignite the system and blows up it forward towards the occupants' heads.

4.2.1.2. ENGINE

In the first part of the chapter 4, we have introduced that the family car would be running on multi fuel concept. Here, the causes will be introduced for perfecting a car with such engine using such source within limits.

4.2.1.2.1. EXPECTATIONS

The causes for selecting hydrogen engine:

- Structure of hydrogen engine typically similar to the gasoline engine. Therefore, it is very advantageous to adapt to the car currently being producing,
- That engines can use the source either gaseous hydrogen or liquid hydrogen from the tank or on-board, or in the form of bonded on the titanium-iron alloy, in addition to gasoline,
- The usage of energy per unit volume are significantly higher, especially in liquid one, and
- As embraced an environmentally friendly engine, if compared with others emission of CO_2 bounded in the level of nearly zero, as in use of electricity.

And selecting one, from four alternatives of the same source, of its storage types basic criteria will be the energy efficiency, storing volume when comparing with the criterion of same operating range to the example of smallest, and the factor "weight".

Energy efficiency of four types of hydrogen using, the one as liquid hydrogen has takes the advantageous of criteria of source hydrogen. Although the hydrogen on metal hybrid TiFe very being an efficient storing, it would require unnecessary loading and occupancy onto the

car since its weight rated with auxiliary components such as protecting elements, or device utilising for servicing.

Storage of liquid hydrogen used an isolated one named cryogenic tank. The cryogenic tank is a heat insulated-double wall constructed tank and so that keeps the temperature of relatively –253 degrees Celsius. The temperature should make zero or compensate for the pressure from the volume inside as a result of heating. For that reason the isolation perfected to a level of three hundred times that of a material as styrofoam. Insulating materials for the tank consist of aluminium foils and glass fibber paper (Seiffert & Walzer, 1991).

Within the similarity as conversion of chemical energy into mechanical energy, the engine could be accepted renovated, or better, modified gasoline engine. Modifying is only adding fuel supply devices as a cryogenic tank and an evaporator for liquid hydrogen, as in family car, and in its mixture formation. Needy to say, since the hydrogen being in air from the range of 5 percent to a highly intensely range of 75 percent, ignition operation is possible for any range.

CONCLUSION

Developing a complete understanding of human behaviours makes relieve the demand sides of the unacquaintance in design process. By the way, in family car the term safety are must-have seen each elements in the no contradiction with unadorned design perceptiveness. Carrying out such concept not only has provided the criteria of usability, comfort, ease of accessibility, visibility, and frenetic performance, it also rated the passive safety of whole design in conjunction with that. But, minimalist theory in geometry, mass, and volume of the family car has signed the number of risks so-called rollover propensity at juncture, on curved parts of the lane, and having insufficient deformation zone, especially in rear-end. Here, choosing the alternative material as reinforced composites, fibreglass, makrolon already lost the mass advantage of the car regained by stiffness. The statistical results also provide our concept (Chapter 2 of 2.1. light car safety in perspective).

Modern technology with reinforced material also allows producing the very curved forms so tangible to the users. Utilizing those technological advantageous, we shaped the outer and interior surfaces smoothly. In doing so, predictable effects of the sharp edges, peak points were completely defected.

Being low-mass can assumed to take the risk of propensity. But, the causal factors propel the dynamic tendency for a rollover, is the velocity at curve parts, center of the gravity, friction between the land and tires, shape, the verbose loads not removed as a result of inefficient suspension design, and mass, and others. As wished, it was not the basic factor alone. So, making changes on other components equals the disadvantageous of lightness as widen surface of tires tangent to the land as Indy car, reducing the motor capacity consequently reducing the velocity, using full time four-wheel drive with variable torque ratio between front and rear axle, and so on.

The concept of multi-fuel is a must-have need for coming up to year 2030. Since the completely for a new technology, the world is not be readied. The best way for introducing

the different technology to the users is to make such prototypes. Besides that, the energy sources and air pollution added the concept viability.

In inner design all design should be focused on the things in high conjunction with driver and occupants. Especially, for driver and steering stability driver positioning area should be rated in space intensity, all design equipments, also safety features for that location should be secured around or new one should be added the characteristics of existings. Instead of new one, redesign of all exists. Then, new designs, new proportions and new meanings on them could completely change the design concept in car. Briefly, reams of redesign is not resulted in same shape, same features, it helps to reach a entirely new one. Also, it provides pure, simply, but efficient conformity and safety.

Essentially, "the real test starts when the driver takes the wheel". With an inefficiently constructed "safety map" on car seems to a man has no eyes, ears, and noise. Aiming that, Safety Map of the project should be prepared and the intensity of design should be directed whilst utilizing it.

As a critic, common designs which take the characteristics of human shape. For its functionality to be in parallel to the human needs could be, but every object candidates to being a part of our life should have their own forms, and identity.

GLOSSARY

INTRODUCTION

A means refers to transportation device has ability to go distance using fuel.

Vehicle refers to a special kind of transporter with motor driven by mechanical power and manufactured primarily for use on public streets, roads, and highway, but does not include a car operated only on rail line.

Vehicle safety means the performance of a motor car or motor car equipment that protects public against unreasonable risk of accidents occurring because of the design, construction, performance of a motor car, against unreasonable risk of death or injury in an accident, and includes nonoperational safety of a motor car.

CHAPTER 2

CV refers to a parameter in terms of coefficient of variation used for determining the repeatability of test results such that a lower % of CV imitates a more repeatable result.

Vehicle equipments refers to any system, part, or component of a car as originally manufactured; and any similar part of the component manufactured or sold for replacement or improvement of a system, part, or component, or as an accessory or addition to a car; or any device or article or apparel that is not a system, part, or component of a car and is manufactured, sold, delivered, offered, or intended to be used only to safeguard cars and highway users against risk of accident, injury, or death.

One land mile a unit of distance is equal to 1760 yards or 1609.35 meters.

One pound a unit of weight is equal to 0.454 kilograms.

CHAPTER 3

Accelerator means a pedal that you press with your foot so as to make the car go faster.

Bulb-check means illumination of each gauge or telltale checked when the headlight or ignition switch is activated, or during car starting.

Clutch means a mechanism that enables power from the engine to be disconnected from the drive shaft in order to allow you to change the gear. Also it can be refer to the pedal that you press before changing gear as the clutch.

Forehead impact zone means the part of the free motion headform surface area, determined the according the procedure listed below:

- Position the headform so that the base plate of the skull is horizontal,
- From the centre of the threaded hole on the top of the headform, draw a 69mm line forward toward the forehead, along the contour of the outer skin of the headform. The front end of the line is designated as Point P. From that point draw a 100mm line forward toward the forehead, along the outer skin of the headform. The front end of the line is designated as Point Q,
- Draw a line 125mm line which is coincident with a horizontal plane along the contour of the outer skin of the forehead from left to right through Point Q so that the line is bisected at Point Q. The end of the line on the left side of the headform is designated as Point a and the on the right as Point b,
- Draw another 125mm line which is coincident with a vertical plane along the contour of the outer skin of the forehead through Point P so that the line bisected at the Point P. The end of the line on the left side of the headform is designated as Point c and the end on the right as Point d,

- Draw a line from point a to Point c along the contour of the outer skin of the headform using a flexible steel tape. Using at the same method, draw a line from Point b to Point d,
- The forehead impact zone is the surface area on the FMH forehead bounded by lines a-O-b and c-P-d, and a-c and b-d.

Gauge means a display in which the device measures the lashings or quantity of something and shows the amount measured. Such as temperature gauge, pressure gauge.

Greenhouse effect is the problem caused by a built-up of gases such as carbon dioxide in the around the earth. These gases trap the heat from the sun, and cause a gradual rise in the temperature of the atmosphere.

Head form means head itself.

Head orientation reference line refers to a horizontal SORL stands for Seating Orientation Reference Line through the Point Z.

Telltale means a display that indicates the actuation of a device, or correct or defective functioning or condition, or a failure to function.

Whiplash injury means the motion of the head and neck relative to the torso and the associated neck injuries occurring when a car is struck from the rear. Symptoms of the pain in the head, neck, shoulders, and arms may be associated with damage to muscles, ligaments and vertebras. Onset of symptoms may be delayed or mat last for a prolonged period.

One gallon is the unit of measurement for liquids nearly equals to 3.785 litres.

Front and rear apron could be described as fender mean part of the body forwardmost, rearmost car, and over wheels. The British word is wing.

Hood means ant exterior movable body panel forward of the windshield that is used to cover an engine, luggage, storage, or battery compartment.

Pillar means any structure, excluding glazing and the vertical portion of door window frames, but including accompanying mouldings, attached components such as safety belt anchorages and coat hooks, which:

- Supports either a roof or any other structure that is above the driver's head, or
- Is located along the side edge of a window.

That distributed as:

- A-pillar means any pillar that is entirely forward of a transverse vertical plane passing through the seating reference point of the driver's seat,
- B-pillar means the forwardmost pillar on each side of the car that is, in whole or part, rearward of a transverse vertical plane passing through the seating reference point of the driver's seat, unless there is only one pillar rearward of that plane and it is also a rearmost pillar, and
- Other pillar means any pillar that is not an A-pillar, B-pillar or a rearmost pillar.

Spoiler means an object which forms part of the body of the car. It redirects the airflow around the vehicle, making a car's forward movement more efficient.

Trunk means a covered space at the back or front in which you put luggage or other things. The usual British word is Boot.

Wheel housing is the area in which the wheels placed.

Window frame means a frame round the edges of a window into which the glass is affixed.

Windshield means is the glass window at the front through car the driver looks.

Windowpane means a piece of glass in the window of a car.

REFERENCES

DICTIONARIES

[1] Definitions of Federal Motor Vehicle Safety Standards (FMVSS),

[2] Dictionary of Collins Cobuild, Harper Collins Express, 1995,

[3] Dictionary of Redhouse, A Lexicon, 1972.

BOOKS

[1] Duffy, Steve, Advanced Glazing Research, NTHSA, February, 1996,

[2] Federal Motor Vehicle Safety Standards, Standard No. 213, *Child restraint systems,* USA, 1998,

[3] Federal Motor Vehicle Safety Standards, Standard No. 101, *Controls and Displays,* USA, 1998,

[4] Federal Motor Vehicle Safety Standards, Standard No. 206, *Door Locks and Door Retention Components,* USA, 1998,

[5] Federal Motor Vehicle Safety Standards, Standard No. 302, *Flammability of Interior Materials,* USA, 1998,

[6] Federal Motor Vehicle Safety Standards, Standard No. 202, *Head Restraints,* USA, 1998,

[7] Federal Motor Vehicle Safety Standards, Standard No. 208, *Occupant Crash Protection,* USA, 1998,

[8] Federal Motor Vehicle Safety Standards, Standard No. 201, *Occupant Protection in Interior Impact,* USA, 1998,

[9] Federal Motor Vehicle Safety Standards, Standard No. 207, *Seating Systems,* USA, 1998,

[10] Federal Motor Vehicle Safety Standards, Standard No. 214, *Side Impact Protection,* USA, 1998,

[11] Federal Motor Vehicle Safety Standards, Standard No. 212, *Windshield Mounting,* USA, 1998,

[12] Federal Motor Vehicle Safety Standards, Standard No. 219, *Windshield Zone Intrusion,* USA, 1998,

[13] Hattula, Jani, *The Effect Car Mass on Internal And External Safety,* University of Oulu, 1995,

[14] Hürriyet Gazetesi, October 30th, 1998,

[15] Inaba, M., *A Robot Vision System Using A Local Correlation Processor,* Journal of the Robotics Society of Japan, Vol. 13, 1995,

[16] Ingram, Gregory K. & Liu, Zhi, *Motorization and Road Provision in Countries and Cities,*

[17] Madnick, Stuart E. & Donovan, John J., *Operating Systems,* McGraw-Hill, 1978, International Edition,

[18] Mason, John L., *Energy and Transportation,* SAE, 1990,

[19] Milliyet Gazetesi, October 30th, 1998,

[20] Newton, K.; Steeds, T. & Gareth, T.K., *The Motor Car,* Butterworths, Tenth Edition,

[21] *Overview of Vehicle Compatibility,* National Highway Traffic Safety Administration (NHTSA), February, 1998,

[22] Palmer, Robert M.N., *Passive Belt Litigation,*

[23] Riley, Robert Q., *Alternative Cars in the 21st Century: A new Personal Transportation Paradigm,* Society of Automotive Engineers, 1994,

[24] Racmilivitch, A., *Anti-Whiplash Protection,* Florence, Italy, 1996,

[25] Seiffert, Ulrich & Walzer, Peter, *Automobile Technology of The Future,* Society of Automotive Engineers, 1991,

[26] Severy, D.M.; Bring, M.H. & Baird, D.J., *Backrest and Head Restraint Design for Rear-end Collision Protection,* 1968,

[27] Stucki, Sheldon L. & Hollowell, William T., *Determination of Frontal Offset Test Conditions Based on Crash Data,* NHTSA R&D, United States,

[28] *The Bosh book of The Motor Car,* Berkeley Publishers Limited,

[29] Yoshimoto, K., *An Automatic Steering Control Algorithm Using Optical Flow,* Proceeding of the Second World Congress on Intelligent Transportation Systems, Vol. 3, 1995,

[30] Yoshimoto, Ken-ichi & Kokubo, Tetsushi, *The Effect of Automatic Driving on Traffic Flow,* University of Tokyo.