ISSN: 2278-0181
NCERAME - 2015 Conference Proceedings

Comparison of Flying Cars since 2000 and Factors considered for its Conceptual Design

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Abstract:- **In this paper an attempt has being made to give a basic idea about the factors which has to be considered for the conceptual design of flying cars. In addition to it, the flying cars since 2000 are compared for major specifications and conclusion is drawn about which flying cars closely satisfy these major specifications and factors for producing successful flying cars. As seen in this paper, it is not very easy to produce a successful flying car. It has to consider a lot of additional factors like safety, very short take off and landing distance extra when compared to producing the vehicle only as car or as aircraft. At present there are three most successful flying cars, they are PAL-V, Transition and Aeromobile 3, which are expected to be available in the near future commercially as they satisfy almost all requirements of a successful flying cars. In addition in the far future we can expect better flying cars than the present ones, the future flying cars are theTF-X, XplorairPX200.**

Keyword- Roadable; flutter; Thermoreacteur

I. INTRODUCTION

Flying cars are roadable aircrafts which can run on a standard road as well as fly in the sky. The concept of flying car is very complicated as it demands a combination of features of car and aircraft, for giving best performance as a car and as an aircraft. The complication intensity of this matter is clear from the fact that since 1903, there were attempts made to develop flying cars. In spite of so many years being passed still at present we do not have any commercially available flying cars. At present, thethree most successful flying cars are PAL-V, a gyrocopter, Transition and Aeromobile 3, are expected to be available in the near future. Amongthese three present flying cars, only PAL V can take off and land vertically.

The flying cars have become the need of the present and the future transportation. The use of flying cars will drastically help in saving a lot of precious time, reduce the travel distance as the route is not restricted, and free you from traffic congestion and many more things. With the advancement of technology, it can be expected that almostall complications of producing a successful flying car can be overcome. With this we will very soon have successful flying cars available commercially.

This paper describes factors, which will form the basis for preparing any conceptual design of flying cars. Here comparisons are done on the basis of major specifications required for conceptual design of flying cars.The comparison is done among flying cars since 2000 anda conclusion is drawn about which cars closely satisfy these major specifications of successful flying cars.

II. FACTORS CONSIDERED FOR THE CONCEPTUAL DESIGN OF FLYING CARS

Conceptual design will usually begin with either a specific set of design requirements established by the prospective customer or a company generated guess as to what future customers may need. The design requirements include so many factors related to aerodynamics; weightextra. It also includes a vast set of civil specifications which must bemet.The factors are explained here along with the factors range of the present successful flying cars. To give an approximate ideal values and limits of the factors, the present successful flying car values are considered. The following are the factors:

A. Aerodynamic Consideration

Reduction of fuel consumption and increase in performance of vehicles can be achieved by different methods like by using better engines, light materials and aerodynamically drag reducing designs extra.

As seen aerodynamic consideration plays a very important role in design of vehicles. Vehicles have to streamline aerodynamically to minimize the aerodynamic drag.

- *Drag*

The drag of the entire configuration must be as small as possible. Thisrequires (a) thin wings, (b) slender fuselage, (c) smooth surface conditions, and(d) proper values of aspect ratio (A) and sweep .The drag at the subsonic speed is composed of two parts. The first is induced drag is caused due to generation of lift, which is a function of wing span and second is parasitic drag which is dependent on the surface area of flying car exposed to air.

- *Lift*

The size of the wings must be such that it must develop sufficient lift under various flight conditions and produce lessdrag. The aspect ratio of wing has historically been used as the primary indicator of wing efficiency. The opening and closing operation of the wing must be easy and automatic. The wings must have good aerofoil design to give maximum lift with less wing span.

- *Interference*

In flying cars we have attached the wings. The attachment should be in such a way that these components in the proximity of each other should not cause interference effect. The interference effect causes change in aerodynamic forces and moments. This leads to increase in drag and decrease in lift. So to avoid this we have to use proper fillets at the joints especially between wing and car body.

B.Lower structural weight

The weight of the flying car must be as low as possible, so that it does not require huge amount of lift. To reduce the weight of the flying car we should use the following

- High strength to weight ratio material
- Aerofoil with high thickness ratio
- Wing with low aspect ratio

While reducing the weight we should make sure that the flying car structure is strong and stiff enough to avoid flutter, able to take up the flight loads and the pay load weight. Innovation of composite materials made this possible. Advanced composites materials such as graphite epoxy,carbon fibres, steel frame with carbon coating materials extra can be used to replace the aluminium and other materials as in [1, 2, 3, and 5].

C.Usage

The flying cars are mainly made for easy commuting for major part of population.

- *Seating capacity*

The minimum seating capacity for the flying cars should be at least two but the preferred one will be 4, for majority offamily.

- *Pay load*

The payload capacity should be from 15 to 60 kg or more, as this is the usual range value allowed in aircraft passengers.

D.Speed

The speed of the flying car in air should behigh. This is a minimum criterion because converting car to flying car involves lot of additional things likecost, latest technology extra.The flying car is to be sized so as to provide required cruise range.

E. Folding of wings

The flying car is made for travelling by air as well as road. It has to fulfil the requirements of the road vehicles and aircrafts. One of the main requirements of road vehicles is to move easily on the road among group of vehicles.The smaller the size of the vehicle the more easily it can move. The flying car when used as car should fold the wings and parts used for flying in a very compact way possible to bring down the size. Another option is to separate the flying parts, but it causes lot of inconvenience about where to leave it and take it back when required.

F.Automatic conversion from car to plane

In today's world of automation, humans are trying to automate all things to save time and energy. Automatic conversion of car to plane plays a very important to role; it has to be automatically done with hardly requiring any human effort. This conversion has to take very less time preferably in seconds or at the most in minutes, as main aim of people to travel fast is to save time. Present flying cars does this in seconds or minutes.

G.Verticaltake off

Sincethe flying car is used on roads among group of vehicles, it's difficult for the car to take off in this situation. If the car is not having vertical takeoff then the car requires a separate clear place to take off and finding such places while travelling is very difficult .This difficulty can be avoided by giving a vertical takeoff through propeller blades such that vehicle can take off from anywhere. This capability requires additional powerful engines,which leads to additional cost and weight. Besides these it also produces huge vibrations and noise.The vibrations and noise should be reduced using suitable mechanisms and dampers. Therefore the design should be such that a common engine can be used for road, air and vertical takeoff. The size of the propeller blade should be compact and foldable. Among the three flying cars only PAL V can vertically take off and land.

H. *Cost*

Due to the requirement of engines that that light weight, small and powerful, the cost of it will be very high. In addition, flying cars would be used for shorter distances, at higher frequency, lower speeds and lower altitude due to which range will be very less. The cost of vehicle can be divided into many categories. Few major ones are the quality, cost of manufacturing process and the number of units produced extra. Since flying cars is yet to be launched for sale, the number of units produced is less and so the cost is high. The final aim of flying car is to use it as personal vehicle. If it has to become a personal vehicle for majority of population, the initial and maintenance cost has to be less. The direct operating cost involves the cost of fuel, maintenance cost extra, which has to be less toensure that flying car are being used on daily basis. The values related to this are plotted later ingraph.

I. Fuel

The fuel to be used should not be costly as flying car consumes large amount of fuel when compared to the amount of fuel consumed by car. Since the fuel resources are depleting quickly, the fuel used should have a large amount of resource. The present flying cars are using unleaded gasoline as fuel.

One of the major concerns is the emissions produced by the fuel. The fuel should not cause any harmful emissions as large amount of fuel to be used. Present flying cars are using unleaded gasoline and some use electric power along with this for extra power.

J. Engine

Flying cars needs to Push enough air over wings to lift them up, and enough air backwards to move forward. Propellers canalso be used instead of wings. The engines of the flying cars have to deal with many Challenges compared to car engines. One of the challenges is to maintain optimum air fuel ratio which usually keeps changing with varying altitude. It should have very less chance of failure and have very long service life. Its maintenance, cost and weight should be very less. It should have very high horse power and produce speeds which are at least thrice the maximum car speed on road. Different engines like reciprocating engine, electric engine extra are used.

The engine used for flying car should be very powerful enough to give optimum performance on road and in air especially at higher altitudes. The engines should have high power to weight ratio.The values related to this are plotted later in graph.

K. Landing System and tyres

The landing system and tyres of flying cars operate under severe operating conditions compared to road vehicles tyres. This is because they operate under heavy load coupled with high speed. The important feature to have in this system is its capability to handle this severe situation. The landing system should have sturdy suspension. The tyres used in the flying cars should have a very high speed rating, as for safe operation the tyres should never be used beyond the maximum speed rating specified by the manufacturers. The material used should have strength even when exposed to high temperatures, since flying car's tyres are exposed to lot of heat. All the above help us to conclude that maintenance practice, material quality, operating techniques extra to be followed are completely different from road vehicles.

The landing system should have shock absorbers. To simplify the process of braking in flying cars especially during landing, Auto brake system should be used. This gives uniform deceleration and frees the pilot to monitor other parameters required for landing.

L. Control and Navigation System

Navigation system in flying cars has to be very quick .This is crucial because as the speed is very high, the system has very less time to calculate the position of the vehicle. Besides this the system has to be very accurate at any point of time, as the vehicle cannot get lost on its route. If that happens, it will drastically increase the chances of collisions and danger of running out of fuel. In addition we cannot stop the vehicle in mid air to conform the position and there is no in flight rescue.

Control and Navigation System requires very demanding features, along with this, it has to be user friendly so that common people can operate it with ease without intense training unlike what the commercial pilots underwent. The system should also monitor the pilot commands to ensure the vehicle is kept within the flight protection envelop. An Autopilot system should be available. This increases the safety drastically.

M. Safety

Although statistically flying is safer than driving, it's because of less number of aircrafts flying and well trained pilots are flying it. This scenario will not remain the same for flying cars, as there will be many in number and thatwill be flown by common people who have not undergoneany intense training.

Three main Challenges regarding safety are about mid air collisions, mechanical failure and bad weather. The mid air collisions and mechanical failures will cause the vehicle to fall from the sky or go through an emergency landing, resulting in deaths and property damage.

To avoid collisions anti collision devices and very quick and accurate control and navigation system be used in vehicle. For mechanical failures especially engine failures back up or a parallel power system should be present in the flying car. A gyroplane technology can also be used during failure flying cars which vertically take off and land. In addition to it a full vehicle parachute facility also should be present. This additional safety of parachute is there in Present flying cars.

One of the biggest challenges is to fly the car in bad weather conditions like lighting, heavy rain, fog extra. To handle bad weather a nose mounted weather radar technology is to be used. This technology has made it possible and easier to detect bad weather and thus steer away from the dangerous weather conditions. People also should be trained about how to deal with bad weather conditions safely.

N. Take off distance

Although the take-off field length may seem like a performance characteristic of secondary importance, it is very often one of the critical design constraints. If the required runway length is too long, the aircraft cannot takeoff with full fuel or full payload and the aircraft economics are compromised. This constraint often sets the aircraft wing area, engine size, high lift system design. The calculation of take-off field length involves the computation of the distance required to accelerate from a stop to the required take-off speed, plus a climb segment.Present flying car values are 300 m to 500 m and around 165 m for PAL V.

O. Landing distance

The landing distance is dependent on the landing speed. The landing speed in turn is dependent on the maximum lift coefficient. This gives rise to the need for right airfoilselection, and use of ways which will avoid separation extra. The landing distance can also be reduced easily by using features like capability to deploy brake parachute extra.Present flying car values are around 100 m and around 30 m for PAL V.

P. Range

The maximal total range is the distance an aircraft can fly between takeoff and landing, as limited by fuel capacity in powered aircraft. The fuel time limit for powered aircraft is fixed by the fuel load and rate of consumption. When all fuel is consumed, the engines stop and the aircraft will lose its propulsion. Sowe should have very efficient form of engine in flying cars to get maximum range.

Q. Interactions of various factors

All factors considered above may lead to conflicting requirements. For instance consider the case of a wing with an airfoil of relatively higher thickness ratio, which has lower structural weight, but cause higher drag. In such cases, optimizationmethods have to be used to arrive at the best compromise as in [1, 2, 3, and 5].

III. COMPARISON OF MAJOR SPECIFICATIONS OF FLYING CARS SINCE 2000

Here comparisons are done on the basis of few major specifications required for conceptual design of flying cars. Some values and costs are estimated and may change with time. The comparison is done among flying cars since 2000. The explanation of comparison is made by dividing into three categories, they are Past cars (but still their research may be continuing in present), Present cars and Future cars.Following are the comparisons for 8 flying cars.

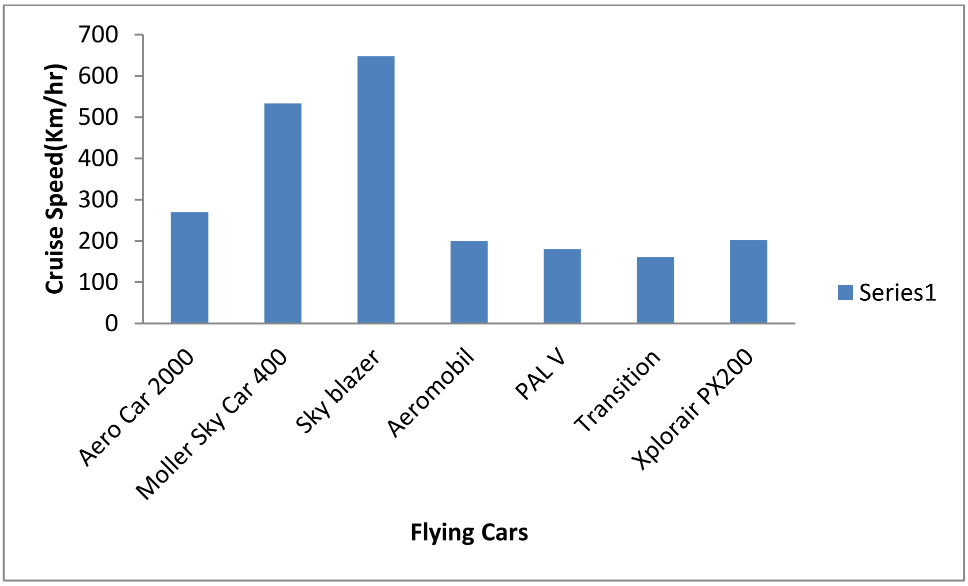

Fig.1 Cruise Speedof Flying Cars

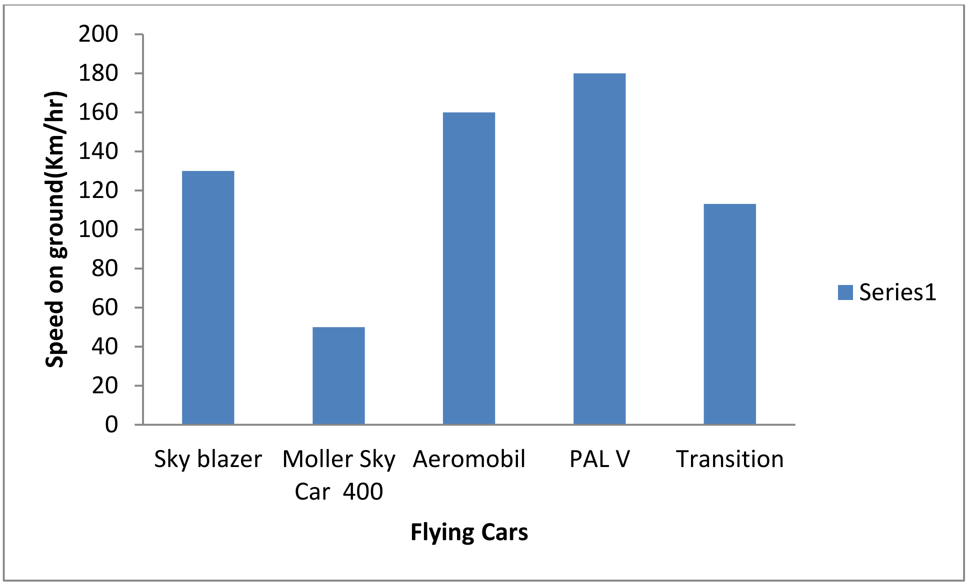

Fig.2 Speed on Ground of Flying Cars

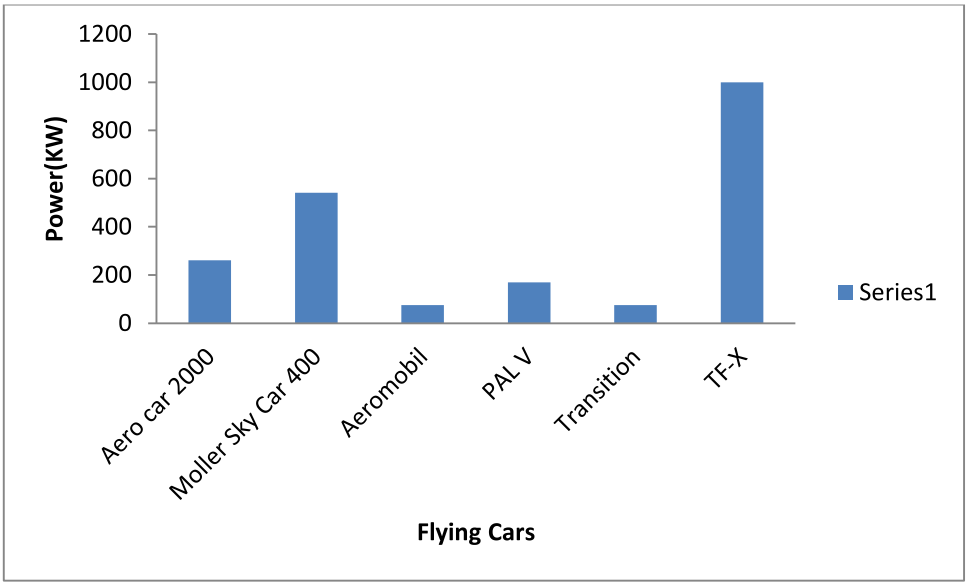

Fig.3 Power of Engine of Flying Cars

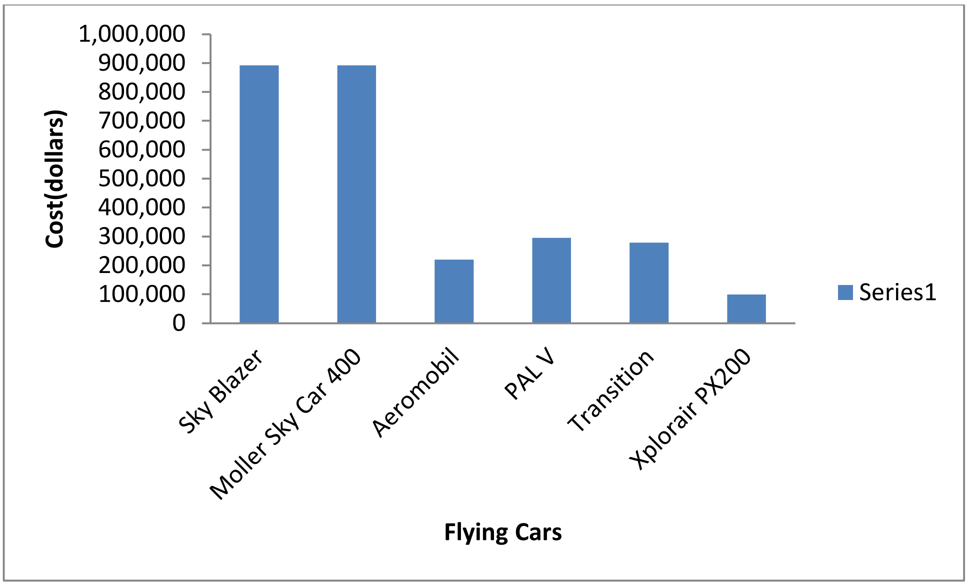

Fig.4 Total Cost of Flying Cars

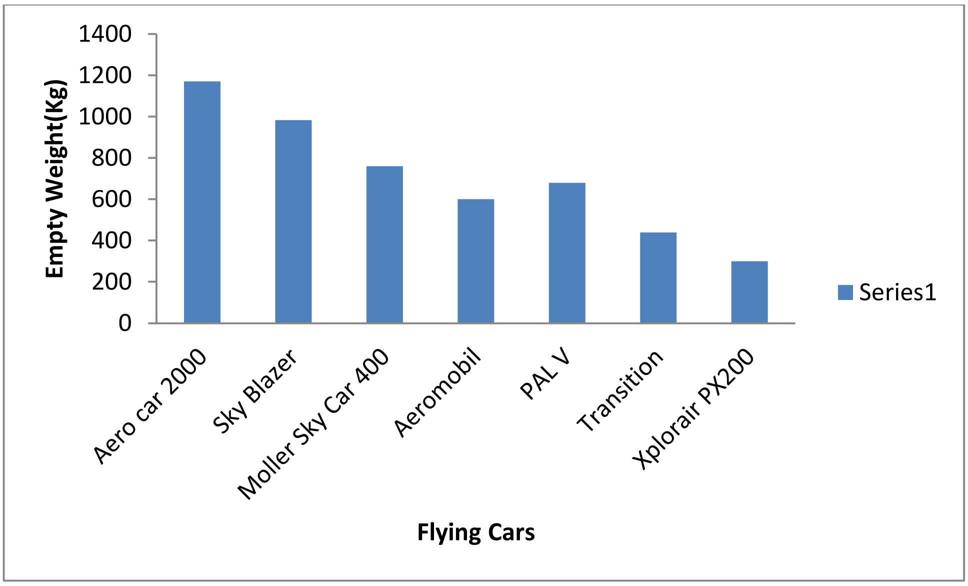

Fig.5 Total Weight of Flying Cars

The Past cars, Aerocar2000, Moller Skycar 400 and Haynes Skyblazer as seen from above data in the Fig.1 to Fig.5, have a very high cruise speed, and high power comparatively but its weight and cost is also more. The major disadvantage of Aerocar 2000 is its modular frame design, in which we have to leave the flight module behind when converting to car and conversion is not automatic as in [4,6,8].

Likewise the Moller Skycar 400 is also having disadvantage, it is not having enough stability .The HaynesSkyblazer is still under development project as in [6].

The Present cars are the PAL-V which is a gyrocopter, Transition and Aeromobile3 .It's clear from above data in the Fig.1 to Fig.5 that its overall feature values are better compared to Past cars. Along with extra features in these present flying cars likeeasy and fun to fly, drive, and convert,safety like full vehicle parachute, integrated designframe, high stability, and autopilot extra leads to conclusion that these flyingcars are better than the previous flying cars. All these cars had undergone successful flight tests, so the commercial launching of these cars can be expected in near future as in [7, 9, and 11].

Coming to the flying cars of far future, there are two well know flying cars expected. They are TF-X,XplorairPX200.They are expected to be better than present cars due to technological advancement .The company which launched the transition that is Terrafugia, hasannounced a new design,TF-XVision.The aim of the new design is to enhance the safety, simplicity, and convenience of personal transportation compared to transition as in [10].

The XplorairPX200 is vertical take-off and landing vehicle which is built around theCoanda effect. TheXplorair PX200 will have a new propulsion system, which will havebrand new engine called Thermoreacteurengine, which has a high power ratio per volume unit, can generate a gain in specific fuel consumption, can minimize maintenance requirements extra as in [12].

IV. CONCLUSION

As seen in this paper, it is not very easy to produce a successful flying car. It has to consider a lot of additional factors like safety, very shorttake off and landing distance, very user friendly, accurate and quick navigation and control system, light weight body, use high speed rated tyres extra .This is not the case when compared to producing vehicle which has to be only a car ora aircraft.

As seen that since 1903, there were attempts made to develop flying cars. In spite of so many years being passed still at present we do not have any commercially available flying cars. At present three successful flying cars are PAL-V which is a gyrocopter, Transition and Aeromobile 3, which are expected to be available in the near futurecommercially as they satisfy almost all requirements of successful flying cars. The requirements are likeeasy and fun to fly, drive, and convert, safety like full vehicle parachute, integrated design frame.For successful conceptual design of flying cars, the following features values have to be closer to present cars values and should preferably satisfy almost all the 17 factors told here. The following table 1, gives the initial values.

General initial specification	
Parameters	Initial ideal Values
Cruise speed	It should be at least 150 km/hr.
Speed on road	It should be at least 100 km/hr.
Power	It should be at least 75kw.
Empty weight	It should be less than 700kg.
Cost	It should be less than 300,000 dollars.

Table 1.Conceptual design Parameters and their values.

In addition in the farfuture we can expect better flying cars than the present ones. The future flying cars are theTF-X, XplorairPX200. The TF-X will have enhanced safety, simplicity, and convenience of personal transportation compared to transition.

The Xplorair PX200 will have a new propulsion system, which will have brand new engine called Thermoreacteur engine, which has a high power ratio per volume unit, can generate a gain in specific fuel consumption, can minimize maintenance requirements extra.

ACKNOWLEDGEMENT

The Authors of this Paper wish to thank Dr.M.S RajaendraKumar andMr.Rajesh Kumar Nfor their support for making this paper. I also like to thank all who directly or indirectly helped Us.

REFERENCES

[1] E.G TULAPURKARA, Airplane Design, NPTEL Notes.
[2] Daniel P.Raymer,AircraftDesign:A Conceptual Approach.
[3] Ing. LadislavSmrcek,StefanKlein,Ing. Antonin Pistek,"Aeromobile Air Transport System Design and Testing", 27th International Congress of the Aeronautical Sciences, 2010.
[4] Retrieved from Aerocar.com: www.aerocar.com
[5] Wikipedia.org:www.wikipedia.org
[6] Retrieved from Moller.com:www.moller.com
[7] Retrieved from PAL-V.com:www.pal-v.com
[8] Retrieved from Haynes Skyblazer.com: www.haynes-aero.com
[9] Terrafugia.com: www.terrafugia.com
[10] Terrafugia.com:www.terrafugia.com/tf-x
[11] Aeromobil.com:www.aeromobil.com
[12] Xplorair.com: www.xplorair.com