Airplane Prototype Super Sonic VOYAGER X
(S.S.V.X.)
NASA project

School Name: National High School of Computer Science ”Tudor Vianu”;

Address:10th, Arhitect Ion Mincu Street, Sector 1, Bucharest, Romania, postal code 011356

Coordinating Teacher: Ioana Stoica

Students: Muraru Sebastian, Felix Liviu Milorad, Muraru Costin Grigore

Class: all 9th

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ABSTRACT

This project aims taking a step forward towards the future of air traffic, not only improving our technology, but also creating something brand new that will take us where no one has gone before.

In essence we, humans, are explorers. This is the real pleasure of knowledge: exploring the universe and its laws.

A mystery, a curious fact, a new event, a new discovery, the unknown, all these and many others put our brains and hearts on fire, a fire that doesn't allow us to sit in ignorance, a fire that brought the human kind to the 21st century and will take us to eternity. This fire is our simple but powerful thirst of knowledge that keeps us evolving.

This is what makes us all explorers of the universe.

The real pleasure of creating a new plane that will break all the limits is the pursuit of knowledge we had done. It is the new discovery that fuels us and the imagination that gives birth to the unimagined.

Our plane is called S.S. Voyager, its goals are to establish new standards for a potential supersonic passenger airliner. It has a 35 to 70 seats, it reduces the minimum runway length needed for takeoff and landing, it is friendlier with the environment (low CO_2 emissions) and the sonic pollution is highly reduced.

S.S. Voyager has a highly adaptable fuselage, it can adapt to very high pressure as well as to low pressure due to the materials it's constructed of and because it has no windows. That also allows the plane to climb to higher altitudes and reduce the effect of the sonic pollution by increasing the distance between the source of the sound and the listener.

The plane is powered by two types of engines: one for speeds under Mach 1, a modified low emission turbo jet-engine that runs on bio-diesel and one for high speeds, a ramjet that functions from Mach 1 to supersonic speeds.

In order to reduce the sonic pollution generated by the sonic boom the Voyager uses as main body frame the Sears-Haack body shape and has a modifiable geometry, it has telescopic wings that retract inside of the body as the plane gains speed. This helps reduce the runway length by having large wings that produce more lift and helps reduce the sonic boom effect by retracting the wings intro the plane's body leaving outside of the plane only the necessary amount of wing surface needed to keep the airplane in the air at supersonic speeds. On the runway the plane's wings are large, making the plane similar to the blended wing form and, as it reaches supersonic speeds, the plane is similar to an arrow: the Sears-Haack body shape being disturbed only by the shape of the ramjet engine and the short wings.

The Voyager will have no windows so that it will resist better to low pressure and climb higher than nowadays aircrafts, the pilots will use high-definition cameras that will be connected to a big screen in the cockpit, the passengers will be able to connect to cameras using their multimedia systems.

1.INTRODUCTION

1.1. A Future View

It's clear to us that fossil fuels are rapidly running out, but that is not the main problem with our classical fuel. It is not only the fact that it's running out it is the way of the past, we are stuck in within nowadays limits because we are still using a method of propulsion from the past instead of going on towards the future and finding new ways of propulsion. It's one thing that the fossil fuel if very good at, and that is delaying our evolution, so we have decided to use bio-fuel for our plane because it reduces the amount of pollution.

1.2. A new eco way of riding the sky

We have chosen bio fuel for our plane because it has been tested in Japan and New Zealand and a possible implementation of our plane can start right away. Effects on the environment will decrease.

Studies show that planes are responsible of 2% of the global CO_2 emissions, if all planes would use bio-fuel the air pollution done by planes would fall considerably [1].

1.3. Our plane **(Features/Effects and Advantages/Disadvantages)**

Before viewing the details of the S.S. Voyager our main objectives will be pointed out once again as well as a table of advantages and disadvantages regarding our plane:

FEATURES	EFFECTS
Ideal supersonic aerodynamic form (Sears-Haack body)	Reducing the sonic pollution
Telescopic wings	Reducing sound pollution and runway length
Modified turbo jet-engine	Reducing CO_2 pollution and improving fuel use
Ramjet technology	Improving fuel use and efficiency and top speed
High-tech board computer	Improving safety, more assistance for pilots, and accurate wing-span control
Bio fuel use	A very low rate of pollution
Ecological materials	Reducing pollution
Sound absorbing materials	Reducing sonic pollution

ADVANTAGES	DISADVANTAGES
Environment friendly, due to bio-fuel.	Passenger capacity is slightly lower than in the ordinary airliners because of the telescopic wings that need space to be stored in.
Shorter runway required, due to variable wing-spam.	The passengers have no natural view of the exterior excepting the multimedia devices that can output camera views from different parts of the plane
Longer flights, due to fuel use efficiency.	Though very reduced, there still is an amount of sonic pollution that will be heard by people on the ground, but it is acceptable.
Safe flights due to high-tech computer.	
Able to climb to higher altitudes due to the fact that the plane has no windows.	
Ramjet and turbo jet engine use the fuel more efficiently.	
The sound absorbing materials lower the sound pollution. A low sonic boom, due to unique bounding together of two different aerodynamic forms that exclude each others disadvantages and sum up the separate advantages of the forms	

2. FORM AND AERODINAMICS

2.1. Two optimal forms brought in the same plane

The form is the most important aspect of an airplane especially when it is traveling at supersonic speeds. Our form for the air plane bounds two different forms together in order to obtain better performances that are: lower sound pollution, less fuel use by reducing the friction force, more stability, reducing the runway length. By bounding these two forms together and using them alternatively, when each one is needed, our plane gains more stability, efficiency and higher performances in situations in which the two body shapes alone would not be as efficient. The two forms are the blended wing (Figure1) and the Sears-Haack shape (Figure2).

2.1.1 The Blended Wing

The blended wing provides a high amount of lift because of the large wing-span and wide wing surface, here the friction/lift proportion is optimal, so because of the large amount of lift the blended wing provides, the runway length required is shortened, the plane is very controllable at low speeds and the fuel use is optimal. Studies reveal that this form saves 20% fuel, but at supersonic speeds is produces a higher sonic boom than the Sears-Haack body shape, so by telescoping the wings and bringing the plane closer to the Sears-Haack body shape the sonic boom is lowered [2].

Figure1 (Blended Wing).

Advantages	Disadvantages
Produces a high amount of lift	Produces a louder sonic boom than the Sears-Haak
Is very stable when taking off and when landing shape	

2.1.2 The Sears-Haack body

The Sears-Haack shape is the best shape for a plane's body in order to create a low sonic boom, researchers ant tests conducted reveal that it causes the lowest amount of air disturbance, that implies the lowest amount of sonic boom. In our plane it is used as the main body, the wings are attached to it [3].

The transition between the two forms is made by the wings mechanisms that retracts them, at low speeds the wings are fully extended (Blended wing form) in order to produce great lift, at supersonic speeds the wings are telescoped inside of sections TL1 and TL2 (Sears-Haack form), only small parts of the wings are outside of the plane in order to produce the necessary lift at that speed, to reduce the air friction surface in order to lower the drag force that implies that the fuel use is optimal.

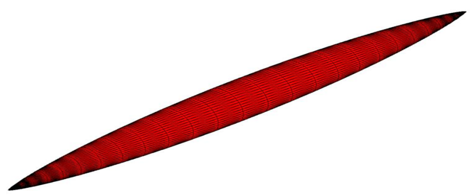


Figure2 (Sears-Haack shape).

Advantages	Disadvantages
Produces a very low sonic boom	It produces no lift
It's aerodynamic glides easier through the air	
It is easier to control at supersonic speeds	

Figure 3.The profile view of the airplane.

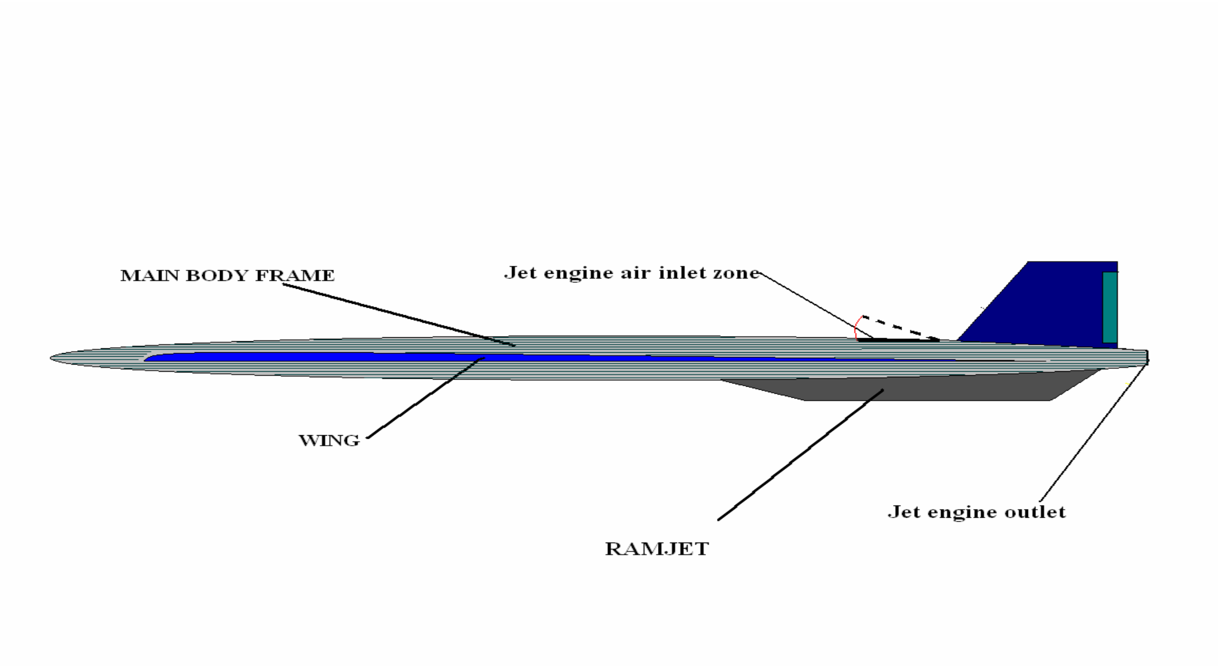


Figure 4.The airplane seen from above.

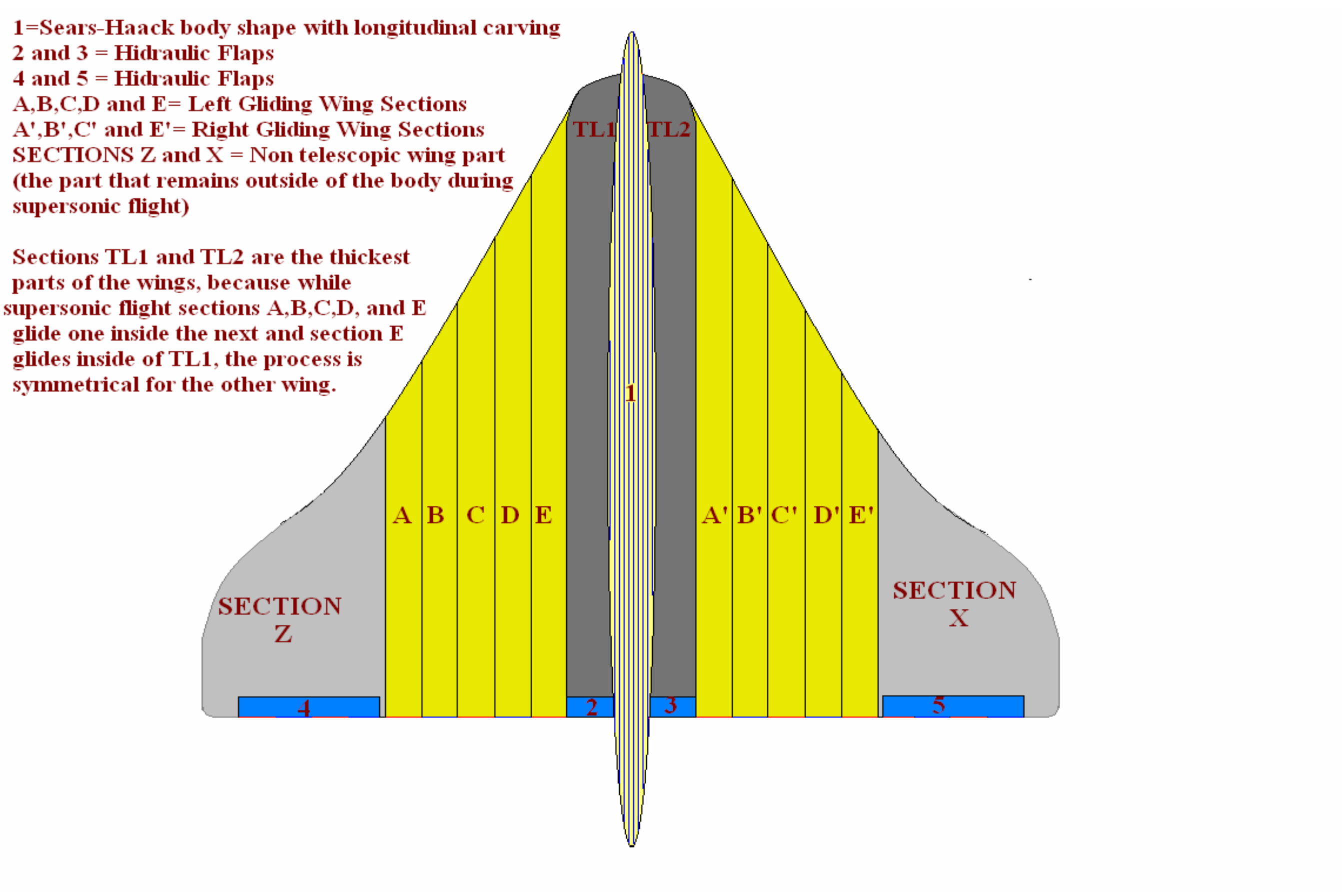
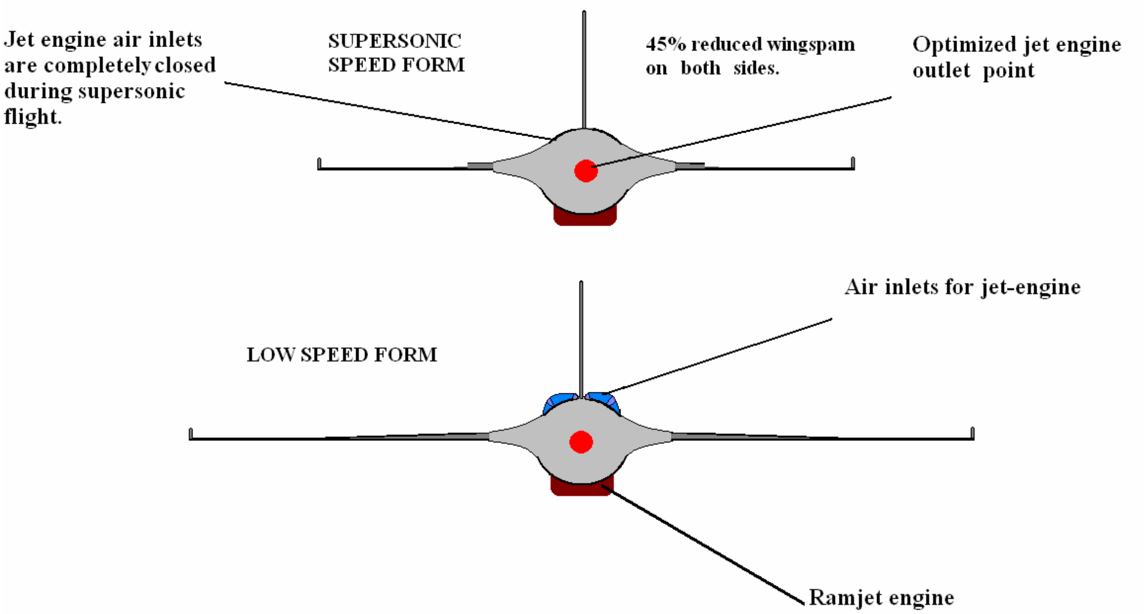


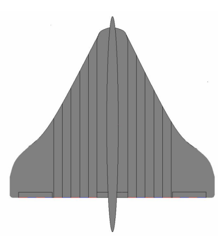
Figure 5.The airplane seen from the back.



2.2. The wings

In most, planes the wings are used for generating lift and controlling the plane, a very important aspect of flight indeed, but in our plane the wings have something more to do: they bound the advantages of two different airplane-design forms together and roll out the disadvantages of the two forms used alone. Our wings are made of seven sections that are able to glide one inside another (see Figure 4.), the mobile parts of the wings are sections A,B,C,D,E,A',B',C',D' and E'. As the plane gains speed these sections glide one inside another in order to reduce the air contact surface of the plane as the need of large wings that provide a lot of lift constantly fades out with the increase of speed. Sections glide by being pulled inside by hydraulic arms controlled by the board computer, section A glides into section B pulling along with it section Z, the process is symmetrical on the right wing as A' glides into B', the process continues along with the gain of speed: B glides into C(and B' into C'), C glides into D, D glides into E, and E glides into TL1 as well as on the other wing E' glides into TL2.

Graphic representation of the process (Figure 6):



Blended Wing Module: Figure 6.1

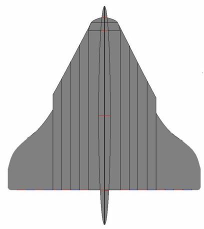


Fig.6.2

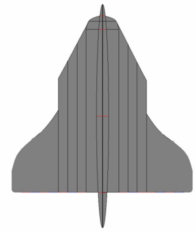


Fig.6.3

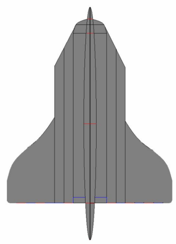


Fig6.4

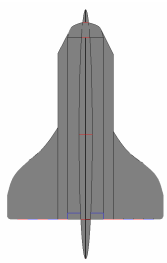


Fig6.5 >

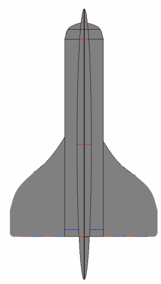


Figure 6.6.
Supersonic Speed module

2.2.1 The wing gliding algorithm:

Once the plane touches 497mph (800km/h) the board computer automatically detects plane's speed configuring the telescopic wing sections to glide one at a time when a certain increase in speed has been observed so that the whole telescopic areas of the wings are completely glided one into the other when the plane touches 0,8 Mach (614mph or 988km/h), if the speed decreases the process is reversed in the same manner.

Research shows that when flying over the sound barrier the air does not behave as a huge mass with no form any more, it hits the plane like millions of thin metal pipes, so in order to reduce the drag force and to lower the sound pollution, our plane will have many small straight longitudinal stripes carved into it's main frame (in figure 1 on section 1) in order to allow the air stripes to pass more easily along the plane's body reducing the drag force and the air disturbance caused by the moving [13].

3.STRUCTURE

The main issue when talking about the structure of a supersonic airplane is the high-quality materials needed for the construction of the airframe. These materials have a crucial role when it comes to supersonic speed and the very rough conditions implied by it: they must withstand very high temperatures, but in the same time they must not exceed a weight limit that would affect the plane's integrity or inflict damage to it.

A valuable property is to use materials that absorb sounds as it helps reducing the sonic boom and thus support over-land supersonic flights.

Using aluminum alloys, titanium alloys and especially polymer matrix composites will do for an impressive combination. Aluminum alloys are light, yet strong; titanium alloys have a great thermal stability and strength, while polymer matrix composites are recognized in the industry for their stiffness, lightness and heat resistance. From the last category we strongly suggest the use of glass fiber – well known in the supersonic aircraft industry. Phenolic resins are to be developed for use with non-flammable fiber reinforced composites, turning out to be very useful [5].

4.PROPULSION

4.1. Future fuel

In recent years, many controversies have emerged regarding the use of kerosene as fuel for airplanes, as it does not meet new environmental standards because of large amounts of toxic gases coming out from combustion. Some scientists promote the use of hydrogen, believed to be the future fuel, but on the other hand hydrogen currently has some disadvantages compared with other fuels such as the bio-diesel.

Bio-diesel is a synthetic liquid, made of natural fats such as vegetable oils or animal fat. Recently, some airlines such as Air New Zealand have tested the properties of bio-diesel replacing kerosene, which proved to be a success. On 30 December 2008, the airline completed a flight test in Auckland using a fuel based on Jatropha oil. The two-hour flight represented a sure step forward for the air industry, due to the discovery of a green fuel that is cheaper and friendlier to the environment than fossil fuels. Air New Zealand wants to use the fuel based on Iatropha oil for at least 10 percent of their flights beginning with 2013 [6].

4.2.Is the bio-diesel the best solution?

Bio-diesel, considered an equal replacement of petrodiesel (with 5%less efficiency), can be made by transesterification of virgin or used vegetable oils. The use of bio-diesel results in substantial reduction of un-burnt hydrocarbons, carbon monoxide and small particles. It is considered to have almost no sulphur, no aromatics and has about 10%built in oxygen, which helps to burn it fully. Its higher cetane number improves the combustion quality. Almost all present emission standards are expected to be reached with bio-diesel[7].

	Bio-diesel	**Hydrogen**
Technological Readiness	Can be used in existing diesel engines, which have already been in use for 100 years	At least ten years away
Fuel source	Algae farms or other vegetable crops, or waste conversion. Completely renewable process, with no net CO_2 emissions.	Electrolyzing water (most likely using fossil fuel energy) or reforming fossil fuels. Most likely non-renewable methods with large net CO_2 emissions
Fuel Distribution System	Can be distributed with existing filling stations with no changes.	No system currently exists, would take decades to develop. Would cost $176 billion to put one hydrogen pump at each of the filling stations in the US.
Overall Energy Balance(each unit of energy put in yields....) [higher is better]	From 1 to 3.2 units (depends on the source)	0.5 units (electrolyzing water into hydrogen with renewable sources)
Price	40-60$ per barrel (Jatropha oil costs 43$ per barrel)	Very expensive
Safety	Flash point of bio-diesel is over 300° F (considered "not flammable")	Highly flammable
Time scale for wide scale use	5-10 years	30-50 years optimistic assumption

[14]

4.3. Jatrpoha

Jatropha is a plant belonging to the Euphorbiaceae family, native to Central America. It can be cultivated on extensive areas in the tropical and subtropical regions. Obtaining bio-diesel is the most recent use of the plant. Jatropha does not require irrigation or fertilizers, although those can be added for a richer harvest. It is a non-food crop that can grow in wastelands and it is said to yield more than four times as much fuel per hectare as soybean, and more than ten times that of corn. The hard Jatropha is resistant to drought and pests, and produces seeds containing up to 40% oil. When the seeds are crushed and processed, the resulting oil can be used in a standard diesel engine, while the residue can also be processed into biomass to power electricity plants. The Jatropha trees take 4 to 5 years to mature fully. At that time, if Jatropha Plantation is rain fed, these plants can yield 0.35 to 0.375 gallon of oil per tree or 375 gallons per hectare. If it is irrigated (3 to 5 liters of water per plant every 15 days) it can be double this amount. According to the U.N., harvesting Jatropha requires 1 worker for every 1 acre of land. Currently most the seeds produced in India, are sorted and used for either Plantation Purposes or for crushing for oil. About 80% of the seeds are used for Plantations all over the world. An advantage of using bio-diesel based on Jatropha oil, is reducing carbon dioxide from atmosphere. Bushes like Jatropha on barren and desert lands, can fix up to 500 kg of carbon dioxide per acre per year [8].

4.4.Why Jatropha?

We chose Jatropha oil because:

-Jatropha Curcas is resistant to drought and can be planted even in the desert climates, and it thrives on any type of soil, grows almost anywhere: in sandy, gravelly and saline soils;

-Jatropha needs minimal input or management and its growth is rapid, a thick live hedge is formed after only a month's planting;

-Jatropha Curcas starts yielding from the second year onwards and continues for 40 years;

-The meal after extraction an excellent organic manure (38% protein N:P:K ration 2.7:1.2:1);

-Other than extracting biodiesel from Jatropha Curcas plant, the leaf and the bark are used for various other industrial and pharmaceutical use:

-Localized production and availability of quality fuel, restoration of degraded land over a period of time;

-Approximately 40 % of oil is extracted from the Jatropha Curcas seed. It can be used for any diesel engine without modification[9].

4.5. The Engines

4.5.1 The Modified Turbo Jet

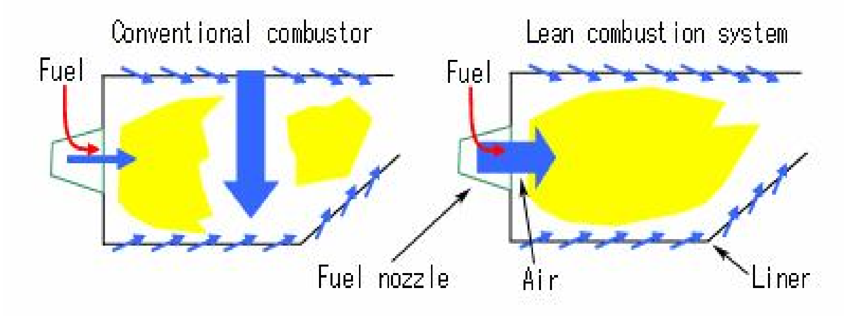
Bio-diesel can be used as a transport fuel in diesel engines with little or no modifications. Blends of bio-diesel with petroleum diesel can be used in diesel engines. To use pure Bio-diesel many engines require certain modifications to avoid maintenance and performance problems. The use of bio-diesel can extend the life of diesel engines because it is more lubricating. It also replaces the exhaust odor of petroleum diesel with a more pleasant smell.

The low speed engine is a modified turbo Jet-Engine that creates lower gas emissions than ordinary turbo jet-engines .

Moreover, according J.A.X.A., there is a method of reducing nitrogen oxides emissions. Clean Engine Team is conducting a research on a low NO_x (nitrogen oxide) combustor for future aircraft. NO_x is produced by the oxidation of nitrogen in the combustor, where a mixture of fuel and highly compressed air burns under a high temperature condition. The fuel consumption rate of an aero engine, equivalent to the amount of CO_2 exhausted, can be reduced by increasing the temperature of the combustor gas. This has an advantage, however, as the temperature of the combustor gas gets higher it leads to the production of more NO_x in the exhaust gas.

The combustors for aero engines being built nowadays are undergoing dramatic modifications to achieve both low fuel consumption and low NOx targets. The combustor (Figure 7) is made of a "fuel nozzle" which mixes fuel and air and a "liner" which covers the combustion area. The conventional combustors adopt a so called “rich-lean” technology in which a small portion of the air enters through the fuel nozzle for rich combustion while most of the air enters halfway across the liner for lean combustion downstream. The NOx can be reduced even in this type of combustion when the nozzle and liner is properly designed. As an alternative, the recent “lean burn” technology attempts to drastically reduce the NOx exhaust by removing the rich combustion zone altogether. In a lean burn combustor, most of the air enters through the fuel nozzle, while only a small portion of air enters through the liner for cooling. These combustors inherently produce less NOx than the conventional combustors because the fuel tends to combust at a lower temperature.

Figure 7. The combustor.

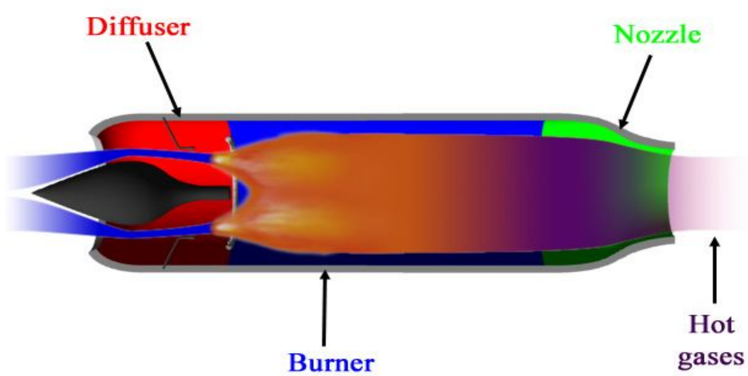


[10].

During subsonic flight, because the engine is integrated into the Sears-Haack shape, inlet openings on the fuselage will feed it with the necessary air. When the ramjet si ignited the air inlets close and as the engine is completely included into the mainframe it produces no dragforce. So at supersonic speeds the plane's main frame form is disturbed only by the wings and the ramjet engine

At more than Mach 0.8 the ramjet engine becomes the main propulsion system that can take the plane to speeds like Mach 3. This system uses high pressure from the inlet of the engine to force the air into a tube where the air is heated by combusting an amount of air and fuel mixture. Then the air passes through the terminal region, the nozzle for producing supersonic acceleration. This acceleration gives the plane the push effect. Because the ramjet contains only static parts, the resulting mass is reduced and the efficiency of the plane gets very high [11].

Figure 8.The ramjet.



[12].

5.CONCLUSION

Our plane bounds together several ideas that make it optimal for supersonic and subsonic flights. It is very adaptable, it can fly at low speeds as well as at supersonic speeds due to it's telescopic wings. The wings bound together two shapes adaptable for each type of speed (subsonic and supersonic), this helps shorten the minimum runway length required.

We suggested building the fuselage out of combined materials (aluminum alloys, polymer matrix composites, glass fiber, phenolic resins and titanium alloys) that will be able to withstand supersonic flights, and in the near future can be easily obtained.

It is very important that the main frame of the plane to have many longitudinal stripes carved into the fuselage surface in order to reduce drag force during supersonic flight (figure 4 section 1).

We suggested using two different propulsion systems, a new type of turbo jet-engine with lower toxic gas emissions for subsonic flight and a ramjet for supersonic flight. Both engines will use the fuel efficiently and help lower the costs.

In order to protect our home planet from the high amount of pollution the kerosene causes, we proposed a new revolutionary way of creating bio-fuel from a plant named Jatropha that can grow almost on every kind of soil.

Regarding Jatropha, aviation currently consumes around 5 million barrels of jet fuel per day, or 238 million tone per year. Presently Jatropha yields – 1.7 tone of oil per hectare – to get the necessary quantity if would take 1.4 million square kilometers, well over twice the size of France. To put this in context, D1 Oils, the British Company pioneering bio-fuel from Jatropha in countries such as India, Zambia and Indonesia, plans to plant 10,000 km2 over the next four years [15].

We hope that our view of future aviation, the Super Sonic Voyager X, is imaginative and innovative enough to become the world's view of future aviation.

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