

# **NASA Fundamental Aeronautics Student Competition**

Technical Area: Supersonic Flight Project

1) Emmanuel Vasileios Garagounis Vlatakis  
Grade 11

2) Dimitrios Tsounis  
Grade 10

HIGH SCHOOL OF KAREAS (GREECE)

CITY: ATHENS (BYRONAS), STATE: ATTTKI, COUNTRY: GREECE, POSTAL  
CODE: 162 33

NAME OF TEACHER: KAZANIS DIMITRIOS

SCHOOL END: JUNE (6)/ 15

## 1.1 ABSTRACT

Daedalus was the first mythological designer of flying system. After thousands years, Chuck Yeager was the first human who breaks the Sound barrier. However, the achievements that followed Chuck Yeager's glorious deed were not able to develop the technology enough so that we can manufacture supersonic airplanes of civil aviation. This difficulty leads humanity to a strange road. We can beat the sound. We can fly faster than the speed of sound but we cannot use this fact for our life. Unfortunately people don't have this ability now. We can only fly with subsonic speeds. Somehow we should find what is necessary in order to have supersonic flights within the next decade. Our civilization is continually developing; by 2020 the earth will have a totally different image. This image might be better if we work together and solve the problems we face or this image might be bad if we behave arrogantly and do nothing about the environment, which is on the verge of destruction.

In this world people need to fly fast, to travel from one side of the world to the other in no time. In this era, we call it an era because we believe that the years ahead are going to be very important for humanity, people need a supersonic aircraft. We had the Concorde but the Concorde was a financial and environmental failure. In spite of this failure, Concorde gave us the opportunity to see the application of the supersonic flight theory. We understood our faults but also we made great strides, since we exceeded our knowledge, and our horizons.

Through this paper we will try to explain to you, what needs to be accomplished in order to have a small supersonic airliner by 2020. We will thoroughly explain why we need it, what the pros and the cons of it are. Here we present you a list with what we will be dealing with in this paper.

- 2.1 Why we need a supersonic airliner
- 2.2 What the pros and cons of it are
- 3.1 Design of a small supersonic airliner
- 4.1 Structural issues, Materials selection
- 5.1 Sonic Boom
- 6.1 Fuel, the "nectar" of an aircraft
- 7.1 Engines
- 8.1 Conclusions

## ***2.1 The necessity of a supersonic airliner.***

The employment of a future supersonic airliner will be called on to deal with the transport of passengers.

This vital sector constituted one of the basic factors for the failure of the supersonic planes (a prime example is the Concorde) and for the decision to stop manufacturing them. We should also not forget the statistics compiled by the United European Committee of Economic Researches that recognizes technological success of the Concorde but at the same time it constitutes an economic failure (ref.1). Aerospace engineering should try to find a solution to this problem, before a new supersonic airliner is to be delivered to the public.

In any economic period, whether it is in a time of a recession or prosperity, one of the basic doctrines of the business world is the phrase "Time is money". This money therefore is "preserved", is created, and it is gained through supersonic flight. Supersonic flights being the fastest way of transportation so much in transatlantic and in transcontinental flights, it is obvious that they will be a pole of attraction for businessmen and obviously for those who work in multinational companies.

(ref.2)According to this research, there is a necessity for new enterprises that select to broaden their horizons in international funds in the application of processes that will help enterprises in the better management of multiple tasks and will close the gap and the pointless delay that is created by the indirect supervision of work. The supersonic plane serves this necessity(ref.3) We should not forget, moreover, the profit that will come about in this new way in a season where the economy seeks ways to recover and to dispel the enterprising fears and wants to support bold new investments. This is a parameter that propels the manufacturing of such planes and the encouragement of integration in the air market.(ref 3)

Another aspect of interest that the supersonic plane will cover is that of the transport of organs, which nowadays are usually transported in military helicopters which may face the danger of delay, a factor that turns out to be fatal many times in the medical sector.

However, apart from those who are interested in the new supersonic plane and what it can provide through the relatively low price of the ticket, the supersonic plane also gives the opportunity to a wider spectrum of people to select it as a mean of transportation. The affordable ticket henceforth is a feasible target with the reduction of costs, and not so much due to manufacturing costs, which under the most favourable terms remain high- but mainly due to the alleviation of cost in transport and maintenance, thanks to bigger efficiency and quality of new fuels and new type of electric engines.

In general, it should be perceptible that the ticket obviously will be expensive. However, it is very important to try to decrease it. This is the only way it can be absorbed in the air situation, offering at the same increased competition. The competition (ref 4) between airliners has proved to be effective, as it increases both supply and demand thus decreasing prices.

The conclusion is that the practical question concerning the viability of this supersonic flight project is hidden in how easily and fast the return of capital will take place which an airline company has spent to purchase a supersonic plane. This depends more on the fuel efficiency, which will not "damage" the engines (Reduction of functional expenses) and on the policy that every company will follow to satisfy

the interests of the mainly interested customers, that is to say the target group of the tourists and generally speaking the inter-country professions.

## **2.2 Pros and Cons**

Supersonic transportation has many advantages over subsonic transportation. First of all, supersonic aircrafts fly faster. Time is a valuable thing nowadays. The Concorde needed around 3 hours and 30 minutes to travel from London to New York. Today, conventional subsonic aircrafts need about 7 hours to cover the same distance. A supersonic airliner would revolutionize air transportation. This would exploit and create “new” global markets. The new challenges for the entire science are also another very important parameter. Internet, for example, is created as parallel digital construction in order to solve a part of a scientific problem. The fact also that the different sectors of science are inter-related allows us to say that the development of supersonic flights will contribute to the progress of technology of the automotive industry

However, supersonic flights under certain circumstances have many disadvantages. The noise produced by sonic boom is annoying and sometimes harmful for the people on the ground. Because of the high per-passenger takeoff weight it is difficult for supersonic aircrafts to obtain an efficient fuel fraction. This, together with the relatively poor supersonic lift/drag ratio, supersonic aircrafts have historically had relatively poor range. This meant that a lot of routes were non viable, and this in turn meant that they sold poorly with airlines (ref. 5). Furthermore, the fuel efficiency of prior supersonic airliners was very bad. Nowadays the price of oil is high, and an expensive ticket would make supersonic flights undesirable. A drawback of supersonic airliners is their small capacity. People want to travel in masses and this would also benefit the airline companies.

All those are the advantages and the drawbacks of prior supersonic aircrafts. The new generation of supersonic airliners should be able to eliminate all those drawbacks.

## **3.1 Design**

The most important factor in the process of creating a supersonic airliner is the design of it. When engineers design a subsonic aircraft they do take into consideration only factors like aerodynamic, fuel efficiency, high lift to drag ratio and more space for the passengers. Unfortunately, this does not happen in supersonic aircrafts. Engineers try to design a supersonic airliner, which will produce a low sonic boom, will be able to overcome the wave drag and carry as many passengers as possible.



Future civil supersonic airliner

Source: NASA

This is something really difficult.

The design above is an artist concept made by NASA. We couldn't make our own design, but we will try to explain why we picked this as the future civil supersonic airliner.

First of all, the nose of this aircraft is like the one in the Quiet Spike project. The nose will propagate or break the initial sonic boom in smaller shock waves. (Elaboration in page 6).

We can't say for sure in this photo, if the wings of this aircraft are designed to change position during the flight. As in the small supersonic airliner suggested by Gulfstream, the wings change position for better performances.

The sharp and long fuselage also plays a major role in the mitigation of sonic boom and the wave drag.

In this design we would change the length and the span of the wings. Although the wings might be just perfect for flying supersonically, they seem to be too large in comparison to the current subsonic aircrafts. This would make it more difficult and would require much more space for this aircraft to land, and find a parking space in an airport. When people create something, they should try to integrate it into the current situation.

#### ***4.1 Structural issues***

In this part of the essay we are going to talk about the structural issues and the skin overheating which all supersonic aircraft face because of the pressure exerted on them and because of their speed. Furthermore, we will suggest some materials, which could be used in a future supersonic aircraft. We know that it is difficult to say simply what the perfect material would be, but we can say which materials could be used. In the process of selecting materials for the parts of an aircraft, we did not take into consideration financial factors, such as the cost of the materials. The potential passengers of such an aircraft, who will be mainly business people, would prefer to pay a more expensive ticket but fly faster.

Supersonic aircrafts fly at very high altitudes and speeds. So, we can easily understand that the amount of pressure, which is put on them, is very high. A small mistake in the design of the aircraft's fuselage, skeleton could be fatal. Furthermore, aerodynamic design for high-cruise lift-to-drag ratio and efficient performance at off-design conditions (transonic and low speed) must be achieved in concert with environmental and performance constraints (ref. 6).

Spinal cord is perhaps the most important part of our body. If we have a problem with our spinal column we might get paralyzed or in the worst case die. Every aircraft has its own spinal cord. We should make sure that the spinal cord of the aircraft is strong enough, light and can withstand the pressures exerted on it.

We strongly suggest that the skeleton of the aircraft, the spinal cord, should be made by Titanium (Ti). The two most useful properties of the metal form are corrosion resistance, and the highest strength-to-weight ratio of any metal (ref. 7). With a melting point of 1668 °C we are sure that the heat which is caused by the friction won't have any effects on this metal. The thermal expansion of it is at 25 °C  $8.6 \mu\text{m}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$  (ref. 8).

#### *Materials selection*

Because of the high speed of the supersonic aircrafts, very high temperatures rise in the fuselage of the aircraft. Advanced materials with high durability and low weight should be used. It goes without saying that different materials will be used in the different parts of the aircraft. The higher temperatures rise in the nose of the aircraft and around the wings. That was also the case with Concorde (ref. 9). Totally different materials should be developed for the engines. In the engines there is a lot of heat and consequently we need a material with very high heat resistance.

Here, we present you with a list with materials and how these materials could be used to build a small supersonic airliner.

- Carbon Fiber Reinforced Polymer (or CFRP) is a very strong, light and expensive composite material or fiber reinforced polymer. It has many applications in aerospace engineering. Much of the fuselage of the new Boeing 787 Dreamliner and Airbus A350 XWB will be composed of CFRP (ref. 10). We believe that the wings of this new supersonic aircraft should be made by Carbon Fiber reinforced epoxy. Epoxy is a polymer which is commonly used in aerospace engineering. Due to its high heat resistance it makes it perfect for the wings, where high temperatures occur.
- Aluminum (Al)-Lithium (Li) alloys are a series of alloys of aluminum and lithium, often including copper and zirconium. Since lithium is the least dense elemental metal, these alloys are significantly less dense than aluminum. Commercial Al-Li alloys contain up to 2.45% lithium. The mixing of Li with Al offers the promise of substantially reducing the weight of aerospace alloys, since each 1 wt. % Li added to Al reduces density by 3% and increases in elastic modulus. (ref. 11). The melting range of the 8090 Al-Li alloy is 600-655 Celsius degrees. Consequently this material could be used to build the extendable nose.
- Aluminum and Polymer Matrix Composites laminates are to be used to build the fuselage of the aircraft. An aluminum alloy which could be used is aluminum 2219-T87. The density of it which is only 2.84 g/cm<sup>3</sup> makes it very light. The Ultimate Tensile Strength of 69000 PSI makes it very strong. The melting range of it is 543 - 643 °C. However its aging temperature is 163 - 191 °C. Usually the temperatures on a supersonic aircraft flying at about 1.8 Mach speed are not that high. (ref. 12)

#### *Materials for the engine*

The temperatures in the engines of a supersonic aircraft are very high, that is a common truth. Thus materials with great heat resistance should be used there. Improved materials with thermal barrier coating (TBC) and environmental coatings will be required for the combustor liners and turbine vanes and blades, and turbine and compressor disks will require improved materials (ref. 6). Ceramic thermal and environmental barrier coatings (TEBCs) are used in gas turbine engines to protect engine hot-section components in the harsh combustion environments, and extend component lifetimes (ref. 13).

Here we are not going to suggest a new TBC, but we will describe to you an idea we have about making TBCs more efficient. The temperature outside the aircraft at 55.000 feet is many degrees below zero. We should take advantage of this cold air. We suggest making a layer no more than 2 cm before the Ceramic coating of the TBC, which will have cold air in it. A machine will suck air from outside and will bring this air into this special coating. The air will be released when it reaches a

certain temperature and after “new”, cold air will be sucked in. This way the structural parts of the engine will not suffer from overheating and consequently they will “live” longer.

Hence, the outside part of the engine could be built with the same material as the fuselage. The inside part of the engine could be built with titanium Alpha alloys, alloys in which neutral alloying elements (such as tin) and/or alpha stabilizers such as Aluminum or oxygen only. These are not heat treatable.

### ***5.1 Sonic Boom***

A major problem, which all supersonic aircrafts face, is sonic boom. The term sonic boom is used to refer to the shocks caused by the supersonic flight of an aircraft. Sonic booms generate enormous amounts of sound energy, sounding much like an explosion. (ref. 14) Sonic boom is the reason why supersonic flights are not allowed over populated areas. So we can easily understand that by solving this problem, we will have done a great step in getting closer to a supersonic aircraft. It is a common truth, that engineers can shape the sonic boom and consequently mitigate it. But before we start thinking about how to reduce it, we should know what affects it.

The following are some factors affecting sonic boom strength:

- Aircraft weight, shape and length  
-The bigger the aircraft is, the more air molecules push aside. Thus a big aircraft will produce a stronger sonic boom.
- Aircraft altitude  
-The altitude of the aircraft and the strength of the sonic boom are reciprocal. As the altitude increases, the strength of the sonic boom decreases.
- Aircraft maneuvers  
- Maneuvers such as pushovers, S-turns and accelerating can amplify the intensity of the shock wave. Hills, valleys and other topographic features can create multiple reflections of shock waves thus affecting intensity.
- Location in sonic boom carpet (ref. 15)  
-Special topographic features in each area such as mountains, hills and valleys can create multiple reflections of shock waves thus affecting intensity.
- Attitude—orientation of the aircraft’s axes relative to its direction of motion. (ref. 16)

As mentioned above, engineers can potentially “shape” sonic boom, but changing the design of the aircraft this would have tremendous effects on the aerodynamics of the aircraft. Engineers should try to incorporate into their design all of those points in a supersonic aircraft.

Taking those details into consideration, we come to the point that, sonic boom, should be shaped not by the aircraft, but from an object, which would be 1 or 2 meters in front of the aircraft. We can annex this object on the nose of the aircraft.

## ***CURRENT IDEAS ABOUT SONIC BOOM***

Quiet Spike project (ref. 17) showed that by extending the length of the nose, and by changing the position of the wings, sonic boom would be reduce to about 55 dB. (ref. 18) But the capacity of Quiet Supersonic Jet suggested by Gulfstream is about 8-11 passengers. The aircraft on which we are working for this project is expected to be able to carry 35 to 70 passengers. More complicated technologies should be developed, in order to have such an aircraft.

The Quiet Spike project is based on the hypothesis, which has been experimentally proven, that the extended and shaped nose of the aircraft will propagate the shock waves. The nose will break up the initial shock of traditional N-wave into a series of very weak shocks. An F-15 was used to test the Quiet Spike idea. We can easily understand that an F-15 had a totally different aerodynamic behaviour from a commercial supersonic airliner. But definitely this kind of design will be the solution to the sonic boom obstacle. (ref. 19)

When engineers design supersonic aircrafts, they should take into account many different factors. For example, when we sketch a design, which is ideal for shaping sonic boom, we should also check, if this design is aerodynamic and connect it with the fuel efficiency of the aircraft. The Sears-Haack body is, generally speaking, the body least susceptible to wave drag. (ref. 20)

## *PREDICTING SONIC BOOM*

Far more important than designing a low sonic boom aircraft is to find a method to predict the sonic boom. Scientists should find an equation, which will provide us with the ability to calculate the sonic boom, when we know the shape (design) the volume and the altitude at which the aircraft flies. In the research and development of a new supersonic commercial plane, computational codes are needed to predict (1) ground sonic-boom noise from various aircraft designs, (2) the occasional magnification of sonic boom called “focusing” that can happen during rapid acceleration, turns or other maneuvers, and (3) design elements for sonic-boom mitigation. (ref. 21)

The fluctuations of the strength of sonic boom are very important, because if an aircraft passes over a city, and a sudden change of sonic boom occurs, this could be harmful for the buildings of the city.

People can calculate the sonic boom signatures, of an aircraft during the flight with special devices. But the whole point is to create software which will show us how the shocks waves will propagate when an aircraft with any given design passes through them.

## *SUGGESTIONS*

After having carried out this research, we came up with some ideas, about ways to lessen the sonic boom. Unfortunately we couldn't scientifically test our ideas, not only because we don't have the knowledge, but because such facilities, are not available here in our country.

The first suggestion is a development of the Quiet Spike idea. As we have mentioned above the Quiet Supersonic Jet suggested by Gulfstream, which is based on the Quiet Spike idea, is predicted to be useful for aircrafts with capacity smaller than 15 people. An N+2 aircraft is expected to be able to carry 35 to 70 people. (ref. 22) After profound thinking we got to the point that by aggrandizing the nose, we would reduce sonic boom in an N+2 aircraft.

We propose this because we think that the size of the nose should be proportional to the size of the aircraft. On a huge track one may put bigger spoiler than in a small truck.

Our second idea, and maybe the craziest, in a good sense, is to make protrusions around the front part of the aircraft. These protrusions will look like rings, which are embodied around the aircraft. We thought that these “rings” will disturb the



flow of the air around the aircraft, and consequently they will cause many weak sonic booms. However, this may have negative effects on the aerodynamics and the lift of the aircraft. Many experiments should be done to test this theory.

In conclusion, we strongly believe that sonic boom is something that will be a barrier to supersonic flights for ever. Engineers may find ways to lessen it, but it will exist for ever like the gravity of earth is. However, people can beat gravity...

## **6.1 Fuel**

Humanity loves hydrocarbons, we encountered them as sources of adoration in the “eternal fires” of Persia, we converted them into massive destruction weapons with the “liquid fire” of the Greeks, we worshipped them as a fuel in factories and in vehicles and we admired them when they “gave” to the humanity their plastic and pharmaceutical derivatives. We hated them, however, for the pollution of environment, the greenhouse effect and... because they are found in minimal parts of planet. No matter how the situation is now, this “addiction” will finish soon. The most optimistic forecasts talk for reduction of production of petrol afterwards 2040, while the most pessimistic expect it from 2006! Of course, the scientists have been searching for decades for the next solution. The problem that aroused in all the means of transportation is that the process of combustion, from which we exploit the “energy” of hydrocarbons, had as a result the appearance of CO<sub>2</sub>, whose accumulation in the upper layers of the atmosphere is almost the exclusive reason of greenhouse effect and of NO<sub>x</sub> (more usually the NO<sub>2</sub> and NO) which, apart from their toxicity (characteristic example the acidic rain) contribute in the creation of ozone hole.

So, not only the scientists but also the entire industry of fuels soon started to seek different sources of energy or, better to say different energy currencies. By saying energy currencies we mean the forms or the institutions of energy that we create changing the sources or their energy content (e.g. the petrol is the energy currency of oil). And we need the energy currencies because they render the movement and the use of their energy wealth much easier. (ref.25)

The growth of technologies that will provide as far as possible “clean”, high efficiency fuel, exploitation of mining fuels is a necessity, since we refer to planes which fly in superior layers of the troposphere. (ref. 26)

For this reason the scientists as well began to seek ways to use biofuels (ref.27) in all the means of transportation. The clues, however, until now, mainly with regard to the experiments for planes and to the research programs, indicate certain particularities with burdening importance that forced the European Committee to aim at goal to cover less than 10% of consumption automotive with biofuels until 2020. (ref.28) The point that the scientists were based on, is the catalytic circle of recycling of biofuels. Actually biofuels are taken through the plants and then they are returned through the “very ancient” reaction of photosynthesis.  $[12\text{CO}_2 + 12\text{H}_2\text{O} \rightarrow 2\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 + 6\text{H}_2\text{O} + 674 \text{ calories}]$  (ref.29)

In the meantime, Airbus (ref.30) has moved on in a new form of fuel, which could be said that it is really the cleanest and the most improved chemical mixture that the coal has attributed until now. It is an experimentation of GLT (gas to liquid) (ref.31), a mixture that was manufactured by Shell and was applied by Airbus and Qatar Airways. “The GLT is limpid, clean fuel, free from sulphur and aromatic hydrocarbons”, reports the website of Shell. The new fuel offers increased fuel efficiency as well as considerably decreased emissions of local pollutants, as the particles, the monoxide of coal and the oxides of nitrogen. At the same time, Rolls

Royce used for flight a mixture that has natural gas as its basic element natural gas. (ref. 30, 32)

All these variations aimed at the creation of fuel that will have the higher possible fuel efficiency and at the same time its combustion will emit the fewer possible pollutants. Mainly, concerning GLT and the biofuels, in the “green” week 2008 (ref .33) , serious objections were formulated by the professor Grazia Zanin of Baylor University of Texas who points out that “we do not believe that biofuels is the answer that we look for because it cannot function well in very low temperatures of big altitudes where the plane flies.”(ref.27) The research team of the “green” week 2008 also formulates scruples about the proportion of land available for the development of biofuels to the ecosystem and about whether these new fuels can constitute a factor of minimization of the greenhouse effect and ozone hole Accordingly, again in the same research, the interruption of the use of petrol and kerosene should come in combination with the appearance of fuels clean for atmosphere. And this should take place at an early date, before the situation henceforth is not reversible. For this reason it is henceforth deliberated to search for alternative sources of energy that agree with our aims and our requirements

Thus, an idea that might be heard utopian comes in light with a lot of promises. A form of clean energy as electricity and capable of storage as petrol, which as a product of combustion in the exhausts will produce simple water vapors, instead of pollutant exhaust has been always a dream of humanity. This is obviously hydrogen.

#### *Why hydrogen?*

Because along with electricity they are the two only that can constitute sources of energy and can be used without emission of dioxide of coal and at the same time these two energy currencies can be produced with use of not pollutant sources of energy. They are also renewable in the precise significance of the term. Also, what concerns the viability of H<sub>2</sub> as fuel is obvious because it is a complete recycling circle. The hydrogen “is created” with the split of water H<sub>2</sub>O and its segregation in H<sub>2</sub> and O<sub>2</sub>, while hydrogen attributes once again water, at its use in combustion. Thus, the water is not substantially consumed but is recycled. To raise the issue of sufficiency is pointless since the probabilities of lack of hydrogen are the same as the probabilities of lack of reserves of electrons for the universe.(ref. 34)

The questions, concerning the hydrogen as fuel of a supersonic airliner, lie in the sector of production of H<sub>2</sub> so that the plane can include it in its reservoirs either from a service station, or even from production of hydrogen during the flight (we will analyze below the unique cases) and in the sector of storage which as in biofuels has burdening importance. [For this reason, moreover, fraction of kerosene was used, because it remains humid in flight conditions].(ref. 27)

#### *Production of hydrogen*

The production of hydrogen is mainly feasible with electrolysis of water, something which means that more energy will be consumed in the split than that which hydrogen will give with combustion. For this reason, the proposal has been rejected. Thus, the interest in hydrogen was turned to alternative methods. One of them is the thermo-chemical split of water with the engagement of thermal energy from thermal circles as the circle of iodine acid - sulphurous acid, known as Mark 16, EURATOM, so that the production becomes friendly to the environment split (ref.35)

The “H. Power Corp.”, however, gave the solution with the method of sponge-like iron. This method has reached the applying stage and is described comprehensively as follows: Sponge-like iron in humidity is changed in oxide of iron (rust) and this reaction releases hydrogen and requires only concrete sum of energy only at the departure. The iron with the inverted reaction, known as reduction, comes back in the initial situation. The proposal of Princeton is impressive using as a reductive reaction agent the  $\text{CO}_x$  (1-2) that emanates from biomass and according to the university, it is recycled again by the plants the biomass is constituted. This is our main proposal which offers ready hydrogen that is stored and simply used in the plane.

The proposal for a light-chemical split of water that will be found in reservoir of plane at the duration of the flight has been formulated. However, this would require photovoltaic systems covered by powerful transparent materials, which accordingly means bigger costs and that is also the basic drawback the idea. However we should not be in a hurry to be opposed to this application after new researches which use multilateral of coal, Kevlar, in transparent situation and believe that if this combination is possible, the water would be rendered feasibly as a direct fuel. (ref. 36, 37)

### *Storage of hydrogen*

So, the only question that has been complex up to recently, is the storage of hydrogen. As an expert says the best system of storage is not to store it by no means.(ref.38) The small size of its molecule and the fact that it is odorless and colorless makes it “sneaky” because it leaks easily from the rabbits of pipings and elements. Moreover hydrogen will shape extremely explosives mixture with atmospheric air.

The use of alloys of hydrides of metal (ref.39) was proposed so that the possible escape has inconsequential repercussions. The entrapment of hydrogen in special metals - which absorb it while frozen them and attribute it while heated - is efficient, but... the cistern weighs a lot and the export of hydrogen requires energy and filling takes too much time!(re.40, 41)

The idea however that can give us the speed that we want is the method of storage in containers with absorption of active coal (University of Syracuse) that was extended thanks to one exceptional conception, the eminent nanotubes of coal (ref.41), which are light perfect traps of hydrogen. It is the similar idea but with the use of material that does not overload the movement of plane. Actually, it is the same precise activity, however, instead of hybrids of metal, the active coal and nanotubes (ref .27) of coal which are institutions [they are called institutions or carriers because they can “carry” everything, mainly metals but also hydrogen without extra weight] are used as material and in concise description, they function as a sponge that you have soaked in water (filling stage), while the way of “draining” is in reality a simple catalytic circle. Thus the problem of all problems(ref.42,43), that the experiments of Airbus and Boeing are presented, is solved.

Thus, a hybrid hydrogen bird (ref. 36) , leading to the supersonic plane of 2020, will be presented, which will be composed of reservoirs that follows the described function with synthetic materials of high resistance with systems of protection against percussion and detectors of escape. These reservoirs for the first years would be partitioned and would contain also GLT as much as hydrogen,(ref.44) until the industry develops completely the technology of hydrogen. With regard to the

danger of the appearance of nitric acid, the solution is found in catalysts from Pt or Pd, giving us the occasion to say that in the near future the unique exhaust will be clean steam.(ref.45.46)

### ***7.1 Engine***

The engine of a supersonic aircraft(ref. 47,48) should not be examined from the view of speed, since people have been able in the past to reach and get over the speed of 1.8 Mach with many different ways and engines.(ref. 49)

The engine should be powerful enough in order to exceed the sound barrier and the frictions of the air. The basic model is a turbojet (ref. 45,46,50,51,52) which will have radical changes proportional with the technological development and the replacement of fuel that is proposed.

The engines were one of the factors why Concorde created deafening noise while on the ground. One of the basic factors which create this noise is bypass ratio. (ref.53,54) Bypass ratio is supposed to be “big” when the plane is near a populated (ref. 55) region and small when it is found in high altitudes, where the sound of the engine will not be able to cause noise pollution. So the need for controlled change of the interval between exterior region of the engine where the air is not used for combustion and the combustion room is a necessity. This could be feasible via a scientific thermometer and barometer, which will determine the distance between the combustion room and cubicles of bypass. The conception is simple. While the distance of the plane from the earth increases, the pressure and the temperature are changing. So a system, following the clues of the meters, will determine the distance of the cubicle of combustion from exterior cubicle. At the same time in the cockpit, there will be special electronic systems that will inform the pilot about all measurements and will also make a digital 3-D of the engines.(ref.56)

Moreover, the manual change of the bypass ratio will be feasible, so in a situation of emergency the pilot himself can control the engines and the distance in case of fire in the engine. Naturally, the stabilization in a certain distance will also be possible.

The “issue” with this particular model is that the speed is altered and does not allow the plane to have a constant speed. The logic is that the bypass is a factor of impulse. (ref. 57)The INASCO, however, showed that if parallel the change of the ratio the change in the valve of entry (inlet) and in the exit (ref.58,59) becomes controlled then one can produce the same speed.

In practice, valves are used which will alter the diameter of import, decreasing the speed entry without altering the pressure. Thus, you do not have to use auxiliary engines for extreme (high-low) speeds.

At the same time, the application of electronic engines and electronic systems that will begin to be used in public transportation by 2013 (ref. 60, 27)should be taken into consideration. Main advantage of electronic engines, which will replace all hydraulic systems, for example in the fins, is that will increase the efficiency and the effectiveness in their operation and will produce a decrease of 20 decibels in the sound. (ref. 61)

The combustion room is not altered as far as its operation is concerned, but at the entry and at the exit a catalytic system is used that will isolate the clean oxygen and will minimize the possibility of the formulation of nitrogen of acid (toxic gas)

,responsible for acidic rain. The process of combustion of hydrocarbons remains the  $H_2 + O_2 \rightarrow H_2O$ .

An important point of this study is the resistance that it can show the engine when it approaches in the superior point of friction from the air caused by sonic boom. A proved pioneering idea that was formulated by Russian scientists of the 70s (ref.62) for the use of plasma for the reduction of sonic boom and the frictions of air can be used henceforth as a semi-shell in the engines. The idea is, in a few words, to produce an electric field, so that plasma is created, heating the local air and making feasible the reduction of waves. The proof was experimentally checked with Deep Space 1. Obviously until 2020 the application of this model will not be feasible, neither will the plasmatic ignition that is going to be achieved in the experiment of NASA with VASIMR engine but after 2040 the results of these experiments will have surely practical application.(ref.62,63)

Until 2020 we will not need to worry so much about this particular question, even if this method will be certainly beneficial, since it would make the aircraft more efficient. Turbojets are engines powerful enough to exceed the friction, while an interesting idea is to use around the engine a layer of foamy sound insulator covered by Thermal Barrier Coating.

### ***8.1 Conclusions***

This was our view on how a small supersonic airliner be realized. This research had many limitations, such as lack of time, lack of expertise and definitely lack of state-of-the-art facilities, such as aerodynamic tunnels. Furthermore the 12 page limit was very restricted for such a topic. What we did is simple. We searched and found what technologies are to be used in a future supersonic aircraft and we developed those ideas though our imagination.

Supersonic transportation will be a momentous time for people. A whole new era will start.

Many things should be done in order to make available to public a small supersonic airliner. First of all we should find a way to integrate a fleet of supersonic airliners into the current situation.

Furthermore, thorough research about the materials, the design and the engine should be done. Materials like Carbon Nanotubes reinforcements may bring the revolution not only to aerospace science, but to the whole world.

We as human beings have the temperament to search, to try to find new things. Humans will never stop searching, trying to explain the inexplicable. The same will happen with aeronautic science. We will never reach the top, because we will always meet new obstacles. This is our world!

Daedalus knew the problems of his flying system but he could not inform his son, Icarus, earlier. Today, we are able to identify the problems of the flight thanks to Concorde but we are able to solve them. The real goal is not immediate. It is not the progress of supersonic flight but the general progress of travelling. By supersonic planes, we enter the travels of the next generation, which promises us travels from one end of the universe to the other in a few seconds.

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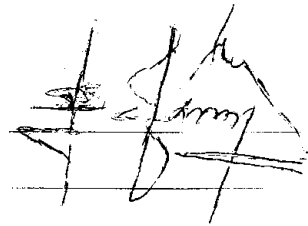
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## SIGN STATEMENT

I, Mr. Kazanis Dimitrios, affirm that this essay was made from Emmanuel Vlatakis, and Dimitrios Tsounis, alone, with no help from others.

Sign

A handwritten signature in black ink, appearing to be 'Dimitrios Kazanis', written over a horizontal line. The signature is stylized and somewhat illegible.

## MAILING LIST

Emmanuel Vlatakis e-mail's: 1) [\[Personal Information Redacted\]](#)  
2) [\[Personal Information Redacted\]](#)

Dimitrios Tsounis e-mail's : 1) [\[Personal Information Redacted\]](#)  
2) [\[Personal Information Redacted\]](#)