# A REVIEW PAPER ON SUPERSONIC UNMANNED AERIAL VEHICLE

**Mandeep Singh[1] , Shubham Sharma[2] , Shalab Sharma[3]**

*[1,2] PG Research Scholar, Mechanical Engineering, DAV University, ( India)*

*[3]UG Research Scholar, CT Institute of Technology, (India)*

## ABSTRACT

*This paper deals with the advancement in aircrafts and the evolution of supersonic unmanned aerial vehicles. Various kinds of aircrafts which are unmanned called drones and some others which travel with supersonic speed are also referred to. The applications and need of such aircrafts are examined along with the challenges which are faced by the researchers in developing such an aircraft with less weight and high fuel efficiency. The future outlook of such aircrafts is also considered.*

***Keywords: Aerodynamic Drag, Angle of Attack, CFD, Mach Number, SUAV, Supersonic Speed, Test Beds.***

## I INTRODUCTION

SUAV is an acronym for Supersonic Unmanned Aerial Vehicle, which is an aircraft travelling at a speed greater than the speed of sound.

UAVs are small aircrafts that can be remote controlled aircraft (e.g. flown by a pilot at a ground control station) or can fly autonomously based on pre-programmed flight plans or more complex dynamic automation systems. Officially, the term 'Unmanned Aerial Vehicle' was changed to 'Unmanned Aircraft System' to reflect the fact that these complex systems include ground stations and other elements besides the actual air vehicles. Drone innovations started in the early 1900s and originally focused on providing practice targets for training military personnel. The first pilotless aircraft were built during and shortly after World War I. Leading the way, using A. M. Low's radio control techniques, was the Ruston Proctor Aerial Target of 1916 [1].

Supersonic aircrafts are those aircrafts which travel with speed greater than the speed of sound. A term Mach number is used to describe the speed of such aircrafts. Mach number is the speed ratio, referenced to the speed of sound. Since these flights travel with great speed so they have to be designed differently than the normal aircrafts. In particular, aerodynamic drag rises sharply as the aircraft passes the transonic regime, requiring much greater engine power and more streamlined airframes. American Bell X-1 was the first aircraft to fly supersonically in level flight. It was powered by a 6000-lb thrust rocket powered by liquid oxygen and ethyl alcohol [2]. Since then there have been many supersonic aircrafts for military and civil purposes. All the supersonic aircrafts are big in size and require a pilot to fly. But a Supersonic Unmanned Aerial Vehicle is an aircraft which can fly at speed greater than mach 1.2 without the necessity of any pilot. Such aircrafts can be remotely controlled by radio waves. The main feature of such aircrafts is that they are light in weight under 50

International Journal of Advanced Technology in Engineering and Science
Vol. No.5, Issue No. 02, February 2017
www.ijates.com
ijates
ISSN 2348 - 7550

kg. The engines used in these aircrafts are small in size and generate more than twice the power than other engines of similar size.

**Figure.1: The Go-Jet supersonic UAV is promised to go faster, using less fuel, than other aircraft in its weight class.**

## II DEVELOPMENT

Researchers at University of Colorado are developing supersonic UAV that's fast, economical, and fuel-efficient. Ryan Starkey who is an aerospace engineer in the University of Colorado has designed such an aircraft which can travel with speed greater than mach 1.2. Go-Jet, the unmanned aerial vehicle will be powered by a new type of jet engine which is also under development under him [3].

Designing a small supersonic aircraft has much different requirement than that with the big ones. The size does not scale down and small supersonic engines have to be used. The engine L-FX00 is a high-efficiency, lubrication-free turbojet engine that weighs about 22 pounds and uses a custom-designed afterburner and innovative fluidic thrust vectoring control system [4]. It already has twice the fuel efficiency than the similar scaled vehicles and will have been doubled again before it can be used in the actual flight. It is also lubrication-free due to which it may require lesser maintenance as well. The engine can be used for several other purposes such as cruise missiles. Both the engine and the UAV are being designed by Starcor, a company developed through the University of Colorado and incubated by e-Space–The Centre for Space Entrepreneurship to transition research from the University's Busemann Advanced Concepts Lab, which Starkey heads, to government and industry. Go-Jet weighs 50 kilograms, and measures approximately 5 feet (1.5 m) wide by 6 feet (1.8 m) long. It has a sufficient thrust capacity to reach the flight at a speed of Mach 1.4 and above [5].

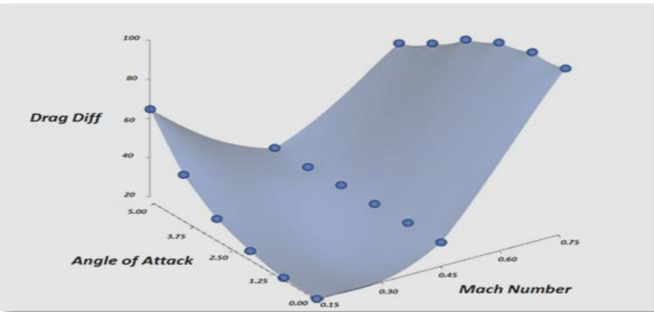


**Figure.2: Surrogate model showing the difference in drag values between two different system models.**

Designing and optimization of airframe made of light weight composite skin and bulkhead reinforcement for supersonic flight has been done using multiple CFD simulations and complicated analysis. Maximum loading conditions in the flight have been analysed using Finite Element Method (FEM) of ANSYS. Also Zona ZEUS CFD solvers validated the aerodynamics of the design and Tecplot Chorus optimized the results [6].

## III DESIGNING CHALLENGES

**Aerodynamic design:** The drag of the flight must be kept limited. Since a supersonic aircraft must take off and land at a relatively slow speed, its aerodynamic design must be a compromise between the requirements for both ends of the speed range. The use of Delta Wing design has the advantage that it can attain a high angle of attack at low speeds, which generates a vortex on the upper surface which greatly increases lift and gives a lower landing speed.

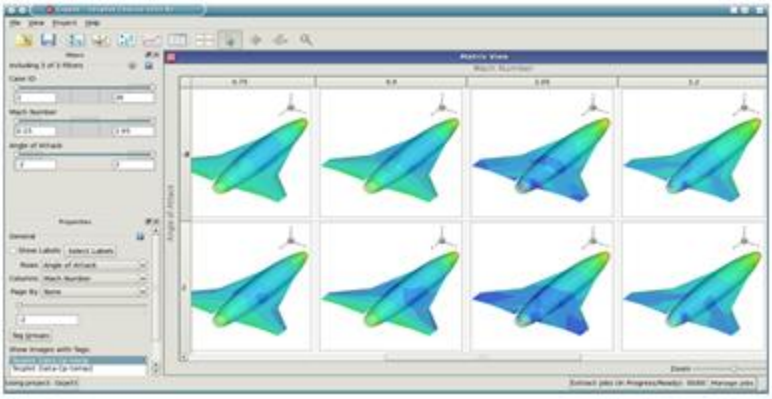

**Figure.3: Evaluation of Go-Jet performance over changing flight conditions.**

**Heating trouble:** Another problem is the heat generated by friction as the air flows over the aircraft. Aircrafts are designed to mostly fly at the subsonic speed. The frictional resistance between the flight and air increases as its speed reaches the supersonic speed and the damage to the flight may become more severe. The material of the aircraft may be made of such material having thermal resistance and do not lose their strength quickly at high temperature.

**Control system:** Fluidic injection thrust vectoring system for yaw (& some pitch) control allows for a tailless design; elevons for pitch and roll control [7]. Since the flight would be moving at very high speed thus it is very essential to keep the aircraft perfectly balanced and give the required motion accurately. The aerodynamic design of the aircraft plays a vital role in controlling the flight.

**Landing Gear:** Fast take-off (60m/s) with a tricycle configuration. During the landing and take-off of the aircraft its speed should be relatively low while during the flight level its speed should be equal to or greater than the speed of sound.

For such purpose special landing gears and delta wings are used which provide a proper and safe landing and take-off.

**Propulsion system:** Miniature turbojet with a custom afterburner to provide 200+ lbf thrust. The turbofan engine passes additional cold air around the engine core, further increasing its fuel efficiency, and most supersonic aircraft have been powered by turbofans fitted with afterburners. Taking off and landing as turbojets, using the afterburner to accelerate to higher speeds when the inner jet core was shut down and all the air was fed round the bypass duct to the afterburner, so that the engine now operated as a ramjet.

**Structural design:** Lightweight, smooth shell that can withstand supersonic thermal gradients [8]. The inlet and outlet of the aircraft is such designed as to allow the passage of air from front and circulate the air inside the jet so as to cool the engine and then eject the air with high velocity from the end which would provide some extra speed to the aircraft.

**Robust system:** Redundant flight computers, onboard video to stream to ground station. Thus each and every movement of the supersonic aircraft can be tracked and any changes in its flight can be directly made from the control station.

## IV APPLICATIONS

1. Analyze storms and hurricanes: These aircrafts can be used for scientific purposes in several regions. One of them is in analyzing the velocity of winds and the pressure built in that area [9]. Earlier it was difficult to measure the strength of the hurricanes but now supersonic unmanned aerial vehicles prove to be of great importance.
2. Reaching long distances quickly: When the need to survey a far distant place arises then these supersonic UAVs can come into. During the time of wars they can bring information from the places which are dangerous for the soldiers.
3. Provide flight test beds for aircraft technology: These jets can provide a platform for the new technologies to evolve and development of innovative products. Scientists can further perform several tests on this vehicle and generate results which may enhance its efficiency and also increase its speed in near future.
4. Fly without being tracked by the radar: Since these aircrafts travel at supersonic speed so they can easily fly without being tracked by any device. The radio waves which are mostly used in tracking equipments can also not trace an object flying with speed greater than the speed of sound.
5. Perform military reconnaissance: In military, these planes have wide range of functions to perform. They are ideal for carrying out dull, dirty, and dangerous jobs: they do not mind circling in enemy's camp for dozens of hours and they can operate in military and civil environments [10].

## V FUTURE OUTLOOK

1. Rescue operations: They can be used in rescue operations where it is dangerous or difficult for humans to do the task. Since they can also be used to analyze the storms and hurricanes so they can also be used to alert the citizens in a large area in such short duration.
2. Environmental compliance: Midnight dumping of toxic waste and other surreptitious activities are the bane of environmental law enforcement. But these drones may prove to be a cost-effective solution to that problem. They can dump the toxic waste to a far distant area where it would not harm the environment.

3. In space research for explorations: Till date only rovers are sent to the other planets for survey purposes but with the advancement of supersonic unmanned jets, they can be used for surveying further areas where the land rovers cannot reach or take much amount of time to reach. The information gathered by the aircraft can be sent to earth via satellites.

## REFERENCES

[1] https://en.wikipedia.org/wiki/History_of_unmanned_aerial_vehicles

[2] https://en.wikipedia.org/wiki/Bell_X-1

[3] http://www.colorado.edu/aerospace/research /research-engineering-center-unmanned-vehicles/ryan-starkey-developing-first-supersonic

[4] http://espacecenter.org/Starkey-Aerospace-Corporation.php

[5] http://www.tecplot.com/blog/2013/01/30/supersonic-unmanned-aerial-vehicles- close-to-becoming-reality/

[6] http://www.rdmag.com/articles/2012/10/cfd-simulation-key-supersonic-uav

[7] http://www.colorado.edu/busemann/node/147/ attachment

[8] http://www.colorado.edu/busemann

[9] http://www.gizmag.com/gojett-supersonic-jet- uav/21675/

[10] https://www.tbmm.gov.tr/ul_kom/natopa/docs/raporlar_2012/