CHAPTER 3

MOTIVATION AND OBJECTIVES

3.1 Motivation

Over the hundred years of development in aircraft history, human beings are able to build and fly different aeroplanes that are capable of carrying hundreds of passengers across the oceans. These aircrafts are able to fly at different speeds at different altitudes. During the decades serious research efforts are made for the development of the subsonic and supersonic aeroplanes. There are many subsonic aircraft are flying nowadays, but the supersonic airplanes are very few. Concorde and Tu-144 have finished their operations due to a host of issues faced by these aircrafts during their operation at supersonic speeds. The human quest for flying higher and faster has made the world a global village and the desires to fly faster than the speed of sound has become a necessity now. This has motivates me to work on design of supersonic transport aircraft. The main problem with the supersonic transport aircraft is that due to a low value of the L/D ratio it requires more power to fly faster and thus the size of the power plant and amount of fuel consumption is large.

For supersonic aircrafts a strong shock wave is generated in front of the body which increases the pressure in front of the main body, hence the pressure drag is increased along with an increase in the overall drag for the body. The pressure drag can be reduced by using the biplane configuration at design Mach number. The biplane elements is arranged in such a way that the strength of the shock wave generated by the one element can be reduced by the one produced by other element through shock-shock interaction. The biplane concept was first introduced by Adolf Busemann in 1935[4]. Currently a group of scientist at

Tohuko University Japan is working on the development of next generation supersonic transport aircraft that uses a biplane wing. But this design has poor performance (high value of wave drag) at the off-design condition ($M_\infty \leq 1.65$) and requires more attention and work towards the minimization of the wave drag for the supersonic transport aircraft, so that the supersonic transport can be feasible in the future. As the aerospace community continues to strive hard for making successful supersonic transport flight, more research efforts are needed to come up with newer ideas and comprehensive solution to the supersonic transport problem. The newer ideas should also be able to withstand the test of practicality and sustainability. Therefore, a comprehensive study of the aerodynamics of staggered supersonic biplanes is done using RANS (Reynolds Averaged Navier Stokes) simulations for the details analysis of the shock pattern and the shock interaction between the biplane elements.

3.2 Objectives of the Research

Among the broad scope of the research in the area of supersonic transport, this thesis investigates the two dimensional biplane configurations which successfully reduce the wave drag at the off-design condition ($M_\infty \leq 1.65$) for the Busemann biplane. In this thesis the practical application of the Busemann biplane with different leading edge and trailing radius at different freestream Mach numbers are also discussed.

The main focus in the current thesis is on the reduction of wave drag at supersonic speed, at the same time enhancing the lifting capability of the Busemann biplane. The main objectives of the current research can be outlined as follows:

1. To study the aerodynamic characteristics of Busemann biplane at different free stream Mach numbers for zero-lift and lifting conditions.
2. To study the effect of stagger on the aerodynamic characteristics of Busemann biplane configurations at different Mach Numbers at $\alpha = 0^o$.

3. To study the effect of stagger on the aerodynamic characteristics of Busemann biplane configurations at different Mach numbers at various positive angles of attack
4. To study the effect of leading edge and trailing radii on various staggered and non-staggered Busemann biplane configurations at different freestream Mach numbers.