INTERNAL COMBUSTION ENGINE OF AN AIRCRAFT

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2.0 Introduction

Today, the public is accustomed to traveling in an aircraft since it has become the safest and the most efficient mode of transportation. The purpose of this document is to report research findings in regard to the team project assigned to team 3. The team project is based on the internal combustion engine of an aircraft dealing with specific concepts related to *mechanism*, *combustion*, *efficiency*, and n*oise pollution.* The role that this team project plays in the whole CCDP 2100L 2018 class project is to follow the theme of cutting-edge technologies for a rapidly changing world. The concept that this report is based on is the *noise pollution* aspect of the team 3 project. There are two research questions that will be answered. The first question asks for what ways noise pollution from the internal combustion engine can be reduced? The second question asks for an explanation of the *sonic boom* phenomenon and how it affects the people onboard the aircraft that are experiencing the *sonic boom*? The answer to the first question is in section 2.1 while the answer to the second question is in 2.2. The technical terms in this report are italicized and appear in the glossary, which is listed after the conclusion sub section.

2.1 Findings of research question one: the ways to reduce noise pollution by the internal combustion engine

Section 2.1.1 will explain how noise pollution originates from the internal combustion engine. Section 2.1.2 will answer the research question by discussing an engine turbine fan modification. Section 2.1.3 will provide another answer by explaining active noise control.

2.1.1 Sources of noise pollution in the internal combustion engine

Noise pollution is the propagation of noise with a harmful impact on the hearing of humans and animals. In an aircraft, a popular source of noise pollution comes from the following scenario.

The aircraft is traveling down the airport runway, gathering *velocity*, as it is about to take off the ground. A *high-pitched* whining noise is produced [1]. This *noise pollution* is being produced as a result of large air waves getting pulled in to the engine by its rapidly rotating turbine fans [1]. Another source of *noise pollution* from within the internal combustion engine is its exhaust *valve*. A *low-pitched* rumble is created when exhaust fumes are being released through this *valve* [1].

2.1.2 Engine turbine fan configuration

The first engineering principle that answers research question one is frequency. An effective way of reducing noise levels originating from the turbine fans is to rework the current design of the internal combustion engine by implementing larger turbine fans into the engine [1]. The original turbine fans turn at a very fast frequency of 4000 rotations per minute. The faster the turning speeds of the fans, the more air waves get pulled into the engine, and the more intense the *noise pollution* produced becomes. The larger fans possess more weight than the original fans and turn at a slower rate. These larger turbine fans will therefore reduce the *noise pollution* production of the engine.

A separate set of design modifications to the engine can be made to reduce *noise pollution* originating from the exhaust value. The modification entails implementing of sound-absorptive enclosures; These enclosures are known as *mufflers* [2]. *Mufflers* are a part of the engine exhaust system that serve to muffle the sounds coming from the engine [2].

2.1.3 Active noise control

Until the aircraft manufacturers are able to incorporate the engine turbine fan configuration into modern aircraft, active noise control is a another, more feasible, way to protect people onboard an aircraft from the harmful impact of noise pollution. Frequency is also utilized in the active noise control. Active noise control is a contingency plan formulated by a group of aerospace experts [1]. Active noise control involves producing a *sound field* as the mirror image of the offending sound [1]. A sensor such as a microphone, *accelerometer*, or other device picks up the annoying sound and relays the signal to an electronic controller, which drives an *electromagnetic* vibration generator to produce the opposing sound. Figure 1, as show below, illustrates the concept of the active noise control.

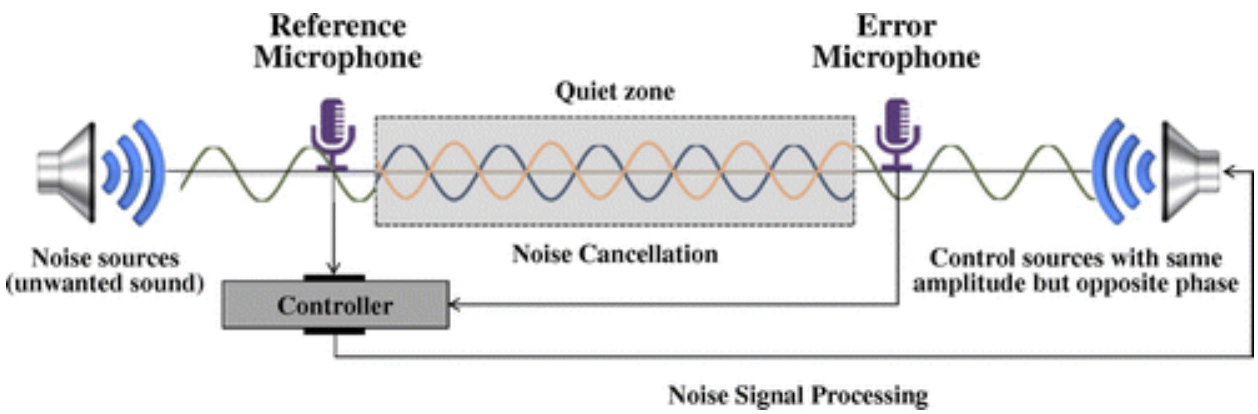

Figure 1: Active Noise Control Visualization [5]

This active noise cancels out the disturbance, with the net result that the sound is significantly reduced. One consumer product that does employ active noise control is headphones typically used by the pilots themselves and being made readily available to the public to ensure a quiet flight for passengers and flight crew [1].

2.2 Findings of research question two: the sonic boom and its effects on the aircraft pilot and passengers

2.2.1 The sonic boom

The engineering principle that answers the second research question is pressure. It is very likely that a sonic boom causes damage to the human nervous system. A *sonic boom* is a situation whereby an aircraft flying at *supersonic speed* and compiles pressurized energy sound waves called *shockwaves* along its body frame and a kinetic energy buildup begins [3]. These *shockwaves* are at their most powerful at tip of the aircraft. Once this energy buildup has attained a certain threshold energy level, the aircraft is then able to break through the *sound barrier*. As soon as the aircraft breaks through the *sound barrier*, there is a sudden "explosion" of sound as a result of several simultaneous collisions between the *shockwaves* at this *supersonic speed*. This "explosion" of the *shock waves* is what's called the *sonic boom* [4]. The figure shown below demonstrates the propagation, range, and effect of a *sonic boom.*

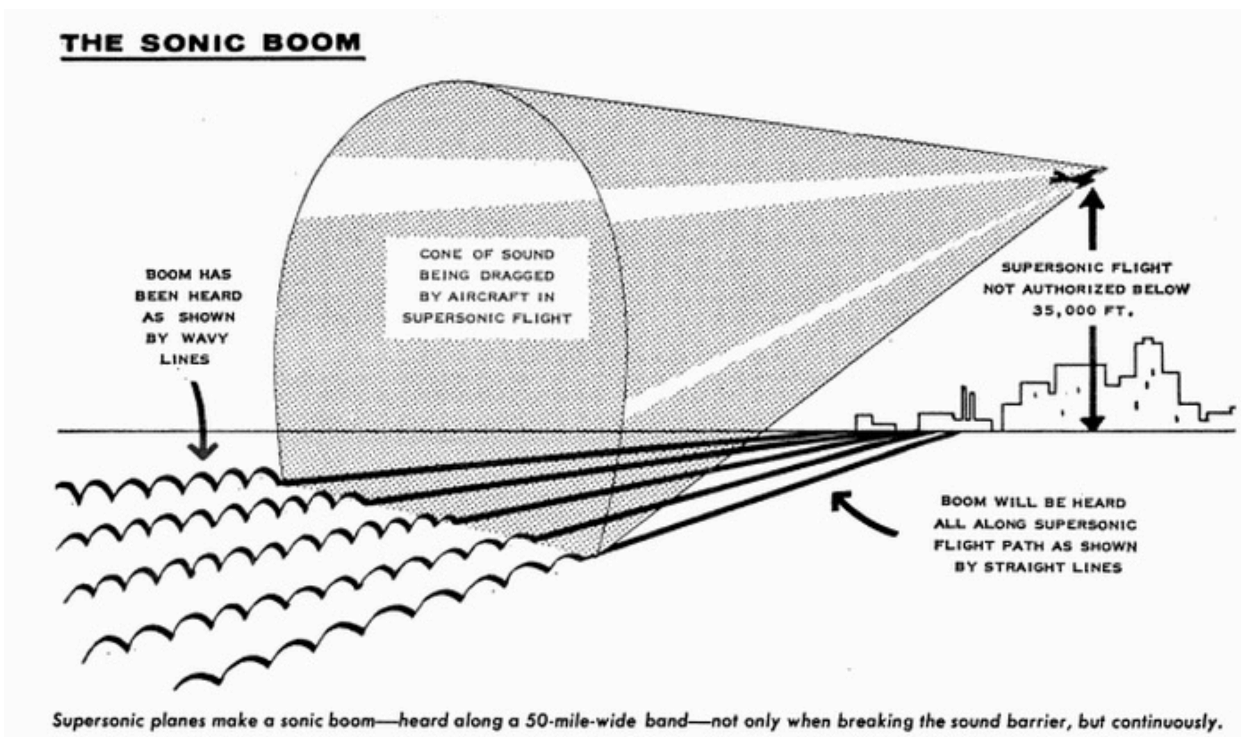

Figure 2: Sonic Boom Visualization [6]

2.2.2 Electric field generating device

There are many ideas from experts in the field of aerospace engineering on how to prevent the *sonic boom* from happening. 30 years ago, a set of Russian engineers made a claim that that they could quiet the sonic boom without having to make any modifications to the aircraft body frame [4]. The Russian engineers proposed the installation of electric field generating device in the airplane's nose [4]. The introduction of the *electric field* serves the purpose of counterbalancing the s*hockwave* buildup. The pressurized energy *ions* and electrons from the shockwaves interact with the electric already containing positively charged *ions* and negatively charged *electrons* [4]. This reaction produced large quantities of *plasma*. *Plasma* is a hot ionized gas consisting of approximately equal numbers of positively charged ions and negatively charged electrons [4]. *Plasma* is a neutral energy entity and so will not form a buildup of its own.

2.3 Conclusion

The first research question asked for what ways noise pollution from the internal combustion engine could be reduced. This question was answered in section 2.1 using frequency as an engineering principle. The second research asked for an explanation to the *sonic boom* phenomenon and how it affects the people onboard the aircraft that is experiencing the *sonic boom.* This question was answered in section 2.2 using pressure as an engineering principle. The role that this team project plays in the whole CCDP 2100L 2018 class project is to follow the theme of cutting-edge technologies for a rapidly changing world. The concept that was discussed in this report is the *noise pollution* aspect of the team 3 project.