A Comparative Study of Sound Design in Top Gun: Maverick (2022) and F1 (2025)

[1] Karol Anto A, [2] Dr S. Keerthana

[1] **Student,** Department of Visual Communication, Hindusthan College of Arts & Science, Nava India, Avinashi road, Coimbatore, Tamil Nadu

[2] **Assistant Professor,** Department of Visual Communication, Hindusthan College of Arts & Science, Nava India, Avinashi road, Coimbatore, Tamil Nadu

Email - antokarol2005@gmail.com, mekeerthanasathish@gmail.com

Abstract

Sound design is an essential element of creating an immersive cinematic experience for audiences. This study analyses the sound design techniques used in Top Gun: Maverick (2022) and F1 (2025). The study looks at the main sound design techniques used in the two films to create an immersive high-speed cinematic experience by looking at engine sounds, doppler effect, pitch bending, bass boosting, ambient sounds, physiological soundscapes, internal focalisation and syncing of sound with visuals. A qualitative comparison will be carried out using extracts from the films. The study will look at how similar and different techniques were used within both films to achieve a technical realistic, immersive and emotionally engaging experience whilst progressing the story. The study looks at how personal perspectives of sound, cockpit sounds, mechanical tones and physiological sounds can help bring audiences closer to the experiences of the racing drivers and fighter pilots. This study aims to demonstrate how the relationship between sound and motion can help communicate a sense of speed, power, tension and force to audiences. This shows that sound design can be much more than just a technical aspect of film making but is also a powerful tool to enhance story telling.

Keywords: Sound Design, Cinematic Immersion, Doppler Effect, Internal Focalization, Psychoacoustics, Engine Acoustics, Spatial Immersion, *Top Gun: Maverick*, *F1*.

1. Introduction

1.1 Sound Design in Films

Sound design involves designing, recording, editing and mixing all the audio elements in a film. This can include dialogue, sound effects, ambiance, foley and music. Sound designers create the soundscape for the film that the audience will hear but may not necessarily be aware of. Sound designers will look at the script in pre-production to decide what kind of audio they want for the film. During production location audio will be recorded and lots of sound effects added during post-production. Foley artists create everyday sounds such as footsteps, fabric sounds and creaking doors. Sounds that cannot be found in real life such as spaceship and creature sounds can be created using sound libraries and synthesizers. Finally re-recording mixers will balance all the tracks so that dialogue can be clearly heard and effects do not overpower the scene. Films such as Star Wars, Jurassic Park and Dunkirk are famous for their innovative sound design. Good sound design will make a film feel realistic, immersive and impactful.

1.2 Doppler Effect

The Doppler effect is the change in frequency of a wave when a source is moving relative to the observer. It was discovered by an Austrian Physicist called Christian Doppler who wrote about it in 1842. If the source is moving towards the observer then the sound waves get compressed and you hear a higher pitch. While if the source is moving away then the waves will be stretched and you will hear a lower pitch. An example of this would be the siren of an ambulance. As it comes towards you the pitch of the siren gets higher but once it goes past you the pitch gets lower. The Doppler effect can be applied to any type of wave, including sound, light and radio waves. How much the frequency changes depends

on how fast the source is moving compared to the wave. The Doppler effect can be used in radar guns, weather radar and ultrasound in medicine. In astronomy it is known as redshift and blueshift. This helps scientists work out the movement of stars and galaxies. In film, the Doppler effect can be used to make the sound of vehicles, flying objects and moving characters seem realistic.

1.3 Importance of Sound Design

Sound design is part of the cinema experience. It helps establish the tone and atmosphere of a scene. Whether creating suspense during a horror scene or creating peace during a tranquil scene. It will draw attention to key parts of the scene, either on or off screen. Adding realism to the scenes to make them seem authentic. Using silence can add suspense which can be just as effective as loud sound effects. It can help to enhance the emotions felt by the audience when watching. It will help tell a story by showing what may have happened off screen. For example if there was an explosion far away. It keeps the film consistent throughout the different shots. It can also help hide any mistakes in the footage and help with the flow of the cuts. A film with poor sound design can make an otherwise great film feel dull and unrealistic.

1.4 Problem of the Study

This study aims to explore the techniques used within the sound design of F1 (2025) and Top Gun: Maverick (2022), to understand how each film creates a sense of extreme speed. Both films immerse the audience into high speeds, using sound to give them a realistic experience. This analysis will look at how sound is used as a key storytelling device to create a realistic sense of speed, danger and skill. This study will look at how sound can be used to put the audience in the vehicle, creating an immersive experience. For example, how engine sounds, gear changes, tyre noise and car whooshing have been used in F1. In Top Gun: Maverick jet thrust, afterburners, whooshing, cockpit alerts and G-force tension have been used. Key elements include cockpit sounds which allow the audience to hear what the driver/pilot is hearing such as breathing, radio and vibration.

We will also look at how the recordings have been edited, layered and mixed to create a sense of depth. With real recordings from racing cars and fighter jets being used as a base for both soundtracks they are rarely used in their raw form. Mixing techniques such as balance between engine, dialogue and music have been used to create a realistic sense of direction, distance and speed.

As one film is set on land and one in the air, we can see how different decisions have been made to achieve the same goals of a realistic, immersive and emotive experience. This should give a clear understanding of how high speed sounds within cinema affect the audience.

1.5 Significance of the Study

Sound design is a topic that does not receive the same amount of research as cinematography and acting despite often being thanked by the audience for creating an immersive experience. This study is important as it compares two contemporary and popular films and analyses their sound design. Findings from this study can be used by students, sound designers and editors in understanding how pitch, bass, silence and physical sounds can work together to create an immersive experience. This also provides necessary research as there are many different areas of research into the Doppler effect, sound design in racing games, emotional soundscapes and sound design in cinema which have not been connected before. This research helps provide a more rounded understanding of how speed can be created in cinema. It may also be used to help inform future research into audience experiences and encourage more academic interest into the practical side of sound design which is still an under-documented area.

2. REVIEW OF LITERATURE:

Neipp and colleagues, working in Spain, revisited the classical Doppler effect, which describes the change in perceived frequency when a sound source and a listener move relative to one another. Their approach was theoretical and mathematical. Rather than assuming a constant speed, they formulated the effect through the travel time of sound waves

and extended it to cases where the positions of the source and the observer change in any manner over time (NEIPP, University of Alicante Spain, 2003).

Examined the evolution of sound design in The Lord of the Rings and The Hobbit film series, focusing on Gandalf's magical sound effects. The study compared frequency ranges, amplitude, and sound-layering techniques through content analysis and practical recreation using FL Studio 24. The findings revealed that The Lord of the Rings used deep, resonant low-frequency tones and synthesized layers to create an intense, immersive atmosphere, while The Hobbit relied more on Foley-based sounds to achieve a lighter, adventurous feel. The study highlights how technological advancements, sound layering, and frequency manipulation influence emotional engagement and cinematic storytelling (Bukhari et al, 2025).

Collins and Dockwray, based in London, studied how sound communicates drive, speed and story in racing video games. Their qualitative method combined interviews with composers, sound designers and audio directors with close listening and textual analysis of the games themselves. They traced a historical shift from simple, symbolic sounds produced by early sound chips toward physics-based realism, and later toward a more cinematic and dramatic approach. In their account, engine noise, tyre sound, surrounding environments and music together shape the player's sense of speed, performance and narrative(Collins and Dockwray,2019).

Examined the impact of sound design in film and television, focusing on the Chinese animated film White Snake: The Floating Life. The study explored how background music, sound effects, and professional dubbing enhance emotional engagement and strengthen character authenticity. It highlighted the use of traditional Chinese instruments, particularly the flute, to guide the narrative and emphasize important emotional moments. The findings suggest that effective sound design improves audience immersion, supports storytelling, and contributes to film promotion and audience appeal (Shiyu Cheng, 2025).

Fiebig, Jordan and Moshona, working in Germany, considered how emotion theory can be applied to the study of soundscapes. Their method was a conceptual analysis supported by a review of earlier literature, and they proposed that emotional response should be built into the standardised framework used to assess soundscapes. They concluded that two dimensions appear again and again in emotional assessment: valence, meaning how pleasant or unpleasant a sound feels, and arousal, meaning how activating or calming it is. They also pointed to unresolved issues such as how emotions should be reported, how they should be measured as they unfold over time, the difference between emotion perceived in a sound and emotion actually felt, and the influence of context (Fiebig, Jordan and Moshona,2020).

Analysed the music and sound design of Christopher Nolan's film Dunkirk, focusing on how sound creates tension and influences audience perception. The study examined Hans Zimmer's use of Shepard Tones, repetitive musical patterns, electronic sounds, and ambient effects. The findings revealed that continuously rising pitches and low-frequency sounds create urgency, suspense, and psychological pressure. The study highlights how sound design goes beyond supporting visuals by connecting non-linear narratives, shaping emotional responses, and creating an immersive cinematic experience (Ning, 2025).

Sonnenschein, writing from the United States, examined the expressive power of music, voice and sound effects in cinema. His approach was a practical and theoretical study of sound design that links sound choices to screenplay, character, narrative and emotional structure. He showed that designers can communicate character, feeling and story progression by varying loudness, pitch, distance, harmony and dissonance, and rhythm (David Sonnenschein).

Analysed the music and sound effects in Christopher Nolan's film Tenet, focusing on how sound design supports nonlinear storytelling and emotional engagement. The study examined electronic music, character-based leitmotifs, reversed sound effects, heartbeat rhythms, and frequency manipulation. The findings revealed that combining music and sound effects creates suspense, psychological tension, and continuity between complex timelines. The study highlights how innovative sound design enhances audience immersion and communicates cinematic themes beyond visual (Wu and Wu, 2023).

2.1 Synthesis and Research Gap

When read together, the four studies form a chain of ideas. Neipp and colleagues explain the physical basis of how motion alters sound. Collins and Dockwray show how those physical cues are shaped into drama and narrative in a speed-focused medium. Fiebig and colleagues supply a framework for describing how listeners respond emotionally, and Sonnenschein demonstrates how professional designers turn sound into storytelling. Each, however, leaves a gap: the physics work is mostly theoretical, the racing-game study is not experimental, the emotion study lacks specific findings, and the cinema study lacks audience testing.None of them offers a direct comparison of sound design in contemporary films about high-speed travel, and none examines how physiological sounds such as breathing and heartbeat place the viewer inside the vehicle. The present research responds to this gap by comparing Top Gun: Maverick and F1 through a qualitative lens that connects physical acoustics, emotional response and narrative function.

2.2 Research Objectives

1. To examine how sound design conveys speed, power, realism, tension, and immersion in racing and aviation scenes.
2. To examine how physiological sounds create an immersive, subjective cockpit experience.
3. To examine how these sound-design techniques create a visceral, physically immersive experience for the spectator.

2.3 Research Questions

1. How do sound designers manipulate pitch, velocity cues, and engine acoustics?
2. How does emotional and psychoacoustic sound design heighten cockpit tension beyond authentic recordings?
3. How do physiological soundscapes create an “embodied spectator” experience during high-speed maneuvers?

2.4 Limitations of the Study

1. The study is restricted to two films, F1 (2025) and Top Gun: Maverick (2022).
2. The study is limited to the technical use of the Doppler effect through pitch shifts, frequency changes, and perceived sound movement, alongside internal focalization.

3. RESEARCH METHODOLOGY:

3.1 Research Approach

This study utilises a qualitative comparative approach to investigate the use of sound design to create speed, tension, and immersion in the films F1 (2025) and Top Gun: Maverick (2022). The study compares the soundscapes of both racing and aviation genres using examples from chosen scenes. This is supported by key terms identified in the literature review such as psychoacoustics, tonal and frequency dynamics, emotional response and the Doppler effect. There are three main areas of the analysis; first being the manipulation of the Doppler effect, boosting of low frequencies and the use of engine harmonics. Secondly, using psychoacoustics, dynamic pauses and hyper real foley. Finally the internal focus using physiological sounds such as breathing, heartbeats and helmet vibrations. This will help identify common and unique techniques used within each film to create a sensory and emotional experience for the audience.

3.2 Data Collection

Primarily the data will come from the F1 (2025) and Top Gun: Maverick (2022) films. Specific scenes will be selected from these films to examine the Doppler effect and internal focalisation. These scenes will feature high speed action, cockpit shots and moments of silence. Secondary research will also be used from relevant academic sources. Each scene will be viewed multiple times, either using quality headphones or a surround system. Each scene will have a focus on

certain sound design elements including; engine noises, pitch changes, bass, breathing sounds, heartbeat sounds, Foley and music. I will structure my listening log to note down details such as what time these sounds occur, what techniques are being used, what perspective they are from and how they may affect emotions and story.

3.3 Theoretical Framework

The Doppler effect is relevant here as it helps understand how pitch and frequency can be used to convey movement and speed in racing cars and fighter jets. In F1 (2025) it helps understand how the pitch and frequency changes in engine sounds help convey how fast the cars are moving as they approach, pass and move away from the camera. In Top Gun: Maverick (2022), it helps understand how the sounds of the jets help convey that they are moving very fast. Looking at both examples helps show how the sound design uses or plays around with Doppler like pitch shifts, engine harmonics and bass sounds to create a sense of speed, power and immersion. This study looks into how this contributes to the audience's subjective belief that they are inside the vehicle.

Overall the Doppler effect helps you understand how sounds can convey speed and movement.

4. Result and Analysis

This chapter shows the findings and analysis of the comparative case study between Top Gun: Maverick (2022) and F1 (2025). The case study is titled ‘Creating Immersion Through High Speed Cinematic Sound Design’. I will explore how sound design can be used to create technical accuracy, spatial immersion, emotional engagement and overall immersion in both Top Gun: Maverick and F1. Both Top Gun: Maverick and F1 focus on high speed movement involving fighter jets and Formula One Racing cars.

Throughout this analysis, I will discuss various aspects of sound design such as engine sounds, Doppler effect, pitch changes, bass boosting, ambient, physiological sound design, internal focalization and synchronised sound. These techniques have been applied throughout Top Gun: Maverick and F1. To understand how these techniques work together to communicate speed, velocity, mechanical power, tension and physicality to create an immersive cinematic experience. I will analyse specific scenes throughout both films.

Throughout the findings section, each aspect of sound design will be noted. This will then be analysed to relate to the research aims. The Doppler effect and internal focalization will be discussed in relation to the research aims. The case study will look at how the sound designers utilised frequency, spatial, mechanical and subjective cues to create a different experience for the racing driver compared to the fighter jet pilot. Overall it demonstrates that sound can be used as a storytelling tool within film to help the audience understand how fast things are moving, the physical forces, tension, technical accuracy and immersion within a fast paced scene.

4.1 Content Analysis

The following analysis will explore how the following five categories have been used: Technical Accuracy, Spatial Immersion, Emotional Engagement, Inner Focus, Narrative Development and Unique Sound Identity. The Doppler effect, frequency change, engine resonance and bass frequencies can all be examined to see how speed and physical force are conveyed. The spatial immersion can be analysed by looking at where the sounds are placed and the cockpit audio. Psychoacoustics, dynamic silences and loudness can be explored to see how the sounds have an emotional affect. The inner focus can be explored through breathing, heartbeat, helmet and mechanical vibrations. Finally, the techniques used can be analysed to see how they create tension in the story and unique sound identities for the Formula 1 cars and fighter jets.



Figure : 1.1 - Doppler Effect in the movie F1 and Top Gun Maverick

4.1.1 F1 - Doppler Effect

Analysis of scene: The racing car speeding past the camera or along the circuit (shown in the first image).

The sound of the engine is shown as the car speeds towards us. This can show the Doppler effect taking place. It gives a sense of speed as the sound pitch changes. The harmonic of the engine as well as the sound of the tyres are changing. Along with the fast movement of the sound. The change in sound perspective from the outside of the track to the inside of the car also helps to give a sense of immersion. This makes the audience feel like they are in the racing car with the driver.The sound design team on the film had recorded real Formula One cars and designed the sound to give an authentic racing feel.

4.1.2 Top Gun: Maverick - Doppler Effect

A scene that can be analysed are fighter jets moving past the camera or performing high speed maneuvers similar to the second image.

This scene can be analysed due to the changing pitch of the jet as it gets closer to the camera. This could be used to show the Doppler effect as the frequency of the sound changes. The powerful, fast and dangerous nature of the jet can be shown using the loud engine noise, turbulence and low frequency. As the camera moves from exterior shots of the plane to interior shots we get a greater sense of immersion with the sound changing perspective. This helps to make us feel closer to what the pilot is feeling both physically and mentally whilst flying at high speeds.

Al Nelson (sound designer) has talked about how they recorded the planes from different angles and chose specific sounds to help tell the story in the film.



Figure : 1.2 - Internal Focalization in the movie F1 and Top Gun Maverick

4.1.3 F1 - Internal focalization

The opening image shows us the driver in the racing car. This close up shot gives the audience a sense of being in the driver's shoes.

Sound effects to consider: Using sound effects such as engine noise, mechanical noises and bass helps show how powerful the car is and how physically close the driver is to the car. Using breathing and other bodily sounds can help show how much effort they are putting into the race, their intense concentration and how stressful it is. Using the sound of the driver communicating with their team can help to show how aware the character is and how they are making decisions throughout the race. Having different perspectives of sound when they are outside racing and inside the car can help to make the audience feel more immersed.Audience effect: Makes the audience feel like they are in the drivers shoes whilst racing, meaning they feel more like they are going fast, intensely concentrating and putting physical effort into the race.

4.1.4 Top Gun: Maverick - Internal focalization

Your second image — the pilot during flight

This shows us how the sound can be used to portray the intense physical and psychological pressure that comes with flying a fighter jet.

Sounds: Cockpit and engine sounds help show us how close the pilot is to the plane's mechanics. The jet engine noises are quite loud and there is also a change in perspective within the sound. We can hear breathing and oxygen mask sounds which show how physical the pilot is. We can also hear radio chatter including commands, warnings and talking to other pilots which makes the viewer aware of how alert the character is and how they are reacting to the danger. Subjective sounds such as volume changes, filters and ambient sounds can be used to highlight how much pressure is being put on the pilot psychologically and how they feel when flying at high speeds. This can make the viewer feel more internally focused.

Effect on viewer: Viewers will feel more connected to how physically stressed, aware and tense the pilot is when flying at high speeds.

5. Conclusion

The findings of this study reveal that sound design plays a significant role in creating immersion, realism, and emotional engagement in Top Gun: Maverick (2022) and F1 (2025). Through comparative analysis, the study identifies the use of the Doppler effect, pitch shifts, engine harmonics, low-frequency reinforcement, Foley, and spatial audio to communicate speed, mechanical power, and physical intensity. While Top Gun: Maverick emphasizes fighter jet acoustics and cockpit experiences, F1 focuses on racing engines, mechanical vibrations, and competitive tension. The research also highlights internal focalization as an important sound-design approach that can be applied across different film genres to represent a character's subjective experience through sounds such as breathing, heartbeat, muffled ambience, ringing ears, and internalized environmental sounds. This technique allows audiences to experience a scene from a character's perspective, adding psychological depth, emotional detail, and narrative meaning. However, the research faced challenges in distinguishing authentic recorded sounds from digitally manipulated audio, identifying specific sound-design techniques without access to production stems, and interpreting subjective auditory experiences through audiovisual analysis alone. Despite these limitations, the study concludes that combining technical sound design with internal focalization can strengthen cinematic storytelling, making sound not merely an accompaniment to visuals but a powerful narrative tool that communicates physical sensations, emotional states, and immersive experiences across diverse filmmaking contexts.

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