

Audio Signal Processing in Ironman

A development of film music analysis from a perspective of music technology

By

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Abstract

The advances in music technology and cinematography in recent years has granted a higher level of importance to the film music. There exists a gap in the academic study of film music as it relates to music technology, as no appropriate methodology exists that can accurately measure the contribution that music technology makes towards the music as it exists in film.

This study aims to contribute towards existing methodologies for analysing film music, but from the perspective of music technology, and more specifically how audio processing in the domains of dynamic, spectral, spatial and temporal processing contribute towards the music in the film. This is achieved by building on the proposed methodologies of the study of film music as proposed by Kassabian (2009) and Altman (2000).

This new method can be utilized to create a reference list of contributions that audio processing can make towards the soundtrack of a film by isolating the particular contribution that every moment of music is contributing to the film, and then finding how audio processing adds to this.

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Chapter 1: Introduction, Background and Purpose

Film music has received significant attention as a source of study by various academic disciplines. In film studies, film music is analyzed as a narratological aid to the film (Young 2007). In musicology, the compositional and theoretical aspects of a film score are considered. In the field of cognitive neuroscience, the effect that music can have on the brain has been studied (Cohen, 2001).

This study came about from a desire to find where music technology fits into this body of research, and to develop a method to analyze the components of a film soundtrack that are added or manipulated by audio signal processing. The purpose of this study is to help entrants into the film music industry to analyze films to create a reference library of effects and how to implement them.

1.1. Audio in multimedia

In the last few years, music has become increasingly important for and integrated into video, film and broadcast production. Advances in delivery methods for cinema, such as the digital cinema playback systems in ultra high definition, the advent of DVD and Blu-ray technologies and the affordability of high-end home theatre systems, have all contributed to a higher expectation for the quality of audio accompanying these forms of communication (Huber & Runstein, 2010).

The cinema and home theatre are no longer the only delivery method for film and multimedia. Personal computers, cellphones and tablet devices have enabled the portable viewing of film. The quality of playback capabilities in these devices has improved commensurately. The same audio-visual quality is expected on the high-resolution screens and high quality headphones. The improvement of the quality of these personal playback systems paved the way for ancillary recreational channels such as mobile gaming and ubiquitous video and audio streaming services such as Netflix and Apple Music, resulting in a constant media bombardment of high quality audio and visual stimuli. This has been the driving force behind the heightened expectation from the consumer, promoting development in the realms of cinematography and music technology to fulfill this consumer need (Huber & Runstein, 2010, p. 17).

The technological advances in music, film and digital media have contributed to the ever-increasing quality of the film medium, resulting in a commensurate higher level of expectation for film music as an integrated part of the audio-visual experience. The study

of the music technology (that enables this elevated position of music in film) has however been neglected.

1.2. The study of film and film music

The academic study of film music is conducted from one of three possible perspectives (Kassabian, 2009, p. 46):

1. The composer's perspective, which addresses the composition of the film score from a musicological point of view.
2. The perspective of the text, which relates to the literature surrounding the film including the script and screenplay connecting the film and its music as a secondary conclusion.
3. The audience's perspective, which evaluates the perception and reception of the music by the intended audience. This method of study is a trope of the disciplines of both film studies and critical theory.

The growth in the study of film music under the disciplines of film studies and musicology has accelerated rapidly since the publication of Gorbman's *Unheard Melodies* in 1987. This groundbreaking work highlights the state of the study of film music at that time. It reminds us how a narratological study of film music can leave the music subordinate to the narrative that it is supporting, and thus is easily subdued by the other elements of the soundtrack, such as the dialogue and the sound effects (Neumeyer et al., 2000).

The interdisciplinary nature of cinema promotes the convergence of different disciplines. The same is true for the study of cinema. Because of this convergence, film scholars now consider aesthetic, historical and formalist approaches to film music, while musicologists integrate hermeneutics, critical theory and sociology (Neumeyer et al., 2000).

This convergence of disciplines in the study of film music (and in particular in the methodology of film music analysis) indicates that there is scope to further develop film analysis from different perspectives. This is what has inspired this study of film music to include a method of analysis from the viewpoint of music technology as an emerging discipline of film music scholarship to take its place in the interdisciplinary approach to film music analysis.

1.3. The purpose of this study

This study explores how the application of modern music technology contributes to the creation of a film soundtrack, and how this contribution can affect how an audience (in this case me, the observer) interprets information in a film. The purpose of this study is to propose an addition to the methodology of film music study to effectively analyze the contribution that audio signal processing makes in a film soundtrack, so that new entrants into the film music industry can have a starting point when considering what techniques to use in terms of audio processing.

To develop this methodology, the 2008 Marvel motion picture Ironman, (Film score composed by Ramin Djawadi) is used as the source for analysis. This film is chosen, in particular, due to its use of modern instrumentation, arrangement and composition techniques, which rely heavily upon the application of the music technology techniques that form the focus of this study.

1.4. Scope and limitations

The scope of this study is limited by the culture of film making and by genre. The function and interpretation of music in a Hollywood film may be different from that from a French, Nigerian or Korean film. This limitation is necessary because the use of music and the interpretation thereof in a film may be specific to the culture of film making and the receiving it. The same limitation applies to genre, as the music in a Horror film or a Musical may serve a different function to that of an Action film.

The term Music technology describes an incredibly wide scope. For the purpose of this study the term will refer specifically to audio processing in the dynamical, spectral, spacial and temporal domains unless otherwise stated.

Finally, this study focuses on film music, although it takes into account all the aspects on the soundtrack interacting, it only does so when the music component is present.

1.5. Research question

The primary research question for this study is: How does audio processing contribute towards an observer's perception and interpretation of events in the film Ironman?

In order to address the primary research question, a proposed methodology is developed to answer a subset of secondary objectives. These objectives are:

1. To analyze the music of the film to establish each musical moment's function
2. To determine what information each moment of music conveys in terms of identification, narrative and mood.
3. To analyze the audio processing present in these moments.
4. To determine the specific contribution that music technology makes towards the information communicated by each musical moment.

Chapter 2: Literature Survey

2.1. Music in film

The introduction identified the study of film music and its related technologies as a topic of importance for the development of cinematography and film as a communication medium. Historically, in studies on the subject of film music, the focus has been on the method of analysing the music in a film to establish the contribution that the music makes toward the narrative of the film (Gorbman, 2007. Kassabian, 2009. Nuemeyer, 2000). Musical meaning refers to the information that music adds to the narrative of a story by providing information that is not necessarily evident in the dialogue or visual. In the context of this study, the question of meaning has to do with the manipulation of the observer's interpretation of any particular moment.

According to Kassabian (2009), the audience perspective is an appropriate departure point for a study of film music, as it encapsulates all the elements of the final product of a film being experienced at once rather than analysing the separate components that contribute towards it such as the film score (Kassabian, 2009). An analysis of the contribution of film music from an observer perspective is achieved by considering three aspects of the music in a film:

1. What is the music's relationship to the diegesis of the film?
2. What is the music's method of communication?
3. What emotions or information does the music evoke in, or communicate to the observer?

In the sections to follow, each of these aspects is explored in detail to see how considerations along these points enables the reverse engineering of the intended function of a musical passage, and how this can be used as a tool for analysis in order to isolate the techniques used to achieve this function.

2.1.1. The music's relationship with the diegesis of the film

Diegesis is defined as the narratively implied spatio-temporal world of the film (Gorbman, 1987, p. 21). Music's relationship to the diegesis of a film can be classified as being:

- **Diegetic:** music originating from a sound source in the diegesis of the film, and therefore perceivable by the characters within that diegesis, or

- **Non-diegetic:** music originating from a sound source external to the diegesis of the film.

There can be a combination between diegetic and non-diegetic relationships. This can be used for the purpose of special effects such as a changing from diegetic to non-diegetic, or in relation to a character's inner dialogue, which is where the sound source originates from within a character's mind (also called meta-diegetic) (Kassabian, 2009). If the music is diegetic, it means that the characters in the film are also aware of it, so it has a direct effect on the characters on screen, while non-diegetic music only affects the observer.

2.1.2. The music's method of communication

The music's method of communication is described as "the method that the music in the film uses to accomplish its purpose" (Kassabian, 2009, p. 47). The method of communication available to film composers is largely comparative. There are three categories of historical comparison (Kassabian, 2009):

1. Musical quotation: where the film music is a direct quotation of a pre-existing source.
2. Musical allusion: where the film music does not directly quote a pre-existing source, but alludes to a narrative of a pre-existing source that it shares common elements with. This develops further into the concept of musemes.
3. Leitmotif themes: where a musical theme is repeated within the film often enough to become self-referential. These themes are often used to represent a character or idea in film.

This type of historical comparison is an important tool in composing music for film, because it either creates a sense of identification with certain elements in a film (as is the case with Leitmotif), or brings an entire existing narrative into the perception of the observer either by or with allusion (Kassabian, 2009, p. 47).

2.1.2.1. Musical quotation:

Musical quotation is used to reference a specific mood or character by directly quoting the melody of the existing theme. An example of this is in the movie *Spiderman 2*, where a street musician plays the theme from the 1970's animation *Spiderman*. This instance of

quotation is used for comedic effect and as a tribute to the history of the character (Halfyard, 2010).

A less specific version of this quotation is where the music with the existing narrative is not directly quoted, but alluded to in a referential way. This is termed musical allusion (Hatten, 1985).

2.1.2.2. Musical allusion:

There are two ways in which music can allude to an external narrative, namely strategic allusion and stylistic allusion (Hatten, 1985, p. 70). Strategic allusion refers to an existing piece of music that is alluded to in order to draw upon a specific external narrative. An example is in *Beetlejuice*, where Danny Elfman alludes to *In the Hall of the Mountain King* (from *Peer Gynt* by Edvard Grieg) through similar orchestration and melodic progression to conjure up the existing narrative of the evil troll chasing the hero.

Stylistic allusion refers to music that alludes to a certain para-musical idea, such as a certain genre, era or school of music, or a certain musical progression, tonality or harmonic device. Examples of this include the use of the tri-tone to signify the devil, or the form of fugue to allude to the learned upper class or aristocracy of the 17th century (Halfyard, 2010, p. 23). The concept of stylistic allusion and the ability for a musical or para-musical phenomena to carry with it a specific socio-musical connotation, is developed further with the concept of musemes.

The term museme was first used by Charles Seeger (1960, p. 76) as a musical application of the word morpheme from linguistics. It can be defined as a minimal unit of musical meaning, and can include harmonic, melodic, or any other devices that can achieve autonomy as a smallest unit of musical meaning (Tagg & Clarida, 2003, p. 94).

The concept rests on the assumption that the museme itself can portray a socio-musical connotation, which will be present whenever the museme is present (similar to how stylistic allusion can carry narrative of the idea being alluded too) (Young, 2007, p. 5). This theory of socio-musical connotation stems from Peircian semiotic theory of symbolism and representation, where music gains its meaning through its use in history (Young, 2007, p. 6). It is also based on the semiotic theory that, in music, signified meaning is directly related to the signifier chosen to express that meaning. This is unlike the arbitrary system of signification used in language where there is no link between the signifier and signified (Hatten, 1985). This allows for a comparative analysis of musical signifiers (and therefore signified meaning) of different musical passages based on the assumption that a specific signifier is linked to its signified meaning. This means that if a musical signifier

can be identified in a film that is similar to a known museme with pre-existing socio-musical connotations, then that connotation will be carried to the new context as long as it exists in the same basic musical culture. An example of this is the ideological concept of anguish, which can musically be represented in any context by the musical trope of the minor add9 sonority as the half diminished chord (or its inversion) used in combination with a melody characterized by disjunct and/or emphasized melodic dissonance (Tagg 2004). This is based on a linear feedback model of musical perception, and does not take into account the reciprocal feedback model as the musical elements dealt with in this study have less to do with creativity and more to do with archetypal and cliché devices. Musematic analysis can also be used to identify meaning in musical passages that have recognizable musemes in them, allowing for a description of the musical meaning that is intrinsically felt when the passage is heard. In the same way that stylistic and strategic allusion is used to evoke an external narrative, musemes are used to evoke more general or archetypal feelings and ideas.

2.1.2.3. Leitmotif:

Composers of film music borrowed the basic idea of the leitmotif from Richard Wagner, but do not utilize this device in exactly the same way. Wagner used reoccurring themes to allude to an idea that represents itself on a repetitive basis in a creation of an internal mythology, but in a different context every time as the mythology develops and never fully quoting itself (Buhler, 2000). Film music departs from the original idea of myth creation and uses the leitmotif in a secularized way as a simple musical signifier for important characters, places or ideas (Buhler, 2000). The leitmotif gains its connotation from its repetitive use and, therefore, becomes self-referential in a film. It is a useful compositional device for identifying with characters, places and ideas, especially when they are referenced in the film by leitmotif without being represented visually.

Leitmotif, like all the other musical devices discussed so far, can exist as a melody, instrumentation, harmony, tonality, or any other device that can create an idiosyncratic musical idea.

2.1.2.4. Musical effects:

While leitmotif is mostly used to signify identification with or commentary about important characters and themes in a film, musical effects contribute to the mood of a scene, and signify the abstract emotions. Musical effects are an example of allusion, but because

these effects do not contain melodic or harmonic themes in the same way that the rest of the music does, they are analyzed separately.

Musical effects are sound effects that can be identified in the music component of the soundtrack. These fulfill a supporting role in the film, since they do not refer to anything specific, but rather add abstract 'commentary' about the progression of the on-screen action. Examples of this are the string clusters that glissando up to create suspense or glissando down to evoke dread. Another example is the ominous bass tones that add a serious and mysterious tone to a scene. By themselves they cannot allude to any tangible ideas, but coupled with the action on screen, they can contribute necessary commentary to clarify an otherwise ambiguous scene (Cohen, 2001).

2.1.3. Analysis of musical contribution

In the context of this study, the information conveyed by the music refers to the way in which music can manipulate the observer's interpretation of a specific scene. This information that the music contributes can be classified under three overlapping fields (Kassabian, 2009):

1. Identification - This communicates geographical and historical space, race, class, gender or associates with specific characters.
2. Mood - This communicates specific emotions within a scene.
3. Commentary - This communicates narrative information regarding a situation or character.

Film music is classified under any of the above fields by considering what is heard in the music that is not seen on screen or heard in the dialogue. This defines the contribution that the music makes towards the diegesis of the film.

Furthermore, the interaction of the music with the dialogue and the sound effects also needs to be considered, as none of the components of the film soundtrack exist in isolation. It is, thus, necessary to also analyze the complete soundtrack to determine the interactions of all the components of a soundtrack. This is the point where the music technology aspect of a film soundtrack has the biggest influence.

2.2. Soundtrack analysis

2.2.1. The soundtrack

The soundtrack of a film is made up of three components that are mixed together into a single audio file at the audio dubbing stage, before its combination with the visual track of a film (Altman, 2000). These components are:

1. The Music - This includes the diegetic and nondiegetic music and all musical effects, composed music and source music.
2. The dialogue - This is all the spoken dialogue and includes narrations.
3. The sound effects - This includes all Foley and designed sounds that are not considered music or dialogue.

In many academic reports about film music in the past (for example by Young, 2000), the music, as it is composed, is used as the source for analysis. The music at the compositional stage and the final product, however, can differ significantly, and the interactions of the music with the other components of the soundtrack cannot be recognized using this method (Altman 2000). The method of analysing the score has been supported by many analysts, because it is the most direct way to analyze the music of a film from a compositional perspective (Bazelon, 1975). For this reason, it is beneficial to also analyze the music from an observer perspective.

Similarly, the dialogue is analyzed textually rather than performatively when analysing a script, thus only the foreground dialogue and narration is considered and it neglects sub-linguistic noises like grunts and coughs and the specific inflections caused by the interpretations of the dialogue by the actors. It also ignores non-linguistic variations in the sound such as reverberation or loudness differences that could add information (Altman, 2000).

When considering the sound effects of a soundtrack, it is important to consider that these are often created by different parties. Even when the same person is responsible for all the audio for a project, there could be conflicting ideas of priorities for these separate components of a soundtrack (Altman, 2000). This creates a problem when analysing film music, as the music can occasionally be obscured by dialogue and sound effects. It is therefore beneficial to also consider the interactions of the sounds on a soundtrack as a single, combined entity to overcome this problem.

2.2.2. Interactions in the soundtrack

In order to analyze the soundtrack as a single combined entity, the relative priority of the components in a soundtrack needs to be established. This can be achieved utilizing the following questions:

1. Is the dialogue louder than the sound effects?
2. Can the music be heard?
3. Do the dialogue, music and sound effects all build in parallel towards a specific goal?

Film sound comprises interactive components, with the interaction of the sounds itself being important due to its ability to draw the observers attention to different aspects of a scene. This necessitates film sound to be analyzed as a single complex unit, rather than as a collection of components. These components interact, since the soundscape on a film soundtrack is a finite space. That space is limited by the following (Altman, 2000):

1. Dynamic range: There is a maximum amplitudinal limit to the output of a sound system, and also a perception threshold of the human ear for meaningful perception.
2. Spectral range: The human ear has a spectral perception range of 10 Hz to 20Khz. Audio masking can affect perception within this range.
3. Attention continuum: The human brain can only pay attention to a limited number of stimuli at any given moment. The soundtrack components thus compete with each other, as well as with the visual elements on screen, on this limited attention continuum.

These limiting factors necessitate the prioritization of soundtrack components and their interaction in what Altman (2000) refers to as a *mise-en-bande* (fit on a soundstage). This terminology is used as the auditory equivalent of the concept of *mise-en-scene* (fit on a stage), which is a term utilized in theatre to explain how all the physical stage components must be made to fit together to create a coherent whole.

Altman has developed a notational system to measure the above-mentioned interactions. This notation is designed to show the relative loudness of the different components of a soundtrack.

A cue sheet is constructed listing each scene and describing the music, dialogue and sound effects utilized within that scene. In addition to this, a graph is allocated to each of

these component depicting relative loudness over time, and thereby showing how the three components of the soundtrack interact in terms of relative loudness (Altman, 2000). This method encourages the analysis of the music in the film as it exists for the observer, and not necessarily the music as it was originally composed for the film. This method can also be utilized to provide additional analysis of film music, where the spectral, temporal, spatial and dynamical data in a soundtrack can similarly be extracted. This data can add an entire new element to film music analysis with the focus on music technology.

2.3. Audio processing

The previous section discussed the importance of the interactions of the various components of a soundtrack, and suggested a notational system to measure relative audio processing levels, such as loudness, reverberation and frequency content. At this point it is necessary to go into some detail as to what these audio processing tools are, and how they are used in film music.

Audio processing (or signal processing) is the action of applying an external process (either digitally or with analogue hardware processors) to alter an audio signal (Huber & Runstein, 2010, p. 469). The four main domains addressed in audio processing are:

1. Dynamics processing: Manipulation of the amplitude of an audio signal.
2. Spectral processing: Manipulation of the frequency spectrum of an audio signal
3. Spatial processing: Manipulation of the stereo field of an audio signal.
4. Temporal processing: Introduction of delay and regeneration of the audio signal over time often used to alter the depth perception of the sound source.

The manipulation of these four domains is utilized during the creation of the individual soundtrack components, as well as their combination into the final sound track.

2.3.1. Dynamics processing

Dynamics processing is used to alter the loudness and other dynamic properties of an audio signal. The most common uses of dynamics processing include changing the overall loudness of a signal using the volume faders on a mixing console (which is essentially a variable resistor which attenuates the total signal by the desired amount). A dynamic range processor changes the dynamic range of a signal, of which the most

popular variation is the downward compressor. Downwards compression reduces the loudness of a signal when it exceeds a pre-defined threshold level. The attenuation of the signal is applied according to a set ratio. (Huber & Runstein, 2010). An example of this is a compressor applied to a signal with a ratio of 1:2 with a threshold of -12 dB. This would reduce any signal exceeding the -12 dB mark on the input meter of the compressor by half, so a signal that reaches -6dB on the input will have an output of only -9dB, because the -6dB over the threshold will be halved to 3 dB (Huber & Runstein, 2010, p. 492 - 493). Compression is used in all aspects of the soundtrack. In the dialogue it is used to reduce the dynamic range of the spoken voice, to maintain a relatively high loudness level, aiding in the intelligibility of the dialogue. In the music, compression is used to reduce the dynamic range of signals that have excessive volume levels, thereby increasing the relative levels that are low compared to the rest of the mix. Compression is used in sound effects such as explosions, to compress all the sound surrounding the explosion giving the perception that the sound of the explosion is louder than it actually measures due to the relative nature of the perception of volume.

2.3.2. Spectral processing

Spectral processing involves the manipulation of the frequency contents of an audio signal. The most common tool in spectral processing is equalization. Like dynamics processing, this alters the loudness of a signal, but it only affects a pre-defined section of the frequency spectrum. An example of this would be a high pass filter, applied at 100 Hz, which would attenuate the frequencies below 100 Hz, allowing the frequencies above 100Hz, to pass through unchanged (Huber & Runstein, 2010).

This process is necessary for fitting various audio components onto the finite frequency spectrum perceivable by the human ear. It is also used to adjust the tone of a signal, or to highlight certain frequencies in order to grant a signal more prominence. It is used to address the problem of audio masking, and ensures intelligibility when more than one sound source occurs simultaneously. Another spectral processing tool is distortion (adding harmonic content), which is used in electronic instruments such as electric guitars to achieve certain sound characteristics. Adding distortion brightens the tone of an audio signal, which adds prominence to the signal without adding to the signal's overall volume (Huber & Runstein, 2010).

2.3.3. Spatial processing

Spatial processing concerns the lateral dimension of a stereo (or surround) audio source by manipulating the proportion of sound played through each side of the stereo spectrum. The most basic element of this is the manipulation of the pan pot to change the lateral spatial positioning (or panning). This essentially diverts the amount of sound coming from each speaker proportionally left or right, which allows for the psychoacoustic placement of the audio signal along the lateral axis of the stereo field. If a signal is stronger in the left channel, the resulting psychoacoustic effect moves the perception of the source signal to the left of the listener on the lateral stereo axis. If the signal to the left and right speaker is identical, there will be a perceived central positioning. This is known as a mono signal (Huber & Runstein, 2010).

The spatial aspect of a signal can also be manipulated for effect, for instance, by artificially spreading a signal to create stereo width. Panning is responsible for representing the perceived location of a soundscape on the horizontal plane (for example, when a car is driving from the left of the screen to the right its sound can mimic this movement by panning from left to right). Dialogue is usually panned in the center position, as panning it off center may result in the observer perceiving it as being removed from the scene (Purcell, 2013).

2.3.4. Temporal processing

Temporal processing involves the manipulation of the timing of an audio signal using delays and regeneration of the signal. This type of signal processing affects the perception of the depth of a sound source similarly to how spatial processing affects the lateral width perception. In combination, temporal and spatial processing are therefore responsible for the three dimensional perception of sound (Huber & Runstein, 2010, p. 503).

Reverberation and delay are used to create depth in an audio signal by emulating the natural reflections of sound off surfaces in everyday life, and can therefore be used as an effect to provide commentary on the size of a room that a scene occurs in, or even the nature of the surroundings (an example would be the hollow sounding echoes in a canyon).

Different audio processors can also be combined. An example is a dynamic equalizer, which is a compressor applied to a specific frequency bandwidth, or an echo delay combined with spatial processing to create a distorted sense of the environment that it

exists in (Huber & Runstein, 2010). There are countless variations that fall beyond the scope of this study. It will thus be restricted to the four main domains and how they can be used to contribute towards the manipulation of the individual components of a soundtrack, as well as the mixing of the components into the final product.

2.4. Mixing the soundtrack

The process of mixing the music, dialogue and sound effects together is referred to as dubbing, which occurs in two stages. The first stage, known as pre-dubbing, consists of the final separate adjustments to the music mix, the dialogue mix and the sound effects mix, before they are combined on the soundtrack. The second stage is known as the dubbing stage. This is where the three components are combined into the final soundtrack for the film. The difference between pre-dubbing stage to the dubbing stage highlights the difference in the roles for the individual engineers managing each of the aforementioned components of the soundtrack, and reinforces the methodology of analysing the final product as the dynamic, spectral and attentional limitations apply to the final soundtrack. (Richard, 1999, p. 106).

2.4.1. Dialogue

The highest technical priority for the dialogue is intelligibility, with the average audience having a significantly lower tolerance for loudness range for the dialogue in a film. Dialogue is generally in mono, panned center and loud enough to be intelligible over other elements in the soundtrack.

2.4.2. Sound effects

The sound effects cover a wide range of function, including hard sound effects (sound effects that are synchronized to the onscreen action) and background sound effects (sound effects that are not synchronized to the on-screen action and add to the ambience). The intelligibility of the sound effect component of the soundtrack is not as important as the dialogue, but often is more prominent than the music. The sound effects are often panned to help locate the source of the sound psychoacoustically, or exaggerated in loudness to draw attention to the source of the sound (an example would be exaggerated footsteps to draw attention to a person walking). The intelligibility of dialogue takes preference over the sound effects, except for special circumstances where they are deliberately interfering with intelligibility (an example would be a loud hair dryer

masking the dialogue to add to the impression that the person drying their hair cannot hear it).

2.4.3. Music

The music on a soundtrack includes source music and recorded music from the film score. In the dubbing process, the music (as it exists after pre-dubbing) is often changed or replaced by the musical editor or director (Richard, 1999, p. 127). This is where composed music is edited most drastically, and why it is important to refer to the music as it exists in the post dubbing stage when analysing the film music.

This section has highlighted the current state of film music studies, as they currently exist from the perspective of the observer, as well as discussing some of the music technology advances and their contributions to the film industry. This literature review revealed that music contributes significantly to the diegesis of a film in terms of identification, commentary and mood, however, the methodology by Altman and Kassabian for the analysis of film music does not sufficiently take audio processing into account when determining these contributions. The proposed methodology therefore aims to append that of Altman and Kassabian in order to extract the data regarding signal processing in film music.

Chapter 3: Methodology

The previous sections established a possible scope to develop a framework for the evaluating of the contribution of audio processing on the interpretation of a film. I have elected to use a cue sheet, developed by Altman (2000) and Kassabian (2009), but refined to include analysis of relative changes in Audio processing as a basis for the collection of data.

3.1. The cue sheet

A musical cue is a new musical passage that is composed for a specific scene. The cue sheet is a list of every musical cue in the film in the form of a spreadsheet. A musical cue refers to a musical passage that starts from and ends with silence in the music component, although some cues do overlap. As this study focuses on film music, non-music cues are omitted (unless they have value to the scope of this study. The data collected from the cue sheet includes:

- Cue number:** for reference purposes to identify each new musical cue.
- Cue title:** a descriptive name to attach to that specific cue for reference.
- Composer:** to indicate music that was contributed by someone other than Ramin Djawadi.
- Cue start and end time:** using SMPTE time code measures to indicate the temporal position and duration of a cue.
- Diegetic or nondiegetic:** the classification of a cue in terms of its relationship to the diegesis of the film.
- Shot/Editing:** a description of the visual on-screen action
- Dialogue/Effects:** to record other important sound components present in the cue.
- Dynamics:** to indicate the total loudness of the soundtrack, and the relative loudness of the music, dialogue and sound effects
- Spectral notes:** observations on the spectral content of the soundtrack.
- Spatial notes:** observations on the panning placement of the components of the sound track.
- Temporal notes:** observations on reverberation or delay devices that influence the sound track in terms of depth perception.
- General notes:** any other comments that may be of importance.

The data generated from this cue sheet is then analyzed to determine every musical moment's particular contribution to the film along the following criteria:

1. The music's relationship to the diegesis of the film.
2. The music's method of communication.
3. The information that the music evokes in, or communicates to the observer.
4. The contribution that the audio signal processing makes towards this information.

This cue sheet is included as Appendix A.

3.2. Analysis of the cue sheet

The question of the music's relationship to the diegesis is simply approached as diegetic, non-diegetic or a possible variation thereof. The question of music's method of communication requires each cue to be categorized as source music, musical quotation, leitmotif, allusion or musical effects. This is achieved by listing and categorizing all the musical moments in each of the cues. In this study, the term musical moment will refer to the smallest unit in a musical passage that can still be considered autonomous. Musical moments can therefore be as short as a two note motif, or as long as an entire song in the case of source music.

The cue sheet is constructed using the 'scene' method of labeling cues, where every cue is given a name based on the scene in the film. There may occasionally be more than one musical moment in a musical cue. Some cues have therefore been divided into sub-cues. In these cases, the sub-cues will be given an additional numerical label (for example: 2.1. Smoke Clears, 2.2. Smoke Clears, 2.3. Smoke Clears etc.).

Once all the musical moments are labeled, the diegetic music is identified and analyzed in terms of its particular function in the film (for example a band playing a song at a gala evening). The Leitmotif themes are identified by virtue of their recurring nature. Musical allusion includes themes that are not leitmotif themes or source music, but that can still be recognized (in the case of strategic allusion), or that evoke familiar emotional responses (in the case of stylistic allusion). In the case of stylistic allusion and the leitmotif, a musematic analysis is conducted to justify the information communicated by the music. The list of all the themes is included as Appendix B. Musical effects are those passages that exist in order to establish mood by pairing with what is occurring visually on screen. These musical effects do not include any recognizable themes.

3.3. Classification of contribution

The classification of the musical moments in terms of their method allow for further classification of the music in terms of the information that it contributes to the film. As discussed in section 5.1, the information referred to here is the manipulation of the observer's interpretation of a certain scene. For the purpose of this study, this meaning is considered in terms of *identification*, *mood* and *commentary*.

Identification relates to music that represents a character, place or object that can be identified with on screen. All leitmotif themes are categorized as such.

Mood relates to abstract emotions felt. This is music, especially some of the musical effects, that is included specifically for enhancing the emotionality of a scene.

Commentary refers to the music adding its own narration to a scene. In this context, it refers more to the music telling the observer something about the scene that would otherwise not be apparent. Leitmotif is often included here; especially if a character theme is used with character not being present in the scene (this adds commentary that something in the scene relates to that character).

Once all these classifications are completed, each musical moment is classified in terms of its purpose, its method of achieving that purpose, and how that affects the observer's perspective, successfully achieving the first two secondary objectives. The next objective relates to music technology and so an analysis of the audio signal processing follows.

3.4. Soundtrack interactions

The first step in the music technology analysis is to analyze relative loudness for music, dialogue and sound effects with commentary on their interactions to gauge the relative attention that each of these components consumes, and thereby establish the priority of each of the sound components at any given moment. These levels are relative and a numerical value on a scale from 0 to 10 in terms of loudness is allocated to each component, where 0 is no attention and 10 is full attention. A graph indicating the loudness of the complete soundtrack is included with indication of short-term loudness and mid-term loudness (with the total program loudness of each section for scale). Observations regarding spectral, temporal and spatial variations are made to indicate how these elements affect the prominence of each component. This provides a comprehensive indication of how the different soundtrack components interact with each

other in terms of loudness. The list of the interactions of the soundtrack is included as Appendix C.

The data concerning the audio processing is analyzed to determine the contribution it makes towards the musical components, and more specifically how it affects meaning in terms of identification, mood and commentary in the film music. This is then compiled into a list of contributions that audio processing makes towards the meaning of a film, satisfying the objectives relating to the research question of this study. This provides for a framework of film analysis that incorporates the analysis of the contribution of applied audio processing in terms of dynamical, spectral, spatial and temporal processing.

Chapter 4: Analysis of the Musical Themes in *Ironman*

Following the methodology as set out in chapter 3, a cue sheet is constructed as Appendix A. From the Cue sheet, Appendix B is constructed as an analysis and interpretation of the cue sheet. This analysis includes the music's relationship to the diegesis, a classification of the music's method of communication (as source music, leitmotif, etc.), and comments on the music's contribution to the film in terms of Kassabian's method of analysing film music.

From Appendix B, the thematic material of the score to *Ironman* is analyzed to identify all the Leitmotif themes, one time music, musical effects and source music. This section serves to find the devices used in the film score in order to determine their contribution to the film in terms of identification, commentary and mood.

4.1. Leitmotif themes

Leitmotif themes are reoccurring themes in the film that are associated with a character, place or action and can be developed without losing identification. The themes act as identifiers, and so are given their meaning retroactively through repetitive use in the context of the character, place or action that they associate with. They do, however, also have socio-musical connotations by virtue of their para-musical content as in the example of the use of snare drum having associations with the military, or the use of certain harmonic devices to evoke emotional responses in the audience, for example the heroic quality of the flight theme on the brass.

The leitmotif theme can be created by the use of instrumentation, rhythm, melody, tonality or any other identifiable characteristic. One prominent identifier in this film is the use of instrumentation from the Classic Metal genre.

4.1.1. Classic Metal instruments

The use of drums, distorted guitars and bass guitars in the style of the Classic Metal genre is a major theme throughout the film and acts as an identifier to Tony Stark and Ironman. Most of the themes associated with him have some elements of the Classic Metal genre.

The two contributing factors to this identification is the fact that Stark himself is a fan of the genre (he chooses the diegetic source music of *Back in Black* by AC/DC and

Institutionalized by Suicidal tendencies, referring to the song as “...his music”. The second is the link between the classic metal genre as a stylistic influence on the leitmotif themes associated with Ironman.

The electric guitar, electric bass and drums combination is used throughout the score as an identification with Tony Stark or Ironman, but it also brings with it connotations of rebellion by virtue of the socio-musical connotations with the genre. Themes that rely heavily on this instrumentation are the “Ironman” theme, the “Tinker” theme and the “Flight” theme.

The identifying character of the instrumentation is aided by audio processing in this collection of themes, because it is the distortion on the electric guitars and bass that give it the association with the genre of Classic Metal. Audio processing in this case directly affects the characteristic of these themes that contribute towards identification.

4.1.2. The Ironman theme

This is the main theme of the film, and has many variations and developments. There are two main contributing factors to the recognition of this theme. The first is the rhythm, which occurs as rhythmical quaver hits (as down strums on the distorted guitar or electric bass). The second is the melody and specifically the minor third interval after the repeated note. The third falls on the second half of a beat and therefore causes a syncopation, giving this theme a boldness that is easily identified in many contexts.

4.1.3. The Tinker theme

The tinker theme is one of the two major variations on the Ironman theme, and occurs in the strings, but often includes elements of Classic Metal instrumentation. This theme is characterized by the repeated notes in the melody with the ascending or descending whole tone interval, while the bass plays the chord progression i ; i^6 ; iv ; VI , and the rhythmic pattern of quavers and crotchets in different variations than the Ironman theme. This theme identifies with the action of building the Ironman suit.

This theme is a bit more delicate than the Ironman theme, and less grandiose than the flight theme. It mimics the sound of a clock, giving connotations of precision and delicate work. The strings usually play *non-legato*.

This theme is associated with Stark as an inventor more than with him as Ironman, and therefore the theme includes some electric guitar and bass, but less so. In the case of

electric instruments, there is also less distortion, resulting in a cleaner sound, and contributing to the identification of this theme.

4.1.4. The flight theme

The flight theme is the other variation on the Ironman theme and identifies with the action of flying. It is characterized by a sustained note, followed by a rising melody and a jump back to the sustained note and is mostly played in the brass to give it a heroic quality. It is accompanied by Classic Metal instrumentation when it identifies with Stark. Early developments have two rising notes before returning to the tonic, but the full development has three. It is worth mentioning that the Rhodes theme is based on this theme, but in his variation there is no Classical Metal instrumentation. This shows how different identifying elements are combined and developed while still maintaining their musematic meaning.

The use of distortion as an identifying characteristic is the main contribution that audio processing contributes towards identification in the Ironman theme, and all the variations thereof as they pertain to Stark and Ironman.

4.1.5. The expensive toys theme

This theme is first heard in **10. Stark Drives To Airport** as Stark drives his Audi R8 racing Happy Hogan (his bodyguard and driver) in the Rolls Royce Phantom to the airport where his private jet is standing by. Later, in **39.3. Test Day Eleven**, the second half of the bass line to this theme plays as a bass fill. In this scene Stark's collection of cars and motorcycles are displayed in the background. In **43. Paint it Red**, this theme starts playing as Stark checks the time on his \$40,000 Bvlgari Diagona, and then it continues as he drives to the benefit in The Audi R 8 again. There is a second part to this theme, associated with dialogue and visuals that relate to people seeing Stark with his expensive toys. This is called the "Playboy" theme by virtue of the Hugh Hefner reference Stark makes to Stan Lee as this theme plays the second time when Stark arrives at the benefit. The first time is when he gets in the private jet and Rhodes is waiting for him. The bass guitar line characterizes this theme. The combination of these two themes is extended in the soundtrack as a full Metal instrumental called *Merchant of Death*.

4.1.6. The Heart Theme

The final theme regarding Stark is the theme representing the MARK chest piece (the heart of light). It is a metallic synth sound, alluding to the onomatopoeic sounds often associated with crystal. The effect is mysterious, as if the chest piece runs on magic. The melody is simple and ascending with a minor second step down to the leading note at the end of the first phrase.

There is no obvious contribution added by the music technology, other than the instrument sound design for the synth.

4.1.7. The Cave Theme

The cave theme is identifiable by its tonality and instrumentation rather than by its melody. It uses two types of drums: a bass drum and a higher pitched tuned drum. It also makes use of a sitar type eastern string instrument and a wind instrument. The harmony is in the Phrygian mode, characterized by the minor second and the major third. The Phrygian mode is used in several themes, and is generally associated with the Middle East as a location and with 'The 10 Rings'. The Cave theme generally has a strong percussion rhythm playing, but in some instances, the percussion will be limited to a single bass drum beat per bar, especially in scenes with dialogue. The foreign sounding instruments create a feeling of 'otherness' in the film, and the Phrygian mode gives a strong harmonic differentiation from the 'Western' themes. An extension of the cave theme is a melody played in the bass called the Raza theme. This variation identifies with the leader of the '10 Rings'. The bass melody is characterized by the minor second interval up, followed by a perfect 5th up and back down and the minor second down to the tonic. This falls in the Phrygian mode, and gives a very menacing feeling because of the heroic perfect 5th on the strange tonality and the use of the low brass. This represents the antagonist by alluding to the musematic themes of 'heroic' and 'villain' in combination.

There are two instances of the eastern instruments and Phrygian scale that do not identify with the cave theme. The first is in **12. Tarmac Afghanistan** where a sitar type instrument plays a rhythmical melody in the Phrygian scale accompanied by a military style snare drum beat. This represents the Afghani Military. The impression of the Middle East is there because of the strange tonality, but the official military variation that the snare drum brings tempers the antagonizing quality that is usually associated with the Eastern sounds.

The other use is not necessarily in the Phrygian scale (Although it could be, there are not enough notes to establish tonality), but makes use of the Middle Eastern theme in **47.1 A Town Called Gulmira**. This theme is identified by the whole tone clash in the strings as the Gulmira theme, and at the same time causes tension, and includes a bass line ending in an interrupted cadence. The same thing happens in **48.1. Realization**, with whole tone clash and the bass line with the interrupted cadence. This tension and interrupted cadence gives a sense of unfinished business with the tension that can be interpreted as an internal torsion for Stark (Because of Yensin, who died to save him and is from Gulmira). The whole tone theme returns, but as a variation on the Ironman theme as Ironman tosses one of the '10 Rings' leaders to the people of Gulmira. The variation on the electric guitars and strings on a rising melody gives a sense of redemption for the Gulmira theme.

4.1.8. Obadiah Stane's themes

The true antagonist of the film is Obadiah Stane. He has two themes associated with his character. The first is the broken arpeggio played on the strings that give a sinister feeling and is called the "Obadiah" theme. The second is a more aggressive passage in the low brass that has the diminished fourth and diminished 7th intervals present representing him as the Iron monger, and is duly called the "Monger" theme.

These themes are mostly used in conjunction with other themes to provide identification with, or commentary relating to Stane's character. There are no identification markers to this theme in terms of audio processing.

4.1.9. The Home theme

There are three components to the "Home" theme. The first is a xylophone playing three notes in the harmony on quick rhythms and is associated with Jarvis. The second is also on the xylophone playing in quavers, but only on two notes a whole tone apart. The rhythmical use of the xylophone in the lower register of the instrument is often used to show happy, reflective moments. Examples of this can be heard in the soundtrack for the motion picture *True romance*, the theme tune to the cartoon series *Rugrats*, the theme in the 1973 motion picture *Badlands* and the soundtrack to the motion picture *Just married*. The third component to the theme is the sustained string chords playing harmonies with a rising major melody giving it an uplifting, triumphant feeling. This is not a major theme and

only occurs three times in this form. The triumphant chord progression occurs more frequently.

This theme identifies with Stark's house (and Jarvis), and with Malibu as a location, which also provides commentary when Stark returns home after his captivity in the cave.

4.1.10. The Pepper Potts theme

There are two components to the Pepper "Potts" theme. The first again includes xylophone rhythms called the "Birthday" theme, but with plenty of echo on them, giving a more reflective than happy feeling. The second is a melody in the clarinet. The use of the clarinet gives the theme a much warmer sound than the electric guitars of the "Ironman" theme or the strings that dominate the rest of the score. The melody itself is simple, slow and haunting, evoking a feeling of longing, but not a deep, tragic longing, but rather of a light almost childlike affection that Stark feels for Potts (or vice versa).

In the xylophone theme, the echo is used as a temporal effect to create a sense of positive melancholy: a lighthearted longing. The music technology alters the connotations of the musical theme, and thereby contributes to the commentary that the musical moment contributes towards the film, and to an identifying component of the theme.

These leitmotif themes all contribute to identification to a character, place, or action. In terms of audio processing, there is some contribution to the identification with the themes associated with the Stark character, because of their electronic nature, and in the Potts theme because of the echo. The themes to follow are themes that only occur once, and therefore do not have the same identification role that the leitmotif necessarily has, and are termed one-time music.

4.2. One-time music

One time music is more difficult to associate with meaning, since it is not self-referential like source music or leitmotif. It is therefore important to do a musicological analysis of this music to establish why it is used, and what connotations it brings with it. The context in which the one-time music is used is less subversive than in the case of leitmotif, because the leitmotif themes can be used as characters themselves, while the one-time music mostly exists to create a sonic backdrop for the events unfolding on screen, and therefore contribute to mood rather than to identification or commentary.

Missile demonstration: This musical cue occurs where Stark presents the “Jericho” missile to the military in **13. Missile Demonstration**. The opening brass notes in this musical moment is reminiscent of the opening bars of the sunrise theme from *Also Sprach Zarathustra* by Richard Strauss, which carries with it connotations of futuristic sci-fi scenes of space travel by virtue of its almost cult usage after Stanley Kubrick’s *2001: a Space Odyssey*. The connotation here could possibly link with the futuristic weapon, and to rockets. After a short build-up in the cello and the snare drum a series of rhythmic chords are played in the strings in a similar rhythm to the military snare and in a chord progression i - VI - vii^o - VII - V - i on a rhythmical pattern semi- quaver, semi-quaver quaver, quaver rest in 3/8 time signature. This rhythmic pattern continues with a rising melody in the brass and ends with the rhythmic hits again, but with a different harmony. The moment builds up excitement and suspense for the launch of the missile, without attaching too much identification with it apart from the military snare drum and the triumphant brass melody.

The interaction between the components of the sound track in this scene is interesting; as the music and sound effects take over once the dialogue is over. The sound effects design for this explosion is very impressive, and although there are many audio processes involved in the design of the explosion sound, it falls beyond the scope of this study. How the explosion affects the music, however, does fall within this scope, as the dynamic processing applied to the complete soundtrack in this instance brings down the volume of the music, in order to raise the perceived loudness of the explosion. This contributes to the impact that the sound has on this scene.

In scene **24. Race To Finish**, a similar chord progression to the music in the missile demonstration is played on the strings, but in common time and in semi-quavers and quavers. It serves the same purpose here to build anticipation and mood. In this scene, however, it is much longer, and therefore the music develops more. There is a moment of quiet in the music where sustained strings are held and all percussion stops where Yensin makes the decision to go out and “...buy more time”. This is a moment of realization for him, and the calm is reflected in the music. The rhythmical devices from before return, but with a rising melody in the brass, possibly representing Yensin’s heroism. It also includes the major second and minor third, showing contrast to the minor second and major third of the Phrygian mode, and by extension an opposition to ‘The 10 Rings’ that the Phrygian mode represents.

Mood Strings: In **25.4. Escape**, There is a moment of calm in the chaos where Yensin is dying. There is string accompaniment with a wind instrument playing a descending

melody, creating a very emotional sonic backdrop to the scene, but still in the major mode. This results in a feeling of sad triumph. The contrast in the soundtrack also directs the attention away from the action scene in order to focus on the tender interaction.

Sustained strings are used for sonic backdrop in **33. Get your mind right** when Stark and Rhodes talk. This moment serves to add some interest to an otherwise empty scene. In **53. Pepper quits**, the sustained strings are used as a sonic backdrop, rising and in the major mode to indicate positive emotions, and falling and in the minor mode to indicate negative emotions reflected in the scene. After that in **54.1. Pepper steals files**, there is a string theme over a driving drumbeat, that is used create tension.

In **61.1 Rooftop**: When it looks like the Iron Monger is gone, there is a cadence played in the strings called the “It’s over” theme, which gives a misleading aural representation of finality. This theme is repeated and developed in **67.1. Alibis** when the action is in fact over.

Final fight music: This theme plays in **65. Rooftop** and is a complex theme with a rhythm in the drums and bass, clashing trumpet rhythms at the top, rising intervals in the lower brass, and a semiquaver theme in an electronic instrument softly underpinning it all. This sounds like something out of a boss fight in a video game and all the components together create a very exciting sonic backdrop to the fight scene.

In these musical moments, the audio processing does not contribute to identification or mood, and only aids commentary in terms of highlighting the priorities of the soundtrack components through relative loudness variations. The themes themselves contribute to mood, as the music is used only as a sonic backdrop. In a similar way, musical effects are used as a backdrop, but they contribute to commentary as well as mood by virtue of their connotations.

4.3. Musical Effects

Musical effects don’t have melodies and themes, but rather act as Sound Effects that are created by instruments. Their justification to meaning is similar to that of the one-time music, but many of the devices used for musical effect enjoy a standardized use within the Hollywood film culture, and therefore have a *cliché* quality to them, making their meaning more easily identifiable. The devices used in this film include string clusters, ominous tones and onomatopoeic sounds.

4.3.1. String clusters

The string cluster is an a-tonal collection of dissonant string tones played at the same time, causing a dissonant cluster harmony. This device is a staple use in thriller and horror movies, and is used in this film with the same purpose: to create tension. This device is used in a variety of ways with different effects in the following musical moments:

16. Heart Machine: The strings ascending glissando creates a dread anticipation of Stark discovering his heart is attached to a car battery.

22.3. Raza: The sustained string cluster chord builds up the anticipation of Raza putting a hot coal in Yensin's mouth.

35.1. Escape: Strings held in a cluster with inner movement, creating sustained suspense, like something is hiding in the dark. An interesting thing to note is that in this case, the suspense is for the soldiers, and Stark is the monster hiding in the dark.

52.3. Obadiah meets the enemy: Sustained notes, but not just strings, some eastern instruments as well. In this context the sustained cluster creates dread with a foreign influence.

54.4. Pepper steals files: The strings start as she discovers the video of Stark being held captive. Combined with the heartbeat type percussion this creates anxiety.

55. Heart removal: This cue includes a string cluster including lower range strings that glissando down. This has a different effect than the ascending glissando. With this, the terrible thing has already happened, but Stark is powerless to do anything about it. The sliding down cluster gives a feeling of dread rather than anticipation like the upwards-sliding cluster.

64.5. Lift off: Here, the string cluster slides up and back down as an interrupted anticipation moment, which leads to an almost comical Mickey Mousing effect.

4.3.2. Onomatopoeic sound effects

This device is used to represent non-musical ideas in a literal way.

2. Smoke Clears: In 2.1, the high pitched sound from the ringing in Stark's ears from after the explosion, and the metallic sound to represent the bright light shining in his eyes.

15. Cave surgery: In this scene, the electric guitar scratches that serve a similar function as the string clusters but with an exaggerated effect. Deep bass drum hits with lots of reverberation adds to the chaos and the occasional high-pitched sound to represent a bright light or electric shock. The exact same devices are used in **18.Torture.**

Apart from sound design in terms of synth instruments, audio processing contributes mostly to the mood aspect of musical meaning with the use of temporal effects to remove clarity from the music, and equalization in the strings, boosting their higher frequency content to create discomfort.

The composed themes often occur in combinations within the same musical moment, resulting in additional contributions by the audio processing on a scene-to-scene basis. These can be viewed in Appendix C, and will be discussed in the next chapter.

The source music present in the film does not have this same integration of themes, and each instance exists in isolation. It is therefore necessary to analyze them separately. The next section lists all the source music with the diegetic music, because all the instances of source music (with two exceptions) are diegetic, and no other diegetic themes exist. This is a coincidental convergence of these two categories, isolating this section from the composed music that occurs in the rest of the film music.

4.4. Source Music

The source music in Ironman is mostly diegetic music, so the socio-musical connotations attached to these tracks will be discussed by virtue of their genre, instrumentation, lyrics and their use in other media. The music all falls into the same basic musical culture, that of Western popular music (and more specifically the Hollywood culture), therefore the use of the track holds socio-musical connotation in other settings according to Tagg. The lyrics to the music (if any exist) also holds program, and therefore contribute towards their meaning.

1. Hummer ride: The first moment of music in the film sets the tone for the main character. It is not immediately diegetic, as it starts playing non-diegetically as the camera shows the landscape with the convoy of military vehicles. The source music is AC/DC's *Back in Black*. The song's genre is an important identifier, as AC/DC is classified as Hard Rock, but was at one stage categorized under the Heavy Metal genre. This particular song ranked no.4 on the VH1 top 40 metal songs of all time (The list itself is not important, but acts as a reference to the genre), leading to the genre classification of Classic Metal for the purpose of this study. The Classic metal genre plays an important identifying role with Stark in the film as discussed earlier. The connotation attached to this song can only be explored by considering its historical use, and thereby establishing the socio-musical connotations attached to this song. *Back in Black* has been used in the following programs:

- The TV series *Alias*, in the episode *Phase one* as Jennifer Garner does a slow motion walk down a hall in black lingerie, high heels and a riding crop.
- The TV series *Supernatural*, in the episode *Bloodlust* as Jensen Ackles drives a muscle car.
- The TV series *The Sopranos* in the episode *Cold Stones* as James Gandolfini receives fellatio while driving.
- A trailer to the 2002 Disney motion picture *Lilo and Stitch*.
- In the Film *Megamind*.
- In the film *Grudge match*.
- In the 2011 Sony motion picture *The Smurfs*.

In some cases this song is used to comedic effect in the less serious scenes, but in all cases it is used to reflect an attitude of rebellion with a self-aware sense of style attached to it. Colloquially it would be termed a 'Bad boy' attitude. This song is revisited in the same context of the Hummer ride in **14. Hummer ride revisited** as the original chronological timeline is continued after it was disrupted by the title scene with the *36 hours earlier* marker, bringing continuity to the chronology of the film.

This musical cue contributes commentary towards Stark's personality by virtue of the connotations associated with the song, as well as identifying with Stark due to the instrumentation and genre of Classic Metal. It also contributes to the mood of the opening scene.

The change in the diegesis of this cue changes the focus of the meaning of the music from mood (when it plays non-diegetically), to that of identification and commentary when it is apparent that Stark and the soldiers are listening to the song in the vehicle. Music technology does not necessarily contribute towards this meaning as such, but the shift in dynamics, coupled with the spatial and spectral change does enable this change in diegesis, and therefore forces the focus onto the radio in the car, which contributes to the shift in perception of the music.

3. News reel: This music is composed specifically for the Ironman film by Ali Theodore of DeeTown Entertainment. This musical moment does not have any obvious identification or commentary, but is rather background music for the presentation. The spectral control of the lower frequencies and the narrower stereo width contribute to the perception of the music being diegetic.

4. Stark Introduction: This is a big band arrangement by Jack Urbont of his own 1960's theme to the Ironman animated cartoon series. The big band setting gives glamour to the

theme reminiscent of the 1920's swing parties. In this context it adds a sense of occasion to the introduction of Stark for his award. Although this music is apparently originating from the same source as the previous cue, the clapping is relatively louder, with less reverberation, giving the sound effects a higher priority than the music, since there is no dialogue.

The same theme is used for **5. Casino**, but here it is non-diegetic and rather adding commentary on the party Stark is having in the casino with the same quotation from the 60's cartoon theme. The controlled low frequency range and narrow width from the previous two themes are abandoned to make this theme non-diegetic. The music, dialogue and sound effects interact in terms of loudness, to make sure that the dialogue and sound effects are always intelligible. The music becomes louder only when these other two soundtrack components are absent.

6. Sex with reporter: This is the other non-diegetic cue under source music, but it is an extension of the previous musical moment because it also makes use of a quotation of the 60's Ironman theme on an electric guitar played in a James Bond style by virtue of the similar rhythm and instrumentation sound (sounding similar to Vic Flick playing on a Clifford Essex Paragon Deluxe, as in the James Bond theme). It is an allusion to the James Bond character and the socio-musical connotations linked to him, drawing a parallel between Bond and Stark, and thereby contributing commentary regarding Stark's character. How the sound is created for this theme can be considered along the lines of music technology as it pertains to instrument and amplifier design, but that is beyond the scope of this study.

8. Institutionalized: The song *Institutionalized* by *Suicidal Tendencies* was released in 1983 and was nominated for a Grammy for best metal performance. It is another example of the Classic Metal genre that Stark is playing in his Lab as he is working on a car. When Pepper Potts turns the music down as she comes in his comment of: "Please don't turn down my music"... shows him taking ownership of the music. The fact that he chose the music in the diegesis of the film contributes commentary and identification regarding Stark. Other uses of this song connecting socio-musical connotations to it include:

- The 1984 motion picture *Repo Man*.
- The 1995 motion picture *The Brady Bunch movie*.
- The TV series *Beavis and Butthead* in an episode called *Couch fishing*.
- The TV series *Miami Vice* in an episode called *Free verse*.

In all these settings (and as is apparent from the lyrics), this song has strong connotations to rebellion. In this context, Tony Stark shows his rebellion from disappearing the morning after the sex with the reporter scene, and keeping the military waiting for three hours while he is fixing his 'Hotrod'.

The audio processing on this song includes the spectral and spatial control associated with diegetic music, but also includes some reverberation to comment on the space they are in.

11. Private Jet Party: The song *Slept on Tony with Dirt* by Ghostface Killah (aka. Denis Cole from the Wu-Tang Clan) plays on the sound system of the plane, with the music video on a screen in the background. This song's lyrics talk about Ironman and Tony Stark. Cole is a big fan of the Ironman series, and called his first solo album as *Ghostface Killah* in 1996 *Ironman*. His own label is called Starks Enterprises, and some of his aliases include Iron Man, Tony Starks or just Starks. His involvement with the Ironman franchise is apparent as he was in a famous lawsuit with Jack Urbont for copyright infringements over the use of Urbont's 60's Ironman theme song. This perhaps shows why they chose this particular song for the scene. The question of its contribution is difficult to determine, because it has not featured anywhere else. The use of the Rap genre could have been chosen because Rap has connotations to rebellion and general bad behavior, and that this particular song lends itself to pole dancing flight stewardesses. The relative loudness changes gradually as the music gains in volume and the dialogue fades to the background. This is indicative of the dialogue taking a rare secondary priority, and the setting of the dialogue becomes more important than the words exchanged.

38. Obadiah On Piano: The piece of music played by Obadiah on the piano is the *Larghetto* movement from Antonio Salieri's *Concerto in Do maggiore per pianoforte ed orchestra*. Playing on the piano gives Obadiah an air of culture, but it is the choice of composer that has the most interesting commentary. The piece is by Antonio Salieri and the scene draws a parallel between Salieri and Obadiah, and Stark and Mozart. Salieri was famously jealous of Mozart's talent and success, a precursor to Obadiah's betrayal of Stark for the same reasons. There is some reverberation applied to the piano track, to emulate the natural sound that the room would make, and in that way give an indication to the size and nature of the room.

42. Entertainment Channel. The song played in the background of the entertainment channel in Stark's lab is called *Groovetronic* by Terry Devine-King and it serves as background music for a news report on the television. It is not a very important musical moment, and sounds more like a generic beat under the dialogue of the presenter on the

channel to make it seem like something exciting is happening. The signal is processed to make it sound like it originates from the television speakers, including the low frequencies being heavily attenuated, and the dialogue from the television having some stereo spread, indicating that it is from an electronic source.

44. Benefit 1: The Jazz number playing in the background of the benefit is *Kool Katz* by Chucho Mecha. The choice of the Jazz genre is to add class to the event, because this type of background Jazz music is associated with expensive taste and a classy atmosphere. Later, in **46. Benefit 2**, when Stark enters the dancehall again, the same track is used to add continuity to the scene. Interesting to note regarding these musical moments is that the only indication of the music being diegetic is the fact that people are dancing to it. It does not have the usual audio processing associated with diegetic music. This creates the question of what effect the visual component can have on the music of a film, but this is beyond the scope of this study.

68. Ending Credits: This musical moment is non-diegetic, but it will be placed here because the diegesis of the film is over at this point. The song played is an instrumental version of *Iron man* by *Black Sabbath*. This song was released in 1980 and won the Grammy for Best metal performance in 2000, identifying it with the Classic Metal genre. This song has more significance for the film. In the cartoon series, Tony Stark calls his suit Ironman because of this song (he is a *Black Sabbath* fan in the animated series). This theme continues in the Avengers film, where Stark is often seen wearing a Black Sabbath t-shirt. As always, the socio-musical connotations with the genre include rebellion.

Chapter 5: The contribution of music technology

In order to determine the specific contribution that audio processing makes towards the film, each musical moment is analyzed according to the method proposed by Altman (2000), but adjusted to include information regarding all four domains of audio processing when considering the soundtrack interactions. This list is compiled in Appendix C.

From Appendix C, it is clear that most of the contributions that audio processing makes towards the film have to do with intelligibility and commentary, and are summarized as follows:

5.1. Intelligibility

Intelligibility is a priority on the soundtrack, because of limitations of the perceivable dynamic and spectral range, and the limit to the amount of human attention that can be granted at any given moment. This means that these separate soundtrack components need to coexist in a finite space. These limitations combined with the trend to produce louder soundtracks in Hollywood films (especially in the Action genre which this film falls under), means that all the aspects of the soundtrack must be manipulated in order to remain intelligible (Altman, 2000).

5.1.1. Dialogue intelligibility

The relative loudness listed in Appendix C shows that dynamic variation is used to weave together the soundtrack to prevent one audio component masking the others and, therefore, to prioritize the components of the soundtrack. The relatively small dynamic range in the dialogue, combined with the dynamic attenuation of relative loudness in the music and sound effects (except when used for a specific effect), shows that the intelligibility of the dialogue is the highest priority. The spatial element to the dialogue is another indicator of its importance. The dialogue does not follow the same spatial rules as the musical effects when it comes to stereo or surround sound placement, and is always panned center with very little in the way of stereo spread (except for special effect, like that used to indicate a mechanical source of the dialogue). It is clear then, that the sound effects and music must be manipulated with audio processing to fit around the dialogue to gain as much prominence as possible without subtracting from the dialogue intelligibility.

5.1.2. Sound effects Intelligibility

The other aspect that is always very prominent in the soundtrack is that of the sound effects that relate to actions that the actors on screen are directly interacting with, such as computer sounds, tools being used or gunshots. These are so called 'Hard' sound effects. These are treated in the same way as dialogue in this context, in that they have a small dynamic range, and audio processing is applied in such a way to improve their prominence. These sounds are generally short in duration, and therefore don't interfere with the dialogue. The other sound effects, such as the building noises and explosions, are not as reliant on intelligibility as speech for their effect to make the same impact, and they are therefore often moved backwards on the depth dimension of the soundtrack using spatial, temporal and dynamic processing.

5.1.3. Music intelligibility

Music has the lowest priority on the soundscape by virtue of its continuous nature. A long, sustained chord can be interrupted by dialogue, sound effects and even other music and still be audible because of its continuity. For this reason, the music is often the softest component when more than one component occurs simultaneously. Spectral effects are often employed to combat loss of intelligibility in important themes. An example is in the flight scenes where the wind noises and general flight noises are at a high loudness level, the bass guitar has distortion added onto it to help it break through the white noise effect that the wind and the engines generate. Another device has to do with arrangement, where an important melody can simply be played in frequencies higher or lower than the dialogue, thereby not conflicting within the spectral range and remaining prominent without masking other more important sounds.

Music often occurs in the film as the only audible component present. The intra-intelligibility of music has to do with the mixing of the instruments to give certain themes prominence at certain times in exactly the same way as the soundtrack is mixed. This again has to do with manipulating dynamics, spectral content, space and depth. An example of this is the use of strings and electric guitar at the same time. Where the strings have a more important theme, the spectral content of the distorted guitar will be limited so the two instruments don't participate in the same spectral space (which would mask one of them). Another example is the use of reverberation on the snare drum when combined with the trumpet, to reduce the snare drum's prominence, and push it

backwards on the depth dimension, leaving the trumpet as the more prominent instrument.

5.2. Commentary

Music technology has the ability to add commentary to a scene in the film. There are different types of commentary that can be achieved with different devices in the dynamic, spectral, spatial and temporal domains. There are four basic groups of commentary that these devices contribute towards namely diegesis, intelligibility, dialogue effects and environmental commentary.

5.2.1. Diegetic commentary

The best example of music technology leveling commentary about the diegesis of the film is in the opening scene in the movie, where *AC/DC's Back in Black* is playing non-diegetically, and then suddenly when the scene changes to the inside of the Humvee, the music becomes diegetic. This change is in the audio processing, and the pictured radio only helps to focus the commentary (that the music is now interacting with the characters). This is done using spectral and spatial effects. The music changes from a wide stereo spread, to almost completely mono and panned center. At the same time, the bass frequencies are attenuated, and some distortion is added to the high frequencies to emulate the sound of the lower quality speakers in the little radio. In general, diegetic music has the bass frequencies attenuated and takes up a narrower spatial width to varying degrees depending on the source of the music in the diegesis. The exception is with the track *Kool Katz* at the benefit scenes, where the music sounds like non-diegetic music and the source of the music is also not visible on screen.

5.2.2. Intelligibility effects

Although audio processing is used to improve the intelligibility of the music in a film, spectral and temporal effects are also used to intentionally decrease the intelligibility of speech, such as in the case of the dialogue after an explosion to give commentary on the loss of hearing caused by the loud noise at close proximity, followed by its gradual recovery. This is achieved by drastically reducing the higher frequencies in the dialogue and the sound effects, and gradually bringing them back to indicate recovery, while at the same time an echo delay and reverberation effect in the temporal domain are applied,

and then gradually lessened to improve intelligibility. This commentary is enhanced by the visual also being blurry and gradually refocusing. The exact same technique is used in reverse for the commentary of losing consciousness. In a similar way, the attenuation of high frequencies and reverberation is used to alter the sound when Stark's head is plunged under water. This proves to highlight the effect that audio processing has on intelligibility.

Explosions are a very interesting point of discussion in the discipline of sound design. This falls beyond the scope of this study, but the use of dynamic compression on an explosion where it mutes all other sound components for a moment to increase the perceived loudness of the explosion, and also to give a more physical impact to them is used extensively in this film.

5.2.3. Dialogue effects

There are several examples of the use of spatial and spectral effects to alter the sound of the dialogue for specific commentary. The first example is that of Jarvis' voice, which is made to sound like a computer talking. This is achieved by adding spectral content (distortion), and modulating this added content giving it spatial width, in juxtaposition of the very narrow spatial range of normal dialogue. This gives the commentary that he is not a person talking, but rather that his voice originates from a speaker. A similar effect is used for dialogue coming over a telephone and in the case of the fighter pilots, the communication system they talk on. Stark and Obadiah's voices are also spectrally altered when they are in the Ironman and Iron Monger suits respectively. Stark is given a similar treatment as Jarvis, while Obadiah is given additional bass frequencies and some reverberation to add some menace to his voice.

5.2.4. Environmental commentary

Temporal effects such as reverberation and delay are used to indicate environmental commentary. The first example of this is the sound of gunfire inside the cave, compared to outside in the escape scene. Outside there is no reverberation or delay. This also has a dynamic implication, and so the gunshots sound less loud outside. Another example is the applause sound effects before and during the press conference scene. The clapping outside is dry and muted, while the clapping inside has reverberation, echo and comb filtering in the higher frequencies. This comb filtering is likely caused by the recording process and not intentionally added, but it adds to the contrast of the inside sound

effects versus the outside sound effects by emulating naturally occurring echoes in nature.

In the hangar speech, the pre-delay from the reverberation for the dialogue is audible, giving an indication that the hangar is a very big space with few diffusing surfaces. The same effect is evident when Rhodes is looking for Stark after Obadiah stole the chest piece. He calls out for him in the room with the piano, which is very reverberant, but when he gets into the Lab, there is almost no trace of a natural sounding echo, because intelligibility becomes more important.

The main contribution made by the audio processing is not the same as the contribution the music makes to the film. There are uses of the processing that fulfill the same role as the leitmotif themes, but the biggest contribution has to do with establishing the diegesis of the music, intelligibility, and the manipulation thereof and providing context for the sound in terms of commentary.

Chapter 6: Synthesis

The development of the methodology used to conduct this film study can be used for compiling a reference list of audio processing tools used in film music. The traditional cue sheet method of data collection combined with the additions concerning dynamic, spectral, spatial and temporal processing is an appropriate method to collect enough relevant data to conduct an analysis of film music to include the perspective of audio processing.

The combination of the thematic analysis and audio processing analysis utilizing this hybrid cue sheet system allows for specific conclusions to be drawn regarding the place that the audio signal processing aspect of music technology has in film music.

This synthesized methodology can be used by new entrants in the film music industry to analyze film music to be used as references for their own film projects, in order to identify the specific processes used in order to create certain effects that have an influence on the meaning of a film. A similar method could also be used in related audio-visual industries such as television, video gaming, or sound design.

Chapter 7: Conclusion

In this study, the current state of film music, modern media, and the importance of high quality audio in the myriad of available playback devices is discussed as a background to the development of the study of film music and more specifically the study thereof from a perspective of music technology.

The study of film music has mainly seen contribution from the parent disciplines of musicology and film studies, but film, being an interdisciplinary form of communication, requires study from a broader scope of disciplines. This study is conducted with the focus on audio processing, and concerns itself with the contribution that the music in a film can have towards its perceived meaning. To this end, a methodology of film analysis is synthesized, that analyzes the film music to determine its function relating the meaning it contributes to the film, the method in which it makes this contribution, and finally, the aspects of audio processing that contribute towards this meaning.

The music is analyzed and divided into thematic content, in order to more easily determine its relationship to the diegesis of the film, the meaning it contributes towards this diegesis in terms of identification, mood and commentary, and the method it uses to achieve this meaning. Once the meaning of the musical moments in the film is established, an analysis of the audio processing applied to the individual components of the film soundtrack (music, dialogue and effects), as well as the processing applied to the soundtrack as a whole is conducted to determine what dynamic, spectral, spatial and temporal processes take place in the aforementioned musical moments, and how they add to the contribution that the music makes to the film.

In this analysis, it is clear that the contribution that audio processing makes towards the film includes identification, intelligibility and commentary. The audio processing contributes towards identification in the case of electronic instruments in leitmotif themes. The audio processing manipulates and enhances the intelligibility of the different components in the construction of the soundtrack. Finally, the audio processing can contribute commentary regarding the origin of the sounds within the diegesis of the film, the environment that the sound exists in.

7.1. Suggested future research

The present study focuses on the contribution that music technology makes to a film in a specific cultural context. The same methodology could be used to explore music from

different cultures of film making, such as Bollywood or the Korean culture of film making to explore the differences in perception of certain aspects of a film relating to socio-musical connotations.

The methodology could also be used to study other components of the soundtrack such as the sound effects and dialogue from a perspective of music technology. An interesting study could be done on films that famously lack the music component of the soundtrack to a large extent such as *Gravity* or *I am Legend*.

A focus of this study was the impact that the audio component exercises on the visual component of a film. A study focusing on the impact that the visual has on the perceived meaning of the audio could be conducted on films that use source music extensively, or on other media such as music videos.

The data in the three appendices could be used in further study of the film Ironman as a thematic or compositional study in future.

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Appendix A - Cue Sheet										
#	Title	Start/End time	Dialogue/FX	LUFS	Music Loudness	Dialogue Loudness	FX Loudness	Spectral Content	Spacial Content	Temporal Content
1	Hummer Ride - Back in Black	01:00:51:00.00 01:02:34:07.75	Wind and Car noise. Match song. Untill diegetic. Then the song fades for dialogue (Gradually). Dialogue over FX and song untill explosion and gun fire. Dialogue still given priority.	26.1	10, then 7 with mono fading till 3 for dialogue	8	7 for car, 10 for explosion		Wide stereo, then very Mono. Music and dialogue mono, only FX in stereo	
2	Smoke Clears - Main Titles (0:53)	01:03:30:00.00 01:04:20:00.00	Starts with a ringing in ears from explosion. Dialogue is muffled and has echo until it comes into focus. Sound background, building up to Title.	24.4	Fade in from silence caused by explosion till 7.	fading in	Explosion 9	low pass filter on dialogue moving up to increase clarity	Wide and modulating music	Dialogue heavy reverb and long echo (Confusion), generally getting clearer.
3	News reel (1:13) - Damn Kid	01:04:20:00.00 01:05:29:00.00	Dialogue and song both from the presentation. Balanced. Applause under music and Dialogue.	26.9	6	7	Clapping 5	Cleaner bottom range	music less spread	
4	Stark Introduction (0:27)	01:05:48:12.40 01:06:10:12.50	FX behind applause now. Dialogue also under applause untill it fades	28.4	4	7	6		Clapping wider	
5	Casino (1:05)	01:06:40:12.40 01:07:42:03.33	Iron Man theme over Casino noises, then fades down for dialogue. Music still present. Music fades up again in the way to the car and ends abruptly with reporter dialogue	27	7, fade to 4 for dialogue and back to 7 after	7 clapping, 6 dice	7		Even off screen dialogue is centre	
6	Sex With Reporter (0:26)	01:08:56:00.00 01:09:08:00.00	Music over FX and Dialogue.	25	7		8	Guitar sound is interesting	very narrow	
7	Lights Up (0:40)	01:09:09:00.00 01:09:42:00.00	Music Background for Jarvis fading over him as the scene pans to outside to give a sweeping view of his house. The music builds to create a sense of grandeur.	27.9	5 under dialogue, fading up when outside	7 fading to nothing as the shot pans outside.		Full spectrum sound. Jarvis has some extra spectral content that is spread.	Wide stereo in music. Jarvis has a wide stereo spread	
8	Institutionalized	01:10:32:18.60 01:10:59:08.79	Music loudly playing in the lab, but FX and dialogue takes precedence. Muted suddenly when Pepper turns it off.	31.1	8, fades to 6 with dialogue	6	7. Car fixing sounds very loud	Bass is light to give the impression of diegetic music	Music not mono	
9	Birthday (0:28)	01:12:02:00.00 01:12:23:12.40	Background Mood music below dialogue. Theme on Xylophone type synth sound	44.2	fade in to 4	6				
10	Stark Drives To Airport (0:43)	01:12:23:12.40 01:13:12:00.00	Loud rock music, loud car racing FX. Winds down when they park and dialogue stops. Loud again when they fly, for a second.	22.6	8, then softer 5 under dialogue, but with arrangement. Back to 8	7	9. Car FX very loud		Driving FX panned as car passes.	
11	Private Jet Party - Slept on Tony with dirt	01:13:51:18.60 01:14:17:00.00	Music Loud and dialogue still audible, but as if they are in a loud club. Dialogue fades out as music gets louder, ending in the plane noise	26.1	7, fade up to 8 at the end	7, fade down gradually (Not louder than music)	5. Jet FX			
12	Tarmac Afghanistan (0:30)	01:14:17:12.40 01:14:38:00.00	Background music. Military snare tattoo with sitaar type instrument playing the diminished second and minor 7th, giving a military and an eastern feel	31	6	7	8. Jets and shouting		Helicopter and Jet FX panned	
13	Missile Demonstration (0:50)	01:15:11:12.40 01:15:48:00.00	Build up with Snare climaxing in launch of missile. FX takes over. Then more suspense music ending in well sound designed explosion.	17.5	up to 8, compressed down with FX	8	10	Explosion is tuned	Missile moving left panned. FX very wide	
14	Hummer Ride Revisited - Back in Black	01:16:24:12.40 01:16:29:00.00	Explosion on the second "back". Earlier than in the first scene. Ends in exposition and goes straight into next cue	23.3	4		Explosion loud			
15	Cave Surgery	01:16:29:00.00 01:16:48:00.00	E Guitar fret noises and Kick thumps and echoes and general chaos.	21.2	8 fade gradually down	6	7			Reverb and delay to lose definition in dialogue
16	Heart Machine (0:41)	01:17:33:15.50 01:18:01:12.40	Ominous tones and string slides to create dread as in horror movie.	28.2	8	6	6			
17	Demands (1:10)	01:19:14:12.40 01:20:19:18.60	Mood music. Tuned Drums. Electric guitar feedback noise. All under Dialogue	28.5	5 under dialogue	8. Door lock	7			

#	Title	Start/End time	Dialogue/FX	LUFS	Music Loudness	Dialogue Loudness	FX Loudness	Spectral Content	Spacial Content	Temporal Content
18	Torture (1:59)	01:20:19:18.60 01:22:10:00.00	Background noise, punctuated by tuned drum beats and sharp high pitched noise. Music under FX. Scene ends with metal sounding percussion sound when they pan to Raza	24.2	7 for effects, 4 under dialogue and 7 at end with brass	6 under water. 8 intelligible		low pass filter to muffle everything under water.		
19	Getting Started (2:36)	01:22:54:12.40 01:25:22:12.40	Iron man theme on e gtr. Fade to tuned percussion (Cave sound). Music under dialogue.	28.1	8 then immediately down to 6 under dialogue na dback to 8 with no dialogue	6 with music (Not louder). Then 8	Working FX and Furnace 8			
20	The Ring & The Diagram (1:51)	01:25:22:12.40 01:26:55:00.00	Mood music, tuned percussion, with elements of the iron man rhythm and the cave drum beat.	30.3	6. Just under dialogue.	7	7.	9 Khz spike with light		
21	Suspicious (1:08)	01:27:27:12.40 01:28:33:03.10	Sitar type instrument. Mood music. Then brass theme (Tinkeringtheme B) with eguitar chords. Sitar sounds with Raza. Ominous tones	27.8	6-9 depending on music	8	6. Under music		FX panned, music and dialogue not	
22	Raza (2:54)	01:28:39:00.00 01:31:16:00.00	Ominous music fading out till Dialogue.Dramatic effect drums. Horror movie style dread tones. Very low pitched and very high pitched. Strings build for hot coal.	29.4	7 up to 8 down to 4 under dialogue. Bass drum 8	7. 10 at shout	door and steps 8	Sinewave spikes for effects sounds		
23	Anvil (1:49)	01:31:23:12.40 01:32:58:00.00	Very percussive theme,. Variation on 19.2 (Tinkering theme.) then faster variation on theme 19.1 (Ironman theme A) fade down for dialogue.	21.2	Fade up to 9. down to 7 for dialogue	9 - anvil. Rest 8	7. Never too loud			
24	Race To Finish (2:17)	01:32:58:00.00 01:35:04:00.00	Tuned percussion and low drum rhythm. Build till door explosion. "Time percussion" building suspense cutting everytime there is dialogue. Suspense build till Yensin is caught and suit powers up.	22.5	8 with no dialogue. 5 with. (Soldiers shouting not dialogue)	9.	FX loud and inteligable		Soldiers shouting at door with Stark and Yensin talking panned	
25.1	Escape (5:02)	01:35:16:00.00 01:37:45:00.00	high strings suspense. Gunfire FX drowns out tones. Fight scene loud, leading into Ironman reveal with Iron man theme A. Fade out for FX. Dramatic end music for opening the door. Door explosion cues music back in. "Fight scene mickey mousing" Until Stark finds Yensin wounded.	19.2	Music loud 7-8 under FX. Shouting lower	Shouting 6	10. Gunfire and explosions	When Tony shouts "Ynsin!" in the mask, the spectral content of his voice is altered.		
25.2		01:37:45:00.00 01:38:54:00.00	Major strings for sad scene. flute to punctuate sadness. Fade out for footsteps FX from outside Cave.	28	5 fading up to 7	8		Voice is fine again with open helmet.		
25.3		01:38:54:00.00 01:40:30:00.00	Gunfire FX and random shouting. Tony voice FX in the mask (Heavily processed).Flame thrower theme. Iron man theme A with flight for one instance, followed by fall.	16.2	8. Loud, but still under FX. Compressed with explosions	8. "My turn"	9 for outside gunfire. 10 for the rest	Gunfire high freq. softer fired from outside of cave. "My turn" in mask heavily altered.		
26	Rescue (2:10)	01:40:54:00.00 01:42:53:00.00	Cave sounds without drums. Exposure FX louder, Sus slymbal build till helicopters. Similar theme to 21. Theme notated. Happens twice. Then a theme with Pots	25.3	6 dessert music. Then 9 down to 6 for dialogue up to 9 down to 6 for dialogue	7 dampened under chopper noise, 8 with no chopper.	6 wind noises, 9 chopper			
27	Cheesburger - Stark Arrives (0:56)	01:43:12:00.00 01:43:56:12.40	Theme and instrumentation similar to "lights up" Malibu theme?	27.7	7	7	7		Chopper goes Right and behind with phasing	Clapping outside and inside are different because of reverb.
28	Press Conference (0:52)	01:45:51:12.40 01:46:34:00.00	Mood music. Fade into Malibu theme	27.5	4. Up to 8 in scene change, then gradually down out fade into Arc reactor sound	9 shouting over press, the 7 outside the Stark labs	Press rabble 8			
29	Heart Reveal (0:57)	01:47:53:00.00 01:48:40:12.40	Soft behind dialogue	33.6	8 down to 6	6 up to 8		At first dialogue and music occupy different space, then with brass, the dynamics must compensate.		

#	Title	Start/End time	Dialogue/FX	LUFs	Music Loudness	Dialogue Loudness	FX Loudness	Spectral Content	Spacial Content	Temporal Content
30	Pepper Called To Lab (0:59)	01:49:20:00.00 01:49:40:00.00	Birthday theme snippets and extended Potts theme elements	41.2	5	7 Soft scene, intimate				
31	Never Again (0:32)	01:51:52:00.00 01:52:38:12.40	Birthday notes and potts theme.	40.5	6	7 Soft scene, intimate				
32	Rhodie Hangar Speech (0:43)	01:52:38:12.40 01:53:14:00.00	Rhodes theme developed from Rhodes Rescue. Similarity with the rescue theme	31	7	8	9. Jet outside			Reverb on dialogue. Predelay noticeable. Big hanger effect. Reverb on snare to push it back in the mix.
33	Get Your Mind Right (0:19)	01:54:06:00.00 01:54:17:09.30	Mood Music	42.2	6	7				
34	Keep Off The Server (0:46)	01:54:17:09.30 01:54:55:00.00	Theme similar to the theme in suspicions (Tinkering B)	33.7	6-7 depending on dialogue	8	7. Computer noises	Jarvis has some distortion	Jarvis is not Mono centre. He has spread	
35	Finding Iron Mask (0:50)	01:54:55:00.00 01:55:35:12.40	Sitar sounds and tuned percussion. Build up to finding the mask. Drum beat with Raza.	27.4	7. 9 for final statement in bass	7	7			
36	Test 1 (0:51)	01:55:35:12.40 01:56:16:15.34	Similar to the second theme in getting started (Tinkering theme A)	35.7	7 down to 5	7	6. Soft whirring			Dialogue and FX forward and music back.
37	Test 2 (1:01)	01:56:52:00.00 01:57:46:00.00		28.5	8 down to 5 with dialogue	8	Blast is loud. 10.	electric guitar is belled off		strings very forward, guitar and synths very back
38	Obidiah On Piano - Saliery's Piano Concerto	01:57:51:00.00 01:58:08:14.04	Saliery, the less talented rival of Mozart.	34.5	7	9			piano has some spread.	Piano made to sound natural in the room, but behind the dialogue.
39	Test Day Eleven (1:47)	01:59:24:12.40 02:01:06:12.40	Very soft background under dialogue. Up a bit with flight FX. Elements of tinkering B	20.1	4. up to 7 later	9. always breaking through other sounds	10 when on screen. Makes way for music and dialogue when not close to the screen.	distortion helps guitar break through		
40.1	First Flight (3:10)	02:01:12:04.65 02:02:21:00.00	Fully developed Iron Man theme. As loud as FX, but softer with Dialogue. Elements of Tinkering B and the IronMan theme with full Rock band instruments. Iron man theme B augmented over normal with Tinkering rhythms. Stops when Jarvis stops from Ice build-up. Start again on startup of suit and modulates up with flight theme (Augmented IronMan B theme). Ends abruptly with "kill power	25.3	6. Up to 8 for "controll surfaces. Down to 6 for dialogue.	8 always. No reverb.	8 for initial assembly, then down under music for controll surfaces.	Jarvis Voice	Jarvis voice	
40.2		02:02:21:00.00 02:03:48:00.00	Take off till ice buildup	19	7	9	8	Jarvis Voice	Jarvis voice	
40.3		02:03:48:00.00 02:04:39:00.00	Fall till "kill power".	19.3	8	8	Falling 9 and flight 8			
41	Trophies (1:06)	02:05:07:00.00 02:06:08:00.00	Birthday tones and pepper theme extracts. Fades to Raza sounds.	20	5 to 6. for pepper. 7 for Raza	6	7			
42	Entertainment Channel	02:06:33:00.00 02:07:11:00.00	Generic entertainment channel background music	39.8	2 up till 4 and fade out	5 for tv, 7 for tony and Jarvis		very low bass (Diegetic)	Slight spread in TV music	
43	Paint It Red - Drive To Benefit (1:15)	02:07:11:00.00 02:08:14:00.00	Similar theme to Flame thrower and drive to the tarmac	22.2	7 in driving scene, down to 5 at benefit and fade slowly	8	10 for driving and 9 for crowd	Distortion in bass guitar helps it break through in driving scene		
44	Benefit 1 - Kool Katz	02:08:34:18.60 02:10:41:00.00	Background music of event	35.7	7 down to 5 for dialogue	8			Jazz is diegetic, but stereo. It does not sound diegetic, but the characters are dancing to it.	
45	Kiss (0:28)	02:11:10:00.00 02:11:31:02.17	Pepper theme	40.2	5 up to 7	8				
46	Benefit 2 - Kool Katz	02:11:44:12.40 02:12:36:12.40	Background music of event		5 fading out under next cue	8				

#	Title	Start/End time	Dialogue/FX	LUFS	Music Loudness	Dialogue Loudness	FX Loudness	Spectral Content	Spacial Content	Temporal Content
47	A Town Called Gulmira (1:21)	02:12:30:00.00 02:13:44:00.00	Fade in over Jazz Music. Jazz fades out.	31	7 up to 9 after dialogue	8	6 background people			
48	Realization - Suiting Up (2:25)	02:13:44:00.00 02:16:02:00.00	Same theme as A town called Gulmira. Then Iron Man theme A as the suit assembles with some variation, ending in a similar theme to the flame thrower theme	25.5	5 up to 7 for suit up building up to 9	7, down to 5 with blasting	8. 10 with blast down to 8 for suit up		Gunshots on TV Mono	
49	Gulmira (1:38)	02:16:04:00.00 02:17:36:00.00	Very soft background with percussion punching through occasionally.	19.8	5. build up to 7	6	9 for gunshots and explosions, 7 for crowd noise. 9 for hand blasts		When dialogue is FX like crowds, it pans	
50.1	Targeting Weapons (2:08)	02:17:59:00.00 01:18:14:00.00	Rhythms of Ironman theme.	20.3	7 up to 8	5 up to 9 for iron man dialogue	9	Heavy spectral distortion for mask voice		reverb and delay on ironman voice
50.2		01:18:14:00.00 02:19:26:00.00	After Tank blows up, Iron Man Theme A in right instruments	17.3	8		8 and 10 for explosions			
51.1	Dog Fight (5:41)	02:19:26:00.00 02:20:45:1.00	Background rhythmic patterns under dialogue. IronMan theme A plays when Stark is flying, and soft string and guitar jabs in the military control room. Thematic material from Iron man 1 theme A and B in dog fight with rhythmical variations.	25.1	7 up till 9 for main theme. Down to 6 for calm dialogue with build up to 8 for phone call	8	7. flight FX 9			
51.2		02:20:45:1.00 02:22:21.00.00	Phone call till phone call	19.9	6 up to 7 for bass freq up to when engaged by Jets. Back down for dialogue, settling on 8.	8	8 Wind noise interferes a bit. Jet and flight up to 9 (Intermittently)	Telephone spectrum. Cut above and below. Same to lesser extent on jet coms.	Rhodes over telephone in Tony's helmet is not Mono. Jet pilot speech also has spread	
51.3		02:22:21.00.00 02:24:40:12	Till end	21.1	7. down to 5 in drama with loud beats up to 7	8	8 for flight noise			
52	Obadiah Meets The Enemy (3:01)	02:25:37:12.40 02:28:30:00.00	Eastern intervals. Ominous tones and arpeggios	29.8	7 down to 6 for dialogue. Down to 5 inside dialogue. Up to 7 for outside dialogue	7 to 8	7 for cars and music drama effects. Gunshots 10	The disabler has interesting spectral effect.		
53	Pepper Quits (2:03)	02:28:26:00.00 02:30:30:00.00	Sad strings under dialogue	37.4	6	8				
54	Pepper Steals Files (4:33)	02:30:30:00.00 02:32:12:00.00	Urgent percussion and ostinato. Dramatic sounds and Obi theme arpeggios	33.1	8	7	Computer noises 7	Computer voice	Computer Voice	
		02:32:12:00.00 02:35:06:00.00	Obi walks in	35.6	6. 8 for the dramatic music effects. Building up to 7 at the end of the scene	7 up to 8 at the end with Phil	7 ambient noises			
55	Heart Removal (3:05)	02:36:02:12.40 02:38:49:00.00	sliding strings for drama. Effects under dialogue. Heart of light theme.	34.4	5. Dramatic noises 8. Heart theme 7	7	8	Heart louder because no interference		
56	Find Tony (1:12)	02:38:49:00.00 02:39:09:12.40	Urgent arpeggios	35.5	8 down to 6 under dialogue	8	7 car noises	Pepper voice over phone		
57	Cardiac (0:46)	02:39:09:12.40 02:40:14:00.00	Heart beat percussion, creepy strings and sounds under FX. Major third interval reminiscent of the Potts theme as he gets the Marc 1 she made for him	27.8	6 with FX 8. up 8 building up. Back down to 7 for Potts theme		Heartbeat 9			
58	Monger Heart (1:48)	02:40:14:00.00 02:40:52:00.00	Obi theme arpeggio theme. Ends with weird cross rhythm theme	23.4	8 up to 9 for "Monger theme"		8 for machine. 9 for powerup.			
59	Rhodes Finds Stark (0:55)	02:40:52:00.00 02:41:21:12.40	Urgent rhythms under dialogue	30.9	6	9				Reverb when shouting for tony in house. Gone when in lab
60	Shield Looks For Obidiah	02:41:21:12.40 02:42:19:00.00	Obi theme fully developed fade to dialogue and door FX	26.3	7. down to 5 for dialogue at the door.	7	9 car noises. 7 arc noise			
61	Rhodes In Lab	02:42:19:00.00 02:43:04:00.00	Dimished Iron man theme with flight theme over	20.7	7	8	8 machine noises. 9 blasters	"Keep the skies clear"		Phasing for War machine guitar

#	Title	Start/End time	Dialogue/FX	LUFS	Music Loudness	Dialogue Loudness	FX Loudness	Spectral Content	Spacial Content	Temporal Content
62	Shield Discovers Monger	02:43:04:00.00 02:44:14:00.00	FX and sound design mingles with lab equip. dramatic bass drums.tention building sounds, simple Obi theme.	30.7	5	7	Lab sounds and FX 8			
63	Monger Attacks (5:55)	02:44:14:00.00 02:45:00:00.00	Sound loud, but still under FX. Fade to dialogue. Stab between scenes with no dialogue. FX drowns out Dialogue between Stark and Potts. Obi Voice in suit heavily altered, as with Stark. Loud fighting FX. Long break in the music for the fight. Occasional mood strings.	18.1	8 down to 7 for dialogue	8 dow to 6 with FX	10	plenty of low end on monger voice		Monger voice plenty of reverb
64	Lift Off	02:47:18:00.00 02:49:11:00.00	Monger theme diminished, Ironman theme variation.	18.5	8 down to 6 for controll centre and back to 8 for flight scene	8	9 and 10 for flight	Monger voice		Monger Voice
65.1	Rooftop (4:02)	02:49:11:00.00 02:49:57:00.00	Strings when stark and Potts talk in D maj. Fight mood music under FX. Obi theme when they talk again about blowing the roof. New theme like monger theme, but different. Then the same theme but sadder. Flight theme variation before Potts pushes the button.	19.1	7. up to 8 for bos battle	8	10 fight noises			
65.2		02:49:57:00.00 02:51:13.00.00	Stark tells Potts to overload the reactor	22	6 up to 8 for boss music	7 up to 9 for fight scene	7 up to 8 in fight			
65.3		02:51:13.00.00 02:52:44:00.00	Obi is deeply enjoying the suit	19.4	7 down to 6 in Obi's speech and up to 8 after	8. 9 shouting	10 gunshots etc.			
65.4	Rooftop - Iron Monger Falls	02:52:46:00.00 02:53:10:00.00	Iron Monger Falls	17.6	8		10. explosion			
66	Sign Of Life (0:39)	02:53:10:00.00 02:53:40:00.00	Heart theme.	30.9	7	6	7			Potts shout plenty of reverb and echo to make it sound as if in a dream
67	Alibis (3:47)	02:53:40:00.00 02:55:48:00.00	Simple string melody. Under dialogue. Turns into pots theme variation similar to the one in the lab.	38.7	6. up to 7 for kiss	8				
68	Ending Credits (3:15)	02:57:14:00.00 02:58:38:12.40	Iron man - Black Sabbath instrumental	26.6			9			

Appendix B: List of Musical Moments in *Ironman*

Appendix B is a list compiled of every musical moment including a **cue number**; a **title for the cue**; the moment of music's relation to the narrative of the film; a classification of its method as leitmotif (with the name of the theme), quotation (source music or otherwise), allusion (strategic or stylistic) or musical effects. Each cue also includes a description as to where it places in the communication fields of mood, commentary and identification; and an interpretation of this communication in terms of what is heard in the music that is not evident in the visual or in the dialogue, or that precedes the visual or the dialogue. This list serves as an interpretation of the cue sheet (Appendix A) as per the methodology set out by Kassabian (2007).

1. Hummer Ride: This cue is non-diegetic at first, but it changes to diegetic when it is played from the little radio in the military Humvee. This moment of music is quotation in the form of source music. The music is *Back in Black* by AC/DC so the entire track can be considered one musical moment. The meaning of this musical moment falls into the mood field, but the choice of song also has some commentary into Stark's personality himself as a 'Bad Boy' who enjoys the genre of Classic Metal.

2. Smoke Clears: This cue is non-diegetic and is comprised of three musical moments. Moment 2.1 is made up of a bass drum, a high-pitched note, and a metallic sound. These are musical effects, and fall under mood and commentary. The high pitched note is onomatopoeic of the ringing in Stark's ears from the explosion, the bass drum contributes to the general drama of the scene and the metallic sound is an onomatopoeic representation of the bright light. Moment 2.2 has a tuned drum playing a rhythm with an eastern string instrument playing. This is a Leitmotif theme representing the cave, the Middle East and the "10 Rings" and is referred to as the "Cave" theme and falls under identification and mood. Moment 2.3 is a short Electric guitar feedback sound used as a buildup to the metal sound of the title. This is an example of musical effect, which falls under mood and identification to Ironman by virtue of the use of the Metal genre instrument.

3. News Reel: This cue is diegetic and serves as background music to an onscreen presentation at an awards ceremony and can presumably be heard by the on screen characters from the sound system in the hall. This is one-time music, but not composed by Ramin Djawadi. The track is *Damn Kid* by DJ Boborobo, so the entire track is seen as

one musical moment and falls under quotation. This music falls under mood music, and does not have much meaning attached to it that could be considered relevant.

4. Stark Introduction: This cue is diegetic, and as in cue 3 it can be assumed that the audience can hear this music over the sound system. This is a quotation to the 60's animated series Ironman's theme song rearranged by Jack Urbont for big band. This music is mood music, but the quotation to the music of the earlier Ironman gives it a sense of identification.

5. Casino: This cue is non-diegetic. This is the same quotation as in cue 4, but now being non-diegetic, it falls under stylistic allusion and so serves more of a narrative function by virtue of its genre. Big band music in a casino setting holds connotation of grandeur and style. This music falls under identification and commentary as the allusion to a certain lifestyle associated with big band Jazz music applies to Stark, and gives insight to his character.

6. Sex With Reporter: This cue is non-diegetic. This is again a quotation of the 60's Ironman theme, but the instrumentation and arrangement is vastly different. It is a stylistic allusion to the Spy sound from James Bond theme, carrying with it the socio-musical connotations of the James Bond character, giving Stark more of the 'Bad Boy' connotation. This music contributes to identification with the ironman character from the quotation, and commentary from the allusion.

7. Lights Up: This cue is non-diegetic. The two rhythmical melodies and the strings form three components to a Leitmotif theme that is called the "Home" theme. This motif serves as identification with Malibu and Stark's home, and as mood with its triumphant chords at its ending.

8. Institutionalized: This cue is diegetic. The music is being played from the sound system in Stark's lab. This quotation is source music. The track is *Institutionalized* by *Suicidal Tendencies* and carries with it the connotations of the rebellion of the classic Metal genre choice, and therefore falls under commentary on Stark's personality.

9. Birthday: This cue is non-diegetic. The rhythmical echo notes form part of a leitmotif that is called the "Birthday" theme. This theme serves to indicate identification of Pepper Potts and commentary of Stark's affection for her.

10. Stark Drives To Airport. This cue is non-diegetic and is made up of two musical moments. Moment 10.1 is a Metal Instrumentation riff. The melody in the guitars and bass is a leitmotif for the Audi R8 the private Jet and other expensive things called the "Expensive toys" theme. This musical moment is used for identification with Stark by

virtue of the Metal genre instrumentation and style, and the leitmotif theme levels commentary into Stark's taste and personality. Moment 10.2 is mainly made up of a bass guitar. This bass line is a leitmotif theme refers to the moments when others are seeing Stark with his toys. The Hugh Hefner reference with Stan Lee in cue 43 leads to this theme being called the "Playboy" theme. This music falls under identification and commentary in the same way as 10.1 by virtue of the instrumentation. An extended version of these two themes is included on the movie soundtrack and title *Merchant of Death*.

11. Private Jet Party: This cue is diegetic. The music is played on the private Jet's sound system, with the music video on a screen and the characters are dancing to it. This is source music. The track is *Slept on Tony with Dirt* by *Ghostface Killah*. The choice of this particular track functions as a quotation, because the song is about Ironman and the artist is a known fan of the Ironman series. This falls under mood and identification with the Ironman character in general.

12. Tarmac Afghanistan: This cue is non-diegetic. The military tattoo on the snare drum is a stylistic allusion to the military. The Eastern string instrument playing in the Phrygian mode is a stylistic allusion to the Middle East. This music is used for identification. The combination of these two elements functions as a combination identification with the Military and the Middle East. The sitar theme shares some instrumentation and mode with the cave theme, so even though their contexts are very different and they do not allude to the same thing, there is the shared connotation with the Middle East by virtue of both the mode and the instrument.

13. Missile Demonstration: This cue is non-diegetic and is made up of two musical moments. Moment 13.1 has sustained notes in the brass with strings and a snare drum. This moment is strategic allusion to the opening bars of *Sunrise* from *Also Sprach Zarathustra* by Richard Strauss, and carries with it the connotations of futurism and of rockets, while the snare drum alludes to the military. This falls under identification to the military and rockets. Moment 13.2 comprises of rhythmical string hits with brass melody. The string hits build anticipation while the brass notes add a sense of grandeur to the scene with the rising melody. This moment falls under mood music.

14. Hummer Ride Revisited: This cue is diegetic. The song plays from the radio in the Humvee. This is source music, the same as cue 1 this is where the story continues that timeline. This falls under commentary, but this time to show continuation from where the movie picks up where it left off at the beginning before the title scene.

15. Cave Surgery: This cue is non-diegetic. The music is instrumental effects highlighting on screen action and creating a feeling of chaos with the electric guitar scratches and drama with the deep thumps. This falls under mood music, and gives us aural representation of the chaos and dread on screen

16. Heart Machine: This cue is non-diegetic. This is another musical effect moment. The strings sliding up create suspense like in a thriller, while the strange occasional sounds make for an increase in dread. The result is dread anticipation. This functions as mood and commentary, because it points to something horrible that is about to happen.

17. Demands: This cue is non-diegetic and is made up of two musical moments. Moment 17.1 includes a bass drum, tambourine and tuned drums playing the cave leitmotif theme. This falls under identification. Moment 17.2 has a sustained bass note with eastern wind and string instrument. There are elements of the cave theme leitmotif, but it is not directly present. This falls under mood music, with an element of identification with “The 10 Rings”.

18. Torture: This cue is non-diegetic and consists of 4 musical moments. Moment 18.1 has sound effect music with high-pitched noises and bass drums to create drama. This falls under mood music. Moment 18.2 has the Eastern Percussion of the cave theme playing a beat in a triple time variation, creating a sense of urgency. This serves as identification with the cave and commentary of what might happen if he does not cooperate urgently. Moment 18.3 has ominous tones and eastern instruments that allude to the cave theme. The ominous tones are commentary of an underlying evil, while the cave theme instruments fall under identification. In moment 18.4 a melody plays in the bass, which is an early development of the leitmotif called “Raza” theme with the cave theme in the accompaniment. This falls under identification with “The 10 Rings”, and more specifically with their leader.

19. Getting Started: This cue is non-diegetic and consists of four musical moments. Moment 19.1 includes the cave theme on drums and an electric guitar riff playing a leitmotif theme called the “Ironman” theme. The electric guitar as an instrument is a thematic identifier with Stark by virtue of the Metal genre instruments. The combination of the cave theme and the Ironman theme falls under identification and commentary about Stark’s thoughts of building the Ironman Suit in the cave. Moment 19.2 includes the cave theme on drums and a string bass melody with sustained strings. The same thematic material as above, but with less urgency and more subdued under the dialogue. This falls under mood music with only a subtle reminder of identification. Moment 19.3 includes the

cave theme on drums and electric guitar with the same thematic material and function as moment 19.1. Moment 19.4 consists of rhythmical strings playing and developing the Ironman theme. This falls under identification, but also under mood, as the theme is developed to maintain excitement; and commentary as the progress in the theme mimics their own progress.

20. The Ring And The Diagram: This cue is non-diegetic and consists of three musical moments. Moment 20.1 includes a synth sound over low sustained chords. This synth theme that sounds like an aural representation of light catching a reflection, is a Leitmotif theme called the “Heart” theme and represents the mini arc reactor chest piece. This is an identification moment. The sustained notes add some mood. Moment 20.2 has percussion building up to a rhythmical melody. The build up is mood music to the reveal of the Iron Suit diagram at which point the Ironman theme plays, which falls under identification. Moment 20.3 includes the cave theme and strings playing the heart theme. This falls under identification with “The 10 Rings” and the Chest piece.

21. Suspicions: This cue is non-diegetic and comprises of three musical moments. Moment 21.1 features the Eastern instruments of the cave theme, falling under identification. Moment 21.2 has electric guitar rhythms and a melody in the brass. The brass melody is a leitmotif theme that has connotations to flight, escape, and later on for colonel Rhodes called the “Flight” theme and is a variation of the Ironman theme by virtue of the accompanying electric guitar. The flight theme falls under commentary and is indicative of the suit having the ability to fly. The use of brass and the tone of the melody fall under mood and generate feelings of hope and perseverance. The cave theme is an identification theme. Moment 21.3 has the cave theme instruments with bass and string melody.

The theme played is the full development of the leitmotif theme called the “Raza” theme and is used as an identification moment for the leader of “The 10 Rings”. The theme also has a menacing nature, placing it under mood.

22. Raza. This is a non-diegetic cue with three moments of music. Moment 22.1 includes a variation on the cave theme, with the Raza theme in the bass. These two themes fall under identification and often feature together, as they are thematically related. Moment 22.2 includes ominous tones that fall under mood music, creating a general feeling of uneasiness, and the Eastern instruments are reminiscent of the cave theme, marking them as identification. There are musical effects present to highlight the onscreen acting. These fall under commentary. Moment 22.3 features string clusters sliding up, a classic Thriller movie style musical effect that can almost be considered a quotation. It functions

as commentary and mood as it builds a sense of dread and anticipation for something terrible that is likely to happen soon.

23. Anvil. This cue is non-diegetic and is made up of six musical moments. Moment 23.1 features the Heart theme on the high register of the strings. This functions as identification. Moment 23.2 has rhythmic strings with hammer hits and electric guitar. This is a triple time early development on a leitmotif theme that relates to Stark building things called the “Tinker” theme. The time signature of this variation falls under commentary on the urgency of the situation, while the theme itself is identification with Stark, and the process of building. Moment 23.3 includes a triple time variation of the flight theme in the brass. Low brass melody gives a sense of grandeur, while the theme falls under identification and the time signature adds commentary to the race against the clock. Moment 23.4 features the first full Metal genre type theme with drum kit, electric guitar and strings playing the Ironman theme. This is Identification with Stark and with the character Ironman. In moment 23.5 the brass and electric guitar play a variation on the tinker theme in the same rhythm, but with a melody in the Phrygian mode. This mode is a Stylistic Allusion to the Middle East and in this context to the cave, with the tinker theme elements identifying with the act of Stark building. The composite effect is retrospective commentary that the suit was built in a cave. Moment 23.6 features electric guitar playing the Ironman theme with developments to hold the pace of the scene, and high strings in Phrygian mode to identify with the East and functions as a bridge to the next scene. This functional use of the music to create continuation between scenes falls beyond the scope of this study.

24. Race To Finish. This cue is non-diegetic and has five musical moments in it. Moment 24.1 includes the cave and Raza themes. Moment 24.2 features a triple time variation of Raza’s theme ending in cluster chords that fall under commentary as they build suspense. Moment 24.3 has percussion that sounds like a fast ticking clock and alludes to a race against time, which falls under commentary due to the imagined consequence should they not beat the clock. There are also string stabs not unlike those of the weapons demonstration scene to add to the mood of suspense. Moment 24.4 contains sustained strings playing one-time music that falls serves as commentary on Yensin’s inner thoughts. Moment 24.5 contains a heroic melody in the brass in the minor mode that functions as commentary on Yensin’s heroic actions by virtue of the brass and the rising melody, and his defiance of “The 10 Rings” by virtue of the contrast in modality.

25. Escape: This cue is non-diegetic and consists of seven musical moments. Moment 25.1 consists of Thriller type anticipation strings and other musical effects in the brass

and percussion that fall under commentary. Moment 25.2 is the Ironman theme extended with driving electric guitar rhythms falling under Identification. Moment 25.3 has the same driving electric guitar alluding to the Ironman theme, while the strings play a variation on Raza's theme. This moment falls under identification, but also has commentary by virtue of their combination. Moment 25.4 consists of one-time music and falls under commentary as the Major mode string chords indicate Yensin's sad triumph, while at the same time falling under mood as they create an emotional sonic backdrop for the scene. Moment 25.5 includes a melody in the bass guitar similar to the Expensive toys bass line. The brass chords give a mood of heroic redemption because of the major tonality and the instrumentation, and the bass line serves as identification for Stark. In moment 25.6 the low brass plays one time music in the Phrygian mode shows danger and indicates the retaliation of "The 10 Rings" by virtue of the heroic connotation of the brass in the Eastern modality and has the combined sonic commentary of the evil hero (or antagonist). Moment 25.7 consists of electric guitars, drums and strings playing the "Ironman" theme with a comedic falling variation at the end. The Ironman theme is identification, with the descending melody in the Metal instrumentation mimicking the Ironman suit falling out of the sky.

26. Rescue. This cue is non-diegetic and is made up of three separate moments. Moment 26.1 features Eastern instruments and ominous tones. It is not the cave theme, but rather a commentary of the harshness of the environment. It does, however carry signifiers of the East by virtue of the instruments, placing it under identification. In 26.1 a leitmotif theme is played on the strings that is an early development of the "Rhodes" theme. It is also a variation on the flight theme, as those two are thematically related. This leitmotif falls under identification. The triumphant brass counter melody indicates heroism, and falls under commentary. The combination is quite a powerful musical moment creating a very emotional backdrop for the scene unfolding, adding to the mood of the scene. 26.3. Features a leitmotif theme called the "Potts" theme in the strings and brass. This theme contributes to identification, and the melody indicates commentary on Potts' affection for Stark.

27. Cheeseburger - Stark Returns. This cue is non-diegetic and includes two of the three elements of the home theme. It contributes to identification with Malibu, and therefore contributes to the commentary that Stark has returned.

28. Press Conference. This cue is non-diegetic. It features the home theme, with sustained notes in the low strings. The home theme falls under identification.

29. Heart Reveal. This cue is non-diegetic. The heart theme is played over a leitmotif theme in the strings. This theme develops into a theme associated with Obadiah Stane called the “Obadiah” theme. The Obadiah theme has angst attached to it that gives it a sinister nature, causing the moment to contribute to identification and commentary.

30. Pepper Called To Lab. This cue is non-diegetic. The full Pepper Potts theme is layered, which is a combination of the birthday leitmotif and the Potts leitmotif. The combination is indicative of his affection to her and of her affection for him, which results in the commentary of reciprocated positive feelings for each other. The moment also contributes to identification

31. Never Again. This cue is non-diegetic, and is thematically identical to the previous cue.

32. Rhodie Hangar Speech. This cue is non-diegetic and includes a snare drum tattoo and a leitmotif theme on solo trumpet called the “Rhodes” theme. Both the snare drum and the trumpet add identification with the military, and the trumpet melody is thematically similar to the “Flight” theme, which adds the commentary that Rhodes is associated with things that fly.

33. Get Your Mind Right. This cue is non-diegetic one-time music. The use of strings enhances the emotionality of the scene, contributing to mood, and the interrupted cadence adds commentary to an unfulfilled emotional response, or disappointment.

34. Keep Off Server. This cue is non-diegetic. The home theme is played on synth instruments, with electric guitars playing the Ironman theme and the strings playing a further development on the flight theme. These themes contribute to identification and commentary.

35. Finding The Mask. This cue is non-diegetic. The Eastern Drums play the cave theme with the Raza theme in the bass, both adding to identification. This is followed by a Raza style variation on the flight theme to add identification with Stark, and commentary about Raza’s intentions to achieve the same goal.

36. Test 1. This cue is non-diegetic. A full development of the tinker theme plays in the strings with electric guitar and bass rhythms as accompaniment. The tinker theme is an identifier with the act of building, while the Metal genre instruments identify with Stark. The commentary is of Stark building the suit. |

37. Test 2. This cue is non-diegetic and contains two musical moments. Moment 37.1 features Electric guitar with a brass melody. The electric guitar accompaniment is a more urgent version of the tinkering theme, adding identification and commentary, while the

brass plays a further development of the flight theme, inducing commentary about their progress. Moment 37.2 has an electric guitar and strings playing the tinker theme harmony, while a synth plays the home theme. This falls under identification.

38. Obadiah On Piano. This cue is diegetic. The music originates from Obadiah playing the piano. The music played is a piece by Salieri, a famous rival of Mozart, and identifies Salieri with Obadiah, and adds commentary to his and Stark's own rivalry being comparable to that of Salieri and Mozart.

39. Test Day Eleven. This cue is non-diegetic and consists of five musical moments. Moment 39.1 involves a variation on the home theme with a buildup in the strings. This combines the leitmotif identifier with home with the musical effect of creating suspense, which in itself is commentary. Moment 39.2 features less home theme and more electronic instruments and strings with the same buildup function as above. Moment 39.3 has the low strings playing a part of the flight theme and electric guitars playing a variation on the expensive toys theme. The identification and commentary is clear. Moment 39.4 contains the climax that the rest of the cue has been building up towards with the triumphant string chord progression, a commentary on the successful test day. Moment 39.5 is a short moment of electric guitar to identify with Stark and Ironman, and to end off the scene.

40. First Flight. This cue is non-diegetic and consists of six musical moments. Moment 40.1 features rhythmical strings playing the tinker theme, while a part of the flight theme is playing in the electric guitars. The nature of this moment is building, giving commentary of anticipation. Moment 40.2 satisfies the anticipation with the full Ironman theme playing in the full Metal genre instruments as the first full Ironman suit is revealed. There are contributions to identification and commentary in this moment. Moment 40.3 features a full Metal song that is also on the soundtrack with the title *Merchant of Death*. The buildup of metal instruments with string rhythms is followed by the fully developed flight theme leitmotif in the strings, with the guitars playing the triumphant chord progression on a Metal type guitar riff rhythm. This musical moment develops as an autonomous song, and is treated as one moment. The montage type nature of the scene make that the music is mostly used as a sonic backdrop, and therefore mod music, with elements of identification for Stark, Ironman, and flight. Moment 40.4 has string chords building up and abruptly stopping, building anticipation for the suit failing. Moment 40.5 features the flight theme as it existed before the failure in the suit, but modulated up, continuing the identification and mood from before. Moment 40.6 features a slightly more rhythmical

iteration of the triumphant chord progression at the end, serving as commentary on the successful flight, and rounding off the first flight scene.

41. Trophies. This cue is non-diegetic and contains two musical moments. The first, 41.1 plays the Potts theme variation on the clarinet with the birthday theme present, indicating identification with her even though she is not there, and contributing to the commentary on their developing relationship. Moment 41.2 has the cave themes Eastern drums and instruments; and Raza's theme in the bass, falling under identification

42. Entertainment Channel. This cue is diegetic, originating from the TV in Stark's lab. The track is source music, *Groovetronic* by Terry Devine-King, and functions as mood music as an upbeat background for the report.

43. Paint It Red. This cue is non-diegetic. It is thematically similar to cue **10. Stark Drives To The Airport**, and features both the expensive toys and playboy theme, contributing to identification and commentary.

44. Benefit 1 This cue is diegetic source music. The track is *Kool Katz* by Chucho Mecha, presumably being played by a live band or playing over the PA. This provides a classy sonic backdrop for the scene at the benefit.

45. Kiss. This cue is non-diegetic, and consists of the birthday theme and the Potts theme on the clarinet, adding commentary about their affection, and identification with Ms. Potts.

46. Benefit 2 This cue is diegetic, with the same material and function as **44. Benefit 1**.

47. A Town Called Gulmira. This cue is non-diegetic, and includes three musical moments. Moment has the a whole tone clash in the strings give a hint to the Gulmira theme, but mostly functioning as a musical effect to create a feeling of dread. Moment 47.2 includes a melody in the strings that is the leitmotif theme used to identify with Obadiah Stane. It is sinister. The theme is called the "Obadiah" theme. Moment 47.3 plays a bass line that follows a chord progression that forms part of the "Gulmira" theme, a theme that is a piece of one-time music ending in an interrupted cadence, indicating identification and the unresolved commentary of the cadence.

48. Realization - Suiting Up. This cue is non-diegetic consists of two musical moments. Moment 48.1 features the tone clash in the high strings that forms part of a dread theme for Gulmira. The bass line is similar to 47.3. The combination is the complete "Gulmira" theme that only occurs this once, but still serves as identification. Moment 48.2 includes the Ironman theme with a descending line variation. This theme has more distortion in the

guitar, and the variation has the effect of building towards something, adding commentary of anticipation.

49. Gulmira. This cue is non-diegetic and has two musical moments in it. Moment 49.1 features Eastern Drums and instruments urgently playing under the chaos of the onscreen action. It is not exactly the cave theme, but the instrumentation does allude to identification with “The 10 Rings”. Moment 49.2 has calmer drums and sustained strings with the same function as 49.1, but a little more background to allow for dialogue, contributing more towards mood, but with elements of identification.

50. Targeting Weapons. This cue is non-diegetic with two musical moments. Moment 50.1 has sustained strings, followed by a variation of the ironman theme with influences of the “Gulmira” whole tone, serving as identification. Moment 50.2 plays the full “Ironman” theme, with the “Tinker” theme in the strings. This falls under identification.

51. Dogfight. This is a very long non-diegetic cue, with thirteen separate musical moments. Moment 51.1 features the tinker theme in strings and military snare tattoo. There is identification with the act of building, which does not make sense in the context, so it is rather used to create interest in the scene and allude to the Ironman character. Moment 51.2 has the Ironman theme in electric guitar. Moment 51.3 has the tinker theme in strings and military snare tattoo again as in 51.1, but ending in an electric guitar rhythmic statement, to build to the next scene. Moment 51.4 features the bass guitar playing ironman theme and flight theme and falls under identification. Moment 51.5 includes a Metal riff that becomes more subtle under the dialogue and then develops into the flight theme on the Metal instruments and ends in strings building up suspense till the explosion, a musical effect that falls under commentary. Moment 51.6 has the flight theme in a complex time signature indicating urgency and danger. The moment ends with ominous bass tones, which is musical effect and falls under commentary. Moment 51.7 is the cellphone ringtone, a diegetic moment of quotation to the 60’s ironman theme as Rhodes’ ringtone for Stark. This is technically identification, but it is so subtle that it can rather be seen as a comical moment for the select few that understand the reference. Moment 51.8 is a statement of flight theme. Moment 51.9 mood strings with the military snare tattoo for identification.

Moment 51.10 consists of the musical effect of a string cluster sliding up, creating suspense. Moment 51.11 again includes the military snare and repeated notes on bass designed to create suspense. Moment 51.12 creates even more suspense with the string cluster, with triumphant brass chords resolving the buildup from the last few moments,

and adding commentary of success. Moment 51.13 recapitulates the Ironman theme and tinker theme in guitars to close off the scene

52. Obadiah Meets The Enemy. This cue is non-diegetic and is made up of four moments of music. Moment 52.1 facilitates the scene change and indicates identification with “The 10 Rings” with the cave theme. Moment 52.2 consists of Obadiah’s theme with occasional eastern sounds and the “Raza” theme in the low brass. This combination mimics the interaction on screen, and contributes to identification. Moment 52.3 has suspense strings musical effect that adds commentary of building tension. Moment 52.4 Features the Obadiah theme in the strings, but a more menacing bass line accompanying it. This falls under identification and commentary to Obadiah’s development.

53. Pepper Quits. This cue is non-diegetic. It consists of one-time music with sustained string chords. Major chords support the mood of positive emotions, and minor chords of negative emotions.

54. Pepper Steals Files. This cue is non-diegetic and is made of nine musical moments. Moment 54.1 features one-time music, consisting of a drumbeat that gives the musical moment tempo and a sense of purpose, while a string melody adds a feeling of danger. Moment 54.2 continues the drumbeat with Obadiah’s theme in the strings, indicating identification with his involvement, and the danger that he might walk in. Moment continues with Obadiah’s theme, and introduces a leitmotif theme in the low brass called the “Monger” theme and it relates to the armor that Obadiah is building. Moment 54.5 is made up of the suspense strings musical effect and dramatic drum hits, both creating suspense commentary. In moment 54.6 the brass and bass plays a variation on the Monger theme, giving identification. Strings sliding up cause suspense. Moment 54.7 is a variation on the Monger theme in the cello in triple time giving a sense of increased danger by virtue of the danger in the Monger theme, and the urgency in the time change. Moment 54.8 has Obadiah’s theme playing over the 3-time Monger theme variation from above, combining the identification of Obadiah, the Iron Monger and the commentary of an increased sense of danger. It also increases the pace of the scene. In moment 54.9 the tempo of the scene increases more as Obadiah’s theme is played with double bows on every note giving a sense of urgency and enhanced danger.

55. Heart Removal. This cue is non-diegetic and consists of three musical moments. Moment 55.1 consists of dread string clusters sliding down with other scary musical effect sounds, creating dread suspense. Moment 55.2 has the heart theme on the metallic synth with Obadiah theme in the strings at the same time, indicating identification.

Moment 55.3 is made up of bass notes, strings and other musical effects to enhance the drama of the scene.

56. Find Tony. This cue is non-diegetic. It is a variation on the Obadiah theme with repeated notes on rhythms, increasing urgency as before.

57. Cardiac. This is a non-diegetic cue consisting of three musical moments. Moment 57.1 has heartbeat percussion with suspense thriller strings to create anxiety with musical effects. Moment 57.2 includes the Pepper theme playing over the heartbeat onomatopoeic percussion, contributing identification with her, and thereby adding commentary about what Stark is looking for. Moment 57.3 is a variation on the Potts theme.

58. Monger Heart. This cue is non-diegetic and includes two musical moments. Moment 58.1 consists of Obadiah's theme with the heart theme worked into the melody, placing it under identification and commentary. Moment 58.2 is a dramatic statement of the Monger theme in the brass.

59. Rhodes Finds Stark. This cue is non-diegetic. Urgent percussion and strings play a variation of the "Tinker" theme, which has identification with Stark and commentary about urgency.

60. Shield Looks For Obadiah. This cue is non-diegetic. Obadiah's theme plays while there is suspense building in the strings ending in an explosion.

61. Rhodes In lab. This is a non-diegetic cue consisting of 3 musical moments. Moment 61.1 includes the flight theme in an altered tonality in the brass playing over the Ironman theme in the accompanying guitar. This takes the sense of the 'expensive toy' theme out of the suit, and gives it a more serious context. Moment 61.2 features a variation on the tinker theme in bass, identification with the assembly of the suit. Moment 61.3 has a heavily distorted guitar playing repeated note on rhythms, which alludes to War Machine, a character in the sequel.

62. Shield Discovers Iron Monger. This cue is non-diegetic. It is a mysterious setting of Obadiah's theme with sound effects to create anticipation.

63. Monger Attacks. This cue is non-diegetic that has two musical moments. Moment 63.1 includes quick string rhythms playing similar notes to those in the "Ironman" theme, but they are mostly masked by the sound effects. Moment 63.2 features a "Monger" theme style brass note with suspense string clusters sliding up and down, a musical effect.

64. Lift Off. This is a non-diegetic cue with six musical moments. Moment 64.1 has the Monger theme extended with string rhythms building tension. Moment 64.2 has strings and electric guitar playing single notes played on quaver rhythms going up in a scale. This Indicates commentary of the ascending characters and identification with Ironman. Moment 64.3 has the tinker theme, which recalls Stark's modifications to his armor to solve the icing problem at altitude. Moment 64.4 has brass notes ascending in the style of the Monger theme, identifying with him. Moment 64.5 has suspense strings up and down, adding commentary of the impending fall. Moment 64.6 is one rhythmic statement of the Ironman theme on the guitars, then a triumphant statement of the flight theme in the brass, which identifies with Ironman and comments on his victory.

65. Rooftop. This cue is a long non-diegetic cue with eight different moments of music. Moment 65.1 introduces the resolution chords, which is called the “It’s over” theme, giving commentary of the ordeal being over. Moment 65.2 interrupts that moment and introduces a theme that sounds like a boss fight in a video game with the clashes in the brass and the complex notes underneath. This is mood music, creating an exciting and dangerous feeling in the sonic backdrop to the scene. Moment 65.3 has Obadiah’s theme in the strings. Moment 65.4 brings back the same thematic material as 65.2, with the same purpose. Moment 65.5 has the Monger theme with no percussion. Moment 65.6 introduces another triple time variation of the Monger theme. This like a march to the gallows with the drums, so the triple meter slows the scene down in this case. Moment 65.7 has the triumphant flight theme with a sad modal change at the end, giving commentary to Stark's proposed sacrifice. Moment 65.8 contains the “Monger” theme repeated three times an octave lower each time with different instruments to mimic his fall.

66. Signs Of Life. This cue is non-diegetic. The strings play sustained chords, with the heart theme in the synths, drawing attention to the chest piece and therefore aiding identification

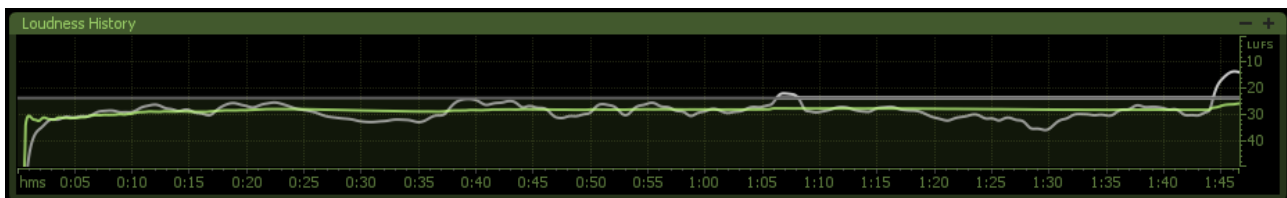
67. Alibis. This cue is non-diegetic and has two moments of music. Moment 67 plays the “Its over” theme fully developed, aiding in commentary of closure. Moment 67.2 features a “Kiss” variation of the “Potts” theme, adding identification and commentary.

68. Ending Credits. This is source music. The track is *Ironman* by Black Sabbath without vocals. The instrumentation and connotations of this song link it to Ironman.

Appendix C: Loudness and Processing Notes

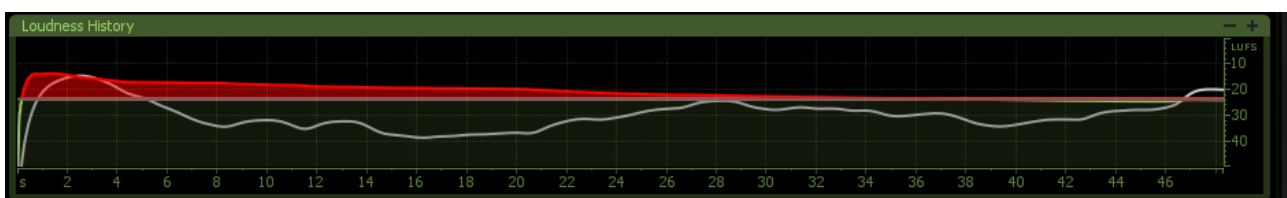
Appendix C is an analysis of the interactions of the different components of the soundtrack. To explore how the various components of the soundtrack interact with each other, a variation on Rick Altman's *mise-en-bande* analysis is done on all the film cues to establish the relative loudness of the music, the dialogue and sound effects in each cue. Additionally, commentary will be made on any applicable dynamic, spectral, spatial, and temporal processing that contribute towards that interaction. The relative loudness will be on a scale from 1 - 10, as it is impossible to get an accurate measurement on the separate components of the soundtrack. This scale from 1 - 10 will fall within the absolute loudness of the scene, which will be notated in -LUFS, with a graph of the short term, mid term and long term loudness included for reference as measured with iZotope insight.

1. Hummer ride - Multi-diegetic. Program loudness -26.1 LUFS.



This scene opens with the non-diegetic *Back in black* playing at 9, then falling to 7 at around 30 sec when it becomes diegetic in the car, and fading further to 3 to make space for the dialogue, which is at an 8. Throughout the scene there is the car sounds at 7, and the end explosion is a full 10. The difference in sound in *Back in black* is achieved by changing it from a wide stereo spread to mono, and by attenuating the low and frequencies in a way that emulates a small radio. The Program loudness of this section is -26.1 LUFS.

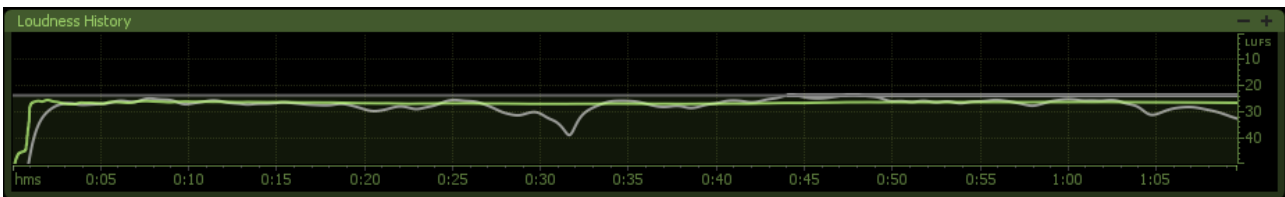
2. Smoke clears - Non-diegetic. Program loudness -24.4 LUFS.



This continues directly from the previous scene, and the high loudness in the beginning is from the explosion at 10. The music and dialogue gradually fade in to imitate Stark's ears recovering from the explosion. The music settles at 7. The dialogue is more an effect than actual dialogue. A low pass filter is applied to the spoken words, moving gradually upwards as the loudness increases to become clearer. At the same time a long echo and heavy delay on the dialogue becomes less to improve clarity while the sound of the

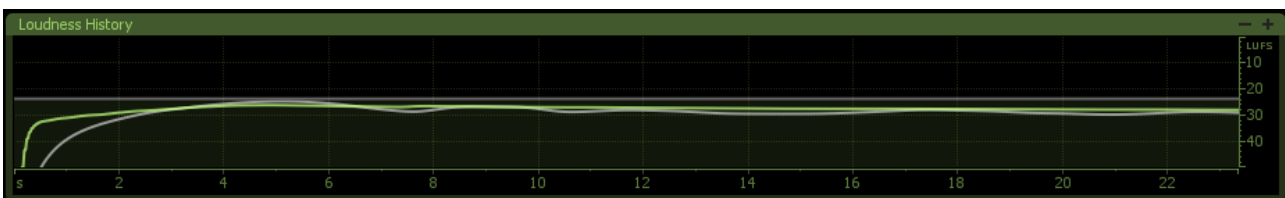
voices move from widespread back to mono. All these effects are done with automation to achieve the total effect of regaining hearing in the chaos after the explosion.

3. News reel - Diegetic. Program loudness -26.9 LUFS.



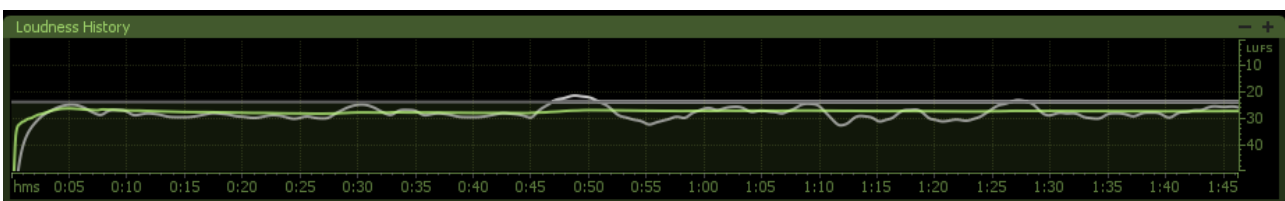
The music and dialogue of the diegetic presentation are the focus point with the music sitting at 6, just under the dialogue at 7. The clapping is less important at 5. The music is made to sound more diegetic with a controlled low end and a narrower stereo spread.

4. Stark introduction - Diegetic. Program loudness -28.4 LUFS.



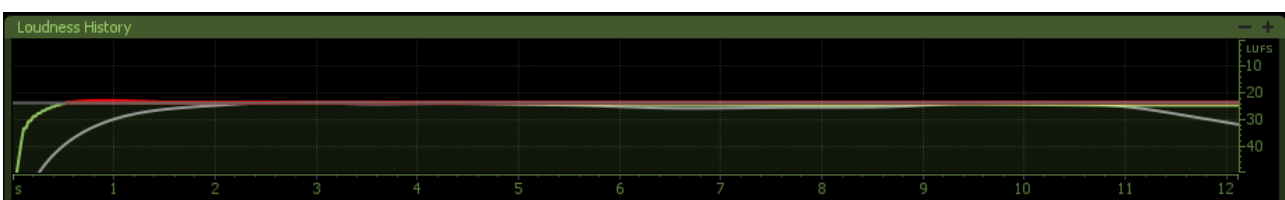
The music is at a 4, with the clapping more important now at 6. Both quieted down for the dialogue at 8. The clapping gains more prominence by being dynamically louder, being more forward in the mix by having less reverberation, and by having a wider stereo spread.

5. Casino - Non-diegetic. Program loudness -27 LUFS.



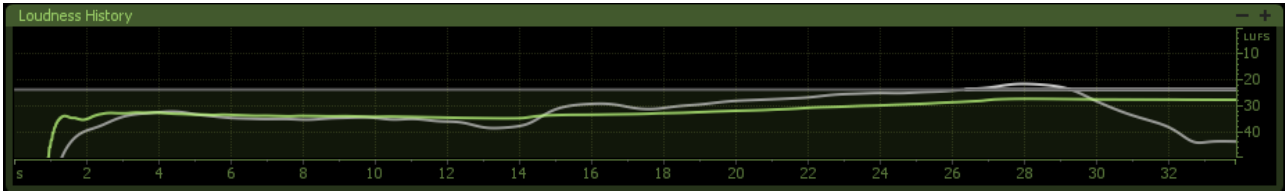
This section has the same music as before, but louder and with more bass because it is now non-diegetic. It starts at 7 and fades down to 4 for the dialogue at 7. The clapping and gambling sounds are always clear at 7, and don't interfere with the music and dialogue because the sound is sporadic. Noted here for the first time is that even when dialogue originates from off screen it is always panned dead center, where it would have been panned had it been a sound effect.

6. Sex with reporter - Non-diegetic. Program loudness -25 LUFS.



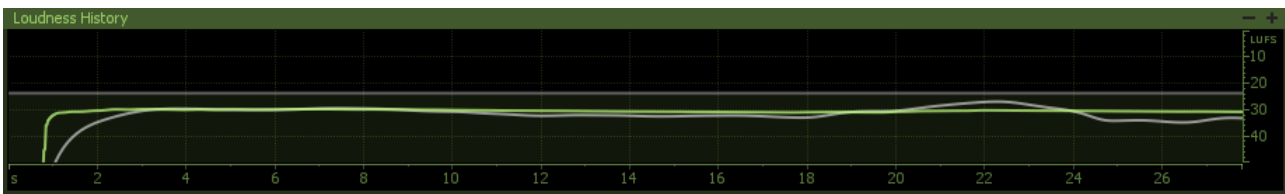
The music is at a constant 7, the dialogue at an 8. The guitar sound is noteworthy as a music technology point. It is created with a semi-hollow electric guitar with f-holes and a valve amp. Very little processing is applied to achieve this 'James Bond' sound.

7. Lights up - Non-diegetic. Program loudness -27.9 LUFS.



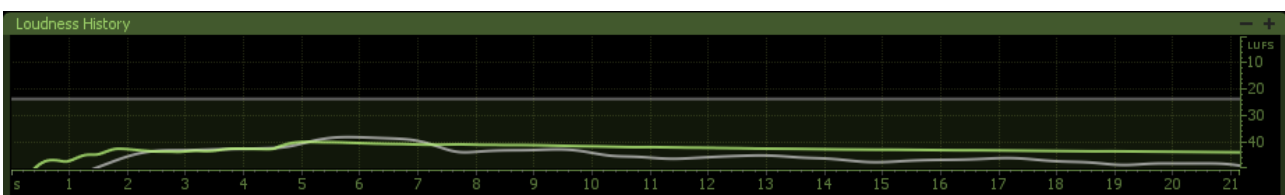
The dialogue starts at 7 with the music coming in at 5 and gradually they become softer and louder respectively, the music coming up to 8 and the dialogue fading out completely. Jarvis has some interesting effects on his voice to make him sound like a machine. Firstly, he is not panned center and has quite a wide stereo spread. His voice also has some distortion and some modulation on it.

8. Institutionalized - Diegetic. Program loudness -31.1 LUFS.



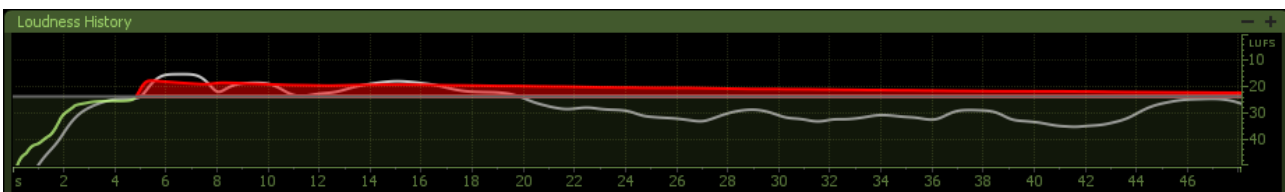
The music starts at 8, but fades down to 6 as the dialogue comes in at 7, and is then cut off completely. The sound effects of him fixing the car are very prominent at 7. Again, the diegetic music is lighter in the bottom end, although it does in this section have some stereo width.

9. Birthday - Non-diegetic. Program loudness -44.2 LUFS.



The dialogue is soft and intimate at 6, with the music fading up gradually, but only to a 4.

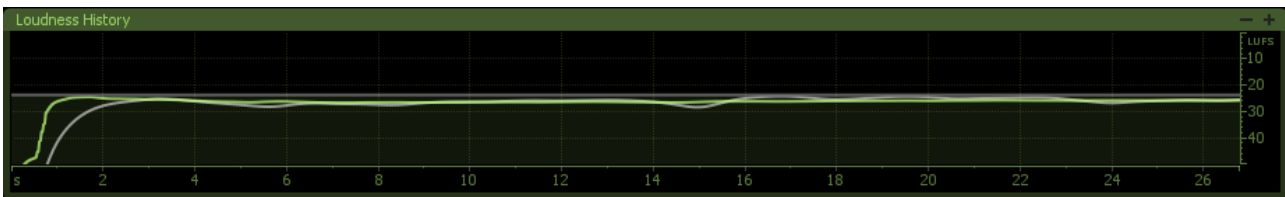
10. Stark Drives to Airport. - Non-diegetic. Program loudness -22.6 LUFS.



The music starts very loudly at 8 for the driving scene, but the sound of the cars racing is a full 10 as they drown out the music occasionally. At around 22 seconds they are out of

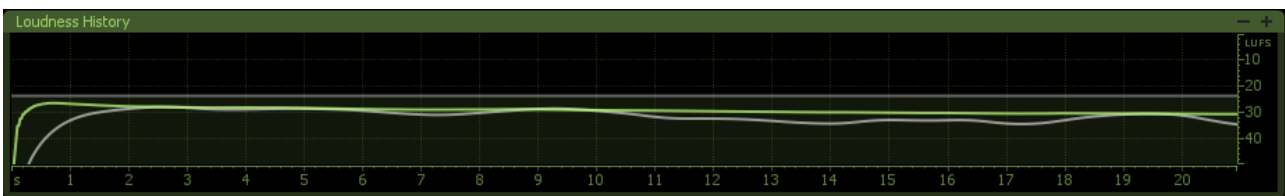
the car and the music comes down to a 5 to make space for the dialogue at 7, and then comes back up to 8 at the end.

11. Private Jet Party. - Diegetic. Program loudness -26.1 LUFS.



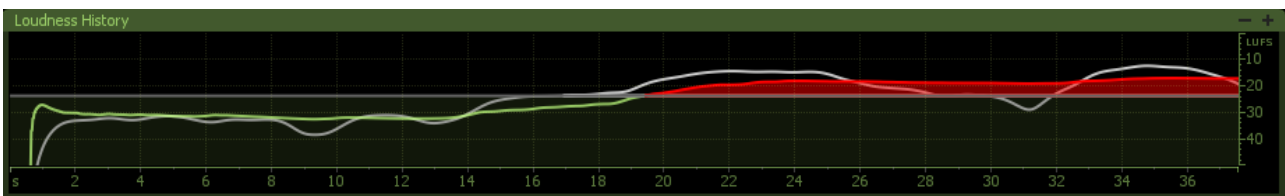
The music is playing at a 7, with the dialogue also around 7. The music gradually builds up to an 8, while the dialogue fades out. The Jet sound comes in at about 5 under the music.

12. Tarmac Afghanistan. - Non-diegetic. Program loudness -31 LUFS.



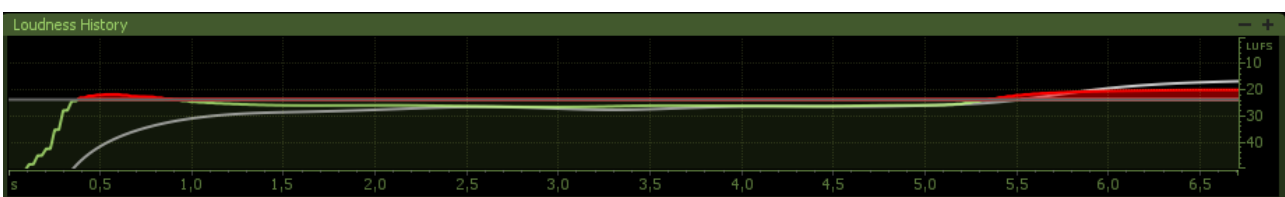
The sounds of the airport are at 8, with the music coming in at 6 underneath, and the dialogue at 7. The helicopter and jet sounds pan from one side to the other as they fly past.

13. Missile demonstration. - Non-diegetic. Program loudness -17.5 LUFS.



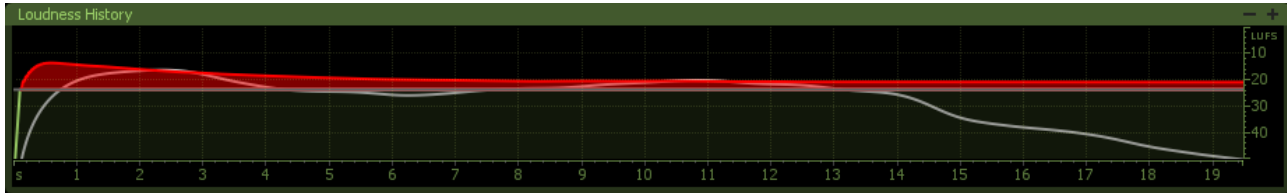
The dialogue is at 8. The music comes in gradually and settled at 8 while the effects take over, ending in various explosions at 10. The music does not go down in loudness with the explosions, but rather the whole soundtrack is compressed to the explosions to make them seem louder. The sound design of the explosion is interesting to look at from a spectral point of view. It is a tuned explosion, giving it an almost science fiction type of quality.

14. Hummer ride revisited. - Diegetic. Program loudness -23.3 LUFS.



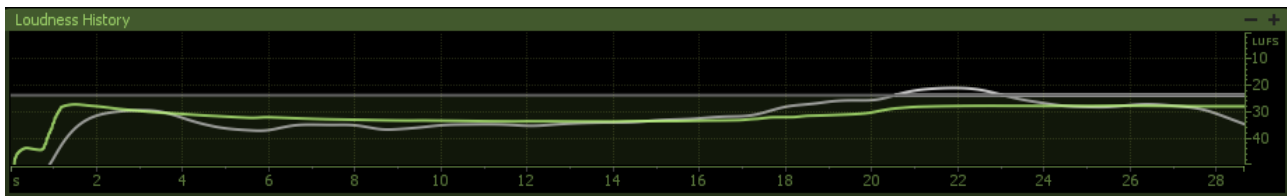
The music plays softly and distorted at 4. It is not very clear, because the frequency bandwidth is very small to simulate the sound coming from inside the car being heard outside the car.. The explosion at the end is a 10.

15. Cave Surgery. - Non-diegetic. Program loudness -21.2 LUFS.



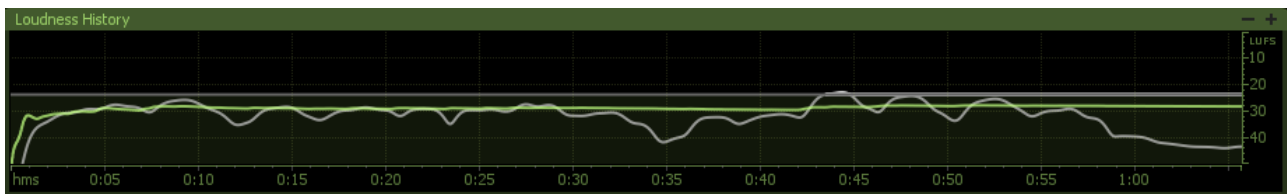
The music starts at 8 and then fades down gradually. The dialogue is at 6 and the sound effects at 7. Reverberation, delay and EQ are used to take away definition from the dialogue in the same way, as in **2. Smoke Clears**, but in the other direction.

16. Heart Machine. - Non-diegetic. Program loudness -28.2 LUFS.



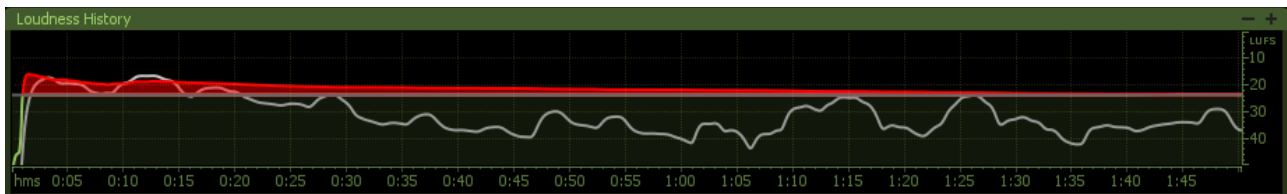
The music is at 8, with the dialogue and sound effects less important at 6. The timing of the components solves the problem of intelligibility.

17. Demands. - Non-diegetic. Program loudness -28.5 LUFS.



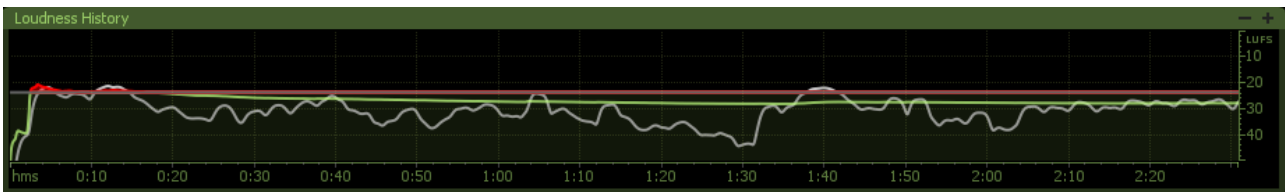
The door lock is loud at 8, but once off, then the music plays at 5 under the dialogue at 7.

18. Torture. - Non-diegetic. Program loudness -24.2 LUFS.



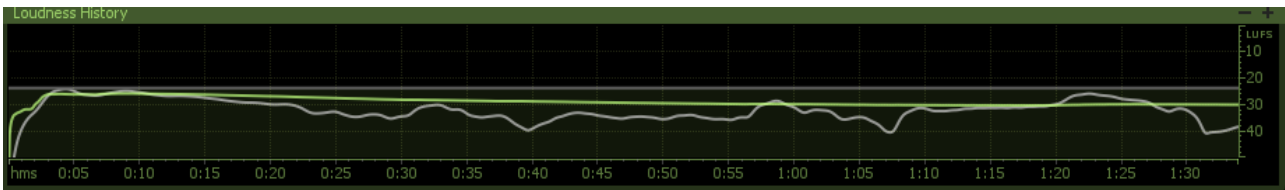
The music starts at 7 with the sound effects music, but comes down to 4 under the dialogue, which is at 7, and back up to 7 at the end with the brass theme. The ambient noises are at an 8, being the most prominent feature. The dialogue when Stark's head is underwater is unintelligible, because all the high frequencies are attenuated.

19. Getting started. - Non-diegetic. Program loudness -28.1 LUFS.



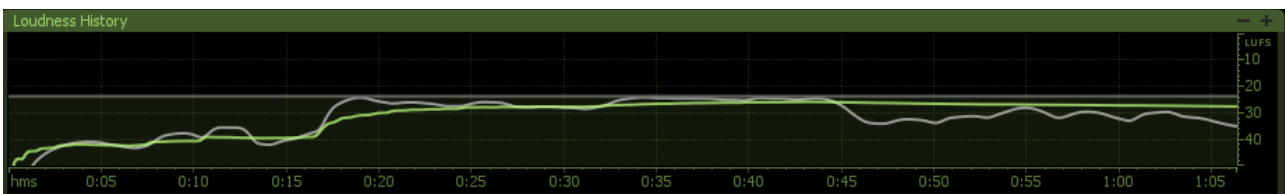
This cue starts off loudly with the music at 8 and immediately fades down to 6 for the dialogue. The dialogue is at 7 with the music and the shouting and working sounds at 8. The music fades back up to 8 where there is no dialogue.

20. The ring and the diagram. - Non-diegetic. Program loudness -30.3 LUFS.



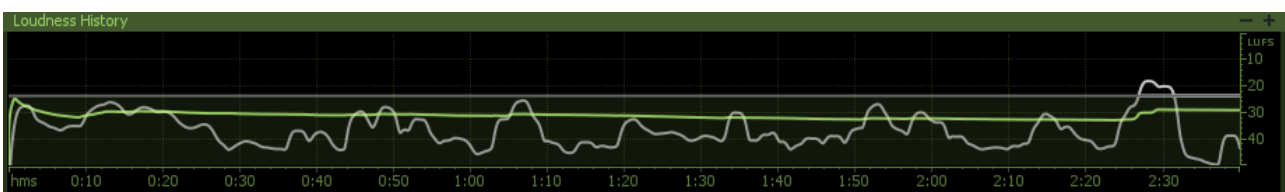
The music is at 6 under the dialogue, which is at 7 and the working effects at 7 as well. This scene is soft and intimate. The 9 kHz tone representing the light does interesting things to the frequency spectrum. It makes the moment top heavy.

21. Suspicions. - Non-diegetic. Program loudness -27.8 LUFS.



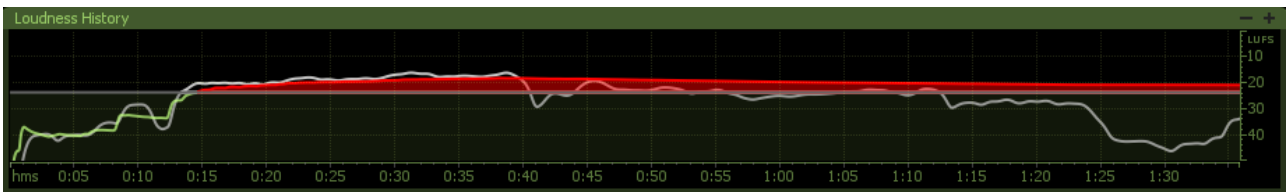
Loud music is at 9, softer music at 6. The sound effects are under the music at 6, and the dialogue at 8, which happens in the quiet music. The sound effects are in stereo, the music and dialogue is mostly in mono and panned center in this section.

22. Raza. Non-diegetic. Program loudness -29.4 LUFS.



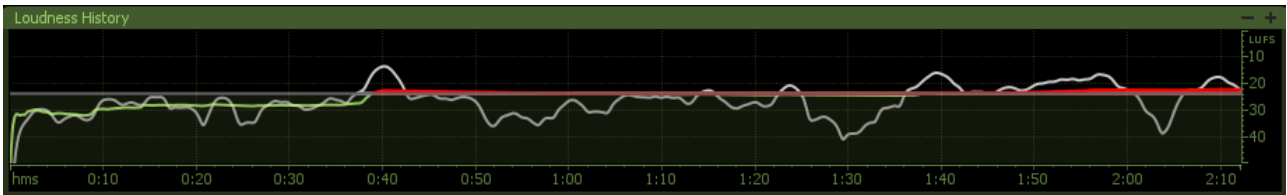
The music comes in at 7 and swells to 8, after which it fades down to 4 under the dialogue, which is at 7, and as loud as 9 when they shout. The bass drum effect in the music is always at an 8. Again, the piercing sounds look interesting on the frequency analyzer.

23. Anvil. - Non-diegetic. Program loudness -21.2 LUFS.



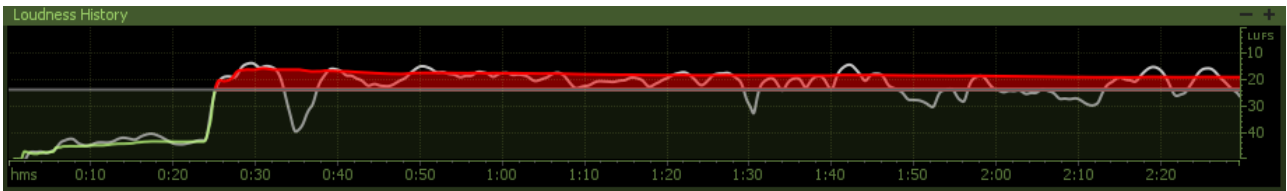
The music fades up to 9 with the anvil hits on a 9 too. The music fades down to no lower than a 7 for the dialogue, which is not too loud at 7, and never overpowers the music. The working sound effects after the anvil are at 8.

24. Race to finish. - Non-diegetic. Program loudness -22.5 LUFS.



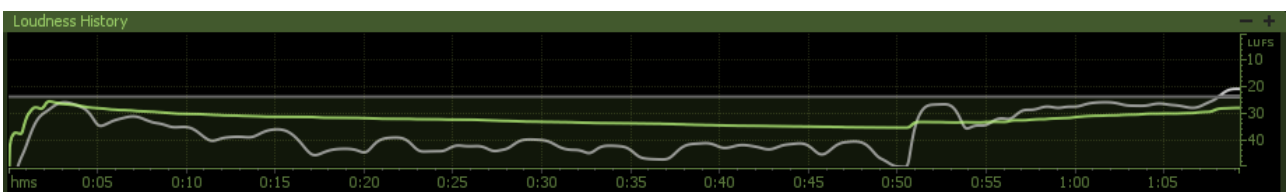
The music is this cue is between 8 and 5 depending on whether there is dialogue or not. Soldiers shouting are treated as a sound effect here and not as dialogue. Interesting to note that the soldiers shouting at the door when Stark and Yensin are talking is panned, the first time that a voice has been panned to show direction. The dialogue is very loud at 9

25.1. Escape. Non-diegetic. Program loudness -28.2 LUFS.



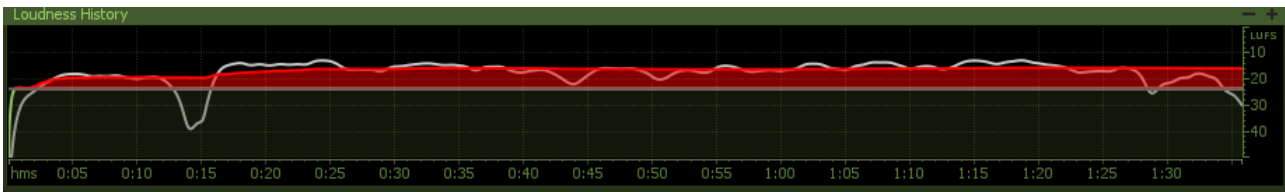
The music is loud: between 7 and 8, with the shouting of the soldiers only at 6. The gunfire in the cave and explosions are full 10. There is an effect on Stark's voice when he yells for Yensin in the mask. The spectral content is altered and there is reverberation applied.

25.2. Escape. Non-diegetic. Program loudness -28 LUFS.



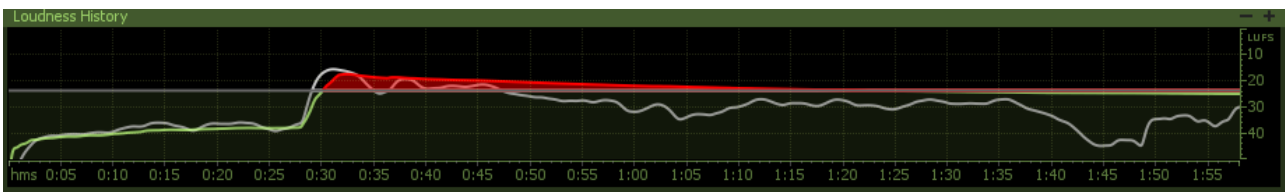
The music comes in at 5 and fades up to 7. The dialogue is at 8. This is an intimate scene with the lower loudness levels amidst some very loud scenes.

25.3. Escape. Non-diegetic. Program loudness -16.2 LUFS.



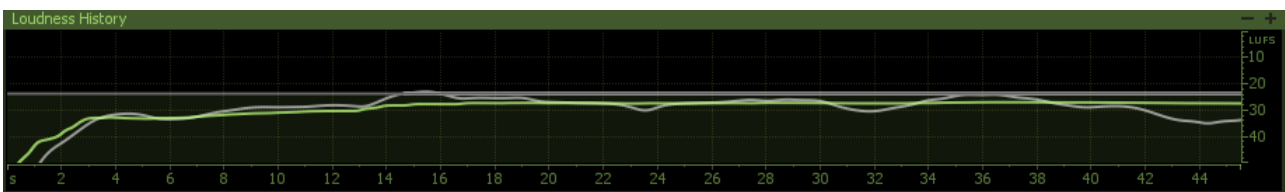
The footsteps become gradually louder from outside the cave until about a 5. The gunfire is a lot softer outside, with less in the high frequencies. Stark's voice is even more altered for his dialogue in the mask and his sound effects are louder than the gunfire. The music comes in at 8, but is often compressed down heavily for explosions, which are at a 10.

26. Rescue. - Non diegetic. Program loudness -25.3 LUFS.



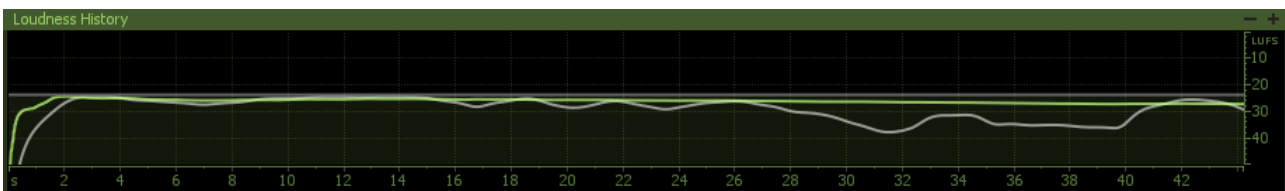
The desert music is at 6. The chopper comes in suddenly at 9 with the music also at 9, fading down to 6 for the dialogue. The wind noises also fade down to 6 and the dialogue is at a 7, being dampened by the chopper sound. The dialogue is at 8 when there is no other sound. It is interesting to note in this section how they shout over the chopper noise is relatively softer than the quiet talking inside the car because there is no competition for space on the *mise-en-bande*

27. Cheeseburger - Stark returns. - Non-diegetic. Program loudness -27.7 LUFS.



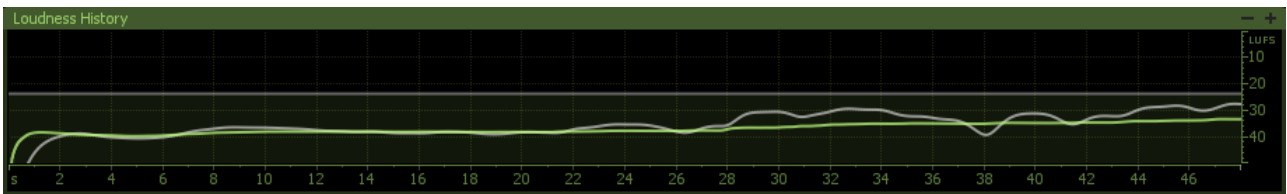
The music, sound effects and dialogue all compete for space at 7. It adds to the unintelligibility of the crowd's noise.

28. Press conference. - Non-diegetic. Program loudness -27.5 LUFS.



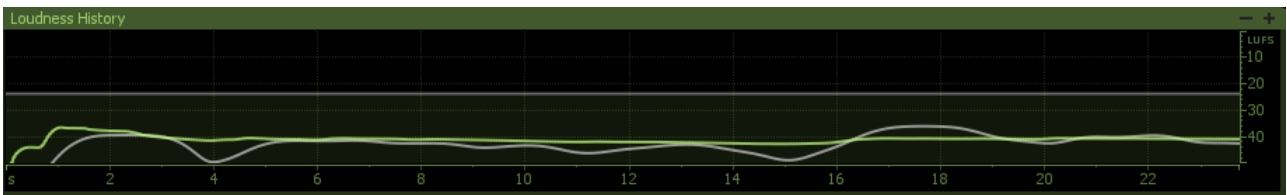
The dialogue and sound effects compete as the press rabble is at 8 and the dialogue at 9 shouting over the noise. The music comes in at 4 underneath and swell to 8 in the scene change and fading out under the reactor noise.

29. Heart reveal. - Non-diegetic. Program loudness -33.6 LUFS.



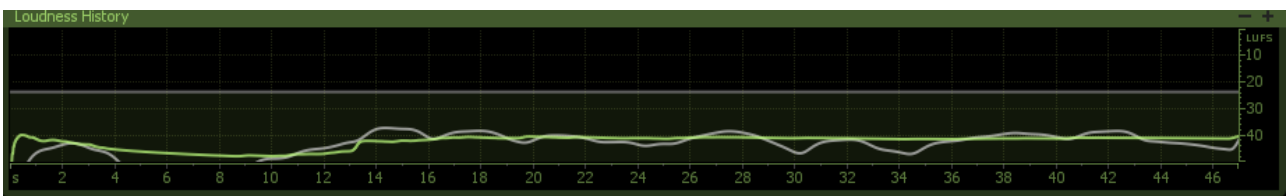
At first the music is at 8 and the dialogue at 6, but they occupy different portions of the frequency spectrum and therefore don't compete. Then, as the brass comes in (Which shares a frequency spectrum with voices), the music fades to 6 and the dialogue to 8.

30. Pepper called to lab. - Non-diegetic Program loudness -41.2 LUFS.



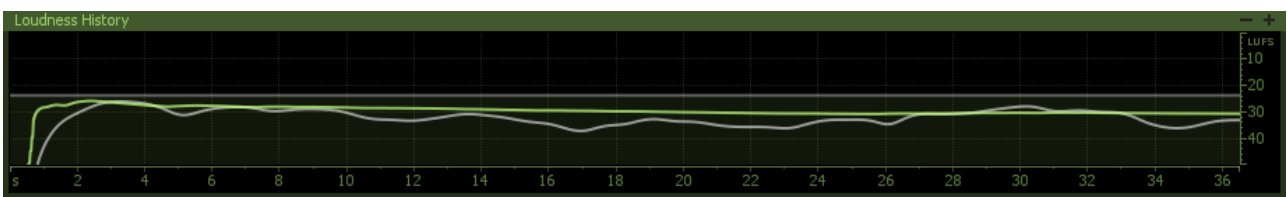
This is a very soft and intimate section. The music is at 5 and the dialogue at 7.

31. Never Again. - Non-diegetic. Program loudness -40.5 LUFS.



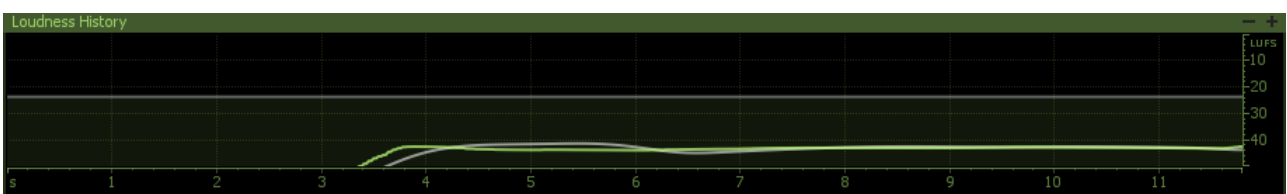
This is the same scene as in **30**, but the music is slightly louder at 6, with the dialogue still at 7.

32. Rhodie hangar speech. - Non-diegetic. Program loudness -31 LUFS.



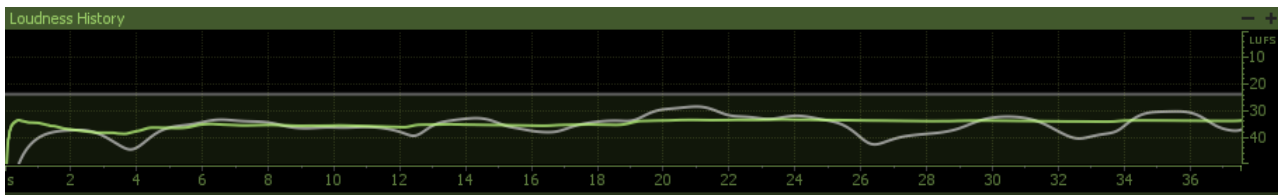
The Jet noise is at a 9, but fades quickly. The music is at 7, with the dialogue just above it at 8. The dialogue has some delay on it to give the impression that the space they are in is very big. Reverberation is applied to push the snare drum back in the mix so it does not interfere with dialogue intelligibility.

33. Get your mind right. - Non-diegetic. Program loudness -42.2 LUFS.



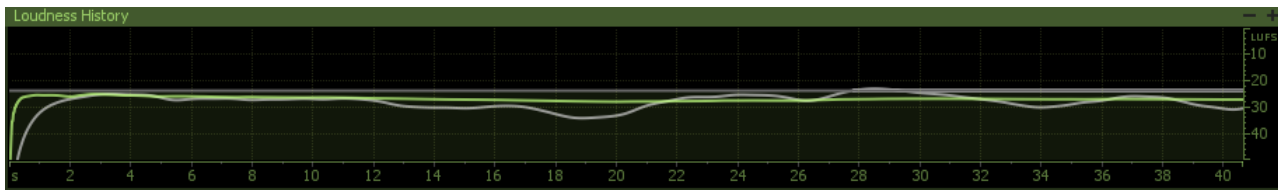
The music is at 6, sitting under the dialogue at 7. This section is quiet and intimate.

34. Keep off server. - Non-diegetic. Program loudness -33.7 LUFS.



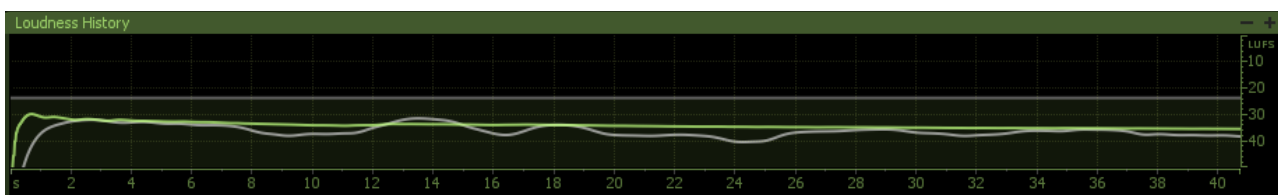
The dialogue is at 8, Jarvis' usual processing is in place. The music swells between 6 and 7 depending on the dialogue, and softer computer noises at 7.

35. Finding the mask. - Non-diegetic. Program loudness -27.4 LUFS.



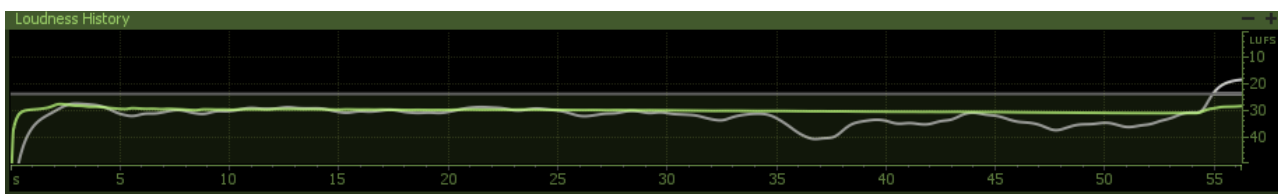
The music and wind effects compete at 7, with the occasional dialogue also being drowned out by the wind at 7. The music grows to 9 with the final thematic statement in the bass.

36. Test 1. - Non-diegetic. Program loudness -35.7 LUFS.



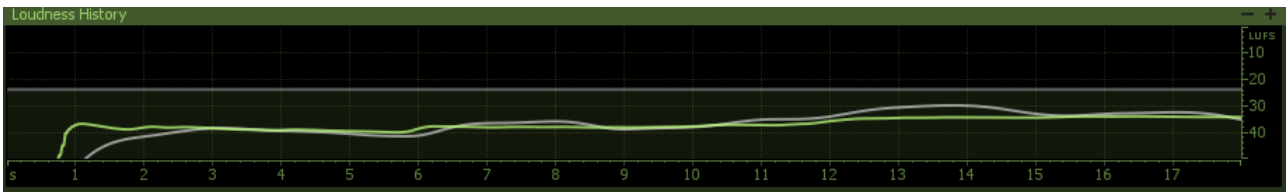
The dialogue is at 7, with the mechanical whirring noises just below at 6. The music starts at 7, but is further back in the mix, and comes down to 5 under the dialogue.

37. Test 2. - Non-diegetic. Program loudness -28.5 LUFS.



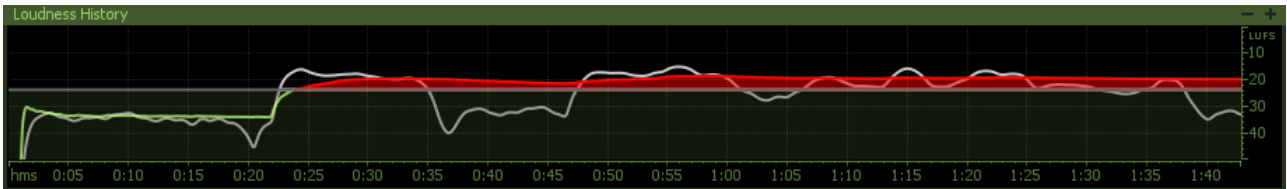
The music starts louder at 8, and fades down to 5 for the dialogue, which sits at 8. The blast sound at the end is a full 10. The instruments have interesting spectral interactions. The strings are very bright and forward, while the distorted electric guitar is not very prominent. It is because only a small section of the guitar's frequency spectrum is present, and there is reverberation applied to push the sound back in the mix.

38. Obadiah on piano. - Diegetic. Program loudness -34.5 LUFS.



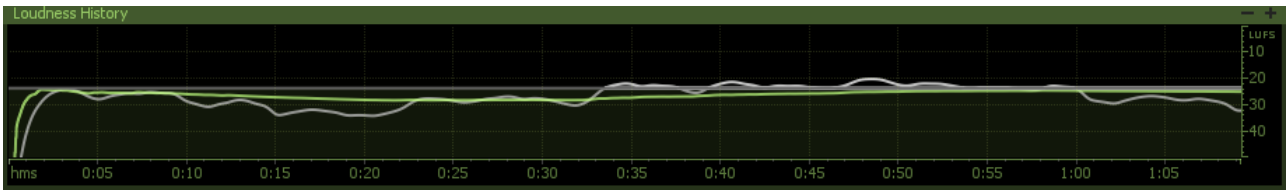
The piano plays at 7, with the dialogue at 9 above it. The piano has some stereo spread, as well as some reverberation on it to make it sound natural in the room.

39. Test day eleven. - Non-diegetic. Program loudness -20.1 LUFS.



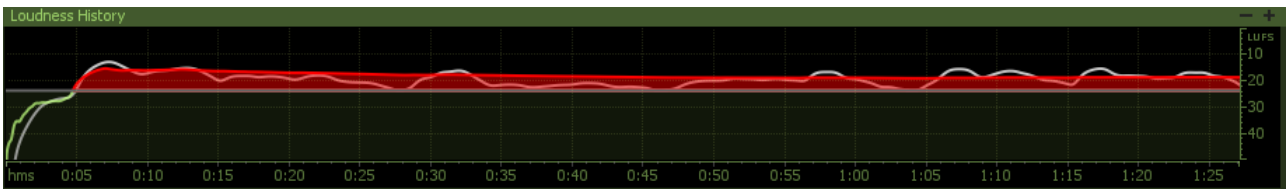
The dialogue is always present in this section at 9, cutting through everything else. The music is at 4, below the dialogue and the sounds of the thrusters, which are a full 10 when center screen, but fade down significantly to 3 when not up close. The music increases in volume when there is no dialogue.

40.1 First flight. - Non-diegetic. Program loudness -25.3 LUFS.



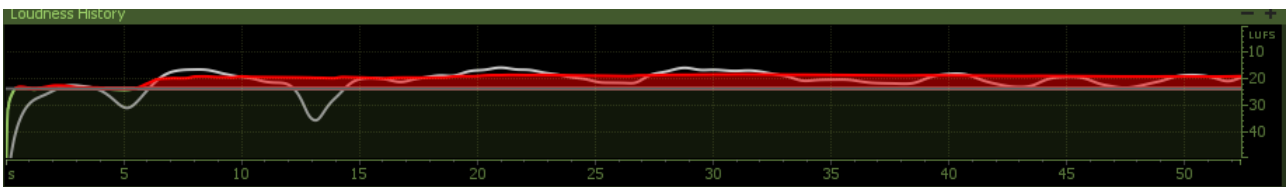
The music starts at 6 with the dialogue at 8. The assembly effects are also at 8, but fade down for the control surface check, at which point the music comes up to 8, and goes back down for dialogue. Interestingly the dialogue is very dry in side the helmet. No reverberation at all, with Jarvis coming from all sides with a wide spatial spread.

40.2 First flight. - Non-diegetic. Program loudness -19 LUFS.



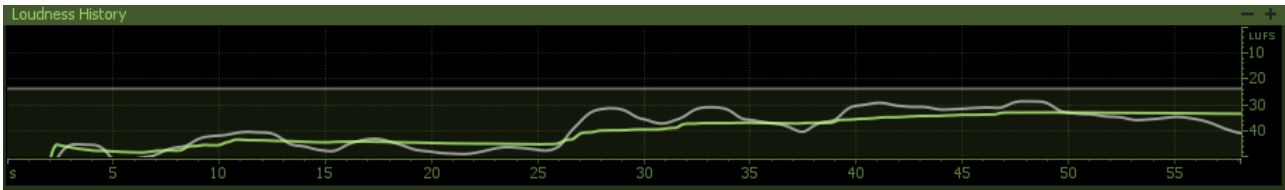
The dialogue is louder in flight because Stark shouts, and has to compete with the flight noises at 8 and the music at 7.

40.3 First flight. - Non-diegetic. Program loudness -19.3 LUFS.



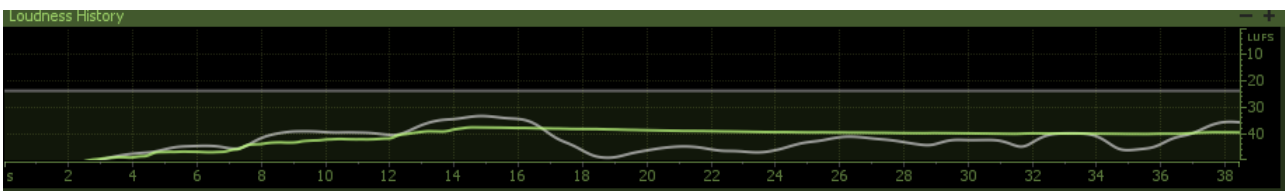
The wind noise as Stark is falling is very loud at 9, but once he starts flying again the flight noises are at 8 as the music comes in at 7 and the dialogue at 8. There is a lot of electric guitar and bass used in this scene, and the distortion helps those instruments gain intelligibility through the rest of the sounds.

41. Trophies. Non-diegetic. Program loudness -33.7 LUFS.



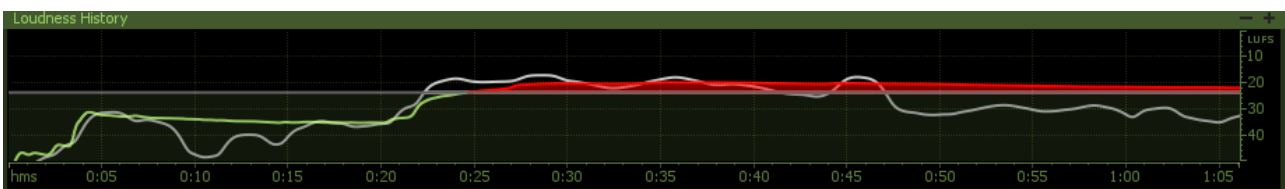
Soft music comes in at 5, then fades up to 7 when the scene changes. The effects are at 7, and the dialogue at 6, under the music.

42. Entertainment channel. Diegetic. Program loudness -39.8 LUFS.



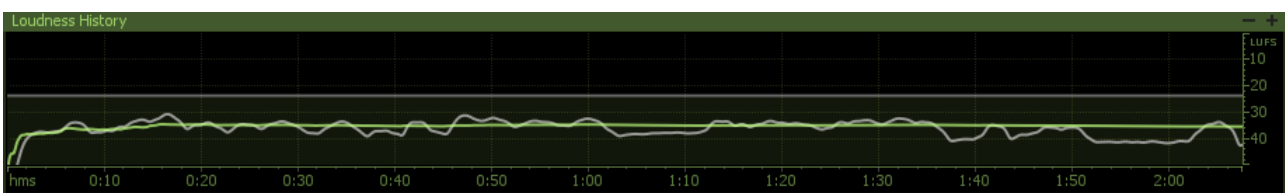
The music fades in from 2 and settles at 4 with the TV dialogue at 5 and the normal dialogue at 7. The music is altered in the frequency spectrum to have very few bass frequencies to help it sound more diegetic. There is also a slight spatial spread in the TV dialogue to make it clear that the dialogue originates from the TV.

43. Paint it Red. - Non-diegetic. Program loudness -22.2 LUFS.



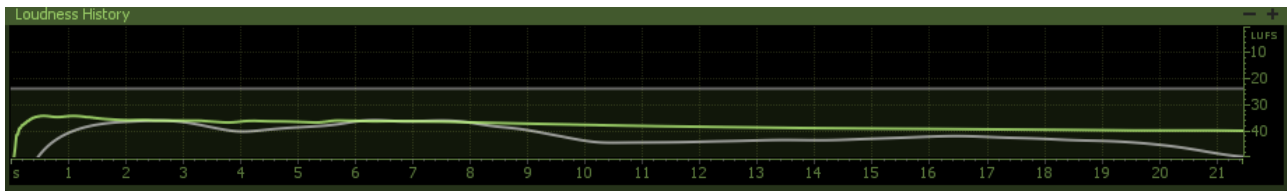
The driving sounds are at 10 with the music at 8 in the driving scene. In the next scene the crowd noise is at 9 and the music down to 5 and fading out, and the dialogue at 8. The distortion in the bass guitar during the driving scene helps the bass to remain prominent.

44. Benefit 1 - Diegetic. Program loudness -35.7 LUFS.



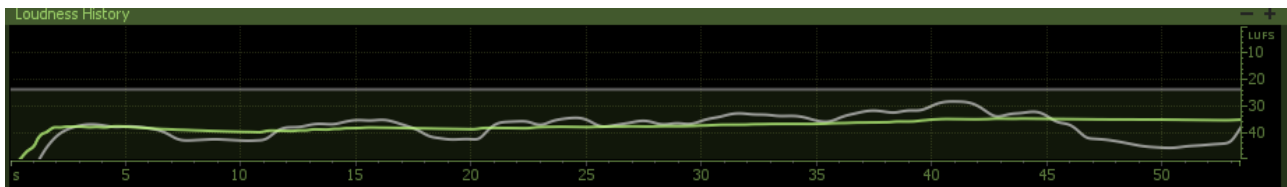
The music starts at 7, and fades down to 5 for the dialogue, which is between 7 and 8. The people are dancing to the music, giving the impression that it is diegetic, but there is nothing audible to justify this. The music sounds non-diegetic.

45. Kiss. - Non-diegetic. Program loudness -40.2 LUFS.



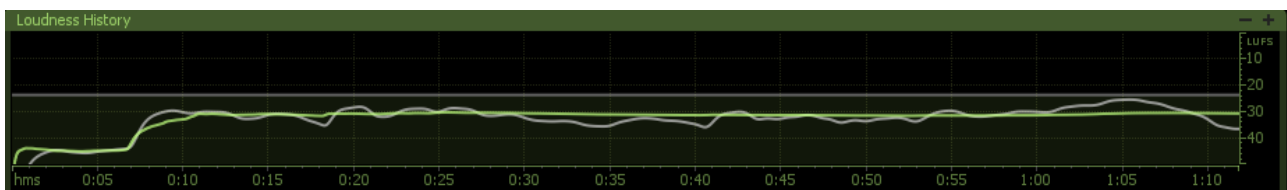
The dialogue is whispery, but the section is soft so it is still an 8. The music fades up from 5 to 7.

46. Benefit 2 - Diegetic. Program loudness -35.6 LUFS.



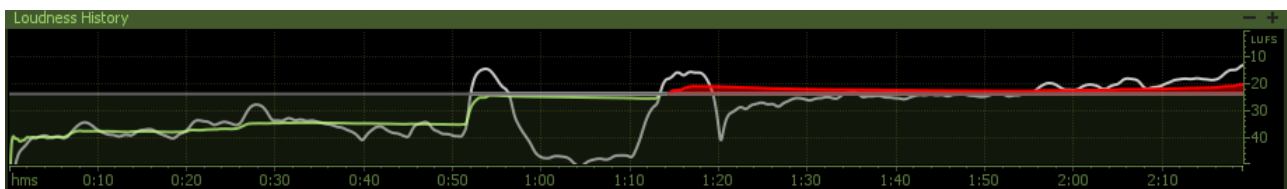
The music is at 5, where it left off, and gradually fades under the next cue. The dialogue is at 8.

47. A town called Gulmira. - Non-diegetic. Program loudness -31 LUFS.



The music fades in over the Jazz music and the noise of the crowd, giving a sense of Stark's mind reeling from the news. The music fades up to 7, and stays there for the dialogue at 8, with new crowd noises outside at 6. The music fades up to 9 as the scene changes.

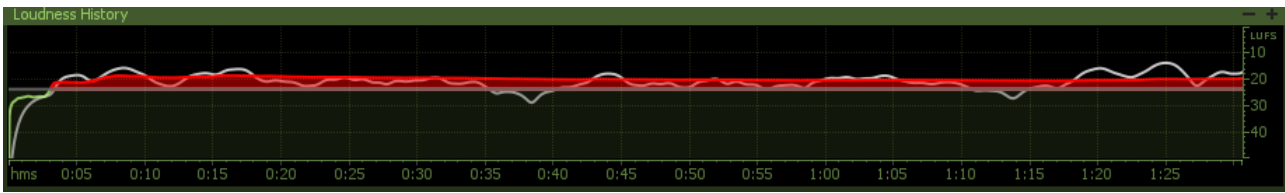
48. Realization - Suiting up. - Non-diegetic. Program loudness -25.5 LUFS.



The music starts at 5 below the TV dialogue which is at 7 and eventually fading down to 5 and fading out with the blast, which is at 10. Then, for the 'suit up' scene the building sound is at 8 and the music under it at 7. The music builds up to 9. Interestingly the

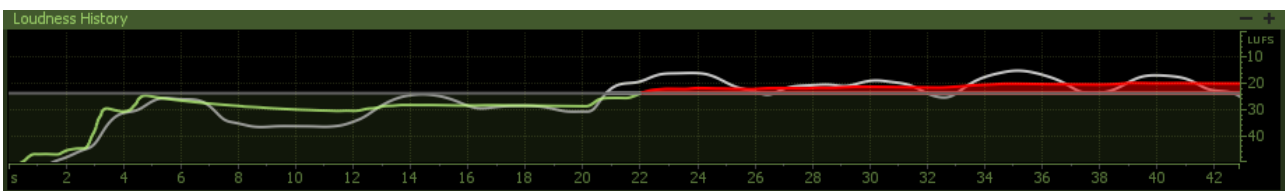
gunfire from the TV is in mono, as opposed to having a wide stereo spread, indicating the TV as the source of the sound.

49. Gulmira. - Non-diegetic. Program loudness -19.8 LUFS.



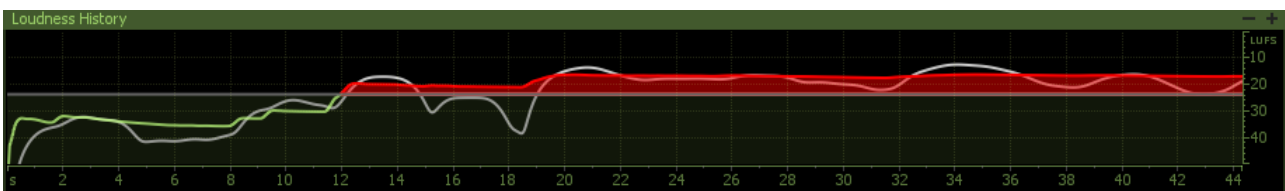
The music starts at 5, and builds up to 7. The dialogue is 6, and the sound effects of the gunshots and explosions at 9, the crowd noises at 7 and full 10 for the hand blasts. Again, the crowd noise is treated like a sound effect rather than dialogue and is panned with movement and placement.

50.1 Targeting weapons. - Non-diegetic. Program loudness -25.1 LUFS.



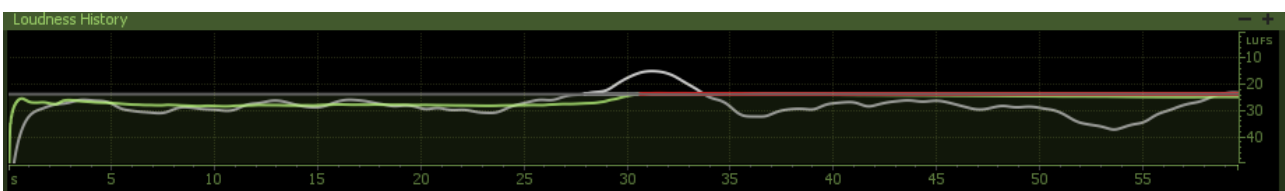
The sound effects of the fighting are loud at 9, with the music at 7 below it and the dialogue of the shouting soldiers at 7. The dialogue Stark is 9, with heavy effects on his voice from outside the suit. The music builds up to 8 as he flies off.

50.2 Targeting weapons. - Non-diegetic. Program loudness -19.9 LUFS.



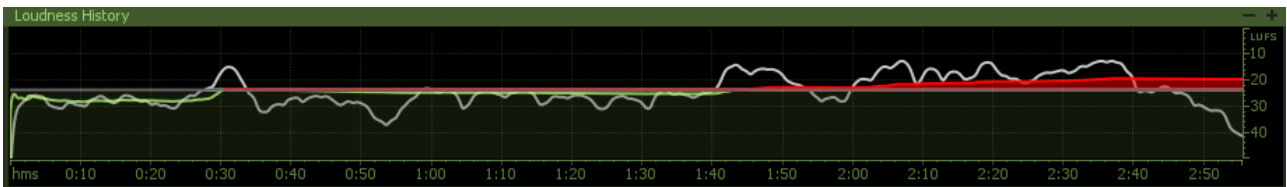
The music is at 8 for this section, with the explosions at 8 or 10 over the music.

51.1. Dogfight. - Non-diegetic. Program loudness -20.3 LUFS.



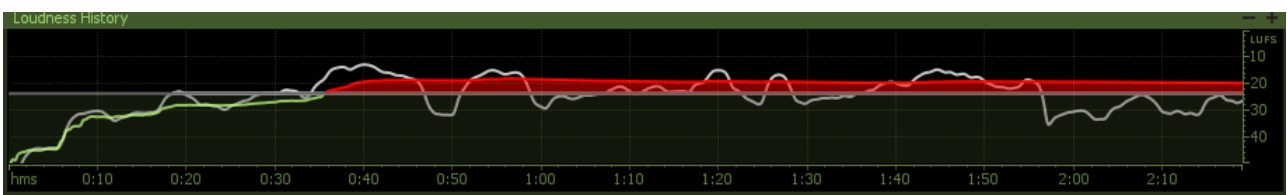
The music is at 7, with the explosions at 9. The music stops until the tank blows up (9) and the music returns with 9 and the flight sounds at 9. The music and effects fade down to 6 for dialogue at 8. The music builds up after the dialogue to the phone ringing at 10

51.2. Dogfight. - Non-diegetic. Program loudness -19.9 LUFS.



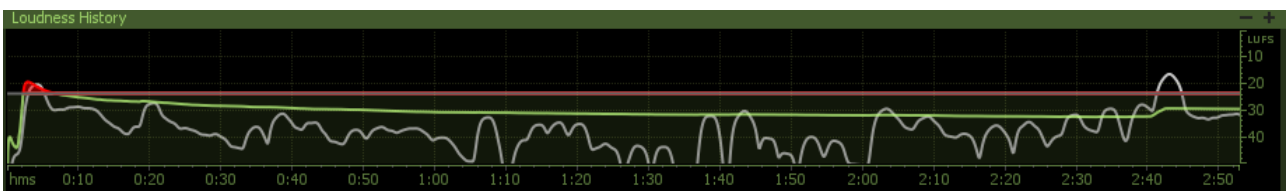
The music plays at 6, with the bass line coming out with 7 when the Jets attack. The dialogue is at 8, with the jet and flight sounds at 9 intermittently. Rhodes' voice over the phone has the high and low frequencies attenuated to make it sound like a phone call. The same audio processing is applied to a lesser extent on the pilot's coms, with altered frequency content. Both the telephone voices and the pilot coms have stereo spread to make their source sound electronic.

51.3. Dogfight. - Non-diegetic. Program loudness -21.1 LUFS.



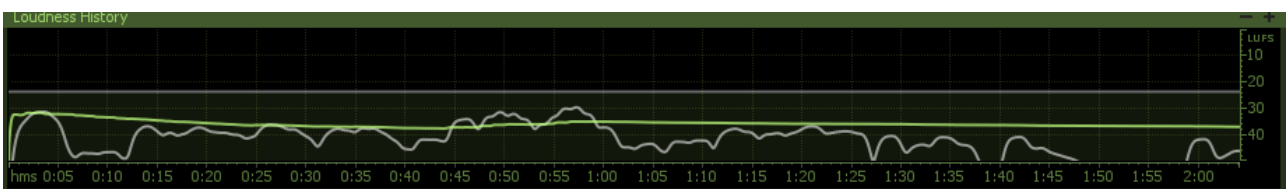
The music starts at 7, but fades down to 5, with the dramatic strings and bass hits playing louder at 7. The flight noise is still intermittently at 8, and the dialogue is consistently intelligible at 8.

52. Obadiah meets the enemy. - Non-diegetic. Program loudness -29.8 LUFS.



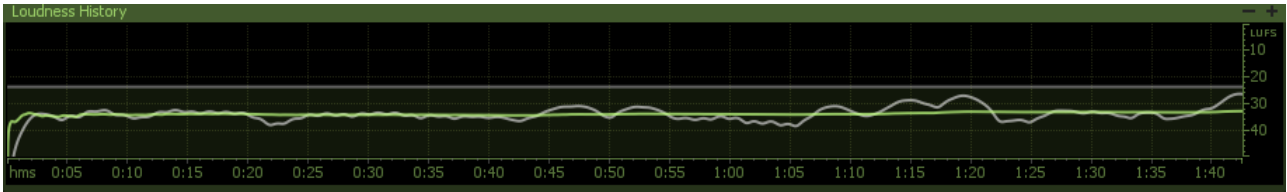
Outside, the music plays at 7, and fades down to 6 for dialogue at 7. The cars make some noise at the beginning of the section with 7. Once inside, the dialogue is softer, but there is less happening, so the overall effect is louder at 8. The music is relatively softer at 5, rising up to 7 again for outside. The gunshots in the generally quiet scene are a 10.

53. Pepper quits. - Non-diegetic. Program loudness -37.4 LUFS.



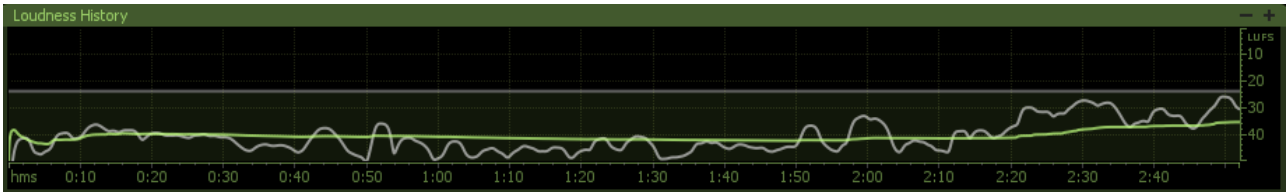
This is a soft, intimate section. The music is at 6 and the dialogue at 7. Occasional computer noises are at 7 as well, but they do not occupy much space on the soundscape due to their short duration.

54. Pepper steals files. - Non-diegetic. Program loudness -33.1 LUFS.



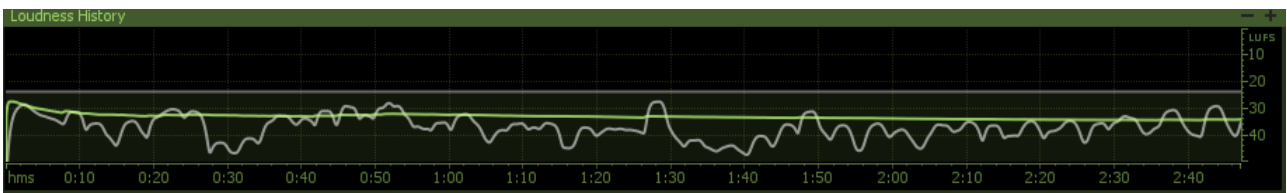
The music is loud at 8 with the dialogue under it at 7. The computer noises are audible at 7.

54. Pepper steals files. - Non-diegetic. Program loudness -35.6 LUFS.



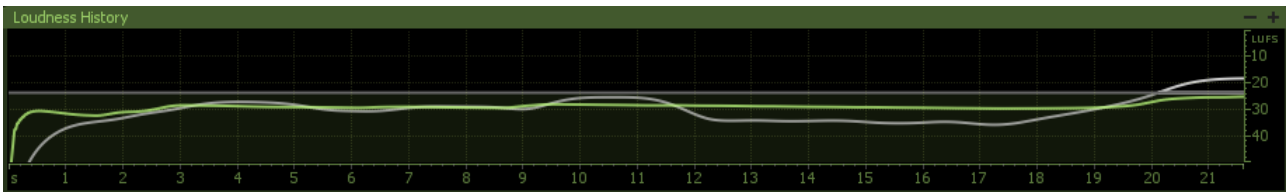
The music is now at 5 to allow for dialogue at 7, except for the dramatic moments, which play at 8. The music and the dialogue build up after Potts leaves the office which builds suspense.

55. Heart removal. - Non-diegetic. Program loudness -34.4 LUFS.



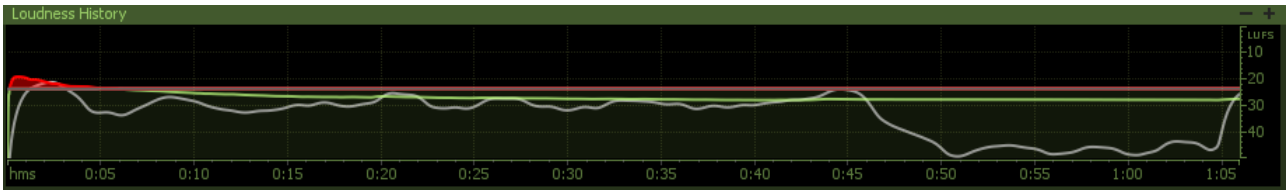
The music is at 5, with the dramatic music effects at 8. The dialogue is intimate, and at 7. The noise from the device removing the heart is relatively loud at 8 to give it more presence. The heart theme plays at 7, mostly because there is nothing else occupying space on the *mise-en-bande*.

56. Find Tony. - Non-diegetic. Program loudness -35.5 LUFS.



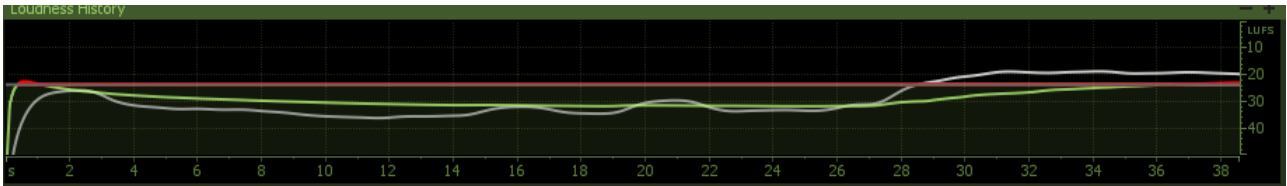
The music plays at 8, and fades down when the dialogue comes in at 8. The car noise is a 7.

57. Cardiac. - Non-diegetic. Program loudness -27.8 LUFS.



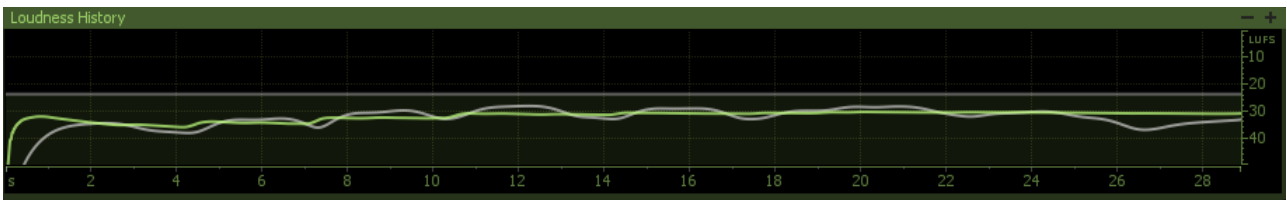
The music is at 6, with the dramatic sounds at 8. The music builds to 8, and fades to 7 for the “Potts” theme. Throughout the scene, the “Heartbeat” percussion plays at 9 and is the most prominent thing in this section.

58. Monger Heart. - Non-diegetic. Program loudness -23.4 LUFS.



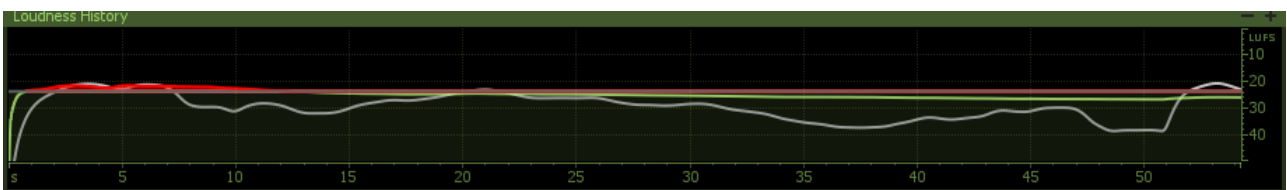
The music plays at 8. The machine noises match that loudness at 8, but become louder with the power-up to a 9. The music swells to a 9 after this to play the “Monger” theme.

59. Rhodes finds Stark. - Non-diegetic. Program loudness -30.9 LUFS.



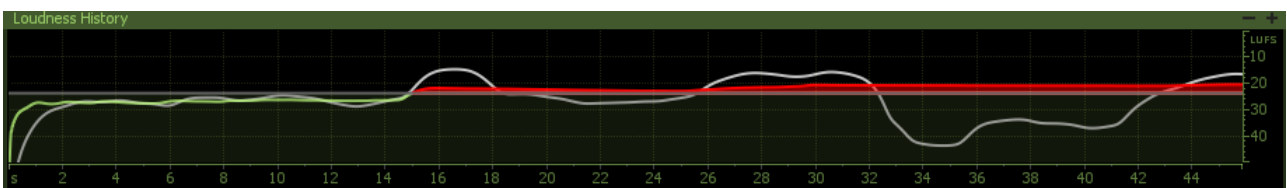
The music is softly playing at 6, and the dialogue is urgent in this quiet setting, putting it at 9. There is a difference in the reverberation on Rhodes’ voice when he is shouting for Tony in the room with the piano. There is an echo, indicating space, which is immediately gone in the lab.

60. Shield looks for Obadiah. - Non-diegetic. Program loudness -26.3 LUFS.



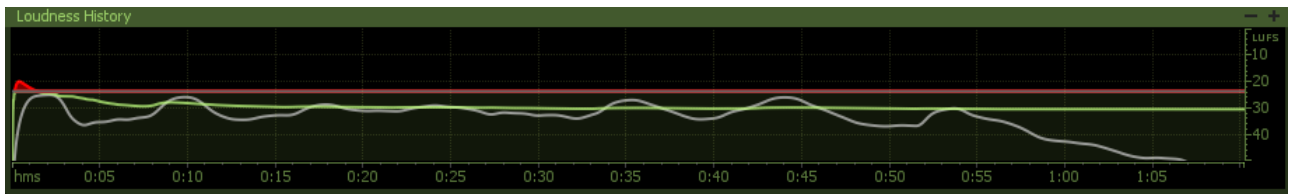
The music plays at 7. The car noise is a 9, and the reactor is at 7. The reactor fades away and the music fades down to 5 for the dialogue at 7.

61. Rhodes in lab. - Non-diegetic. Program loudness -20.7 LUFS.



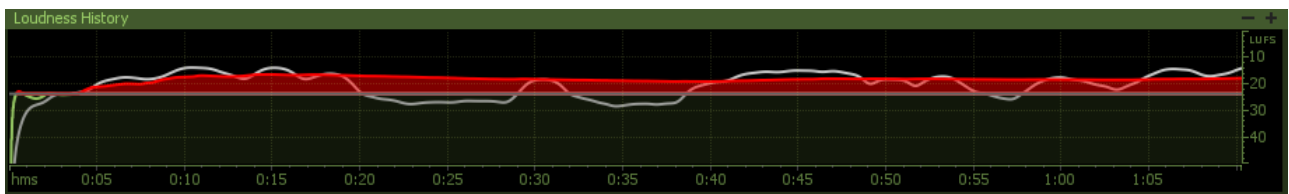
The machine building noises take president here at 9. The music is under it at 7, with the dialogue at 8, and 9 for Ironman saying “keep the skies clear” because of the processing on his voice in the helmet. The guitar used to identify with Iron Monger, is phased to sound like it is coming from behind in the surround sound spatial domain.

62. Shield discovers Iron Monger. - Non-diegetic. Program loudness -30.7 LUFS.



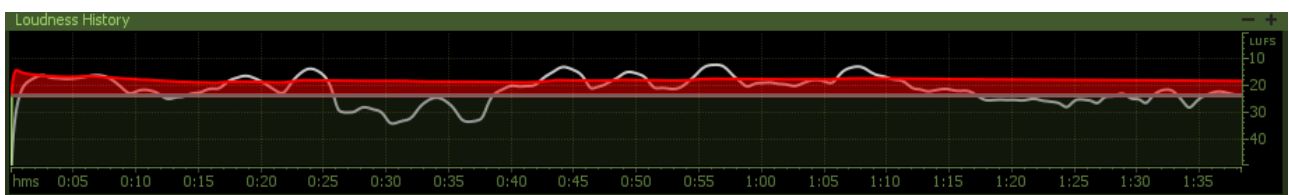
The lab sounds are relatively loud in this quiet context at 8. The music is in the background at 5 and the dialogue is in hushed tones at 7

63. Monger attacks. - Non-diegetic. Program loudness -18.1 LUFS.



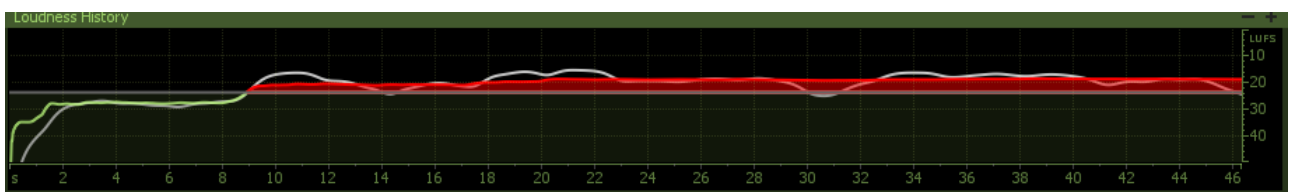
The loudness of this scene is accentuated by the quiet that preceded it. The sound effects of the Iron Monger destroying everything are at 10. The music is a loud 8, quieting down only to 7 for dialogue, which is at 8 in the helmet, and 6 otherwise, under the sound effects. The Iron Monger’s voice from within the suit is more processed than the Ironman voice with plenty of low frequency boost, and reverberation.

64. Lift off. - Non-diegetic. Program loudness -18.5 LUFS.



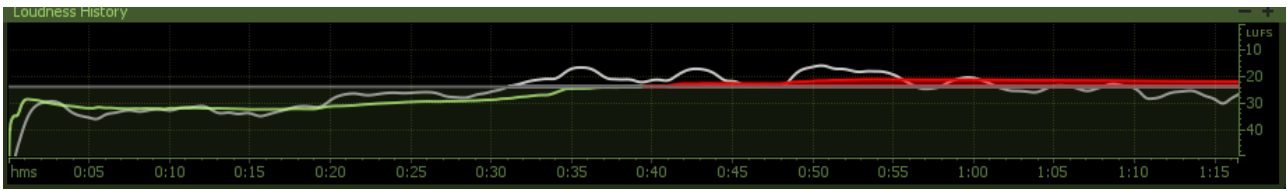
The music is at 8 in the flight scenes, and 6 for the military control room scenes because the effects in the flight scenes are at 9 with all the wind noise. The dialogue breaks through all of it at 8.

65.1. Rooftop. - Non-diegetic. Program loudness -19.1 LUFS.



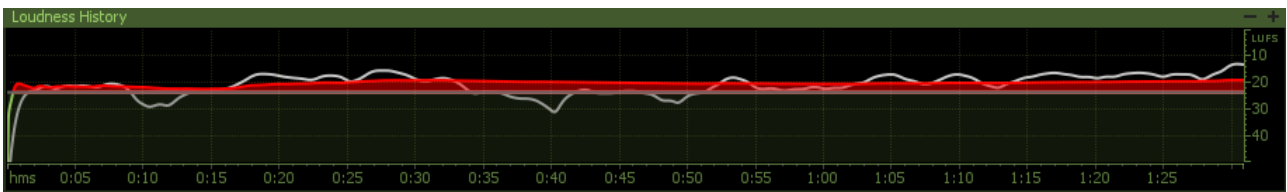
The fight sounds are full 10, with the music at 7, building up to 8 when there is no dialogue. The dialogue is at 8.

65.2. Rooftop. - Non-diegetic. Program loudness -22 LUFS.



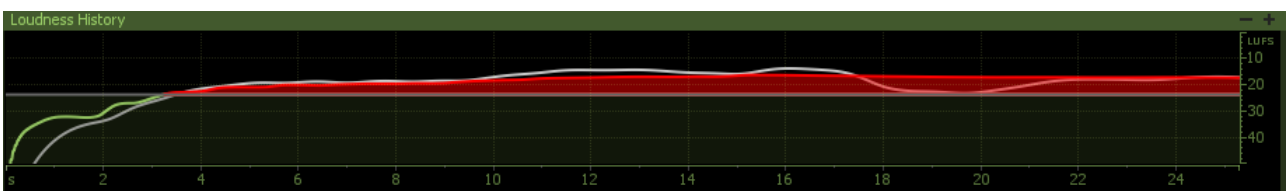
The music starts lower at 6 with the whispering dialogue at 7. Then the music builds and the dialogue is up to 9 for the fight scene. The battle sound effects are still at 9.

65.3. Rooftop. - Non-diegetic. Program loudness -19.4 LUFS.



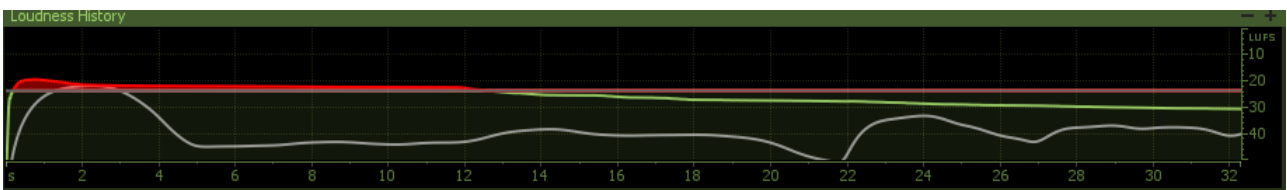
The music starts at 7, but comes down to 5 for Obadiah's monologue, which is at 8 and at 9 when he is shouting. His gunshots are a full 10, as is the reactor overload.

66. Iron Monger Falls. - Non-diegetic. Program loudness -17.6 LUFS.



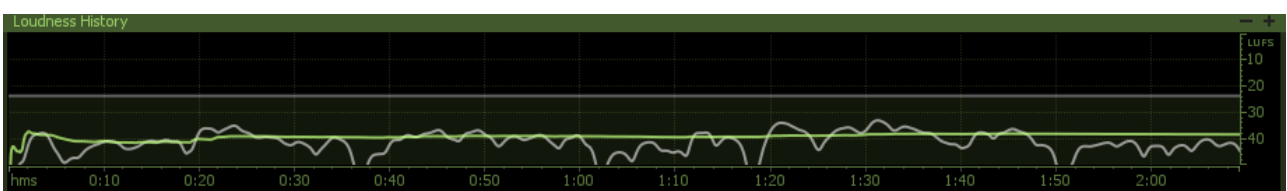
The music is at 8 and the explosion at 10, drowning out the music.

67. Signs of life. - Non diegetic



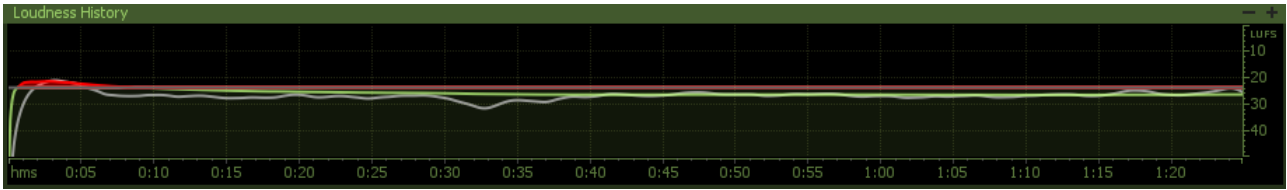
This is a softer scene, with the music at 7, the dialogue at 6 with heavy reverberation and echo to give the impression that Stark is losing consciousness and the ticking sound of the chest piece is a 7.

68. Alibis. Non-diegetic. Program loudness -38.7 LUFS.



The music is at 6 with the dialogue at 8. The music swells to a 7 with the "Potts" theme.

69. Ending credits. Program loudness -26.6 LUFS.



The music is the only sound happening and the film diegesis is over.