Constant Bit Rate vs. Variable Bit Rate Compression: A Comparative Analysis and Introduction to Related Issues within the Field of Digital Preservation

New York University
Moving Image Archiving and Preservation
Cine-GT 1807—Digital Preservation

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December 2018

We are living in a digital age, where most videos are stored as files and consulted on streaming websites in the archive, production and consumer spheres. That said, for videos to exist and be viewed on streaming platforms, they need to be compressed. This compression happens through the use of many variables and settings that are either brought forth manually or via presets. Bitrates are a key factor of compression and function on a Constant (CBR) or Variable (VBR) basis. The following is a presentation of research findings on the subject of CBR and VBR and is organized in two sections: the first pertains to an explanation of compression and both bitrate modes as well as a comparative analysis based on the factors of quality, time and size. The second section will present an exploration of the topic in the field of digital preservation. The goal of this research is to find out if CBR or VBR is more optimal for archives, and to find out just how much this is discussed within the field, shining a light on ethical and practical issues.

At this point, it is to be noted that many other factors affect the overall size and quality of a video (codecs, high definition vs standard definition, etc). In fact, there are a lot of moving parts that are related to bitrate encoding and that should be investigated further. However, what ensues is a presentation of research findings focussing only on bitrates as a means for understanding the effects of constant and variable compression.

Encoding/Compression

To contextualize this research, it is important to understand the terms bitrate and compression, respectively. To begin, video compression is an essential part of streaming and delivery. Without it, there would be no way for sites like Vimeo and YouTube to exist[1]. So,

[1] Birks, Patrick. "The Basics of Video Compression." *Zion and Zion*, 6 July 2016, www.zionandzion.com/basics-of-video-compression/.

bitrate compression is a key factor in our moving image experiences, in fact, it is essential. Encoding and compression are often used interchangeably in a variety of sources. Encoding simply refers to the process of information being turned into a code; translated into a language or form that a given program can read. Compression, on the other hand, is a term used to describe making a digital object smaller. Essentially, video files are usually too big to upload/download if they have not been compressed, or again, in more general terms, made smaller first[2]. So, what happens when you compress a video to a smaller size? The danger of compression is a subsequent loss of image quality, which will be discussed in greater detail throughout this research. However, it is also possible that artifacts appear on the video post-compression. Areas of the image might appear grainy or blocky as a result of this. They also may contain other distortions affecting colour and movement[i]. For reference, there is a video[3] posted on Zion & Zion by Patrick Birks as part of his article, *The Basics of Video Compression*. In this video, the image is separated in two, so that the same video can be compared at two different bitrate compressions. The video that was rendered out at 0.20 Mbps is blocky, grainy, and flickers. The one that was rendered out at a higher bitrate of 6 Mbps is far superior in quality and runs smoothly. On the matter, he states: "This is what we call compression artifacting, which is what happens when you push your compression too far for your aspect ratio"[ii]. Artifacts occur when there is a loss of information significant enough that part of the picture cannot accurately be described.

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[2] "Video Compression Guide." *video4change*, www.v4c.org/en/content/video-compression-guide.

[3] Birks, Patrick. "The Basics of Video Compression." *Zion and Zion*, 6 July 2016, www.zionandzion.com/basics-of-video-compression/.

Bitrates

Now that compression and encoding have been defined, let us look at bitrates, a term made up of two words: Bit and Rate. A bit is a unit of data in a computer that has a single binary value; either 0 or 1. The bit language, along with respective values and term abbreviations, tend to get slightly confusing and are an essential part of understanding compression. Please refer to a very basic conversion table (Fig. 1) below that can be used for reference throughout this research.

UNIT	ABBREVIATION	VALUE
1 Bit	b	0 or 1 (binary)
1 Byte	B	8 bits
1 Kilobyte	KB	1024 B
1 Megabyte	MB	1024 KB
1 Gigabyte	GB	1024 MB
1 Terabyte	TB	1024 GB
1 Petabyte	PB	1024 TB
1 Exabyte	EB	1024 PB

Fig. 1 Desjardins, Anne-Marie. Bit Vocabulary and Conversions, 2018.

Now that we have defined what a bit is, let us understand video bitrate. Put very simply, this refers to the number of bits that are processed within a unit of time[iii]. Video data rates are given in bits per second (bps). However, bits are a starting point by which rates can extend out of. You may see other units listed in reference to bitrate, for example Mbps (Megabytes per second). Please refer to the abbreviations and values listed above when needed. Bitrate affects three factors of video: quality (how the video looks), accessibility (the internet speed that you need to view it)[iv] and storage (file size). In addition to this, these factors are moving parts that affect one another. For example, a higher bitrate generally means higher quality video, at the cost of a

bigger file[v]. Compression is essentially a compromise between quality and file size[vi]. So, how does one choose the correct bitrate for a given workflow? Compression requires an evaluation of these three factors against the needs of a given institution and alongside the purpose of the video in question. The ultimate goal is to determine which factors need to be favored and which can afford to be, not overlooked, but pushed aside slightly. First, consider if people are going to view this video[vii], or if it is intended for preservation purposes only. If you have decided this video will indeed be ingested by a certain public, then consider what the scope of accessibility will be. Will people be viewing the video on a streaming platform and will this be conducted within the institution or at home? If people will be able to access an online archive and view the video there, will people in more rural places be able to view the videos too? This is an important question to consider for memory-based institutions, as the common mission is to preserve and make culture and information accessible to the public. The advent of streaming and, as an extension, the need to consider the scope of virtual accessibility inherently ties bitrate compression to questions of discrimination and exclusivity. We must remember our roles within society and work towards inclusivity, something that is probably generally overlooked when making video compression decisions.

When you are setting up compression, as defined previously, depending on what program you are using, you will either be asked to set the bit rate or it will be set by default. Nonetheless, it is important to understand how the bitrates are affecting the video. Whether you are asked to set this manually or not, there is a setting that will determine whether the bitrates will be constant or variable: CBR and VBR. The effects of bitrate settings on video are: quality, size, and time. These are also the factors by which both types of bitrate settings will be analyzed and later on, compared. The following section will define both types of bitrates, respectively.

Constant Bitrate (CBR)

Constant Bitrate means that you are setting one value for your bitrate, and that every part of your video will get compressed according to this one setting[viii]. In other words, every single frame of the video, regardless of its content, will be compressed to a bitrate as close to the target as possible, varying within about only 20% of this value[ix]. For reference, please see the graph included below, which illustrates Constant Bitrate alongside frames from *The Last Days of Disco*[x]. (Fig 2.)

Fig. 2 Desjardins, Anne-Marie. Constant Bitrate Applied to *The Last Days of Disco*, 2018.

As illustrated, a target bitrate is set for compression throughout the entire movie, regardless of the content of the frame. If your video is constant throughout, for example, if the content is a talking head against a black background, then this is fine. However, the likelihood of videos

being static are slim. If parts of your video are static, but then other parts are busy and contain a lot of detail and movement, then setting a Constant Bitrate might introduce some problems to the end result. Pictured in the graph are five incredibly distinct stills. One of them is busier, illustrating a dance scene at a club. Some are more static, namely, the two static shots of the individual girls against fairly simple backgrounds. Finally, the two remaining shots are somewhere in between; the medium shot of the two girls sitting in the club, and the one of them standing and looking into a mirror. What will happen here is that the target setting might be too high for static parts of your video, which means that you would be wasting bandwidth by compressing them to the target. By contrast, your target setting might simply be too low for the more complex segments of the video, which means that you would lose information and detail. However, one constant rate throughout a video means that the render time will be reduced.

Variable Bit Rate (VBR)

Variable Bit Rate, on the other hand, does the opposite of Constant Bit Rate. It means that different parts of your video will be compressed more or less than other parts[xi], which is where the term variable comes from. As a user, you will set a minimum, maximum and target bitrate. The final rendered bitrate will never exceed the maximum setting or go lower than the minimum setting. The target bitrate is the average. Please refer to the graph below (Fig.3) which uses the same example as Fig 2. To illustrate variable bitrate.

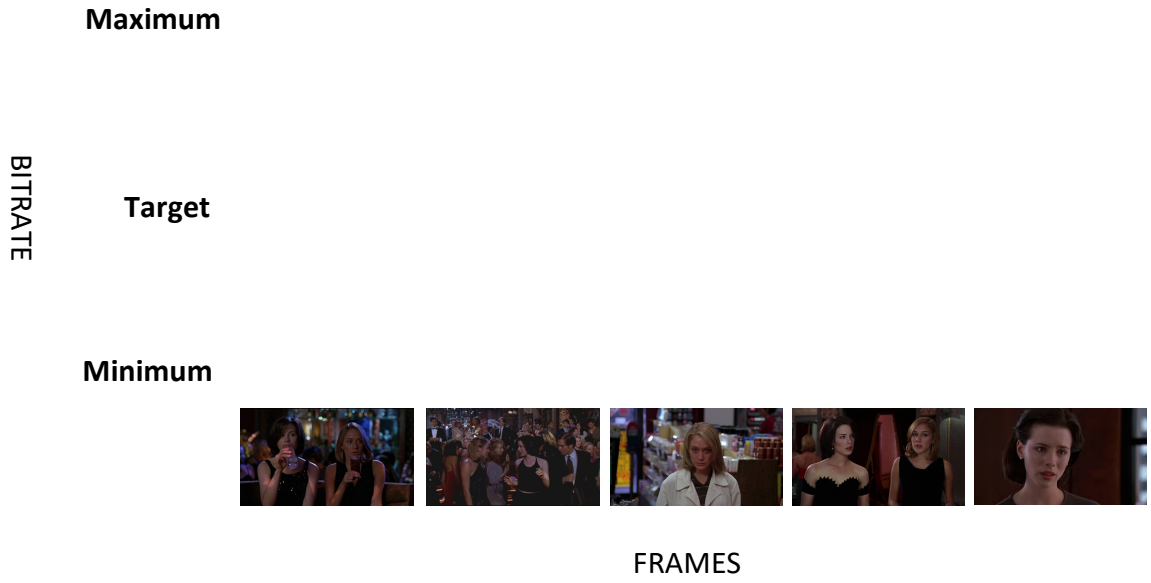

Fig. 2 Desjardins, Anne-Marie. Variable Bitrate Applied to *The Last Days of Disco*, 2018.

As illustrated, a higher bitrate setting will be allocated to more complex segments of media and lower bitrates to the simple segments (2). Here, the first frame is moderate in its content, depicting two girls sitting rather statically in front of a decently busy background. As such, the bitrate starts off near the target setting. It then moves up to the maximum bitrate for a much busier dance scene taking place at a club, with lots of movement and detail to catch. It then plummets down to the minimum bitrate setting area to cover a static scene with a fairly simple background; a girl standing at a store. It rises back to the target for a moderate sequence in which two girls are standing in front of a mirror at a club, and plummets back down again for a simple fairly close up shot of a girl in front of a plain background. In this instance, the variability of the bitrate means that you aren't necessarily losing information in the more complex shots and aren't wasting too much bandwidth compressing the simple shots. This means that the quality and size

should both be affected positively. However, it might take more time to render the movie out. Of course, this example is based off research findings' assumptions, and has not been tested out.

Now, part of the way in which time is affected with VBR is the option to set 1-pass or 2-pass rendering. Passes refer to how many times the video will be looked at to determine bitrate compression. The more passes you allow your codec to do, the smarter it will be and the better image quality you will get at no cost to your file size. However, this will add to the total render time.[xii] (1) Setting a 1-pass render ends up being similar in terms of time as CBR, as the video is only looked at one time, which is the same amount as with as CBR. With 2-pass rendering, more time needs to be taken into consideration for rendering, as the video is being looked through completely twice. The first pass serves as time for analysis of the file and to determine how much bandwidth is needed in each part[xiii]. With one-pass, the complexity of a video and its bandwidth needs are estimated, which is less efficient.

CBR vs. VBR

Now that the two types of bitrate settings have been defined, let us compare them. The results of the research in terms of comparing both CBR and VBR are incredibly variable. Perhaps because this works best on a case by case analysis. Let us continue to compare the two based on the three factors individually: Quality, Size and Time.

In terms of quality, it is generally agreeable that VBR should produce a better image than CBR, because its capability to allocate more bitrate to more complex segments, avoiding loss of information. However, if you were to set the target bitrate of CBR incredibly high, disregarding the other two factors of size and time, you would arguably get superior picture quality than with VBR, as a high value of bitrate would be allocated to every frame, regardless of its simplicity or

complexity. That being said, perhaps the term to employ when discussing quality here is not superiority but consistency. VBR would produce a more consistent video image quality than the variability of CBR's image quality[xiv].

If time is of issue, then an option would be to set 1-pass VBR with lower bitrate values than you normally would use for maximum and target. With 1-pass, it would take just as long as a CBR setting would. The difference is that, for the simpler parts of the video, the compression would jump to the minimum bitrate setting and not waste time allocating a higher bitrate than needed. Of course, if one didn't care about quality at all, a decision could be made to set CBR with a very low bitrate value, however, the likelihood of wanted such a result is low.

Now for size; say you want high-quality and aren't so much concerned about time, but you are lacking space. Setting a 2-pass VBR with the highest possible maximum bitrate and a target rate lower than a CBR rate would result in a high-quality video with reduced size. Reduced size means that it would also take less long to upload the video to a streaming platform[xv]. It is also said that in general terms, VBR's size is unpredictable, or is less easy to foresee, because of the variable bandwidth consumption. With CBR, on the other hand, size is predictable because the bandwidth consumption is fixed[xvi].

However, the answer to comparing CBR and VBR is not that simple. That said, different motivations and end-goals will reel in different optimal settings. In real-life situations, you or your institution's needs would probably combine mix of things and not only be motivated by one factor. In addition to this, it is likely that anyone would want the highest possible quality of video, regardless of the purpose of it. That said, size and time will affect the outcome of the overall quality. In other words, the way we treat each of the three factors affects the other two.

In addition to the three more technical factors that inform the decision of bitrate settings, there are also institutional goals to consider. To circle back to initial discussions on the matter, you must think of the final output of the video, what is its goal and its public? Will it be used for preservation or access. If this video is being created for preservation purposes, specifically for a master file, then you would want an uncompressed lossless file, optimally. If the goal here is access, then what streaming platform is it going to live on? Is this for use by one researcher who will be granted access to the video through a special request or will the video live on a digital archive that is accessible to the public? For example, the latter is the case for the New Museum of Contemporary Art, where their digital archive is both a repository and is accessible to the public. Though most institutions would not use Youtube for access, the widely used platform has readily accessible information that we will use as a streaming example and presents an important factor to consider. Youtube compresses videos regardless of your encoding settings. That being said, you would want to produce the highest quality video possible so that the Youtube-compressed version would not be too horrible[xvii].

Many of the streaming platforms have video guidelines that you can follow for optimal results before uploading a video. To pull only one example into this discussion, vimeo states the following about bitrates in their guidelines:

> If your video editing software gives you the option, choose a "variable" bit rate and select a value from the ranges below. You can experiment with different rates if your file is too large or you're not happy with the quality of your source file"[xviii]

What is described above can be translated into the analysis that was just conducted based on the three factors. Here, Vimeo is favoring the factor of quality by encouraging users to set bitrate to VBR, following their compression guidelines, which I have included below for reference.

Quality	Bit rate (Mbps)*
SD	2 – 5
720p	5 – 10
1080p	10 – 20
2K	20 – 30
4K	30 – 60
8K	50 – 80

Fig. 4 *Vimeo*. Video Bit Rate Compression Guidelines

To return to Vimeo's bitrate guideline statement, time is not mentioned, but size is. They note that if you are not happy with the size of the file then you can experiment with the different rates. This also implies an issue of time, as a higher quality is sure to add time to your render and a larger size will add to your upload time. That being said, while they are lobbying for highest quality input, this seems to be a blanket statement that attempts to cover the very complex facets and consequences of high bit-rate VBR and telling users that they can experiment is not much help.

CBR and VBR in the Field

Now that bitrate, compression and CBR and VBR have been defined and compared, let us examine the current state of the field of digital preservation and its use of the two types of encoding. I first encountered CBR and VBR in a production setting, when I was exporting a film restoration and creating a DCP. In other words, this was being done for access. However, upon questioning the effects of both CBR and VBR on the digital objects that were being created, I began to wonder if these were issues or decisions that archivists were contemplating in their

workplaces and to what degree they were being considered. My very broad questions were: how common is it for CBR and VBR to be selected? If they are being intentionally set, then is it on a case by case basis, or does an institution include one type of bitrate compression within their workflow and treat every video the same? How does this vary with preservation and access?

With these questions in mind and the research beginning to result in the notion that CBR and VBR both have pros and cons and that they the ultimate outcome is to make a selection on a case by case basis, considering on the institution's needs, capabilities and end goals, I began to wonder what the ethical implications of these individual selections were. Circling back to the Birks video that was used as an example in the "compression" section of this research, which revealed a very clear line between low bitrate and high bitrate, I began to wonder how one can reconcile the loss of information and quality in a video meant for access with the archival standards set in place. Should the end-goal really affect the decisions that we make in terms of a video's quality, even if we are saving an uncompressed master file elsewhere? Shouldn't all people have access to high-quality videos, regardless of its content or an institution's current hurtles? And if we are going on a case by case basis, then, who are we to favor culture and content and judge what is important in world memory? In an attempt to understand how institutions were tackling these issues, I began doing some preliminary research. Here are my findings:

First, I looked at several workflows by institutions that had decided to make theirs public online, namely, through the AMIA open workflows section of github. The Barbara Goldsmith Preservation and Conservation Department of New York University has published a guide for digitizing video for long-term preservation. In this guide, they do identify the bitrate mode for

access copies (Internal Access DVDs: VBR 7mbps).[xix] A number of online workflows, for example CAVPP[xx], include bitrate information but do not mention CBR or VBR.

Archivists often use preexisting programs that dictate the format of a video. As such, I was wondering just how much their involvement was with determining bit rate and decided that the best way to obtain an answer was to ask people within the field. Ben Turkus, of NYPL, provided me with a very generous answer. Part of it was that if he is using Vrecord and decides to create, for example, a 10-bit uncompressed (v210)/24-bit PCM Quicktime file, the bit rate setting will come as a standard of approximately 224 Mbps CBR. Now, if he opts for what he refers to as "the best combination of all time", FFV1/24-bit PCM wrapped in MKV, the video stream, "which takes advantage of FFV1's super smarter compression algorithms, will be something closer to 98.4 Mb/s. This is an approximation, which raises another important issue: you should use a variety of tools to check bit rate attributes."[xxi] The result of this is that bitrate is usually packaged into these programs as preexisting settings, and it may not always be obvious to find these attributes.

I thought I would put one of the tools to find these attributes to the test myself by bringing three distinct video files of mine into MediaInfo and trying to find the Bitrate Mode. Here are the results: Video1 was a short clip that was transferred to my harddrive from the a Blackmagic camera. MediaInfo revealed that the bit rate was CBR set to 176 Mbps. Video2 is a rough-cut of a film file that was rendered out of avid, when I had no knowledge of bit rate compression, and would have essentially been setting this blindly or used presets that had these settings boiled into them. The MediaInfo reading also revealed that this clip was CBR set to 175 Mbps. Video3 is a file of the movie *Don't Look Now*[xxii], and MediaInfo was not able to tell me what mode the bitrate was in, only revealing that it was set to 1773 kbps. Of course, without

much of the context for each clip and the rest of their specs, these results might not mean much. However, the purpose of this exercise was simply to understand what information you can get when you are actively searching for it, to try and draw parallels with the statement that Ben Turks had given me about the need to use tools to examine bitrate attributes. The fact that the bitrates settings had been set on my own personal works in video 1 and 2 without any intention on the creator's part (here, myself), shines a light on the very problematic neglect of bit rate settings. We also need to consider that archives are receiving files by filmmakers, artists, and a variety of creators who also might not be paying attention to bitrates. In fact, these three files existed on my hard-drive for years now, and I have no idea why they are compressed the way that they are. Finally, the fact that MediaInfo was not able to tell me what the bitrate mode of Video3 *Don't Look Now* , is disconcerting. This means that beyond having to integrate bitrate settings into their workflows, archivists will have to analyze their files and conduct investigations to figure out what the bitrate mode of certain videos are, using more than one tool. The fact that MediaInfo, a tool that is used widely in the world of digital preservation, is not reliable in terms of providing this information, also shines a light on the way that archives perceive bitrate mode, or perhaps rather, their inattention to the subject. Echoing this remark of MediaInfo's reporting instability is a post on github in a mediainfo issues thread, wherein Ben Turkus flags a lack of representation for the audio bitrate of a file[xxiii].

To conclude, I have learned that between VBR and CBR, one is not inherently better than the other for preservation and access. Indeed, this depends on a given institutions priorities in terms of quality, upload time and file size. Where CBR takes less time to produce and upload, it provides limited flexibility in terms of quality, risking loss of information. While VBR might produce a higher quality depending on the maximum, minimum and target bitrate settings, it will

take longer to produce. In both cases, the file size will depend on the bitrate value settings, with the higher resulting in better quality and bigger file size. In addition to this, I learned that for the most part, CBR and VBR are not discussed thoroughly or are embedded in presets, which people might not question. However, for the places that do decide to set bitrate type based on the project at hand and depending on the priorities of the three factors, this leads to ethical questions in the archive such as favoritism at the cost of demand, when we really should be objective in how we distribute quality and offer accessibility on a larger scope. The accessibility portion of this argument also comes into play when archives will set up their workflows, considering the scope of a public they can reach (if this is a digital archive), depending on the bandwidth that is required to view videos.

The case by case basis for determining which type of bitrate will be chosen also presents an issue with standards and quality within the archive. If a setting isn't streamlined throughout, then would the access files not be uneven? The takeaway is that CBR and VBR truly do produce different results, especially if they are being used differently throughout one repository. As such, archives should integrate a standard for these settings within their workflows. Even if there are instances where the bitrate setting has to defer, for example, with different types of access files and methods of accessing videos, it is important to delineate these instances within the workflow and set the standards for the institution. That way, there is no question of cultural favoritism, and a convention will be set for future employees to consult.

Works Cited

Birks, Patrick. "The Basics of Video Compression." *Zion and Zion*, 6 July 2016, www.zionandzion.com/basics-of-video-compression/.

CalPreservation, 13 Mar. 2017, calpreservation.org/wp-content/uploads/2017/03/CAVPP-File-Specs-2017.03.08.pdf.

Clark, Jonathan. "CBR vs VBR Rendering in Adobe Premiere." *Soporific Airs*, 1 Mar. 2017, djbolivia.blogspot.com/2017/03/cbr-vs-vbr-rendering-in-adobe-premiere.html.

De Stefano, Paula, et al. "NYU Guides." *NYU Guides*, 2013. guides.nyu.edu/ld.php?content_id=24817650.

Edchelp. "Understanding Bitrates in Video Files." *Encoding.com* , 16 Mar. 2017, help.encoding.com/knowledge-base/article/understanding-bitrates-in-video-files/.

Turkus, Ben. "Re: Quick question about CBR vs VBR." Message to Anne-Marie Desjardins. December 6th, 2018. E-Mail.

"The Pros and Cons of Constant and Variable Bit Rates." *Supercircuits*, 9 Aug. 2012, www.supercircuits.com/resources/blog/constant-and-variable-bit-rates.

"Video Compression Guide." *video4change*, www.v4c.org/en/content/video-compression-guide.

"Video Compression Guidelines." *Vimeo*, vimeo.com/help/compression.

"What Is Bit Rate?" *Videomaker*, Videomaker, 9 Dec. 2013, www.videomaker.com/video/watch/tips-and-techniques/17316-what-is-bit-rate.

[i] "Video Compression Guide." *video4change*, www.v4c.org/en/content/video-compression-guide.

[ii] Birks, Patrick. "The Basics of Video Compression." *Zion and Zion*, 6 July 2016, www.zionandzion.com/basics-of-video-compression/.
[iii] Edchelp. "Understanding Bitrates in Video Files." *Encoding.com* , 16 Mar. 2017, help.encoding.com/knowledge-base/article/understanding-bitrates-in-video-files/.

[iv] "What Is Bit Rate?" *Videomaker*, Videomaker, 9 Dec. 2013, www.videomaker.com/video/watch/tips-and-techniques/17316-what-is-bit-rate.

[v] "What is Bit Rate?"
[vi] "Video Compression Guide."
[vii] Edchelp
[viii] Clark, Jonathan. "CBR vs VBR Rendering in Adobe Premiere." *Soporific Airs*, 1 Mar. 2017, djbolivia.blogspot.com/2017/03/cbr-vs-vbr-rendering-in-adobe-premiere.html.

[ix] Edchelp
[x] Stillman, Whit, director. *The Last Days of Disco*. 1998.

[xi] Clark, Jonathan. "CBR vs VBR Rendering in Adobe Premiere." *Soporific Airs*, 1 Mar. 2017, djbolivia.blogspot.com/2017/03/cbr-vs-vbr-rendering-in-adobe-premiere.html.

[xii] "What Is Bit Rate?" *Videomaker*, Videomaker, 9 Dec. 2013, www.videomaker.com/video/watch/tips-and-techniques/17316-what-is-bit-rate.

[xiii] Clark, Jonathan. "CBR vs VBR Rendering in Adobe Premiere." *Soporific Airs*, 1 Mar. 2017, djbolivia.blogspot.com/2017/03/cbr-vs-vbr-rendering-in-adobe-premiere.html.
[xiv] "The Pros and Cons of Constant and Variable Bit Rates." *Supercircuits*, 9 Aug. 2012, www.supercircuits.com/resources/blog/constant-and-variable-bit-rates.
[xv] Clark, Jonathan. "CBR vs VBR Rendering in Adobe Premiere." *Soporific Airs*, 1 Mar. 2017, djbolivia.blogspot.com/2017/03/cbr-vs-vbr-rendering-in-adobe-premiere.html.
[xvi] "The Pros and Cons of Constant and Variable Bit Rates." *Supercircuits*, 9 Aug. 2012, www.supercircuits.com/resources/blog/constant-and-variable-bit-rates.
[xvii] "What Is Bit Rate?" *Videomaker*, Videomaker, 9 Dec. 2013, www.videomaker.com/video/watch/tips-and-techniques/17316-what-is-bit-rate.

[xviii] "Video Compression Guidelines." *Vimeo*, vimeo.com/help/compression.

[xix] De Stefano, Paula, et al. "NYU Guides." *NYU Guides*, 2013. guides.nyu.edu/ld.php?content_id=24817650.

[xx] *CalPreservation*, 13 Mar. 2017, calpreservation.org/wp-content/uploads/2017/03/CAVPP-File-Specs-2017.03.08.pdf.

[xxi] Turkus, Ben. "Re: Quick question about CBR vs VBR." Message to Anne-Marie Desjardins. December 6th, 2018. E-Mail.

[xxii] Roeg, Nicolas, director. *Don't Look Now*. 1973.

[xxiii] bturkus. "Audio Bit Rate in ffv1/Pcm Mkv · Issue #304 · MediaArea/MediaInfo." *GitHub*, 7 Nov. 2018, github.com/MediaArea/MediaInfo/issues/304.