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Movie dynamics evaporated in recent years. Can we turn the tide?

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ABSTRACT

Loudness levels in movies have gone up and playback volumes in cinemas have consequently been lowered. Since many cinemas keep the playback level low for all movies, postproduction facilities were forced to adjust their playback level. These days, mixes for cinema are mixed less dynamic than mixes for television. A solution is proposed by setting a maximum for the Program Loudness of -27 LUFS (-21 LUFS for 'loud cinemas') and for the Short Term Loudness of -6 LUFS. Playback volume can then return to normal reference level.

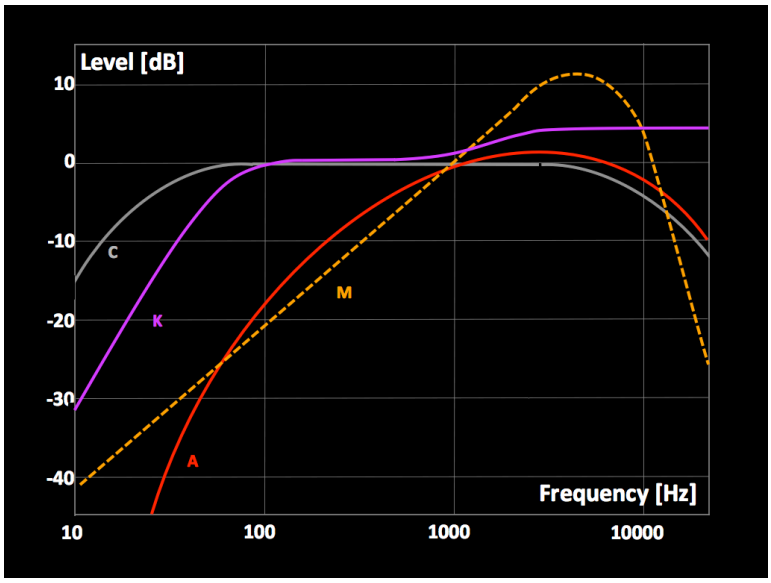
1. Introduction

In the 35mm days someone from Dolby had to be present during mastering. Masters were always printed with volume set to 7. The trend at the end of the 35mm era was already towards very loud mixes. People present during the mix of movies like Tron were advised to wear hearing protection. The audience does not appreciate this level anymore, there are lots of complaints.

In Belgium there has even been a case of hearing injury which led to legal action by the Belgian government. This will soon put an official limit to the volume. Cinemas now routinely put the volume setting much lower than 7.

With DCP the Dolby official is not present during mastering anymore and playback volume control during postproduction is also often lower than 7. The result is that headroom suffers. The current dynamics in the cinema is now smaller than that with a R128 television broadcast. Is there anything we can do to turn back to normal?

2. Backgrounds



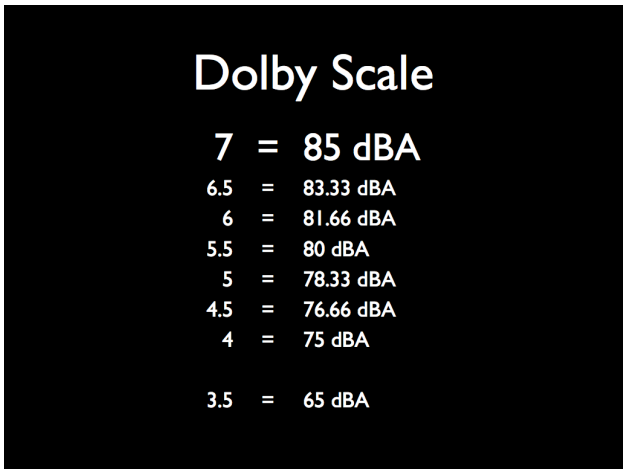
Here we have a graph that shows all weighting curces that matter to us. ‘A’ weighting is originally based upon the the 40 phon curve, but nowadays mainly used in Sound Level Meters to predict potential hearing loss by environmental noise. The ‘C’ curve that was originally based upon the 100 phon curve, finds some use in electro-acoustic system calibrations. The ‘M’ curve stems from Dolby. It is based upon the CCIR curve, which was developed for measuring the annoyance of noise. Ironically it is now used for measurement of commercials in cinema. ‘K’ weighting is the well know ITU1770 curve, developed for subjective loudness estimates of electrical signals. I will freely juggle with mixing A, C, K and M weighting in this presentation and I am aware that this is a compromise that is dependent on the spectrum of the sound.

Loudness measurements are routinely used with gating: either a foreground gate (PL) that takes all but the low levels into account, or a dialog gate (VL) that only measures dialog. Which one to choose depends on the goal of the measurement.

Since the director wants to have control of the loudness that his audience experiences, cinemas are calibrated in level. The SMPTE standard says that with the Dolby box volume set at 7, the special ‘Dolby noise’ signal should give 85 dBC per speaker. The bandwidth limited signal is designed in such a way that it also gives 85 dBC and even 85 dBM. It is 0 VU on the meter and its loudness is -21 LUFS.

This level is intended for a forte passage, it is quite loud. The average level of a movie should normally be app. 6 dB below that. In film work, using digital audio,

it was generally agreed that dialog levels were consistently running 30 dB below full scale, giving film audio 30 dB of “emotional” headroom. Dialog is therefore 7 to 9 dB below the reference level. This would be equivalent to app. 76 dBA.



The picture above shows the scale of the Dolby box volume control. The reference noise is 85 dBC at "7", 80 dBC at "5.5" and 75 dBC at "4". Below 4 the scale becomes 10 dB per 0.5 step. At 3.5 the ref noise is at 65 dBC. From the Dolby CP650 manual I quote:
"The main front panel fader knob on the CP650 controls the volume level in the theatre. It works in both normal and bypass operation. When the CP650 has been correctly installed, setting the fader to 7.0 plays the film at the level at which it was mixed. This is the proper level for any Dolby encoded film. Although a minor adjustment in playback level might be required under unusual circumstances, avoid significant deviations from the correct level 7.0 established by the installer. If the playback level is set too low, dialogue may be hard to understand; too high a level may cause complaints from the audience, and under extreme circumstances, can damage the theatres sound system."

Then somewhere something went terribly wrong.

The original SMPTE standard for commercials and trailers was 82 LeqM, which is approximately 6 dB above dialog level.

Next the standard nudged to 82 LeqM for commercials and 85 LeqM for trailers, or 9 dB above dialog.

Today commercials and trailers are all normalized to 85 LeqM. This because the experience is that trailers and commercials are played back at a much lower level than 7 anyway. In the Netherlands 3.5 is used for commercials and trailers, or 20

dB lower than '7'...
It's not just commercials and trailers that are played back much lower than '7'. Reason is the audience started to complain more and more about too loud levels of the main movie and cinemas have responded to that. There are good reasons for the complaints.

The Flemish association for Tinnitus and Hyperacusis has measured sound levels in a couple of cinemas in Belgium. They measured peak levels up to 118 dBA! How is that possible? Well: one channel is calibrated for 85 dBC at -21 LUFS and therefore peaks at app 105 dBSPL. But there's 4 channels (surrounds are measured as one), which means 6 dB more. With full scale clipping distortion you gain another 3 dB per channel, and of course close to a speaker the level can be higher than in the middle of the room. 118 dBA seems insane, but in theory it is possible. And the future is interesting. With Dolby Atmos every single channel is calibrated to 85 dBC. The Atmos peak demand is 115 dBC per loudspeaker. A system can have 64 speakers, or in other words the theoretical max SPL can be 133 dBC...

In Belgium September 2010 a 17 year old girl was struck with permanent tinnitus when visiting the movie Inception. This received a lot of attention from the press and the government. The cinemas are very actively limiting the volume now already. In Kinepolis' cinemas the absolute max is 5.5, position 5 is normal. This summer Belgian government will make a law for maximum allowed loudness levels in cinemas. They might put a legal maximum level to the volume control.

But in general it is not the hearing damage risk that makes cinemas turn the volume down. It's just that the audience complains during the break that the film is too loud, even long before it becomes a potential threat for their hearing. Another cause for complaints is that due to poor sound isolation loud scenes of the neighbors movie disturb their own. Because of this many cinemas turn the volume down and also modify the original calibration of the cinema. LFE's are often turned down to limit crosstalk to the neighboring room and many times the balance between C, L, R and surrounds is off. Nevertheless it seems like many cinemas are at least calibrated once in a while for a festival and I think the average cinema will be quite close to SMPTE calibration. Deviations from this are certainly not the main cause for a playback lower than 7.

We should emphasize that SMPTE calibration is important and should remain the reference, also in DCP times.

3. Signs from reality

I called a couple of operators of Art Houses and Multiplexes. My informal survey already shows a solid trend: no movie is ever played at 7 anymore, 5 is standard.

Commercials and trailers are routinely played back at 3.5, maximum 4. A check of the playlist notes of arthouse Studio K in Amsterdam reveils playback levels for the main movie between 4.2 and 5.

The operator of arthouse Louis Hartlooper in Utrecht tells me that every Thursday various parts of all movies are viewed in their cinema (this is much easier with DCP than 35mm). Even when movies move to a new cinema room, they are viewed again. The optimum level is set by ear and programmed into the DCP server. Almost always that level is between 4 and 5. Another arthouse in Utrecht, 't Hoogt, also previews every movie on Thursday's. On average they end up at 5.5, 4.5 was the softest, once in a while they come across a movie that can be played at 6.3. Their goal is that soft sounds should be audible, loud scenes not too loud. They want to avoid complaints by the audience. The experience is that in larger rooms the level can be a little higher than in small rooms. In the new film museum Eye in Amsterdam new movies are also previewed in the cinema. Because of it's main task, most movies are digitized old movies. The level varies, but many movies are projected at 4, the maximum after one year of opeation is 5.4. In Multiplexes the problem is that many of the bigger theatres do not employ true operators anymore. Everything is completely automated, a handful of people - mainly bar personnel - run the complete facility. The operational manager assembles the projection program in his office computer and most of the time sets the playback volume of the main movie to a default position. This can be 5 or 4.5. Trailers and commercials are often played back at the same setting as the main movie (which can be really loud), or at 3.5 to 3.8. In special cases such as the premiere in a major cinema like Pathe Tuchinski in Amsterdam, the movie is played back according the wishes of the director. But for the normal viewings, the level is always adjusted. For instance the recent James Bond premiered in Tuchinski cinema 1 at 7, and was played at 5.5 for the normal viewings (still leading to complaints).

A special case is Kinepolis in Belgium. For a Multiplex organisation they do care a lot for sound quality, installing high quality loudspeaker systems and taking care of proper acoustics. But they care even more for their visitors. The board of directors decided to put the standard playback level at 5, maximum 5.5, but still check every movie in its cinema. Often playback is then adjusted to even lower levels. Trailers and commercials are projected at 3.5. Kinepolis' main theatre, Metropolis 1 in Antwerp, has a continuous measurement system that monitors dBA levels and sends reports to the main office. This week an official report about SPL's in cinemas has been given to the Belgian government upon which a law will be based after summer. Unless the industry offers an alternative soon, the maximum playback volume in Belgium will be limited to probably 5 by law.

4. What this means for your mix

All this has a major influence on the mixes that are made today. The Belgian Art House hit "The Broken Circle Breakdown" was mixed in two versions. One for television with a Program Loudness of -23 LUFS. And one for cinema with a Program Loudness of -20 LUFS. The cinema version had a lot more compression to get dialog at the intended level with the maximum allowed playback level of 5.2 for this movie in the Belgian cinemas.

At the largest postproduction facility in The Netherlands, Cinemeta, playback level is now set to 5 by default. Last year a compromise setting of 6.3 was used, but this year complaints from directors that their film was too soft in the cinema were getting too strong.
I called director Dave Schram of Shooting Star productions. He told me "I always visit at least ten cinemas when my movie is out. In the past I always mastered at 7. But these days projections have a maximum at 6, more usual 5.5, sometimes even 4.7. This is mainly caused by audience complaints about loud movies. I have surrendered and now work at 5.5 myself." I even found cinemas that considered buying broadcast dynamics processors to control loudness automatically. Let's forget about this potential nightmare as soon as possible and look at what solution we can think of.

5. Measured levels in movies

First we need to have some objective figures. A first data point is the trailers and commercials. These are all normalized to 85 LeqM and then played back at 3.5, or 65 dBA. Current trend is that commercials and trailers are screened with only dimmed cinema lighting, so people can conveniently chat a bit. Appearantly 65 dBA matches that well. Some cinemas use a '4' setting for trailers, which is 10 dB louder or 75 dBA. These are viewed with lights off. Mark that this is approximately the originally intended dialog level and since trailers are very compressed, their dialog will indeed be at this level.

Another data point would be the long term dose that's allowed for hearing protection. Usually the figure used for that is 80 dBA for 8 hours, which is equivalent to 86 dBA for 2 hours. This means the limit for the Program Level should be approximately at reference level.

But as we now know, cinemas do not adjust their levels for hearing protection but mainly for audience comfort. A dose of 85 dBA over 2 hours is very loud for a movie and will not be accepted. A more appropriate standard level would be around 80 dBA. The Program Level of the SMPTE ref noise is just below -21 LUFS. 5 to 6 dB below that would be about -27 LUFS for Program Level.

Finally, in Europe limits do apply for maximum sound pressure levels in clubs. In Belgium, 100 dBA average level is used, in The Netherlands 105 dBA. A movie is not a pop concert however. In my opinion it would make sense to limit the short term (3 secs) exposure to 100 dBA. That would be a max S of approximately -6 LUFS. I repeat that I am aware of the differences between the various weighting curves. Measuring electrical A weighted levels however does not make sense either since that's also no true representation of the acoustical levels in the cinema. I think that A weighting should only be used with an acoustical Sound Level Meter, and the K weighted LUFS measure should be used in the electrical domain. A maximum of -6 LUFS for max S is a rough estimate, research is needed to find the figure that is right most of the time.

With this in mind, let's check a few movies. Together with Michel Schöpping, a well known film mix engineer in The Netherlands, I analyzed 24 (mainly Dutch) movies. They vary wildly. Program Level goes from -38 LUFS to -20 LUFS. Max Short term level from -29 LUFS to -8 LUFS. Max True Peak level from -7 to +3.5 dBTP. Dialog levels from -41 to -25 LUFS. The huge spread of about 20 LU with these levels gets much smaller when we take the playback level during mastering into account.

And then something interesting is found:
- The average PL for movies, mastered at '7' is -28 LUFS (-29 to -25).
- The average PL for movies, mastered at '6.3' is -23 LUFS (-25 to -21). They are projected 3 dB softer, so if we corrected the average to a '7' level, it would be -26 LUFS.
- The average PL for movies, mastered at '5' is -20 LUFS (all were -20). They are projected 7 dB softer, so the corrected average would be -27 LUFS.

This means that the intended average playback level of all these movies, regardless the volume setting during mastering, is about -27 LUFS. This is approximately 79 dBA in the theatre. There were a few exceptions, like the movie with a PL of -34 LUFS. This movie however was soft on purpose, it was a "silent movie".

6. Conclusion

Is there anything we can do to turn back to normal? We could use a similar strategy like with EBU R128. It's not by coincidence that two of the people behind that standard are sitting behind this desk, although I must stress that we are by no means representing EBU here.

In my opinion there's four requirements to start with:
- A solution must be compatible with the current cinema hardware, which often

are Dolby boxes. No new investments should be needed, only a software update in the DCP server.
- All SMPTE calibration demands should be kept in tact.
- The directors must stay in control of the level, but at the same time an objective measurement is needed.
- A comfortable overall loudness level should be guaranteed towards the cinemas, potentially damaging levels should be made impossible.

And this is my proposal of how it could be done:
1. Measure the Program Level and max Short term level of the movie in the DCP server.
2. If the Program Level is at or below -27 LUFS: just play it as it is. With low levels, the movie is probably intended as a "soft movie".
3. If the Program Level is above -27 LUFS, check if the cinema has set the "loud movie playback" option. If not, attenuate the sound track during playback to -27 LUFS. If yes, check if the Program Level is above the absolute limit of -21 LUFS. In that case, attenuate to -21 LUFS.
4. Check if max S is above -6 LUFS and also if max True Peak is above -1 dBFS. If so, attenuate accordingly.
5. The Dolby box is now set to 7 for a normal playback level. In small cinemas, a lower level can be selected. Such a calibration in principle only needs to be performed once.

Commercials and trailers undergo the same procedure but may get a standard offset by the cinema since they are often projected in dimmed light and conversation should then be possible. To get the current '4' level, this would be an offset of '1' Dolby position lower (6 in stead of 7 or 5.5 in stead of 6.5 etc). For '3.5' more attenuation is needed. I should mention that the foreground gate was designed to match wide loudness range material like movies with compressed material like commercials. So maybe no extra attenuation is needed.

This whole procedure can be easily done by a software update in the DCP server (which of course is just a computer, Windows even if I'm right).

The advantage of this proposal is that directors who like to use dynamics will have their artistic freedom back again. And cinemas and their audience will not encounter unpleasant loud surprises anymore. Loud playbacks are still possible in selected cinemas, with only slight limitation to protect the hearing of the audience. No investments are needed for the cinemas. The ITU loudness standard is open source and many broadcast tools can easily be adapted to indicate this cinema limits.

Obviously more research is needed and the proposal needs to be tested in practice.

To my opinion this topic can only be researched in cooperation with the cinemas, since they will only use a recommendation if it really solves their probem. I am glad to inform you that the Belgium Multiplex company Kinepolis has offered to participate in a pilot project testing a measure like the one I proposed. If this pilot is succesful, they will help us to convince the Belgian government to use a solution like this in their upcoming cinema loudness laws.

And to those who are opposing any type of regulation, I would like to say that you should be aware that paradoxically refraining from loudness measures to not limit creative freedom will definitely lead to a limited creative freedom, as is being proved right now.