

Know how to Hear

Part III

A public health matter

In this concluding part of the article, Pro Sound Systems magazine feels quite concerned to see everyone involved in this wonderful world of sound and music to secure his most valuable assets that are our ears.

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Recording industry may deserve some attention

It is difficult to imagine a sound engineer wearing earplugs while working during long sessions. Of course regular breaks are good to get some relief but everybody knows how much it costs when you rent a studio for a production. In a scientific study made in the US by Wesley Bulla and James Hall¹² in a studio where seven sound engineers were participants during a complete week, it appeared that the average workday was 10 hours. So for them the only applicable option is to monitor at a conservative levels between 80 and 83 dB(A) taking as general philosophy that repeated exposure to average SPLs of 85 dB(A) or above will result on the long term to hearing impairment. But as they rightly say OSHA, DOD or IEC standards have been set for permissible noise exposure for the industry. Furthermore the handicap that could result from prolonged noise exposure is generally defined for the frequencies known to be the most necessary for speech (500 Hz to 3000 Hz). For the safe side of the problem, you may say that music has nothing to do with the noise you may find in a automotive factory or in a printing workshop. This is right. But for the unsafe side if we consider that before a sound engineer is recognized as handicapped hearing people we may won-

der if this is the good approach. Also as Didier Gervais says: are sound engineers ready to go for regular audiogram tests, and are they willing to hear someone telling them that their ears have been damaged? Probably not. And this is why at the Maison de la Radio there is just one audiogram examination made when the sound engineer starts working there. There is no doubt that some sound engineers may have some hearing losses.

But Didier Gervais just wants to recall that the hearing system has some compensation process that can make hearing still pretty sharp despite some losses. And for him the sound engineers are quite good in this loss compensation process due to their high sound education and practice level. The conclusion we can bring here now is no more different than the one drawn five years ago by Wesley Bulla and James Hall. Much scientific work is needed to extend the current definition of noise exposure and audiometric assessment to the specific recording industry. For them, and we do share the same opinion, if we follow the OSHA criterion,

then one day we will wake up with our sound engineers witnessing noticeable and permanent hearing loss. But for the time being how should we set the sound level in a control room. In 1993 David Moulton¹³ was giving some hints that are still valid. He was used to send pink noise in both channels at a level of 0 Vu and from that he adjusted both monitors to get a resulting loudness of 90 dB SPL at his seat (about 84 to 87 dB SPL from each speaker. With this setting he could usually made his mixing with levels between 0 to -5 dB VU, with highest levels that never go higher than +3 dB Vu. Of course usually a sound engineer doesn't spend all his time at mixing with these levels. He has to perform other tasks that



For Didier Gervais, director of the recording studios at La Maison de la Radio (French broadcasting corporation) here sound engineers are used to work at relatively moderate levels compared to their colleagues working for TV studios.

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Table 1: Average continuous sound level exposure allowances calculated in dB(A) SPL.

Time exposure	16 H	12 H	10 H	8 H	6 H	5 H	4 H	3 H	2 H	1 H	½ H	¼ H
dB(A) France	85	87	88.4	90	92	93.4	95	97	100	105	110	115
dB(A) OSHA	80	81.7	82.7	84	85.7	86.7	88	89.7	92	96	100	104
dB(A) DOD	82	83.2	84	85	86	87	88	89	91	94	97	100

In this table the law of equal energy is applied to calculate the permissible noise exposure according to the following formula:

$$\text{Permissible Exposure (dB)} = \text{Ref. Exposure} - k \times (\log T/8)$$

France:	Ref. Exposure = 85 dB(A)	and	k = 10	T = Duration of exposure in hours
OSHA:	Ref. Exposure = 90 dB(A)	and	k = 16.61	
DOD:	Ref. Exposure = 84 dB(A)	and	k = 13.33	

can accommodate with much quieter levels.

The perverse effects of audio compression

As we have already mentioned it, sound level is one thing that deserves some attention, but the dynamic range shouldn't be forgotten as it may play an important role in the final result to sound exposure. For Yann Coppier and Thierry Garacino record labels and artists have more and more recourse to audio compression¹⁴. Thanks to audio compression there is a kind of sound energy profit, a sort of drug-taking or boasting musical attitude which the public has quite some feeling for. So why should we deprive us of it? Usually the audio compression enables sound engineer to adapt the dynamic range of the audio signal (about 70 dB to 90 dB for a symphonic orchestra) to fit the dynamic range of the sound carrier that will be used for distribution, whether it is a physical medium (45/50 dB for a LP vinyl record¹⁵, or 96 dB for a CD) or a broadcasted signal like FM (35 dB). Here on one hand we want to avoid signal saturation, and on the

other hand we want to have the quietest part of the signal at a certain level above the noise floor to make it audible. The audio compression can be used also for artistic reason or aesthetical reason. We can recourse to it in order to obtain a better intelligibility of the audio content. In its principle audio compression consists in reducing the space between maximum levels and minimum levels. By doing that you can increase the average sound level of a recording without taking the risk of saturating the sound carrier you are going to use. All along this recording you will get a good definition of the sound. With the increase in the number of FM radio stations using this technique, audio compression has become a common practice, but not only for good technical reasons. As there is a legal limit to the loudness of sound on the air, the only way to sound louder than the competitor is to increase the average sound level. This can be easily achieved by means of audio compression. So louder you are perceived, the greater are your chances to be better heard than your competitors. And thus started the race for compressors

and with each station catering their own special sound identity. Sometime we call this specific audio compression technique: signal densification. This practice has spread through the record industry and recording studios. In the pop music business producers share the idea that the way to get your record on the air (and as a result selling it) is to make it as loud as possible. So again, as the loudness of your medium is subject to physical limitation, the only way to sound louder is to have heavy compression. Some records are now so heavily compressed that their dynamic range is contained just within a few decibels. To let oneself be convinced of this audio compression drift, Yann Coppier and Thiery Garacino set up a very interesting study that covers over the years different types of music. The demonstration they put in place for us was definitely speaking for itself and could reveal the potential hidden dangers of audio compression. About rock music they started in 1971 with the emblematic rock group Led Zeppelin which at that time was all the rage and its music was regarded as aggressive and

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violent with its sound level measured at -16.8 dB¹⁶ with its "Rock'n Roll" track. In 1979 the "Sex Pistols" band is shocking the subjects of her Majesty with "God save the Queen" that furiously exudes its sounds at -15.5 dB. But all this may appear totally atonic when compared to the devastating track "People = Shit" played by the Slipknot with its -9.5dB. As we can see with the screen-shots that Yan Coppier has captured for us, in a 30 year period time we went from a raging music that had still room to give us a breath, to a "submerging" (and always subversive by essence) that you may term "suffocating" sound.

When a top model wins by 5.5 dB against Led Zeppelin

But Rock'n Roll is no exception when audio compressors have to play their part with the band. In a totally different genre of music Yann and Thierry made an astonishing demonstration with melodic music. Let's get back in 1964 with the famous singer Jacques Brel¹⁷ who sings "Au suivant" ("Next"). With this song we get a singer who in his expression will have light and shade into his voice using a large dynamic range within an harmonious orchestra that never submerge

the song. The hearing result is of very high clarity. Everything is at its place and can be heard. Average sound level is -20.5dB. In 2003 the French superstar model Carla Bruni turned singer. With her album "Quelqu'un m'a dit" (Someone told me) she took France by storm. As she has not the kind of sound chest that Celine Dion can offer, Carla Bruni is rather whispering her sweet song in your ear than singing for a large audience. Never mind, people like her intimist performance. But would you believe that with her whispering "Quelqu'un m'a dit" song, you get a level of -11.3 dB in your ear. In this song there is no rhythmic section which of course contribute to a certain degree to the absence of dynamic. We get a sound which is plastered and at the end we have lost the deepness, the clarity and the space we had with Jacques Brel. So as Yann Coppier so rightly says "Carla Bruni literally blows up the Sex Pistols and Led Zeppelin". It means that thanks to audio compression Carla Bruni is able to generate in terms of energy 5.5 dB more than Led Zeppelin. This difference is huge. What should we say now considering the 7.3 dB sonic inflation that we get when switching from Led Zeppelin to Slipknot? It is absolutely surprising

how much louder it is possible to make recording sound by crushing the dynamic range. Thanks to that the sound engineer can significantly increase the average transmitted power and eliminate at the same time any risk of saturation when peak levels arise. So now for some record labels and artists, audio compression is nothing else than a gun to march for the loudness war. To illustrate this subject Yann Coppier and Thierry Garacino gave us some screen-shots that we reproduce here. As louder seems to be the rule to be heard, audio compression is not just used for music. Everybody has already experienced the advertising spot shouting at the TV. Just to draw your attention and make sure you won't miss the message, the dynamic range is severely crammed into few decibels.

So looking to these screen-shots we can see that the 0 dB horizon is more and more darkening over the years. What we should remember from this demonstration and that should incline young people listening to walkman with earphones to be cautious, is that music with heavy audio compression is permanently delivering an average energy quite higher than the same sound would do with no compression. In

Audio compression through the years according to Yann Coppier et Thierry Garacino		
<p>1971 : Led Zeppelin « Rock'n Roll » Average level = - 16,8 dB</p>	<p>1977 : Sex Pistols « God save the Queen » Average level = - 15,5 dB</p>	<p>2001 : Slipknot « People = Shit » Average level = - 9,5 dB</p>
<p>1964 : Jacques Bre l« Au Suivant » Average level = - 20,5 dB</p>	<p>1981 : Michel Jonasz « Les fourmis rouges » Average level = -17,5 dB</p>	<p>2003 : Carla Bruni « Quelqu'un m'a dit » Average level = - 11,3 dB</p>

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terms of acoustic and music, the result is a kind of smashed music where instruments have lost their true sounds and singers deliver an over-voiced message. For our ears there are no more periods, even if they are short intervals, during which our auditory system can get some relief. This insidious trend or drift increases listener fatigue and in case of prolonged listening will inevitably lead to hearing loss that may be permanent. Unfortunately this phenomenon is a reality and statistics are there to witness the importance of young people experiencing already serious impairment of hearing. Our society can not turn a deaf ear to this.

Heartfelt cry of the choir

What comes out from all this that there is a steady tendency to listen to music at louder levels. Without noticing it this phenomenon is becoming an integral part of our culture which finds itself immersed in a more and more noisy environment that pushes us to push up the volume. Our civilization like free electrons under heat excitation, generates noise. About this point it is interesting to note that the conference hall where we held this workshop had an intrinsic noise level of 55dB. Due to this the organizers had to set the level for the demonstrations to 70 dB in order to make the listening comfortable and audible for all attendees. Christian Hugonnet comes to the idea that this sound level inflation has consequence for all of us in the way we speak. Everybody would tend to speak louder and according to his experience this phenomenon is quite noticeable with the kids since they attend the nursery school. One could wonder if in this context the phonatory and language training mechanisms with young children are not distorted in a profound manner due to the disturbances they might get at the auditory-phonatory pair (with its complex feed-back mechanism) level. It is already possible to witness the harmful effects of this loudness contagion with young musicians for who it is more and more difficult to play pianissimo. So it is really



It is time to shout: save our choristers.

time now to give a shout and sound the alarm, failing which we would see shortly the disappearance of our so much beloved young choristers who have been brought back to the front scene with the French movie "Les Choristes".

Pro Sound Systems magazine is very much aware of this situation and feels quite concerned to see everyone involved in this wonderful world of sound and music to secure his most valuable assets that are our ears. Thanks to this auditory treasure that nature took so much time to give us through the evolution of the mankind, music finds its way to offer us a wealth of emotion. So it is Pro Sound Systems' responsibility to have this "cri de coeur" and to salute Christian Hugonnet's initiative and by the way the numerous associations all around that fight with the same energy for the sake of our ears. If these initiatives are not aiming at big noise, the minimum we can do here is to echo them at least.

Jean-José Wanègue

To know more on this subject:- We highly recommend you a visit of the web site Nous vous conseillons la visite du site web « Promenade' round the cochlea » that has been made by the university of Montpellier under the scientific management of the professor Rémy Pujol.

<http://www.iurc.montp.inserm.fr/cric51/audition/index.htm>

The aim of La Semaine du Son is to awaken public awareness about sound and the need for quality in our sound environment. Several institutions will be hosting and actively participating in this weeklong event: the Bibliothèque nationale de France, Ircam, the Cité des sciences, Unesco and Radio France. La Semaine du Son is supported by the Ministry of Culture and Communication (Department of Music, Dance, Theatre and Performance), the Ministry of Family



Protect your Ears with PocketEar: a judicious device created by Brüel & Kjær. PocketEar is designed to help you look after your hearing by showing you the noise level in the environment you are in. A red light will appear if the level exceeds the pre-set level which can be one of three levels – 65, 85 or 105dB. For further information: <http://www.bksv.com/default.asp?ID=2538>

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Health and People with Disabilities, the Local Delegation for Research and Technology (the Ministry's Delegation for Research and New Technology), the National Film Centre, the Rectorate of the Académie de Paris, and various organizations (SACEM, INA, ISIS: the association of audiovisual manufacturers and providers, etc.). Newspapers, magazines, television and radio stations are also lending their support. During these five days, leading experts and specialists will be conducting sessions, open to the public and free of charge. ■■

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Footnotes

¹² Noise exposure in the studio: a scientific study » in Audio Media – January 1999.

¹³ “About the loudness of sounds and the risk of hearing damage” by Dave Moulton - 1993

¹⁴ Please do not confuse with data compression which aims for a reduction of the bitrate.

¹⁵ Finest vinyl can reach 60 dB.

¹⁶ For all these examples, the sound levels display negative values as measured in dB with regard to the maximum output of the playing device which has been set to 0 dB by convention. This measure has nothing to do with the sound pressure level (SPL) used for listening which depends on the amplifier and its setting.

¹⁷ Jacques Brel was Belgium and became an artist of international renown with famous songs that have been adapted in English : « If you go away » or « If we only had love ».