COMPARING HEADSET TECHNOLOGIES

The Two ANRs - Active Noise Reduction *vs* Adaptive Noise Reducation

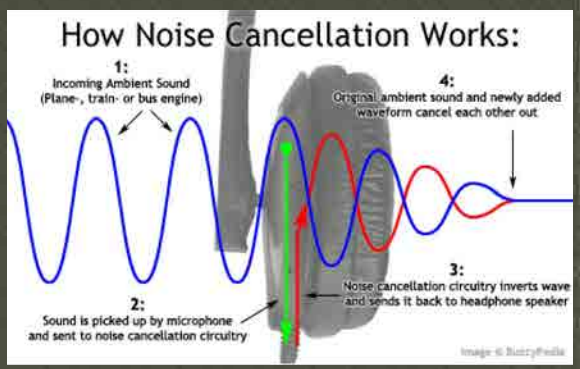
ACTIVE NOISE REDUCTION

Active Noise Reduction (ANR), also known as Active Noise Control (ANC) has been around since 1934, with its first commercial applications in helicopters and airplanes in the 1950s. Needless to say the technology is old and there are newer technologies, such as Adaptive Noise Reduction (discussed later), that are more advanced and effective.

ANR uses a microphone to pick up a constant noise and then replays that noise inverted (180 degrees) through a speaker, so that the peaks and valleys of the sound effectively cancel each other out. See FIG. 1. This process is called interference and phase cancellation. It is important to note that ANR can only attempt to cancel constant noises without a variable frequency, which means for example that gun shots or wind cannot be affected by the ANR system and that engines that accelerate and decelerate are not effectively cancelled either. ANR is also is not a full spectrum anti-noise solution and the best systems on the market will only work between 20Hz and 500Hz, whereas human hearing is generally accepted to be 20Hz-20,000Hz, this leaves a large gap in the frequency spectrum where ANR does nothing.

The absolute best ANR on the market provides about 10 decibels (dB) of noise reduction in the low frequencies (20Hz-500Hz). This system is an earmuff/earcup style headset and not an in- ear style headset. The muff allows for more room to have a larger speaker to produce the inverse anti-noise. A larger speaker with a soft diaphragm produces the best low frequencies and enables a Resonant Frequency (Fo) in the range of ANRs frequency sweet spot (20Hz-500Hz). Fo is the speakers natural resonance.

FIG. 1



All this means that ANR systems are affected not only by the type of noise it is trying to cancel but also by the size and type of the anti- noise speaker, which means that not all ANR systems are created equal and some ANR systems on the market may not do nearly as well as a simple good passive earplug (standard non-electronic earplug) with a high dB rating.

THREAT4™

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ANR IN PRACTICE

Let's say that an in-ear headset on the market has a passive noise reduction rating (NRR) of 22dB and this same system also boasts an ANR system. If we infer that that the ANR system produces an extra 6dB of noise reduction, we have a total noise reduction of 28dB, however that will only be 28dB where ANR is effective which is below 500Hz, leaving the rest of the spectrum at 22dB. It is important to note that NRR ratings are an average and at specific frequency ranges there may be less or more attenuation.

ANR CONS

- Only works in low frequencies (20hz-500hz) human hearing is 20Hz-20,000Hz, and therefore most of the spectrum is un-protected (potential hearing damage outside ANR spectrum)
- Hissing sound caused by ANR circuitry
- Potential dizziness, light headedness or headaches caused by ANR frequency manipulation
- Large power draw
- Is a fixed solution and can only process audio in the fashion the circuit was designed (not adaptive)

ANR Pros

- Can help alleviate fatigue from exposure to low-constant noise (originally intended for pilots)
- Increase dB protection from constant noise in the low frequencies (only 20Hz-500Hz)

ADAPTIVE NOISE REDUCTION

Adaptive Noise Reduction is a true full spectrum noise reduction technique that is managed by an algorithm that adapts to the users environment. This system can only be implemented when there is more than one (1) microphone per side for the talk-through/hear- thru system. Threat4`s 62000 has two (2) mics per side for a total of four (4).

In an Adaptive Noise Reduction system one (1) mic is used as the primary mic and the second (2) as a reference mic. In a noisy environment, both microphones receive noise at a similar level, but the primary mic compares that constant noise that the secondary mic hears, and substracts the noise. This means that most of the unwanted noise is cancelled while the desired sounds (human vocals) are retained. The net effect in this type of system is the removal of noise found anywhere in the spectrum from 20Hz to 20,000Hz while being tuned for human vocals.

A good Adaptive Noise Reduction system can remove 12dB of noise in the entire spectrum. When coupled with a good passive earplug, this can greatly reduce all unwanted noises no matter what frequency they fall in.

To put this into practice: if a passive earplug provides a 32dB decibel reduction on average, you can add on up to an additional 12dB of hearing protection with Adaptive Noise Reduction on. Since Adaptive Noise Reduction is not using noise to cancel noise, but rather just does not replay the unwanted noise, there is no risk of ill effects on the body, yet the pros of a traditional ANR system remains.

→ Threat4's 62000 uses Adaptive Noise Reduction in Mode 3. Headset can also be muted so that only passive plugs and radio audio works in Mode 2.

COMPARING HEADSET TECHNOLOGIES

Audio Compression *vs* Audio Limiting

COMPRESSION

If you have ever called someone on their cellular telephone when they were somewhere loud like a bar or a sporting event, you would have noticed that the background noise was nearly as loud as their voice; this is audio compression. Audio compression attempts to narrow the difference in loudness between sounds, attempting to equalize them to the same decibel (dB) level. The effect is that quieter sounds appear louder and louder sounds appear quieter.

COMPRESSION IN PRACTICE

There are headsets on the market in both the in-ear and over-the-ear form factor that use compression to achieve bionic ears, and it does work - sort of. What happens is that noises that would be quieter to the human ear, such as a truck in the distance, become louder and closer sounding (bionic) as compared to the closer sounds, such as the person you are talking to. So if you are speaking to someone face-to-face and a truck off in the distance is idling, both the truck and the persons voices are heard at close volume levels, making conversations (speech intelligibility) difficult.

Audio Limiting

Audio limiting simply limits the sound coming through the system that are too loud. Limiting is not to be confused with clipping, limiting just lowers sounds that are too loud, whereas clipping cuts out the sound. The 62000 uses audio limiting, which means you hear sounds as your ears would. Farther and quieter sounds sound lower and farther away, and close and loud sounds, sound louder and much closer in comparison.

→ The 62000 uses Limiting Audio in Mode 1 & 3 and increases sensitivity of the mics (instead of compression) for bionic ears in the following increments: 0dB, +2dB, +6 dB, + 9dB, +12dB via its single button volume control. Left and right volume can be independently controlled on the headset (or be factory synchronized) or can be controlled in unison on the PTT.

COMPARING HEADSET TECHNOLOGIES

Boom Mic *vs* In-Ear Mics for Radio Transmit (TX)

IN-EAR MICS

In-ear mics are what are found in traditional in-ear headsets. The radio transmit mics are located in the ear canal. They allow for a small form factor solution but their design has inherent problems.

In-ear mics are found inside the ear and are designed to pick up audio that is generated by vocals and resonates within the ears fatty tissue and bones. When an operator is in a normal environment and without any vibrations the system works well, background noises are not heard and radio transmission is relatively clear, although not as clear as if the voice was picked up from audio waves as oppose to body resonance. The two main issues with in-ear mics occur in high vibration and quiet (whispering) environments. When the body is exposed to vibration from rotary vehicles, tracked vehicles or running, the in-ear mics vibrate as well and this vibration noise is transmitted over the radio waves when the PTT is depressed. You can replicate this noise if you stick your finger in your ear and wiggle it. In a quiet environment where the operator wishes to whisper the sensitivity of the in-ear mics must be increased to pick up their voice, this is usually achieved by a "whisper" mode. Unfortunately this mode would have to be toggled by the operator manually when the environment is loud again, and normally this is during operations when loudness is unexpected and uncontrollable.

Some in-ear systems also shut down one ear, turning off talk-through, upon PTT depression as the talk-through mic doubles as a radio transmit mic. This sensation is disorienting and bothersome, as you effectively become deaf in one ear while you depress your PTT.

From a mechanical standpoint there are several issues with traditional in-ear headsets. The main issue is that there are sensitive electronics that make the system work housed in a small and breakable earbud. The nature of the design makes it that your ear and potentially a small friction fitted holder bear all the forces that may occur from the earbud cables snagging, while crawling for example. Operators have often complained that the earbud falls out then gets broken. Not only is hearing protection and radio comms compromised when a bud falls out, but the system no longer works without a costly replacement.

The 62000 earbud harness system has no electronics whatsoever and is field replaceable for a couple dollars. This feature is also handy from a hygiene perspective when operators share headsets, where each operator can have their own earbud harness.

BOOM MIC

The boom mic has always proved to provide the clearest radio communications. It is mechanically isolated from the body so is unaffected by vibrations. It can be spoken into loudly or in a whisper and is always secure and available for transmit. The boom mic has a noise cancelling feature which greatly reduces the transmission of background noise, similar to an in-ear mic.

→ The 62000 uses a waterproof noise cancelling boom mic in either a Dynamic or Electret version

COMPARING HEADSET TECHNOLOGIES

Independent Comms *vs* Integrated Comms System

INTEGRATED COMMUNICATIONS

Integrated communications systems means that the audio system for radio transmit and receive are part of the audio system for talk-through. This means:

1. If the electronic system of the headset fails or runs out of power you can no longer use the radio
2. Typically in a traditional in-ear system one of the talk-through mics shuts down when transmitting audio, making you essentially deaf in one ear every time you transmit.
3. Radio audio goes through the headsets electronics and is therefore not as the radio manufacture intended. May have delay, clarity, and volume issues.

INDEPENDENT COMMUNICATIONS

In an independent setup the headset electronics standalone and are completely isolated from the radio's audio. This means that the headset's radio system would have its own radio receive speakers and its own radio transmit microphone. The main benefit of this is failsafe radio communications, meaning that in a catastrophic headset electronics failure, radio receive and transmit would always work when using a Dynamic microphone setup. This can be tested by removing the headset's power source to simulate a failure, in a military connector that would be the center pin of the standard DoD connector. A secondary benefit of an independent communication system is that the radio audio, both receive and transmit, are not altered or even touched by the headset manufacturer, meaning that the radio clarity, volume and transmission speeds are exactly as the radio manufacturer intended.

→ **The 62000 has independent communications and is available in either Electret or Dynamic Mic configurations.**

COMPARING HEADSET TECHNOLOGIES

1-Mic *vs* 2 Mic (For Talk Through/Hear Through)

2 mic system allows for the use of Adaptive Noise Reduction,
see THE TWO ANRs - ACTIVE NOISE REDUCTION VS. ADAPTIVE NOISE REDUCTION

COMPARING HEADSET TECHNOLOGIES

In-Ear *vs* Muff (Over-The-Ear) Headsets

OVER-THE-EAR (MUFF STYLE) HEADSETS

These are the age old headsets that most people are familiar with. They are traditionally big and bulky. The farther the cup ended from the ear the better the hearing protection. When the military wanted to use these, the cup profile had to be greatly reduced so they would fit under the helmet. This greatly reduced the hearing protection. Using muff style headsets with helmets have long caused comfort issues, not only with heat but with pressure points called hotspots, generally caused by the headset's headbands. The muff headset requires a band to put pressure on the cups to form a seal around the ear which prevents sound from entering freely. This seal requirement inherently squeezes the head and the band gets sandwiched between the head and the helmet. Behind-the-head bands try to address the hot spot problem and do work, however they allow for less sound attenuation as they afford less pressure on the cups around the ears. In addition the band is typically outside the helmet under the back of the helmet which makes neck articulation difficult, particularly in the prone (on your stomach) firing position. Muff style headsets in either behind-the-head or over-the head styles have been also know to affect the cheek-to-stock weld required for proper aiming and firing position.

IN-EAR HEADSETS

In-ear headsets are much smaller and lighter in size and allow the outer ear to be open to the air, which is crucial for temperature control. In addition they deliver the audio directly into the ear canal which affords a much clearer audio receive from both the radio and the talk- through system. This improves speech intelligibility. This increased audio quality is due to both the proximity of the audio to the ear as well as the fact that in-ear headsets typically use the much more advanced digital audio processing technology, not the analogue technology typical of most muff style headsets. Digital technology can be tuned across various audio bands and honed in on human vocals. Some higher end headset, such as the 62000, use hearing aid style algorithms to replicate the human ear even while the ear is protected from noise. In addition digital audio processors can do electronic noise elimination called Adaptive Noise Reduction, which can remove unwanted background noises on top of the passive removal of noises that the earplug offers. In- ear headsets generally offer better hearing protection than muff headsets, and they are not affected by hair or glasses that may compromise the seal of a muff style headset.

→ **The 62000 is a hybrid in-ear digital headset that uses hearing aid style algorithms, Adaptive Noise Reduction and a 32-39dB Noise Reduction Statistic (NRS)**

COMPARING HEADSET TECHNOLOGIES

Headborne Electronics *vs* PTT Mounted Electronics

PTT MOUNTED ELECTRONICS

Traditional in-ear headsets have their brains housed in a remote box that doubles as a PTT. This setup works fine, except requires the operator to switch out the entire headset & radio harness. This includes the radio patch cables. What this means is that legacy radio patch cables & PTTs, which are sometimes custom and expensive, become obsolete. PTTs and radio cables are simply required to bridge the connection between the radio and the headset and generally are still fit for service. The traditional in-ear headset is effectively a headset system, instead of simply a headset.

HEADBORNE ELECTRONICS

With headborne electronics, the headset is independent of any other control box. This means that the headset can plug into any existing legacy PTT and radio cable or plug directly into a 3rd party control system such as a NETT Warrior system, without the need for a redundant secondary control box.

Being able to simply upgrade the headset side of the system, allows existing PTTs and radio cables to remain in service thus greatly reducing the cost of upgrading and the speed of deployment of a new headset.

→ **The 62000 has Headborne mounted electronics for a total weight of 136 grams.**

COMPARING HEADSET TECHNOLOGIES

Ultra Low Power Components *vs* Traditional Componentstronics

Traditional headsets use standard components and audio processing technologies like ANR (Active Noise Reduction) which use up a lot of power and therefore typically require their own power source. The 62000 uses hearing aid style technology using very little power (peak 6mAh) which allows it to parasitically draw power from the radio without affecting the radios performance, effectively eliminating the need for its own battery supply, which reduces weight, size and re-supply logistics.

→ **The 62000 can run off the radio's powersupply and only requires peak 6mAh**