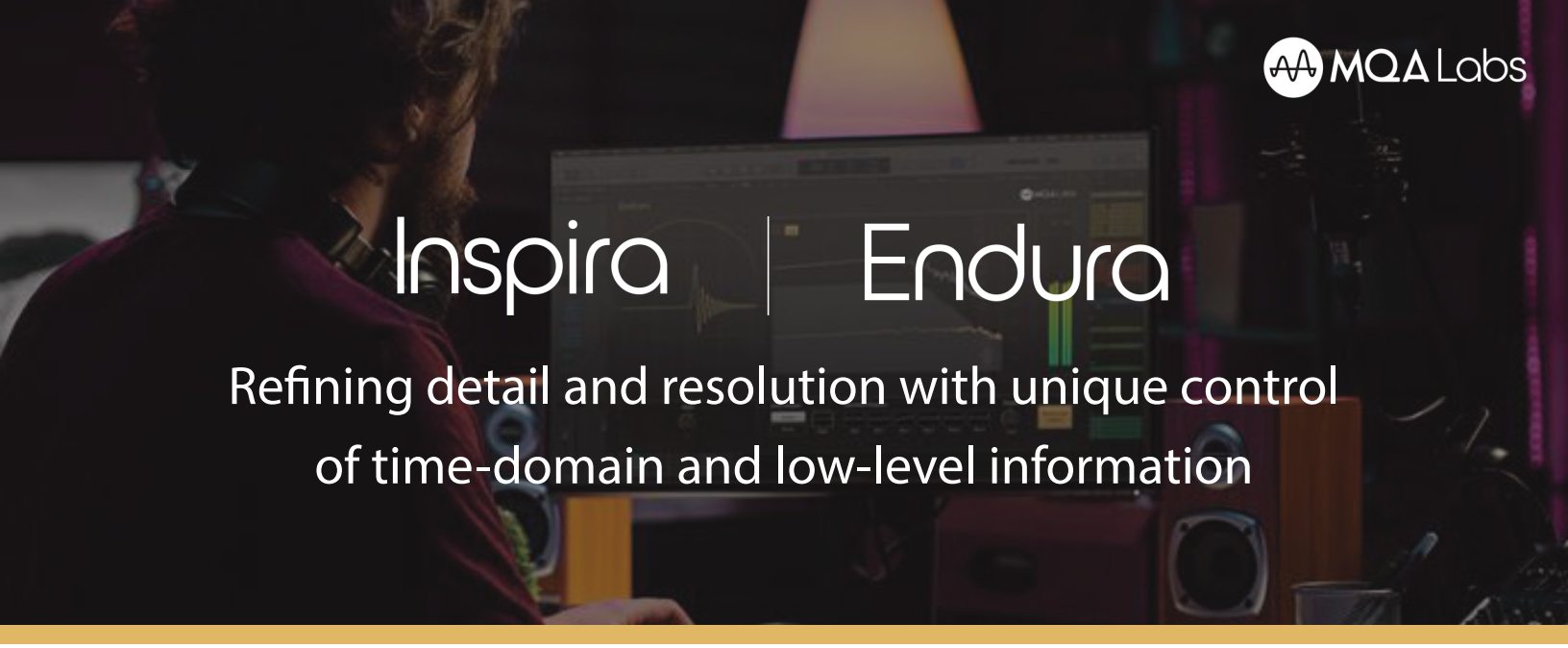

MQA Labs

Inspira | Endura

Refining detail and resolution with unique control of time-domain and low-level information

Background

Human hearing is fascinating and has evolved with us in the natural, analogue world. It works wonderfully to tell us things that are important to us. Our hearing protects us from danger and allows us to detect things we may not yet see. It's quite a complex and beautiful system that goes beyond just the simple mechanics of turning sound pressure waves into electrical signals in our brains.

The music we love has also evolved with us over millennia in the natural, analogue world, travelling in air.

For decades, the industry has been using digital techniques for capturing audio. The methods to digitally record, store or distribute the analogue signal cause it to deteriorate through the addition of noise, distortion, and other unnatural artefacts. People noticed that listening to music through a digital system was a much different experience to that of an analogue system. While digital no longer had the problems of wow, flutter, warping, skipping, scratches and inherent noise, it was also noted that it lacked the same sense of space and subtlety and conveyed a distinct flatness.

For many, the fundamental question remains, *"Why doesn't digital audio sound more like analogue?"*

Many argued that sampling frequency was too low, or that increased bit depth was required to improve resolution at lower levels. Others felt that drift and imprecision in the timing of the recording and playback circuits (jitter) was to blame. Yet after these issues were addressed, it was still widely understood that even the best digital recordings failed to measure up to our best analogue experiences.

Time Is of The Essence

When an analogue signal is digitized, it is represented as discrete steps through the mathematical technique known as quantization. That process introduces errors as modulation noise, which our hearing can detect. Throughout the production and playback chain, including the conversion back to analogue, errors are introduced which contribute to a cumulative, unnatural smearing of individual sounds.

So how do we make a digital recording that sounds as good as analogue? The answer is attention to time. Recent discoveries in neuroscience show the precision of our hearing when listening to sounds with fine time detail. We can perceive distinct auditory signals as close together as 7 microseconds [1-3].

As it applies to music perception, it provides the fine texture, clear delineation and spatial impression of musical instruments. The key to resolution, therefore, lies in time domain accuracy.

Digital conversion processes use filters conventionally designed in the frequency domain with the intention of preserving all the audible frequencies of human hearing. Due to choices made decades ago and based on technology of the time, conversion filters most often targeted the very edge of our audible hearing range. The filters are designed to let in all the frequencies up to a point, but then sharply filter out those beyond that point. They may look perfectly fine on a frequency plot, but when viewed in the time domain we discover something very unnatural.

Figure 1 shows the response of a standard digital system to a very transient input. Imagine a clave or striking a cowbell with a drumstick being played into a digital recorder.

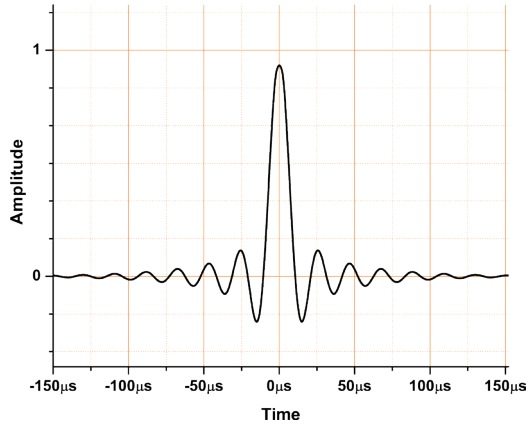

Figure 1: Response of a standard digital system to a transient input.

As we would expect, it reveals the ringing after the impact. That is what happens in nature. However, it also shows ringing ***before*** the impact which is entirely unnatural. You should never hear the reverberant effect of the room before the actual stick hit.

It is this fundamental discontinuity in how digital systems operate that informs the core of our approach for preserving resolution. As illustrated in **Figure 2**, at MQA Labs, we design systems so that sound behaves as it does in the natural, analogue world, as we hear music traveling through air.

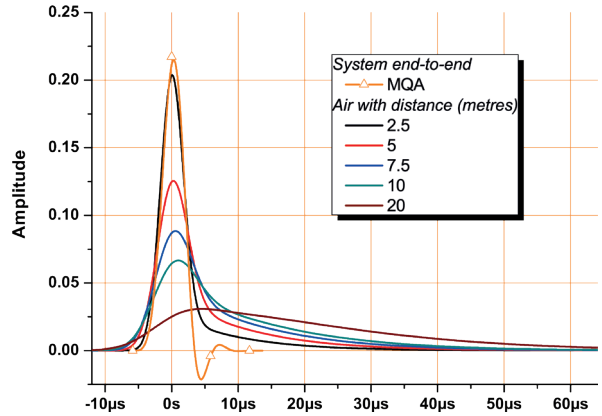

Figure 2: Response of an MQA Labs system compared to how air reacts to the same stimuli.

Inspira Plugin

The Inspira plugin (main window shown in **Figure 3**) is designed to avoid the unnatural time domain effects of the analogue-to-digital converter (ADC) and allows the user to preserve resolution in their recording. We believe this is essential at the beginning of the process because it makes it possible to layer tracks and subtleties in the recording that would otherwise be masked by the errors that are introduced.

Figure 3: Inspira plugin UI.

The Inspira plugin is to be used across recording, overdubs, and mixing. It provides two core functions:

1. **Clarity Control**. This is a mechanism used to shift unwanted and unnatural time distortions. As shown earlier in this document, **Figure 1** illustrates unnatural response. **Figure 4** shows the response out of the Inspira plugin, which moves the pre-response to after the main peak. The user will decide how much adjustment to apply. This includes the ability to move artefacts back in time. In some cases, it can be useful to undo a process where too much post-ring had been applied previously. Let us know if you find a creative way that the pre-ring has helped!

2. **Noise Shaping and Dithering.** For enhanced resolution, it's important to dither the musical signal with a very small amount of noise. This dither tightly constrains time-smear and allows us to hear details below the noise floor of the recording. The other key to this is shaping the noise away from the most sensitive parts of our hearing range, where the dither accomplishes its function without being audible. The UI shows a real-time rendering of the noise floor of the recording. The user can then select from several pre-determined shapes, while the Depth knob will shift the shaped noise up and down to achieve the maximum resolution. The noise-shaped dither works most effectively when moved up from the lowest level. This should give the greatest resolution, but the user has ultimate control.

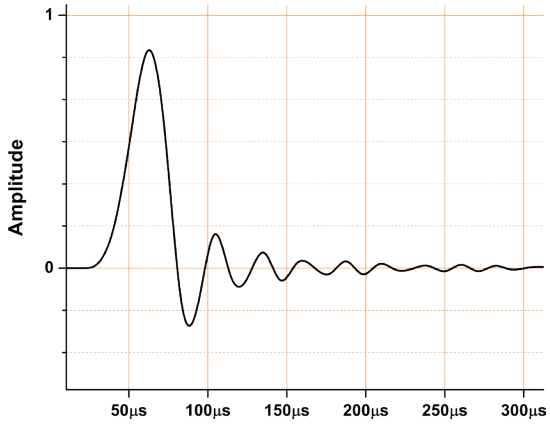

Figure 4: Response of Inspira plugin.

Note: If the **FOQUS by MQA Labs** ADC has been used upstream of the Inspira plugin, it will automatically configure itself to avoid "overcorrection" to the signal.

Endura Plugin

The Endura plugin shares some concepts with the Inspira plugin and contains key differences. The Endura plugin is meant to be used on the Output Bus as the last process in the chain after the master fader.

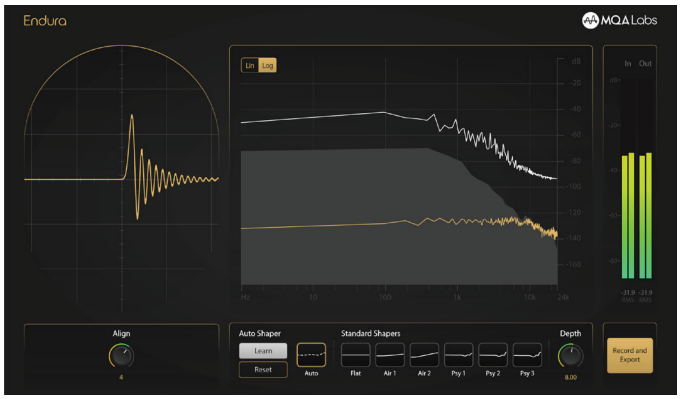

Figure 5: Endura plugin UI.

Figure 5 shows the main window of the Endura plugin.

1. The **Align** and **Depth** functions work together to enhance the entire mix, much like in the Inspira plugin.
2. **Custom Noise Shaping and Dithering.** In addition to a selection of standard shapers, one of the key features of the Endura plugin is its 'Learn' mode. This is where the noise floor is analysed to create a noise shaper, uniquely customised to the track. Following its analysis, it will:
   - Return with its optimised suggestions for both Align and Depth
   - Allow the user to compare the custom noise shaper to the standard shapers. *Note: Though the plugin will select the placement of the chosen Auto shaper below the noise floor of the recording, the Align and Depth settings can still be custom tuned.*
3. **Export**. The user can capture and record their track with the settings that were chosen, and export in WAV or FLAC formats.

The plugins by MQA Labs provide a new window into revealing all that digital music has to offer. With its unique take on enhancing resolution in the time domain, these tools provide each music creator and engineer the tools to take their productions to levels only the best analogue productions could achieve.

References

[1] Krumbholz, K., Patterson, R.D., et al., 'Microsecond temporal resolution in monaural hearing without spectral cues.' J. Acoust. Soc Am., 113, No. 5, 2790–2800, (2003) https://doi.org/10.1121/1.1547438

[2] Kunchur, M.N., 'Temporal resolution of hearing probed by bandwidth restriction', Acta Acustica, 94, 594–603 (2008)

[3] Kunchur, M.N., 'Auditory mechanisms that can resolve 'ultrasonic' timescales', AES 128th Convention, London, (May 2010)

[4] J. R. Stuart and P. G. Craven, "A Hierarchical Approach for Audio Capture, Archive and Distribution," J. Audio Eng. Soc., Vol. 67, (2019 May). Open access: https://doi.org/10.17743/jaes.2018.0062

[5] J.R. Stuart, and P. G. Craven, "The Gentle Art of Dithering," J. Audio Eng. Soc., vol. 67, no. 5, pp. 278-299, (2019 May.). doi: https://doi.org/10.3813/AAA.918069

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