The recording of a raw signal.

Who Said Tape Recording Is Obsolete

This article describes how technology that was thought to be obsolete is once again in action.

WHEN TAKING measurements and analysing the vibration directly on site we can find ourselves in situations where time does not permit trying various measurement types with various parameters. The reason is that the running time of the machine is too short to be able to take the readings repeatedly.

Run up and coast down are the typical examples of this situation. The risk of setting up the measurement parameters inappropriately or making a mistake in setting up phase can be quite high, especially with the added pressure of knowing that the measurement cannot be repeated.

Radomir Sglunda
Managing Director,
Adash Ltd.,
sglunda@adash.cz

My personal experience happened when we were supposed to measure explosion vibrations in a quarry. The preparation had taken the whole day due to the sheer volume of explosives involved. Moreover, the measurements needed to be taken synchronously from many sensors placed in different spots at various distances from the point of detonation.

The required measurement report should have contained time waveform from each sensor and a graph showing the energy decay curve with respect to the distance from the detonation centre. We had set up the amplitude trigger so that the wave from the detonation coming to the first sensor would start the measurement.

Naturally we had used a pre-trigger (250ms), so we could see the noise just before the detonation. We were all nervous as we counted down to detonation; we held our breath and the explosives were detonated.

Troubles Ahead

When we viewed the signal we instantly knew something had gone wrong. There was no expected low noise at the beginning with the sudden increase from the blast energy. There were high blast amplitudes present from the very beginning of the measurement (in the first sample as well) and they decreased with time.

Something had gone wrong. We opened the setup menu in the analyser with a trembling hands and immediately realised what had happened. Instead of a 250ms pre-trigger we had set up a 250ms post-trigger!

We had lost the whole beginning of the detonation signal and the measurement had started 250ms after the wave reached the sensor. This meant that we could not perform the analysis as ordered by our customer.

Trust me – it was very hard to explain to the customer why we could not perform the analysis. When we jokingly suggested performing the detonation once again, the customer did not find the idea funny at all. This was an example of a perfect situation when a recording should have been done of the whole event and post analysed.

In this case, the recording would have been started manually and allowed to run maybe up to a few minutes before the explosives detonated and then manually stopped. This approach would have eliminated the need for the pre-amplitude trigger that resulted in the disastrous experience described above.

Another situation, when it is better to record the raw signal, is a measurement of a machine that continuously changes its state. This can be caused by change of power or other similar condition. An elevator engine is another example; first here is a short run-up, then the elevator runs constantly for a while, then it stops.

The whole cycle can take just a few seconds. It is better to make a recording of the whole cycle and then pick up the required part of it and analyse it. The record can be required also in route collection. All required readings (for example overall values, spectrum and time waveform) can be processed from the record in the computer later.

The History of Tape Recorder

When I started to work in the field of vibration diagnostics a long time ago in the 1980s, tape recorders were used for signal recording. Back then they were

The record can be required also in route collection.

huge and heavy devices, so a strong guy was needed to perform the route with this equipment. To analyse the recording a separate "analyser" was needed. This device was even bigger and heavier than the tape recorder!

In the 1980s the first "portable analysers" appeared on the market and they caused a revolution in the field of vibration diagnostics – especially in route measurements. The tape recorders were quickly abandoned as all of their readings could be saved at this stage to the memory of the portable measurement device. The readings were saved, but the "raw record" was not.

The processors were too slow to record the raw signal, and the memory was too small to save such a large amount of data. To those who are much younger than me, I need to say that the hard disc in my PC in 1990 was an impressive 10MB. Since it was impossible to save a large file, I had to always consider the trade-off between the values of saving 400 or 800 lines of resolution in the spectrum and to save higher resolution was only done for very special circumstances.

Nowadays, when the capacity of memory seems to be unlimited, it is very difficult to explain to customer that 25 600 lines in spectrum is not necessary. His response to this can be that it does not harm anybody to save the spectrum with more lines.

It is true when we are talking about the route measurement, when the readings are repeated in long time interval such as days, weeks or months. However, when we start to think about the online monitoring, then the situation changes dramatically. If 25 600 line spectrum is set up on dozens of channels and the readings are taken every second, then even today's conventional memory discs can be filled very quickly.

We could not perform the analysis as ordered by our customer.

During these early years I had repeatedly wished that I could have implemented a version of the "tape recorder", so that when back at the office I would refer to it when I had discovered that my set up in my portable analyser would be different if I had the chance to do it over again. As a manufacturer of vibration equipment, we patiently waited until processor performance and memory size would be high enough so that we could revisit the option to integrate the recording option again.

"Tape Recording" Is Now Available Again

The Adash 4400 VA4Pro recording module was later developed and the "digital tape recorder" is now a reality again. The "recorder" is one of the 11 modules that is included in the analyser. To utilize the recorder, the first task is to set up the channels from which we want to record.

Today we can record 4 AC and 4 DC channels simultaneously. When using eddy current (proximity) sensor, we connect the sensor to the AC and to the DC channel in parallel. We can record the AC signal for factors such as orbits and DC signal (gap) for getting the centreline.

Because of the large memory available, the record length does not have to be defined before the recording. Usually the recording is started and stopped manually.

The recording can also be triggered (started) by an external TTL signal, so recording will start when the signal is detected and then stops when the signal is gone. Because of the high processor speed and memory available, a sample rate of 64kHz (25kHz frequency range) is commonly used although during the post processing much lower frequency and resolution settings are normally sufficient for analysis.

The fs=64kHz sample rate offers an amazing 160 hours of single-channel recording time or when utilizing all four channels and a speed sensor input over 32 hours of continuous recording can be done. Once the recording is completed, the signal is displayed on the screen. You can then select the portion of interest to crop and save and delete the rest if you wish to minimize unnecessary use of memory. ■

Part 2 of this article will be released in issue 3/2016.

A technician performing machinery vibration diagnostics.

RECORDING – Back to the Future (Part 2)

The recording of the raw signal was described in the first part of this article. Now we will move on to the post-processing of recorded raw signal.

RADOMIR SGLUNDA,
Managing Director,
Adash Ltd.,
sglunda@adash.cz

THE TWO MODES most commonly used to post-analyse the raw recorded signal in the Adash firmware is the Analyser and Run Up/Coast down. You can post-analyse immediately after recording in-situ or in the office at a later date. The Analyser mode offers a wide range of readings: simple (overall value), commonly used (time signals, spectrum) or more advanced readings (frequency response).

The Run up/Coast down mode enables readings to be continuously measured and saved. This means that you can set up the time interval between two readings (example: the reading is taken every second) or the interval depends on the speed change (the new reading is taken when there is a speed change of more than 1 Hz from the previous saved reading).

You Can Make Time Run Faster....

If the record of run up, for example, is 20 minutes long, then post-processing in normal mode the play back time is real time (20 minutes). This creates a situation in which it is the same as if you had walked back in time and were doing an evaluation right next to the machine, but you have the advantage of playing back multiple times with a different setup until you have the data analysed at optimum resolution and frequency.

In the event you do not want to wait 20 minutes to have the data analysed, then we have developed a very unique feature – the time can run faster. One minute can be reduced for example to only one second. It is done by special block data access and a bulk current evaluation algorithm.

The speed up of time is inversely proportional to the complexity of the required analysis. In the case of processing the simple readings like overall values, we can make the time even 1000 times faster (it means that 1 hour of recording is processed in 3 seconds). In the case of processing more complex readings, such as order analysis that requires relatively a long computing time, we can make the time only typically 50 times faster.

The big advantage coming from this feature is user freedom to try different setups and view the different results in a fraction of the time. It allows the analyst to "experiment" as if in the field and to repeat the data collection process on the equipment.

Virtual Unit in the Computer

Up to this point, we have been talking about the use of an instrument for recording and also for analysis. However there are more options. The recording

can be easily transferred from the instrument memory to the computer (by USB cable).

A version of the firmware running on the VA4Pro unit is available to download and run on your PC or Windows Tablet. This is the 4410 Virtual Unit VA4Pro software and it is available free of charge to download from www.adash.com.

This software is a fully functioning version of the firmware running on the VA4Pro unit. Once the virtual software is loaded onto your PC you will have the same screen as that which appears on the A4400 VA4 Pro analyser. Initially it was developed for marketing purposes, as it enables a potential customer to work with a virtual version of the VA-4Pro Analyser.

WITH RECORDING FUNCTION YOU WON'T MISS ANY IMPORTANT INFORMATION HIDDEN IN VIBRATIONS.

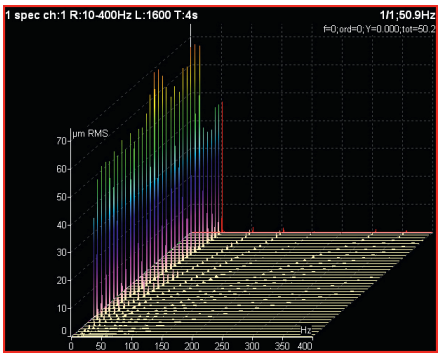
As a result we quickly saw the benefit of being able to process the saved recordings taken in the VA4Pro on the PC. Although the mouse and keyboard, (or touch screen if using Window 8 or 10) makes this process much faster and more user-friendly, the main advantage is the superior processing speed and power of most PC's as compared to the CPU in the Adash VA4 results in much faster analysis time.

Share Your Records

The simple explorer-based file architecture allows you to export the records in .wav format and share with colleagues so they can utilize it with various software platforms. Although you can play the .wav file by audio output in your computer and then connect the analyser to perform the analysis, it is of course not the best solution because the frequency range starts at over 20Hz. The conversion from digital to analogue also is not painless, but it is better than nothing.

However, an Adash provides a much more elegant solution on how to share the recordings with your colleagues who do not have the VA4 Pro analyser. Remember – a fully functional version of the VA4Pro firmware can be downloaded for free from our website.

Once downloaded onto your PC the recorded raw data files can be shared without restrictions and analyzed by anyone who wishes. This can be a very powerful tool when the data is collected (or recorded to be more exact) in one location, but analysed at will by various analysts that may have varying perspectives on what is of interest; then the results are collaborated and discussed.



Post-processing of data.

The SAB Paired to a Laptop is the same as the VA4 Pro analyzer

We don't necessarily need the VA4Pro instrument to create the record. The Adash 4404 SAB (Signal Acquisition Box) unit, which has the same AC/DC inputs as A4400 VA4 Pro is available. Simply upload the license file that corresponds with the SAB 4 Channel module into the 4410 Virtual software then connect the SAB to the laptop or tablet using a standard Mini-USB and your PC or table becomes a four channel analyser with all the features of the VA4.

Many users prefer this alternative as the navigation is much easier, it can be shared real time with others by utilizing the wireless and remote desktop connection. This application also offers a unique option to "stack" up to four SAB units, which turns your PC into a 16 Channel monitor.

The small SAB units are much cheaper and easier to ship, and they are can be more conveniently transported in a backpack with a few sensors and cables rather than having the burden of a large hard transport case and all the accessories needed.

What about the Future, Recording Only?

The possibility to make a recording is also available when collecting route data. It means that you can make a recording for post-analysis apart from common route readings (overall, spectra...).

And what is our vision of the future? Why should we take common readings such as overall values or spectrum in the route? Why don't we just make a recording of the raw signal and do all analysis later in the computer interface?

We have been considering these futuristic visions in our company for some time. It is obvious that the voices of opponents will appear and they will be saying that they need to see the results of measurements at the site, which is true for the analyst.

On the other hand there are companies where the routes are taken by technicians or even operators who don't know much or anything about vibration. In that instance a record is a better solution when technically feasible as the "remote analyst" then has more options. He/She can review data as in standard route mode, but also has the option to post analyse in higher resolution or frequencies should the need present itself.

We have been cooperating long time with our customers in the nuclear power industry to develop this platform for condition-monitoring. There are thousands of measurement points at that site, but only 2 vibration specialists to analyse the data.

In this case they could not manage to take all the readings, so maintenance personnel have simple data collectors to record the data and then the vibration specialists can post-analyse. When more advanced data acquisition is needed then the vibration specialist would use advanced analysers and leave his desk. ■