

Smart attack: some thoughts on Internet noise monitoring

By John Shelton

History

There's nothing like moving house or office to unearth some old project from the past, and while unloading all my shelves of documentation, I happened upon an old presentation I put together more than 20 years ago when I started AcSoft. Lovingly crafted on overhead transparencies using WordPerfect and Freelance Graphics, it extolled the virtues of PC-based instrumentation, which is what we peddled at the time, but also made some rash predictions for the next 20 years.

One prediction was that PC-based systems would become commonplace, based on emerging operating systems and hardware, and that dedicated instruments would not fade away, but become more "consumerised". This means that sound or vibration meters would be built for specific tasks, become cheaper, and much more widely available.

It's fair to say that PC-based systems are now industry-standard, and most noise and vibration acquisition systems now consist of a front-end combined with software running on a PC or similar device.

Similarly, dedicated sound level meters are now widespread, and much lower in cost. A Class 1 sound analyser that used to cost more than £10,000 is now available for little over £1,000, and specific applications, such as STIPA, can be built into low-cost devices.

Not a bad prediction then, except that the idea of using the Internet in noise and vibration applications completely passed me by. At least I was in good company - Microsoft famously made the same mistake, and it could be said that they have only caught up in recent years!

Generally speaking, though, we are using our modern kit for broadly the same purposes now, as we were 20 years ago. Noise enforcement, aircraft and road noise, product development, product quality, building acoustics, health and safety etc all have a set of procedural standards to which we adhere, with instrumentation standards ensuring the quality of our instrumentation. These have of course been tightened over the years, and now BS EN 61672:2013 lays down some tough criteria which must be met before an instrument system is labelled Class 1.

This is as it should be, but it also creates a "closed" market, with some innovations being stifled in favour of doing the same thing, but faster/cheaper. Rather than widening the appeal and application of acoustic measurements, the tendency has been to keep it amongst "the professionals".

Ultimately, a Class 1 sound level meter can only be made so cheap, a large part of that cost coming from the condenser microphone, which in many cases is still hand-built by angels on the south face of Happy Mountain.

The Internet of noisy things

The ubiquity of the Internet, along with new technologies, now challenges that, as well as making completely new possibilities in democratising noise measurement.

The first idea to come along is the "Internet of things" (IOT) where any device can now be connected via the internet to provide data and also control our environment. This is not just happening with noise - it applies also to your refrigerator (order some more milk on Supermarket.com when you're running low), your car (tells the dealer when you need a service and what parts might be needed), weather data (real-time online weather for the budding sailor) or air pollution (redirect traffic to avoid build-up of particulates). The list is endless, but one thing is clear - all the information is easily available to Joe Public, and perhaps no longer in the hands of the closed-shop professional. Noise is just another number (albeit a difficult to understand

decibel), but it makes sense that noise, pollution, vibration, temperature, UV radiation, rain, etc. are just part of the information flow.

The idea of the 'Smart City' is now with us, where our environment can be managed to improve the quality of urban life, and also make large efficiency savings.

Smart cities

The Measurement and Instrumentation (M&I) Group in the IOA regularly runs one-day meetings covering aspects of noise and vibration measurement. One such meeting was organised by Ben Piper, a member of our committee, last year called *Sound sensing in smart cities*. It was a fascinating day, which covered exciting stuff on instrumentation and data management.

NPL has been working for some years on new microphone technologies such as MEMS to see if it's possible to make a low-cost microphone meeting accepted standards of accuracy. The idea of this is to make noise monitors so cheap that they can be widely deployed in a network, for urban and other applications. A MEMS-based microphone was developed and demonstrated to meet Class 1, albeit in a "traditional" package.

Similarly, the Dreamsys project showed how data from such a system could be collated and publicly presented as part of a noise management programme.

I had the opportunity to visit NPL recently and see the latest developments. Ben and his colleagues are now working with a little box based on a Raspberry Pi, with Class 1 MEMS microphone, measuring Leq and 1/3 octaves (!) and delivering the data to the Interweb. Very impressive considering the whole hardware cost is around an order of magnitude cheaper than a conventional system. Trial sites include a large railway development in Central London, and around a large airport in the London area.

Of course, they are not the only ones doing this kind of thing - Azimut Monitoring in France have networks which measure noise and other air pollutants; the *Sounds of New York* project have many noise monitors deployed and feeding data in real-time; and European projects such as DYNAMAP are working towards dynamic noise mapping.

Measurement Quality

As the M&I Group, we should of course ask questions about the quality of such noise data. Does it meet recognised standards like BS EN 61672? How do you calibrate it? Is the cost-saving in hardware irrelevant if the cost of deployment and maintenance dominates? Should it be Type-approved?

The measurement accuracy of any system is normally defined by the purpose for which the data will be used. If certifying the sound power of a machine, or settings limits to noise exposure, or certifying aircraft engines, or testing pass-by noise of cars, then clearly the instrumentation must meet very tight standards, and demonstrably so.

Is the same true of wide-area noise monitoring/mapping? Perhaps we are more interested in trends, rather than absolute accuracy. Is it noisier today ▶



Figure 1: The NPL Raspberry Pi-based noise monitor with MEMS microphone

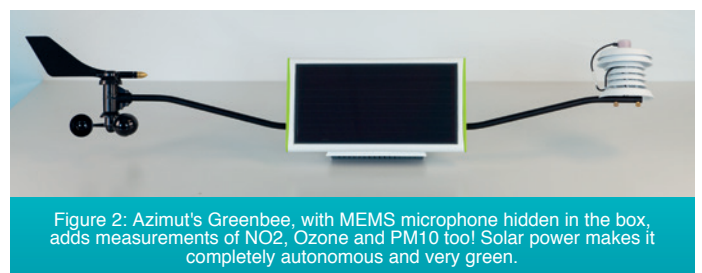


Figure 2: Azimut's Greenbee, with MEMS microphone hidden in the box, adds measurements of NO2, Ozone and PM10 too! Solar power makes it completely autonomous and very green.

than it was yesterday? What was that loud noise at two in the morning? Do we only need to measure over a limited range? Noise in London for example rarely falls outside the range 45-65 dBA, so why measure it with an instrument that can measure linearly from 20 up to 140 dBA?

Taking the example of the Raspberry Pi, some even have a MEMS microphone on the PCB, so why not use this and forget Class 1 completely?

Perhaps we can use a different quality-of-life indicator too, on a simple scale A-G instead of confusing decibels?

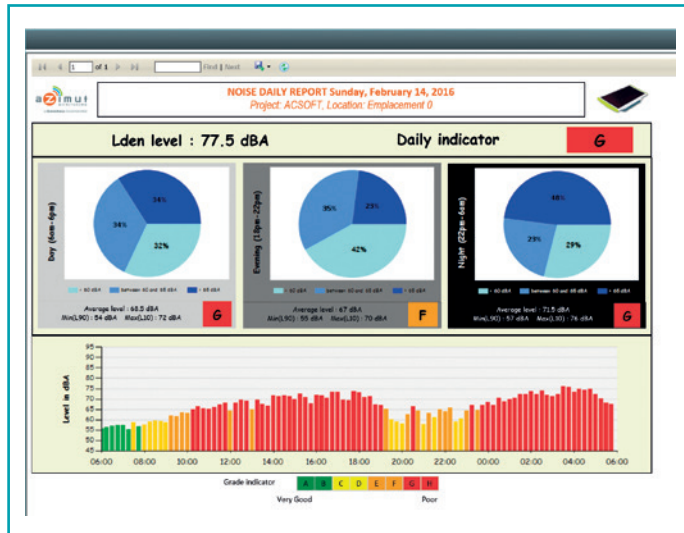


Figure 3: An example of different QOL indicators as well as Lden dBA

Calibration

We are all familiar with calibrating our sound measurement instrument, using a reference source to confirm we are measuring the right levels. For a remote noise monitoring system, this could also be done by such techniques as electrostatic actuation, or insert voltage.

Regular calibration of, say, 300 noise monitors could be a real chore and cost for the operator, negating the cost advantage of the hardware. Perhaps other techniques could be used.

Again, NPL are working on this – by looking at the statistics of the measured data, e.g. $L_{A,50T}$, it's possible to spot slow trends, indicating system calibration drift, or system failure (obviously wrong data). As the network is so widespread, all you need to do is flag or ignore the data until the monitor has been visited and fixed, just like a faulty light bulb in a street lamp, on the next maintenance round. You could also put in a couple of regular expensive noise monitors to provide a sanity check to the data.

This is a great example of doing things differently, rather than just doing the same but more cheaply.

Summing up

The idea of this article was to be thought-provoking, as we move to an even more connected world. Of course, all the traditional players are watching with interest – is this the end of the sound level meter? How will we pay the mortgage in five years' time?

Of course, the “legal” metrology will continue, with the associated costs, standards and procedures and will undoubtedly feed future meetings of the M&I Group.

But noise (and other pollutant) monitoring over wide areas will become widespread, perhaps with completely different technologies and methodologies. Exciting times indeed!

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