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Further Comments on “The Hum”

-by Bernie Hutchins

In the past, here we have often offered reports, summaries, and comments on “the Hum” [1-10]. My comments are also often found on Glen MacPherson’s excellent website [11]. In addition, I often respond to direct emailed questions, since my email address is often attached to comments, and is easy to find. As a consequence of there being three possible outlets, I sometimes find it hard to determine exactly where some issue has been addressed, or even if it was actually published/posted. In any event, below are some issues that probably ought to be summarized in a webnote.

PITCH MATCHING

We have noted that the usual “Hum” often has an apparent associated notion of a “pitch” which may (or may not) correspond to an actual acoustic phenomenon. Because of the low pitches (50 to 100 Hz) and low levels, this is a difficult experimental test, even for folks with good musical ears and audio engineering experience. While Glen has a column on his tabulation to list a matched pitch, mostly folks don’t fill in anything. (Even when they do, they often enter a wide range instead of a single number, and curiously, values for consecutive entries often repeat.) As noted [10] we are most impressed with the fact that there is a scatter in the reports as opposed to a tight cluster.

FIRST HUM THE HUM !

Here is an idea that I know I have suggested somewhere but can’t find posted. Instead of trying to directly match the Hum to a tone generator, first “hum the Hum”. By this I am suggesting that you first sing (hum softly) a matching pitch. Because this is

likely to be a very low pitch in the range of 50 Hz to 100 Hz (NOT a normal singing range even for the male voice), this takes a small amount of practice. You more or less have to “buzz” it so don’t worry about a fine vocal technique, and try it in private if you are self-conscious! You can, however, adjust your pitch quickly and intuitively, without any equipment. This is essentially the same way you sing in tune with a group. Because your own humming will probably shut down the Hum, this will be an alternating A↔B situation. Then start up the tone generator (using saw or square) and match the computer tone to either or both of the Hum or your singing-hum. You will get beating with the vocal hum. This “hum the Hum” scheme may make matching easier.

WHY DO YOU SAY YOU CAN’T HEAR BELOW 100 Hz VERY WELL?

This statement strictly refers to sine waves (pure tones). Our sensitivity (Fletcher-Munson curves) [12] famously show this. With anything other than a sine (e.g., square or sawtooth), all bets are off. This is because for a sawtooth of say 70 Hz (hard to hear the 70 Hz fundamental) there are easy-to-hear harmonics (140 Hz, 210 Hz, etc.) which support a strong 70 Hz pitch. That is, the “missing fundamental” [13] is heard.

It is useful here to take examples of vibration rates that are not only low audio, but well below what we consider to be actual hearing. (After all, a hammer pounding a nail has a repeating pattern of something like 1 Hz.) So, take a plastic ruler and hold 9 inches of it off the edge of your desk, holding the three inches on the desk with firm pressure with four fingers. “Pluck” the end, and you will see it vibrate in a blur, but won’t hear anything. (If you do hear a “slapping”, press the four fingers down harder to the desk). Now pluck it and immediately touch the vibrating portion ever so lightly with a fingernail, and you will hear the clicking (at a sub-audio rate – perhaps 20 Hz) as the energy damps away. That’s right – you hear a click rate of impulsive sounds.

Another way to make this point is to use a popular online tone generator.

http://onlinetonegenerator.com/

Set it to a 2 Hz sine wave and you won’t hear anything. Now change to a sawtooth and you will hear clicking at a 2 Hz rate. These are the discontinuities (resets) in the saw. Couldn’t be clearer what is going on – like a tapping hammer. Now change to square and you will hear clicks at a 4 Hz rate. This is because there are two discontinuities per cycle of the square (one the positive-going step, the other the negative-going step).

The same general issue was posted in response to a commenter, Steve, who was a musician reporting a pitch of 68 Hz for the hum (and a curiosity about a thunder storm). Here is my response (one edit in [ ]):

Bernie Hutchins

AUGUST 12, 2017 AT 9:31 PM

Steve – good report – thanks

The 68 Hz is consistent with the C to C# as you know. Your remark about using a square wave reminds me of a question I have answered by email to someone but I don't think it was here on Glen's blog. Paraphrased:

" You say that frequencies of say 50-70 Hz are very hard to hear. Middle C is 262 Hz, so these frequencies are just two octaves below middle C (which would be 65.5 Hz) and there is more [than] a full octave even below that on the piano, which I hear just fine. What are you saying??? "

Well, it is pure tones below about 100 Hz that start to get difficult. In contrast, supported by harmonics (as a piano string is, and tone generators are, if you use anything OTHER than a sine wave), the low pitches are quite audible. We don't actually know what the waveform of the Hum is – no one has ever recorded/displayed it. (Happy to be proven wrong if so.) If we had to guess, it almost certainly has harmonics.

The thunderstorm is curious. If you can remember the date well, were there any sharp changes of local barometric pressure (say half an hour duration, up or down) associated with the storm? Such might shake up the middle ear (speculation).

Again thanks.

Bernie

WHEN A TRUCK IS JUST A TRUCK

There is without a doubt an elusive phenomenon known as "The Hum" which is distinct from a whole mess of hum-like noises that likely have rather prosaic causes. Since no one has ever displayed and/or recorded the Hum (or pretenders for that matter), we rely on descriptions, technical if possible, and search for patterns. This has proven difficult, although many features that seem to point to the real Hum phenomenon have been brought forward. Those of us who have heard the Hum for many years recognize it as an "old friend" (old fiend more likely). It is persistent in most aspects. This familiarity is, I suspect, something that non-hearers do not and cannot appreciate. Such a non-hearer who encounters some unexpected hum-like sound could be excused for supposing that this is what the "world-wide Hum" is all about. Not so fast please! There are tests to pass here.

One of the most common descriptions is that of a truck engine idling somewhere up the road. It sounds a lot like a truck, but does not behave like a truck. For one thing, trucks up the road can be located (like - - - up the road!). The Hum can't. For another (in the experience of many) personal grunts or sharp head shakes can shut down the Hum for a half second, after which it promptly and reliably ramps back up. Still another is that very few people (some say 2%) hear the Hum so if you are standing around in a group of many people all asking what the noise is, it's probably NOT the Hum. Most hearers likely have their own checklist of these and other familiar features.

For the person who happens upon an incidental hum-like occurrence, relief may be near at hand. The construction crew finished their job. The truck finishes unloading and moves on. The person travels on. Or, at least, the source (like an industrial fan) may be located. It would not be unusual for such a person to suppose that not only is his/her personal annoyance explained, but it is probably similar for all hearers of the World-Wide Hum. (That was easy – they might suppose!) It would be incorrect however to suppose that you, as an incidental hearer of a hum-like sound have solved the more general mystery. It would be presumptuous to assume that; or that long-suffering Hum hearers have not tried. And in many cases, tried very hard.

Here is an example where a fairly widely-heard hum was found to be an industrial noise.

https://www.theguardian.com/world/2016/jun/07/windsor-hum-canada-zug-island-united-states

So, each Hum-hearer is a relative expert, in comparison to the non-hearer. Not to sound smug – recall that hearing the Hum is not really a "talent" but rather an affliction. Here is an amusing instance which I posted on Glen's site where I heard an incidental humming noise which left me bewildered for a few minutes:

Bernie Hutchins
NOVEMBER 11, 2016 AT 9:33 PM

Hi Jempson and Charlie –

Certainly structural resonances MAY play a role in hearing one-off, hum-like sounds that are NOT the typical world-wide Hum.

Two evenings ago I was working, for several minutes restocking the shipping area in my cellar: a small area about 3 feet wide with floor-to-ceiling shelving on the sides. Seldom am I there more than just in-and-out. That evening I heard a vibration, louder than the Hum but similar. It did not interrupt when I shook my head as the Hum always does. And it was not the fridge upstairs, or the heating. In fact, if I backed away even 5 feet it virtually disappeared. Weird.

I went upstairs directly above, and I could barely hear it. I was staring out the large living-room picture window and I noticed a light shining from the house onto the bushes outside. I had of course left the cellar light on, and there WAS a basement window overhead when I was standing down there hearing the new hum. Now I was standing upstairs in front of a much larger window. Why did that not make the new hum not only audible, but even louder?

Ducking outside, I now heard the new hum loud and coming from the Golf Club across the street. Apparently a large fan? It was after hours and too cool for air conditioning. Perhaps accidental, or airing out a new paint job? That was where the new hum was coming from. Mystery solved? Yes and No!

The downstairs hum was through the (closed) basement window, apparently coupled to the small shipping space. Apparently a resonance. The upstairs had a much larger and more exposed (closed) window, but much less sound. Apparently the living room was too large for an appropriate resonator. Last evening and this evening, no hum inside or out.

So – sometimes a truck really is a truck (or a fan or a pump or a water line). And structural resonances do matter with real acoustic hums, and may vary within a building. (We have all heard certain windows and sides rattle on occasion in response to road trucks.)

Very interesting and even fun – but unrelated, I believe, to the world-wide Hum.

BLOCKING THE HUM – OR NOT

It is sometimes said, in defense of a contention that the source of the Hum is a real acoustic sound, that an individual is certain it is real because he/she can block the sound. The blocking mechanism is likely described as something plausible, but too often with insufficient details. Let's begin with four comments about this issue:

SOME SOUNDS ARE REAL: Above we suggested that many folks who hear an incidental sound (real, acoustic) suppose the Hum is all about what they hear. If the sounds are acoustic, it is no surprise that traditional and rather mundane sound-blocking measures (pillows, ear-protectors) work.

HEARERS WOULD LOVE IT TO BE TRUE: Some hearers of the Hum are so greatly afflicted that surely, most reasonable and even some extraordinary sound-blocking attempts, have been explored. It's not easy.

PRESSURE ON THE EARDRUM: The details of the blocking technique need to be explained. If you "covered your ears with your hands", exactly how? Did you press the palms so that the openings to the ear were shut airtight, or just lightly? Perhaps you blocked the sound by inserting fingers. If tightly fit, there is the well-known issue of rumbling of throbbing sounds of muscles and blood flow. If an airtight fit is achieved without using the (noisy) hands (perhaps earplugs or plastic pads), a non-atmospherics pressure, slightly high or slightly low, might distort the eardrum and change the coupling in the middle ear.

BLOCKING VS MASKING: We also often hear that the Hum is "blocked" by a radio playing or some environmental noise that drowns out the Hum. It doesn't take much. Some hearers leave a bathroom fan running all night to hide the Hum. But this is "masking" (a distraction) and not blocking. It may well be helpful. In fact, many of us walk around most of the day with the HUM masked, and hear it in the night as everything else quiets down.

WATER

Folks who comment on Glen's site often relates (usually with insufficient details) various supposed blocking measures. One of the most curious is that water blocks the hum. This always leaves me uneasy guessing how one arranges for water to block both ears. You could, I suppose, jump right into a pool and remain underwater for an acceptable time. But there would be issues of significant pressure changes, bubbles, pumps, and such complications. Here is a comment of mine from Glen's site:

Bernie Hutchins
JULY 23, 2017 AT 9:18 PM

With regard to whether or not water would block the Hum, I can't think of how to do an uncomplicated experiment. In the general rendering of the basic suggestion, I speculate that water would block ordinary sounds but not the (likely otoacoustic) Hum. But how to prove this? Not so easy.

In a case of a presumed external source of the Hum, we are talking about an acoustic vibration in air passing (or not) through water and subsequently reaching the hearing structures in the ear/brain. We might suppose that an experimenter is already (dry) hearing the Hum and has arranged for other sound sources to be on-call as well. The experimenter fills a basin with water, and tilting his/her head, dips an ear into it; just enough to block the access through the air (but by making sure the immersion is minimal), avoiding complications of excess pressure in the ear canal (pressure on the eardrum). [Note – air is trapped in the ear canal.] However, doing this on both ears simultaneously is beyond anything I can imagine (strike one).

Now, in a simplified view, we would have (acoustic) sound striking the surface of the water in the basin and being transferred to the liquid. This in turn would emerge at the water-air interface at the opening of the ear canal and proceed (through trapped air) to the eardrum, where it would be transferred by the middle ear (hammer, anvil, stirrup) to the inner ear (cochlea), ending up again in a liquid. The problem is the IMMENSE impedance mismatches of the THREE air/liquid interfaces. The middle ear is a famous, biologically implemented, impedance-matching transformer. But the other two are horrendously mismatched and EACH transmits less than 1% of the signal (strike two).

[A fish story: Famously you can shout to your friends while fishing, and the sound never gets into the water. But don't kick two rocks together in the water or you might as well go home.]

Even in the simplified view, there may be complications (like a resonance of perhaps a few kHz in the water-blocked ear canal). If one tries a real experiment, things will get ambiguous and confounded quite rapidly. Everything you do to try to solve one problem creates others. Using a bathtub? – is a bathtub an antenna? Partly submerged (head or whole body), is there hearing through body/bones etc., even if ears are blocked? What audio signals are used to test? If the Hum did seem to go away, did it come back dry? Way too many unknowns (strike three).

DESCRIPTION BY ANALOGY

Having written much about music synthesis over some 45 years, I have had many occasions to wish that it were possible to just present actual audio to describe the acoustic implications of some technical process. Today this is plausible by transmitting sound files over the internet. Initially a very expensive "sound-sheet" (thin plastic sheets bound in, to be removed and played on an ordinary turntable) was sometimes found with journals, and eventually CD's in some issues. If that was not possible, we often relied on oscillographs (plots of waveforms on paper), which looked like what engineers saw (and listened to) on the face of an oscilloscope. Or, we could say things like "to generate "bell-like" sounds, use FM. Of we might compare to an instance from a well-known commercial recording.

With the Hum, we are kind of stuck with analogy. No recordings or oscillographs seem to exist. So, we see the common description that it sounds like a truck. I don't know if someone first suggested this and many followed in agreement, but I expect the vast majority who offer this comparison do so spontaneously. I know I went looking for a truck after hearing the Hum (nearly 20 years ago) before ever hearing of the Taos Hum.

Here is a response to an engineer (non-hearer) who wished for a better description.

Bernie Hutchins

JULY 5, 2017 AT 2:27 PM

Henrik –

(1) Actually, characterizing the Hum is a good part of what Glen has (heroically!) been doing for years. And it's not easy. If you yourself heard it, you might well (as an EE) be able to characterize it. But even a room of 50 EE's (with audio experience if you wish) is likely to have only one hearer. People in the general public can't fathom a question you would want to ask – (not a criticism – why would they)? I think there are some excellent accounts by non-engineers on this site, and I always feel when I read one of these that the person has journalistic training.

(2) If the hum were in the range of 440 Hz, we could likely expect excellent descriptions (e.g., sounds like a trumpet at 500 Hz). It's not of course. It's low in pitch and loudness. Very difficult to pitch match, even for experienced matchers who likely also try very hard. Don't suppose it's easy.

(3) In working with synthesized sound for 45 years, and writing about it, one of the most difficult things is describing in words what something SOUNDS like. We are VERY LUCKY to say that it sounds like a truck. Mostly we have to use analogy, and the same (relatively few) comparisons keep occurring. This is especially valuable when it is spontaneously offered (like "I went out expecting to see a utility truck, yellow light flashing, two blocks up").

Don't sell this short – it's all you get!

-Bernie

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