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Aircraft Noise, Wildlife Sounds, and Beethoven's Ninth Symphony

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Ever since my childhood, when my parents bought a half-sized cello and I learned to play music, I have been interested in sounds and music. As I began my lessons I also learned firsthand about how some "sounds" can be interpreted by others to be "noise".

Later, when I went to MIT in Cambridge, Massachusetts to study architecture, I was fortunate to be able to study acoustics with Professor Bob Newman. Newman was one of the founding partners of Bolt Beranek and Newman, better known today as BBN -- world-renowned acousticians. He split his time between teaching and traveling the world as a BBN consultant. If you look at the literature of airport noise and its impacts on communities, you'll find many BBN reports. Of course, with Bob Newman I mostly studied the architectural acoustics of auditoriums and lecture halls, along with how to isolate sound between apartments and sleeping rooms.

It was only later in my life when I worked to site a downtown heliport that I became involved with the issue of airport "noise". So what really is airport noise? If we look at the history of airplanes and airports, we find that the sound of an airplane has not always been "noise". In the earliest days of aviation, airplane pilots would often intentionally circle a village several times at low altitude, and then land in a nearby field. The sound of the engine -- like the story of the pied piper -- was a kind of music that drew people from all around. They had to come see this new magical machine. The barnstormer might then do aerobatics or give rides. People paid good money to sit next to this loud contraption. The sound of the engine was one of optimism and wonder -- man for ages had dreamt of flying and here, now, after thousands of years it was happening in our neighborhood!

During WWII the sound of aircraft meant different things to different people. It could be the sound of terror as the enemy approached, or it could be the welcome sound of one's country's own military force as it provided security. I was born in 1949 after WWII, so I am a child of the Cold War. For me, while lying in my bed as an eight year old drifting off to sleep in the rural outskirts of Chicago, the sound of a jet aircraft approaching from the distance would strike terror in my heart. Was this the airplane or missile that would drop an atomic bomb killing me and my family, while wiping out all of Chicago? I listened for the whistle of a dropped bomb. As the aircraft passed overhead and then on into the distance, I would think: "Well, I guess it wasn't that one, so I'm lucky to still be alive." So that is one measure of noise impact from O'Hare Airport at a distance of 12 miles.

Yet the sound of an airplane could also create a happy yearning within me. During summers at our remote log cabin on Lake Matinenda in northern Ontario, Canada I would hear the sound of Tommy Thompson's float plane in the distance coming from the other end of the lake. I would run from the cabin to watch as he flew into our bay, landed gently on the water, and taxied to our neighbor's dock at the western mouth of our bay. Then I would watch in awe as he taxied to the back of the bay by our beach for his take-off run. I always silently prayed that he would invite me to

fly with him the several miles down the lake back to his cabin.

As the use of aircraft became a common mode of transportation in the 1960's, and people near large airports experienced aircraft incorporating progressively larger jet engines with take-off's and landings at greater frequencies, the issue of aircraft "noise" became a full-fledged scientific problem for our country. In the late Seventies, the problem of aircraft noise was studied in depth by five agencies -- the US Departments of Transportation, Defense, Veteran's Administration, Housing & Urban Development, and the Environmental Protection Agency.

In 1980 this five agency group created a definitive study entitled, "Guidelines for Considering Noise in Land Use Planning & Control". It remains today virtually unchanged as the standard for evaluating noise impact around airports. The analysis method utilized in that document requires one to add up all of the noise from aircraft throughout a year's period as it impacts a specific location, and then to find its average value. Thus all the peaks and valleys are smoothed out to find a constant noise level that would have the same amount of energy as all of the individual flights put together.

Sound is measured as a peak air pressure level from small waves traveling through the air. Like water waves eroding a beach, its impact is also measured and is accumulated second by second as it continues in duration of time. Thus one might think of sound as water coming from a spigot. The higher the pressure, the more water that is delivered. A 65 hp Taylorcraft take-off might deliver 1 gallon of water, while a Boeing 757 taking off at the same distance might deliver 10,000 gallons of water. (These are somewhat accurate comparisons.) The FAA approved noise analysis adds up all these gallons of water for a year and then divides by the number of seconds in a year to find what the average number of gallons per second of noise that would be delivered to that site. The formula as developed by the five agency commission is adjusted to compensate for the fact that noise at night (defined as after 10 PM but before 7 AM) is worse than noise during the day (because people are trying to sleep). To account for this, the noise impact from one night flight is counted as if there were 10 day flights. Thus, if the Taylorcraft flew over at night it would be counted as delivering 10 gallons not 1 gallon. If the 757 flew over at night it would be counted as 100,000 gallons of water, not 10,000 gallons.

This method of evaluating aircraft noise impact is based on maintaining a person's very basic health, much as how the Occupational Safety & Health Administration (OSHA) would evaluate a problem from a purely scientific standpoint. The five agencies' report determined that noise levels of greater than 65 dB, on annual average modified for night flights, would be harmful for one's health.

Using this methodology the FAA has created a computer model in which the flights to and from an airport (including touch-and-go's) are programmed for every aircraft expected to use the airport during a year. The computer then finds the average noise levels that are created by the computer model and is able to print out noise level contours based on flight paths and power settings set up by the planner who wishes to study the impacts.

This Integrated Noise Model (INM) is a very sophisticated tool which now allows experimentation with all types of aircraft, various flight paths, various power settings, and various flight profiles (vertical angles of approach and departure) so that the noise environment around the airport can be simulated and experimented with. The latest version of this model is called INM 6.1B and runs on a standard Microsoft Windows computer.

This use of an average noise level to determine noise impact is a methodology that does have great value. However, some who live near large airports criticize it because it does not take into account the fact that a single fly-over by a noisy

aircraft can in itself provide an instantaneous impact that is extremely disruptive to a community. Nonetheless, the FAA utilizes that basic methodology in conjunction what are called Part 150 studies in order to study and reduce aircraft noise impacts on surrounding neighborhoods.

In 1993, a new agency was formed to study aircraft noise. It is called the Federal Interagency Commission on Aviation Noise and its members are: the US Departments of Transportation, Defense, Housing & Urban Development, Interior, Health & Human Services, the National Aeronautics & Space Administration, and the Environmental Protection Agency. Some felt that the 1980 methods were outdated and that new approaches were needed. This agency, called "FICAN", has provided a forum for some who wish to initiate a lowering of the 65 Ldn threshold, while others have advocated to FICAN to consider using a peak noise level as a noise impact determinant. FICAN is so far only functioning as a forum for research and public involvement. FICAN's review has to date not resulted in any changes to the 1980 standards.

Another topic that FICAN is investigating concerns special uses that may require new noise standards. For example, studies are being made of public school classrooms near airports to see whether there should be a more conservative standard for noise impacts in those situations, where students need concentration and aircraft noise may be distracting. As an educated citizenry is fundamental to democracy, FICAN is considering whether there are special standards for where schools should be located relative to airports.

FICAN is also examining the issue of "quiet in the wilderness". FICAN sponsored a symposium on this subject in 1999 and though I was unable to attend, their Web site (www.FICAN.org) gave the names and addresses of the five presenters at the symposium. I mailed a letter to each asking for a copy of their paper. Several papers came back in the mail, and they were impressively thick and full of data measured at national parks. I have a degree in physics and was interested to read them, but was disappointed that for all their thickness there didn't seem to be much useful content or conclusions. But then one day, one of these presenters, Bernie Krause, just called me up on the phone to talk about the subject. I'd like to tell some stories he told me because they're fascinating and they also relate to aircraft and wildlife. [Wildlife control was the subject of the prior speaker at this OAMA conference.]

Bernie has become a somewhat popular figure in America on the radio and in print, in part because he has traveled all over the world recording the sounds of nature. He has gone to the tundra, he has gone to the rain forest, and he has championed the idea that the sounds in the wilderness are not just a cacophony of different animals, but are a kind of live symphony. He has developed the concept of "biophony" and through recorded data has shown that in a rain forest different species of animals sing to each other with a frequency and spacing that shows they are coordinating with each other and responding much like the musical instruments of an orchestra. He has found some native cultures where people go into the forest and even participate by singing cooperatively with the animals. He calls this natural symphony a "biophony" -- "bio-" meaning living, "-phony" meaning voice.

I asked Bernie if there are any specific impacts from normal general aviation aircraft to wildlife. He said that he himself is a pilot and enjoys flying, and that generally he doesn't see aircraft as being particularly worse or different from all the other of man's noise-making activities. But he did have one specific story which I'll tell here.

Bernie was at Mono Lake in California, recording the "pulsed chorus" of spade-footed toads. These are toads that are on the endangered species list and that are able to burrow, if I understood Bernie correctly, 3 feet underground in the mud where they create cocoon-like structures that they hibernate in while waiting out dry spells. They

may live in this arrested state for up to six years, when finally there is a flood of water that seeps down through the soil and awakens them. They then shovel their way back up to the surface where they all sing for joy and procreate excessively. Bernie was hired to go record the pulse chorus of these frogs to try to learn how they coordinate their "croaks" to be synchronized so that these thousands of toads sound, from one place, like a single throbbing beast. We've all heard the pulsed chorus of crickets in late summer, though I for one, never really questioned how or why it was pulsed.

While he was recording these toad sounds on his machine that visually records the various frequencies and intervals in time, Bernie heard a jet in the distance. He then saw a military fighter jet approaching over a distant hill and hugging the ground in a simulated wartime tactical flight. The aircraft came roaring through and was quickly gone in the distance. Suddenly the "pulsed chorus" of the toads was gone, each toad instead honking on its own. Bernie then noticed that hawks and coyotes were racing through the area darting here and there, eating the toads. Bernie had discovered firsthand one of the reasons the toads sing as one combined voice. By pulsing together, their predators could not be certain where any single toad was sitting. It was a form of self-protection for the species. Within ten minutes after the jet had passed, the pulsed chorus was together again and the feeding frenzy was over.

So at least in that one case, we can be certain that there were fundamental health issues related to the single peak event level of one aircraft flying through the area. There likely were several hundreds of spade-footed toads who severely regret the loud noise of that jet!

For most medium and small sized general aviation airports, the average noise level contours that are determined as part of FAA planning grants, do not provide much help with solving community noise problems. For small airports, the problem of aircraft noise is more one of "annoyance" than of a real health problem. The FAA does not regulate to solve "annoyance" problems, however if a community gets angry enough at an airport, the local citizenry might well vote the airport out of existence. So it is in the vested interests of pilots and users of airports to pay attention to the "annoyance" issue.

How can airports deal with aircraft annoyance? Basically, one uses common sense. The fundamental solution involves maximizing the distance from the aircraft to the noise sensitive use. This is called the slant distance, and since noise dissipates as the square of the distance, it is extremely important to maximize the distance in order to reduce the sound levels. A doubling of slant distance reduces the same aircraft noise to one quarter its level.

The second important issue is to reduce the actual noise level at the aircraft, which is mostly being generated by the tips of the propeller. If we focus on propeller aircraft, which are the most common aircraft at GA airports, the greatest problems occur when the tips are approaching sonic speed -- the speed of sound. Thus, it is extremely useful for pilots to reduce the RPM of their propellers after take-off if they will be passing near noise sensitive areas. Even a reduction of 10 or 15% of the RPM can have very great reduction of the sound affecting people.

Since noise abatement procedures are not enforced by the FAA (safety is mandated, while noise abatement is optional), how do we get them to happen? My experience is that the best approach is to use peer pressure. To accomplish this it is best to first work with a small group of local pilots who are held in the greatest respect at the airport -- the pilots everyone "looks up to". If this smaller group can agree upon standard ways to significantly reduce noise impacts on concerned neighbors, and if they are willing to fly that way, then they become mentors for the others. Through peer pressure one can then achieve some sort of standardization of how to fly in and out of the airport while being sensitive to neighborhood concerns. Of course it is

important as part of this process to include representatives from the neighbors while meeting with pilots so that the pilots can understand the severity of neighborhood concerns and how their flying may be disrupting activities in individual households.

Finally, I'd like to end this talk with a look to the future. It is my hope that future aircraft can be designed so that they are able to produce more specific tones or frequencies of sounds when flying. In this way while aircraft fly overhead they can be "tuned" so that via use of standard air traffic control procedures, planes may be arranged in either major or minor chords as is appropriate to the community activities below. Perhaps if we are able to sufficiently develop the technology, there will be a day when aircraft coming to and from airports will be able to provide the sound of Beethoven's 9th Symphony to all below. Truly, we can hope that there may still be a time when the sound of aircraft is considered music and not noise.