EDITORIAL

Entertainment or Stimulation to Study?

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First published in 1913, Yakov Perelman's *Physics for Entertainment* was translated from Russian into many languages and influenced science students around the world. To describe his approach, Perelman wrote:

> *I have quoted extensively from Jules Verne, H. G. Wells, Mark Twain and other writers, because, besides providing entertainment, the fantastic experiments these writers describe may well serve as instructive illustrations at physics classes.*

Many topics of the book were devoted to acoustics and vibration: "Sound and Bullet," "If the Speed of Sound Were Less," "The Train Whistle Problem," "Acoustical Clouds and Aerial Echo;" among others.

The entertaining stories on physics (in particular, acoustics and vibration) may help students better understand the laws of nature and become good engineers and scientists. Certainly, such publications cannot replace the fundamental books and courses, so they should be recommended as extra-curricular or self-education literature.

Yakov Perelman (he died from starvation in 1942, during the German Siege of Leningrad) was not related to the famous Russian mathematician Grigori Perelman (born in 1966), who solved the Poincaré conjecture but rejected the Fields Medal and the Millennium Prize of one million dollars for this extraordinary achievement. However, Grigori's interest in science, particularly mathematics, was inspired by his father who gave him *Physics for Entertainment* and popular books on mathematics written by Yakov Perelman. This article contains a few case stories developed in the manner of Yakov Perelman.

The Mutiny Bell of Uglich. At his death in 1584, Russian tsar Ivan the Terrible left two sons, Fyodor, who was mentally handicapped, and Dimitri, an infant. Fyodor became Czar but because of his inability to rule, Boris Godunov, a capable and wise nobleman, became his regent. Dimitri and his mother were exiled to Uglich, a town on the Volga River.

On May 15, 1591, little Dimitri was found dead with a knife in his throat. Dimitri's mother and her supporters at Uglich, summoned by the loud ringing of a local church bell, blamed Boris Godunov for murder. The regent's agents were killed by the enraged town residents. (Later, Moscow investigators ruled that the prince had been playing with knives, had suffered an epileptic seizure and had fallen on his own knife).

Boris Godunov sent soldiers to Uglich, and the rebellion was quickly quelled. After the artillery volleys hit the town gates, most of the rebels gave up and were sent off to colonize Tobolsk, a town located in Siberia and recently captured from Kuchum, the ruler of Siberian Tatars. The "mutiny" bell that sounded the alarm had been exiled together with them. In addition, the bell had its clapper and crown (the tongue and ear, respectively, in Russian) cut off and was slashed 12 times by a hangman at the town square.

Most likely, such a harsh symbolic punishment on the bell was done to scare the soon-to-be Tobolsk residents without executing them. However, it is noteworthy that many medieval people believed in the magic power of bells. This may have come from the ancient belief that the sounds of nature were the voices of spirits, the link between mortals and gods.

Revengeful Piper of Hamelin. In 1284, the town of Hamelin was suffering from a rat over-population, an eloquent stranger proposed and provided his services. He played a musical pipe to lure the rats with a song into a river where all but one drowned. However, the townsmen refused to pay the rat-catcher the money promised in advance. The man left the town angrily, but later came back with revenge: on Saint John and Paul's day, while the inhabitants were in church, he played his pipe yet again, this time attracting the children of Hamelin. Some 130 boys and girls followed him out of the town and were never seen again. Despite multiple hypotheses (a landslide, epidemic disease, abrupt emigration, etc.), no scientific explanation for this historical event was ever agreed upon.

We may never discover what kind of music was played by the Hamelin piper to exterminate the rats, but one study[1] may partly answer this question. A curious student got 72 mice and divided them into three groups: one to test a mouse's response to hard rock, another to the music of Mozart and a control group that wouldn't listen to any music at all. The young vivisectionist got all the mice accustomed to living in aquariums in his basement, and then he started playing music 10 hours a day. To estimate the effect of music via comparison, he put each mouse through a maze three times a week that originally had taken the mice an average of 10 minutes to complete. Over time, the 24 control-group mice managed to reduce their maze-completion time to 5 minutes. The Mozart-listening mice also reduced their time but just to 8.5 minutes. But the hard-rock mice *added* 20 minutes to their original time.

Finally, all the hard-rock mice killed each other, while none of the classical mice did that. This case history may look anecdotal, but some observers indicate that mice and rats typically do not stay for long at a permanently loud place.

Flying Mosquitoes and Psychoacoustic Parameters. A ringing pitch of flying mosquitoes is dreaded by people who hate to be bitten by those blood-sucking insects. Most sound coming from flying insects is due to the vibration of their wings. Butterflies and moths flap their wings slowly (about 10 beats per second), so, the sound is not perceived by humans (the lower limit of perception is about 20 Hz). The wings of bumble bees make 180-240 beats per second and so are audible. The wing-beat frequency for mosquitoes is 300-600 beats per second.

Because mosquitoes can carry many diseases (among them: west nile virus, causing inflammation of the brain, and malaria, which may result in fever, aches, and even coma), it is very likely that human ears are most sensitive to tones in or close to the mosquito's frequency range.

Soundscapes. The new term "soundscape" (reminiscent of "landscape") is related to the environmental noise design for human acoustic comfort.[2] This is a relatively new trend in architecture developed for people to enjoy the areas in which they live or walk. However, it is not just about noise reduction, it is also very much about sound quality by creating sounds liked by people.

A key soundscape technique is based on masking the unwanted noise by wanted sounds. In particular, high-frequency tones can be effectively masked by broad-band noise, even of a lower magnitude. To some extent, a sound masking can be explained by an analogy using light.[3] Imagine a dark room where someone is periodically turning a flashlight on and off for long time. This light performance must be distracting to others in the room. Now imagine that the main room lights are permanently on. Even though the flashlight is still being turned on and off, the effect is not as annoying as before. Sound masking is a similar process of covering a distracting sound with a more pleasant one, or at least one that is less intrusive.

Importance of Publications on Amusing Acoustics. The papers and books on amazing acoustics are not just for entertainment. They could be a formidable invitation for students into real science and engineering. Besides, they may raise the importance of our great profession to wide public in the U.S. and throughout the world.

1. http://www.edu-cyberpg.com/Music/Mice_and_Music_Experiment_Mo.html
2. *A.L. Brown,* "Soundscapes and soundscape planning" *18th International Congress on Sound and Vibration,* Rio de Janeiro, 2011.
3. http://en.wikipedia.org/wiki/Sound_masking

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