frequencies and loudness levels. Although there is a small variation from person to person, normal ears agree within a few dB with the plot reproduced here (ISO Recommendation 226).

An even more significant peculiarity of the ear is its response to the pitch and bandwidth of a noise. Broadband sounds, like those of jet aircraft, seem much louder than narrowband noise of the same sound pressure level. Thus accurate loudness measurements can be made only by taking into account the spectral distribution of the sound and relating it to empirically determined critical bandwidths. This phenomenon has given rise to the Bark scale: the audio range comprises 24 Bark, each of which equals the ear’s critical bandwidth at a given center frequency.

Probably the most significant difference between objective and subjective measure of loudness occurs when two sounds are presented to the ear simultaneously. If the two sounds are widely separated in frequency, their partial loudnesses simply add to form the total loudness. But if they are not separated by a critical bandwidth, one sound masks the other: the closer together, the greater the influence. The noise analyst expresses this characteristic quantitatively in terms of loudness density, in sones/Bark.

The HP 8051A Loudness Analyzer is, in effect, a calibrated electronic ear that takes all of these subjective reactions of the human ear into consideration in measuring loudness based on ISO Recommendation 532 (Zwicker’s Method). It listens to sound through a calibrated microphone or tape recorder, automatically produces a continuous spectral analysis and displays it as a plot of loudness density vs. subjective pitch. The instrument also computes and displays the total loudness of the sound, that is the integral of the Zwicker diagram.

The instrument is a great help in noise abatement studies because it shows how noise reduction techniques can be applied most effectively. Its spectral analysis points the finger at the most obvious sound-producing component, suggests what kind of sound-absorbing material may be needed, offers quick before and after comparisons of noise abatement programs.

A much more complex and versatile instrument for audio spectrum analysis, the recently announced HP 80501A Audio Data Processor combines the equivalent of a Loudness Analyzer with a powerful HP 2115A Digital Computer. The 80501A measures loudness with Kryter, Stevens, TALARM, SAE or dB weightings depending on the choice of standard computer programs. Results are available immediately; for example, the 80501A yields a complete analysis of aircraft noise while the plane is still overhead.


HEWLETT PACKARD

ANALYTICAL INSTRUMENTS
No time for downtime

A machine as complex as the Bell System's new Electronic Switching System (ESS) must help with its own maintenance. Consider, for example, that an ESS installation in a single Bell System central office can perform nearly a billion and a half switching, logic, and memory operations per second. And that we expect it to provide service for 99.999 percent of the next 40 years. Also, the system employs a totally new concept: "stored program control." That is, each of the many actions in connecting one telephone with another is governed by a central digital data processor which draws upon program instructions and other stored data; new and revised features are incorporated by changing memory content rather than by rewiring.

All of this makes traditional servicing obsolete, and calls for advanced ideas in reliability and maintenance of electronic equipment.

Vital units such as the central data processor and the memories operate in pairs; if one unit ever falters, its twin maintains service. But, because there is no standby until the defect is repaired, ESS itself helps with the work. For instance, there are three principal fault-detection schemes:

"Match and Check Circuits" constantly compare critical information in duplicated units.

"Audit Programs" check that the system's temporary memory reflects what is actually going on.

"Exercise Programs" use the brief intervals between telephone calls to check all circuits, including those for maintenance.

If a fault is found, alarms operate and "fault recognition" programs take over. These automatically find the defective unit and reroute the information flow through its duplicate. Or, if the problem is simply a memory error, it is corrected. Such actions take less than a millisecond; office operation is unaffected.

Finally, "diagnostic programs" test any faulty unit, store the results, and print them out with a reference number. A craftsman looks the number up in his "ESS Troubleshooting Manual" and finds a list of possibly defective circuit packs. He replaces one or more of them to clear the problem.

Over half of ESS—circuits and stored program—is devoted to maintenance. But only with modern techniques can so complex a system meet today's communications needs.

From the Research and Development Unit of the Bell System—
13) Warts or lichens from the leg of a horse powdered and drunk in water, 28:19.
14) Slough of a snake. But, when taken with wine and frankincense, it aids labor, 30:14.
15) Sisymbrium. Women going with child must take heed how they eat sisymbrium (cress, thymbraeum, water-mint) unless the fruit of their bodies be dead within them, for if it be but applied outwardly, it will send it forth, 20:22.

Many of these substances might have been put in the flame of an ordinary Roman lamp and used to fumigate a room or a woman. Castoreum was sometimes used with powdered shellfish (ostracum or onyx—Pliny was not sure what these were), or with perfume as a suffumigant to treat pain in the womb. Galbanum was used regularly as incense and still is. It is one of the ingredients that the Lord directed Moses to put in the incense used before the decrees in the tent of meeting, Exodus 30:34-38. Thus, castoreum or galbanum may have been the abortifacient in the smoke of Roman lamps.

For moral reasons Pliny probably has omitted other drugs that abort, 25:3. He asks about "those Greeks": "What color and pretense had they to set down medicines and receipts to cause women to slip the untimely fruit of their womb... I am not for them that would send the conception out of the body unnaturally before the due time: they shall learn no such receipts of me, neither will I teach any how to temper an amatorius cup, to draw either men or women into love, it is no part of my profession." Also he would have nothing to do with magic or witchcraft.

If putting out common lamps in the customary way usually induced abortion then there would have been few viable births. Obviously there was something extraordinary about the Roman lamps that induced the abortions or perhaps the account is exaggerated or incomplete. In my opinion, Pliny, in spite of his denial has given items that depend on magic for their operation. Possibly "magic" has changed its meaning over the centuries.

HOwARD McCULLY
Four Hermosa Place, Menlo Park, California 94025

References

Even a minor molecular rearrangement can have a dramatic effect on chemical activity. These profiles* recorded by a Durrum-Gibson Stopped-Flow Spectrophotometer reveal a 40-fold difference in azide-hemoglobin reaction rates. One reaction is with normal hemoglobin, the other with a mutant containing alpha-chain tyrosine residues in place of the usual proximal histidines.

Equilibrium constants would not have hinted at this difference; only kinetic tests with the Durrum-Gibson instrument permit the use of this new technique for classifying mutant types.

The Stopped-Flow Spectrophotometer is a versatile, general-purpose system that is widely used to determine the kinetic characteristics of reactions with half-times in the 5-millisecond to 50-second range. A temperature-jump accessory is available for studies involving even faster reactions, down to 10 microseconds or less. The accessory is uniquely designed to allow combination T-Jump/stopped-flow studies of pseudo-equilibrium reactions.

For complete information on the D-100 Series Stopped-Flow Spectrophotometer and its applications, contact... Durrum Instrument Corporation, 3950 Fabian Way, Palo Alto, California 94303, Phone (415) 321-6302.

*As reported by Henry J. Epstein and Lajos Sutny in Volume II (1964) of The Journal of Molecular Biology.
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