1. Introduction

This article was derived from the Symetrix 601 owner's manual, which I wrote in 1993 while employed there. The meat of this article, however, came from an old Langevin Recording Equipment catalog, as credited in the footnote below. However dated the examples may be, the information is still useful nearly 40 years later.

The familiar piano chart found at the end is the work of James (Flash) Husted, an Adobe Illustrator Wizard if there ever was one. James also worked at Symetrix.

1.1 Equalizing for Spectral Character

Equalization is nothing more than selectively (or not) amplifying a signal based on frequency. Since audio signals consist of combinations of fundamental signals and their harmonics, changing the tonality or the spectral balance of a signal involves nothing more than altering the relationship of the fundamental to its harmonics, and the harmonics of to themselves. Each harmonic is responsible for one aspect of the audible character of a signal; knowing these relationships allow you to quickly zero-in on the correct frequency range of the signal and quickly apply boost or cut to enhance or correct what you are hearing. "equalization:

The audio spectrum has several critical portions that are responsible for our perceptions of sounds that we hear:[1]

Range	Frequencies	Musical Location
Very Low Bass	16-64 Hz	1st and 2nd octaves.
Bass	64-256 Hz	3rd and 4th octaves.
Midrange	256-2048 Hz	5th, 6th, and 7th octaves.
Lisping Quality	3000 Hz	Between the 7th and 8th octaves.
Presence Range	4750-5000 Hz	Between the 8th and 9th octaves.
Brilliance	6500-16 kHz	Part of the 9th through the 10th octave.

1.2 Power and Fullness.

In the very low bass region lies the threshold of feeling, where the lowest sounds, like wind, room effects, and distant thunder, are felt, rather than heard. In the upper half of the first octave of this range, research has shown that the fundamentals of piano, organ and even the harp reach well into this range. Harvey Fletcher (of Fletcher-Munson fame) charted the sensitivity of the ear for various parts of the spectrum at levels that are lower than those of reality. Fletcher's compensation curves (the well known Fletcher-Munson curves) show that for equal loudness in this range at lower recorded and reproduced levels shows requirements for tremendous boosts, on the order of 10 to 30 dB. Aside from the subjective effects of this range, the ability to control unwanted sounds in this range is equally important to subdue stage rumble and outside traffic noise (especially important where there are subways beneath buildings!). Overemphasis caused by close cardioid microphone placement can cause muddiness in the overall sound; attenuating (cutting) the very-low-bass region can greatly improve overall clarity.

1.3 Rhythm and Musical Foundation.

In the bass region, most of the low, grave tones of the drum and piano can be found. Here we can also find the fundamentals of the rhythm section, as well as the foundation of all musical structure.

It was Leopold Stowkowski who said "If I had a thousand bass viols I could use them all!" This is not as extreme as it may sound. A bass viol, even though it is reinforced by its sounding board, generally plays single notes and possesses little dynamic range. In a large orchestra, as many as

---

[1] The majority of the material here is taken from "Equalizing for Spectral Character," Langevin Corporation, 1966 Catalog.

eight bass viols may be used. A total of 1000 bass viols in this case would only give an additional 21 dB of level, which is not an inordinate amount given a glance at Mr. Fletcher's equal loudness curves. Pay attention to this range because the overall musical balance of your program can be controlled by equalizing or attenuating the 100 Hz range.

1.4 Telephone Quality

The ear is reasonably sensitive in the midrange frequencies, and sound restricted to this range has a telephone-like quality (which is generally why telephone-quality frequency response covers the 300-3 kHz range).

If you make the 6th octave (500-1024 Hz) louder with respect to the other octaves, the subjective result is a horn-like quality. If you emphasize the 7th octave (1000-2000 Hz), the effect is one of tinniness.

The fundamental tones in most music lie equally above and below middle C (261 Hz), from 128 to 512 Hz. As most instruments are rich in the first overtones, the majority of sound energy is found up to the 2.5 kHz range. Music editors and others engaged in listening to music over long periods find that listening fatigue can be reduced by attenuating the 5th, 6th, and 7th octaves by about 5 dB.

1.5 Lisping Quality

The 3 kHz range delivers a generous stimulus to the ear. At very loud levels the region of greatest ear sensitivity shifts downward from 5 kHz; this is why many "PA" speakers have broad peaks in this region. A characteristic of low-level signals peaked at 3 kHz is a "lisping" quality, and the total inability to distinguish labial sounds such as m, b, and v.

In wide-range lower level systems, a peak in the 3 kHz region has a masking effect on important recognition sounds, and on others which lie above 4 kHz. Brilliance and clarity are lost and without attenuation of this region, an unconscious strain with increasing fatigue is felt according to the amount of 3 kHz boost.

1.6 Presence Range

The usual band affecting clarity in male speech is 3000 to 6000 Hz. In a woman's voice, the fundamentals are roughly an octave higher than a man's, and a woman's range of consonant clarity lies between 5000 and 8000 Hz (the high-end of this range approaches a region of hearing insensitivity in humans). Furthermore, the total range of a woman's voice is about half that of a mans, stimulating fewer hearing nerves, and for this reason, is consequently still weaker upon reception.

Wide range sounds, especially those of singing voices, have fundamentals with harmonics in the 5 kHz region of good ear sensitivity. Voices that are powerful or rich with harmonics at 5 kHz sound especially pleasing, clear and full. Male opera singers are particularly favored with 5 kHz sounds, women less so. In popular music, this range shifts downward somewhat. It follows that voices deficient in the 5 kHz range can be enhanced in listening value by a generous boost on the order of 5 to 8 dB at 5 kHz. A secondary benefit of this boost is an apparent increase in level; a 6 dB rise at 5 kHz frequently gives an apparent increase of 3 dB to the overall signal.

Attenuating the 5 kHz range on instruments gives a "transparent" quality to the sound, providing, of course, that the remainder of the signal is otherwise wide range. Microphones having a dip in this region lack the "punch" or "presence" to which we (Americans) are accustomed.

1.7 Brilliance

Unvoiced consonants attributed to tooth, tongue and lip sounds are high in frequency, and reach the 10 kHz range. These frequencies account for some clarity and most brilliance, even though they contain less than 2% of the total speech energy. This also holds true for musical

instruments; especially percussion. Boosting or cutting this range affects clarity and naturalness. In speech, the 9th and 10th octaves impart intimacy although too much emphasis can make secondary speech sounds (lip smacking, etc.) objectionable (a good case for a downward expander).

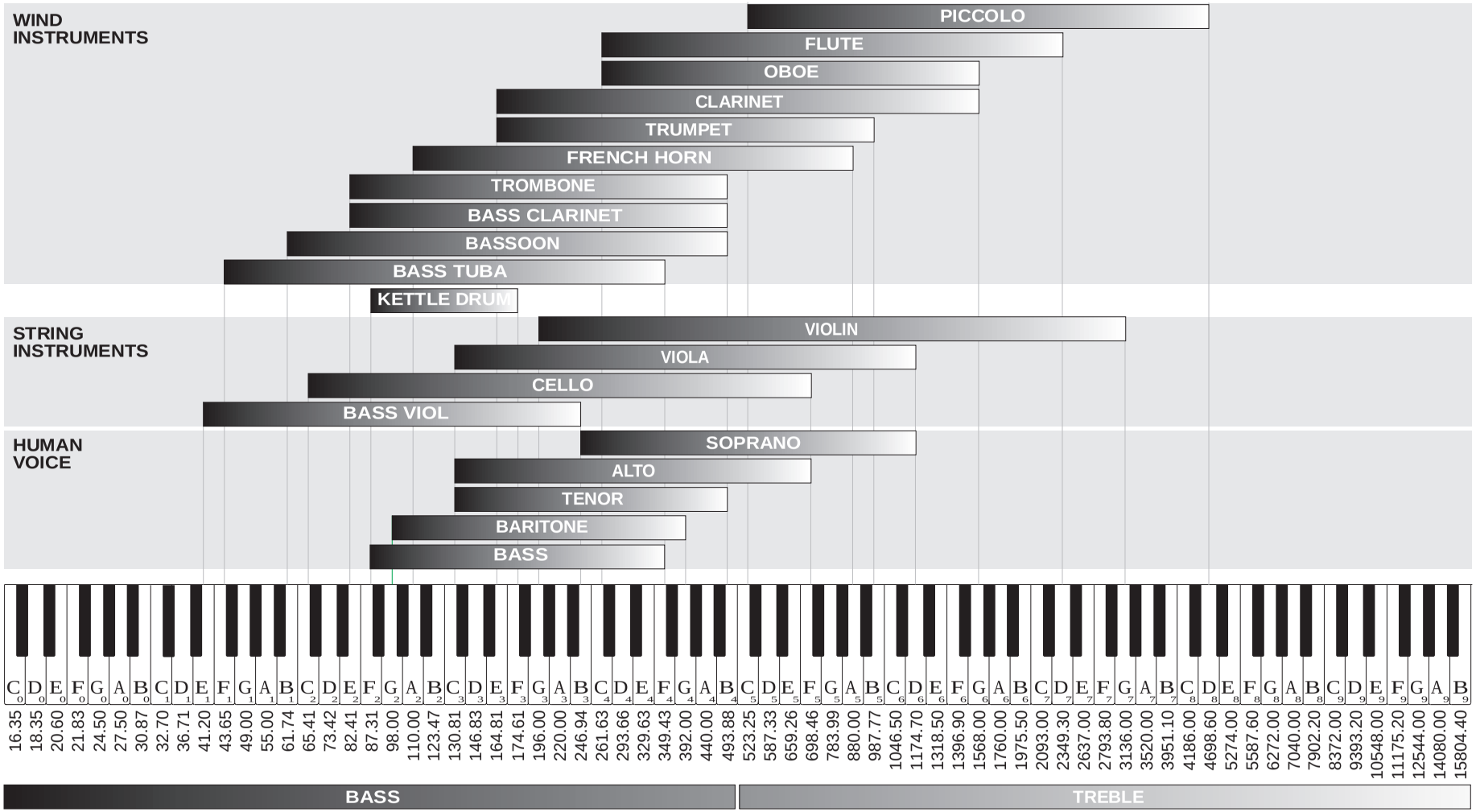
Some microphones having a rise at the higher frequencies (especially omni microphones) benefit from some attenuation in this region. Those microphones having under damped diaphragms may ring at these frequencies, causing an annoying sibilant distortion on speech. On musical forms using hand percussion, boosting this range frequently results in an astonishing and pleasing feeling of clarity.

1.8 Conclusions

When the article containing the above excerpts was written (probably around 1963), stereo was just becoming a commercial reality (you could still purchase mono and stereo versions of an LP and there were still more FM stations broadcasting in mono than stereo), and as many mixers contained rotary mix pots as those that used slide pots. The value of individual channel equalization was known, but it was both technologically and financially prohibitive. The article concludes thusly:

> *"With the advent of stereo and three-channel recording, nearly three times the equipment, with more elaboration, seems indicated, and expansion of console area in the horizontal plane offers the only direction in which to proceed. But a single engineer has arms only so long."*

How times have changed!



Relationships of Musical instruments, Piano, and actual frequencies.