(draft)

TERMINOLOGY

As part of learning *how each processing technique sounds*, it is pertinent to try to describe in words the different qualities of a sound. Verbal description of sound characteristics has always been a challenging task especially when it comes to quantitative definitions based on mathematical descriptions. The task increas-es in complexity when we have to accept that the same adjective may be used in different contexts: for describing a single instru-ment tone, the sounding concert hall, a complex synthesized sound and an artificial reverb. On the acoustical scene the term *warm sound* is often described as *having a lot of energy in the lower frequency region* without stating exactly where and how much. This may work as a global quasi-quantitative term as it could be used in all four contexts, and relates to resonance in a certain frequency area. Other adjectives like *edgy, biting, reedy* and *pure* may not have the same kind of global significance.

If we consider a distinction between sounds with a clear tone sensation (stationary frequency, perceived pitch, imagination of an acoustical instrument) and sounds without this sensation (noise, synthesized sounds, electronically processed sounds), we may consider Zwicker's *roughness* (*rauhigkeit*) [2] with its con-trary attribute *smoothness* as an important timbre space factor in the description of the tone sensation. This effect is mathematical-ly described based on modulation by single frequencies with a transition area strongly related to the hearing mechanism's *criti-cal bandwidth*. A detailed and comprehensive discussion is given in [3]. Even without a mathematical foundation it seems tempting to use this *roughness-smoothness* sensation in the description of non-stationary synthesized sounds as well.

Some examples of sound descriptions and tests of subjective attributes are shown in the following.

Single instrument tones

Single instrument tones have been thoroughly examined mainly with the focus of defining timbre factors in a multi-dimensional timbre space. Kendall and Carterette [4] interpreted a two-dimensional timbral domain for wind instruments as having a principal dimension of *nasality* versus *richness* and a secondary dimension of *reediness* versus *brilliance*. In acoustical terms the-se adjectives relates to specific spectral qualities (*richness* of par-tials, *brilliance* with lot of upper harmonics) except for *reediness* that maybe more related to the excitation process with reeds. An example list of 61 adjectives can be found in the appendix of [4].

Room acoustics

After the ingenious introduction of reverberation time (RT) by Sabine [5], room acoustic parameters have been developed and been strongly based on physical parameters. Important room measuring parameters are defined by international standardiza-tion [6] and include the five acoustic quantities *sound strength* (subjective level of sound), *early decay time* (perceived reverber-ance), *clarity/definition/center time* (perceived clarity of sound), *early lateral energy fraction* (apparent source width) *and late lateral sound level* (listener envelopment). A detailed and ex-tended terminology description for evaluation of concert hall measurements can be found in [7].

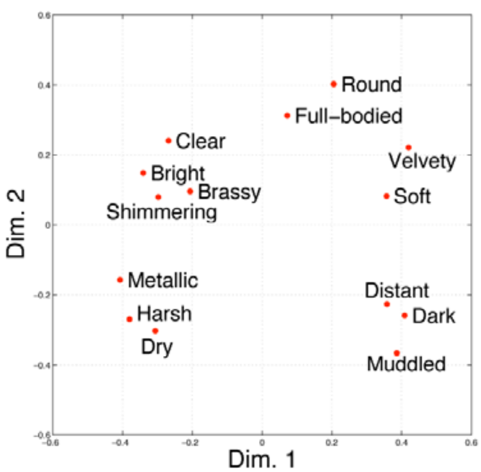

Figure 1: *Dimension 1 and 2 of a multidimensional semantic space of piano timbre descriptors (from [8] with permission from the author).*

Performer's experience.

As part of his PhD research, Bernays studied how piano perform-ers can control timbre nuances [8]. This study includes mean evaluation of familiarity with 14 selected piano timbre verbal descriptors (in descending order *soft, bright, round, clear, harsh, dry, dark, full, velvety, metallic, shim, distant, brassy* and *mud-dled*). Five terms to best describe the whole semantic space are *bright, dark, dry, round* and *velvety.* The relations to acoustical characteristics are not defined even if his analyzed dimension 1 can be interpreted as an inverse frequency scale (see Figure 1).

Parameter orthogonality

Is it possible to analyze and treat musical features (pitch, timbre, dynamics, rhythm, etc.) as independent factors?
Referring to Houtsma [9] in music-related studies timbre has always been treated as a multidimensional continuum in which any point is potentially meaningful. It has been established by rating and multidimensional scaling techniques that the space can be adequately described in four subjective dimensions (dull-sharp, compact-scattered, colorful-colorless and full-empty) which are linked to physical dimensions such as spectral energy distribution, amount of high-frequency energy in the attack, and amount of synchronicity high-harmonic transients.
Houtsma is concluding by stating "because of their subjective nature, the parameters pitch and timbre should never be present-ed as independent variables in perception studies. Doing so would amount to describing one unknown in terms of other un-knowns".
Stepanek is stating: "Musicians internal imagination of tim-bre supports orthogonal dimensions, but their saliency or rela-tionship in real sounds is sound context dependent (for example depends on pitch or type of the instrument — violin, organ, etc.)" [10].

Amplified effects
A study by Dempwolf et.al [11] presents the results of a listening test employing eight attributes for the description of the perceiv-able timbral changes caused by effect units and amplifiers for electric guitars. Eight attributes (*aggressive, smooth, broken, fuzzy, crunchy, singing, warm* and *transparent*) were selected for listening tests. Appropriate terms to describe guitar distortion were *aggressive, smooth, warm, fuzzy, transparent,* and (partly) *broken*.

Concluding remarks on terminology
As a basic rule we have to make sure that adjectives will not be misinterpreted, i.e. we have to avoid terminology ambiguity.
If possible adjectives should be explained with common basic characteristics in the frequency and time domain. To clari-fy and pinpoint the use, each adjective should also be accompa-nied by at least two sound examples where it appropriately can be applied.
As available technology evolves the introduction of new ad-jectives should be acceptable for the music technology communi-ty as a whole.

[2] E. Zwicker, *Psychoakustik*, Springer-Verlag, 1982.

[3] E. Zwicker and H. Fastl, *Psychoacoustics*, 2. Aufl. Springer-Verlag, 1999.

[4] R. Kendall og E. Carterette, "Verbal Attributes of Simultaneous Wind Instrument Timbres II," in *Music Perception,* vol. 10, no. 4, pp. 469-502, 1993.

[5] W. C. Sabine, *Collected papers on Acoustics*, Harvard University Press, 1922

[6] *ISO 3382-1: Acoustics - Measurements of room acoustics parameters: Part 1: Performance spaces*, International Organization for Standardization, 2009.

[7] L. Beranek, "Subjective Rank Orderings and Acoustical Measurements for Fifty-Eight Concert Halls," in *Acta Acus-tica*, vol. 89, no.3, 2003.

[8] M. Bernays, "Verbal expression of piano timbre. Multidi-mentional semantic space of adjectival descriptors," poster at International Symposium on Performance Science (ISPS), Toronto, 24 August 2011.

[9] A.J.M. Houtsma, "Pitch and Timbre; Definition, Meaning and Use," in *New Music Research*, vol. 26, no. 2, 1997.

[10] J. Stepanek, "Musical Sound Timbre; Verbal Description and Dimensions," in *Proc. of Digital Audio Effects* (DAFx-06), Montreal, 18-20 September 2006.

[11] K. Dempwolf et al., "Verbal Attributes Describing Distorted Electric Guitar Sound," in *Proc. of Digital Audio Effects* (DAFx-10), Graz, 6-10 September 2010.