wireless world

Can sound quality be quantified?

Anyone who has read that curious book *Zen and the art of motorcycle maintenance* will recall that the narrator apparently drove himself into a mental hospital by his obsessive attempts to discover by pure reason the essence of "quality". Even Socrates had trouble with such universals. It is still difficult when one descends to particular, concrete instances. Those who design audio equipment have the problem that even after the application of the most precise, thorough and foolproof engineering their products are still finally submitted to the vagaries of subjective assessment. They would really like to have an objective measure of sound quality, perhaps a figure of merit obtained from measurements of electrical and/or acoustic variables, which would be causally independent of personal preferences but at the same time correlated with subjective experience.

A correspondent writing in this issue (letters) is right to assert the primacy of subjective evaluation but perhaps a bit harsh in condemning the concept "loss of information" because it cannot at the moment be expressed in engineering terms. Engineers certainly do follow Lord Kelvin's dictum that you can't properly understand a phenomenon until you can express it in numbers. Galileo, though, after saying something similar, added "what is not measurable, make measurable". "Loss of information" presumably could be measured on the basis of quantisation (as in p.c.m.) and information theory. "Musicality" is more difficult.

Apart from the variations from listener to listener depending on circadian rhythm, degree of tiredness etc., a big problem with subjective assessment is that hearing is not merely a passive registering of impressions but an active process of attention and even intention. (See C. A. Malcolm, *Hi Fi News*, June 1977, on this.) To some extent you hear what you want to hear. An engineer may listen for a particular type of distortion and suppress the emotional or intellectual effect of the programme content. A musician may listen for features of musical performance and "not hear" quite obtrusive distortion. Whereas an engineer carries in his mind a distinct *a priori* concept of frequency, which he may regard as the primary characteristic of sound, it is possible for a musician to say "I cannot accept the distinction between tone colour and pitch as it is generally stated. I find that tone makes itself noticed through colour, one dimension of which is pitch." (Arnold Schoenberg in his *Harmonielehre*.)

Attempts to arrive at a numerical index which correlates with subjective evaluation of sound quality have already been made but nothing workable has emerged yet. It's interesting to note, though, that parallel searchings have been going on in other fields such as linguistics and the behavioural sciences. The most recent is an attempt to formulate and measure value judgments of the kind made in ethics, religion, politics and aesthetics (J. Pearl, "A framework for processing value judgments", *Trans. IEEE*, vol. SMC-7, No. 5, May 1977). The paradigm in this case is that "value judgments and probability statements are the same thing". Both are "codes of experiential data . . . constructed by the same mental procedures".

Probability may be a clue. One approach to measuring sound quality might be based on the principles of pattern recognition, using the known statistics of successive values in the waveforms of musical or other sounds as references. (By analogy, in written English the probability of letter "u" coming after letter "q" is some precise value in excess of 0.9.) With integrated analogue-to-digital converters, high density memories and microprocessors, the instrumentation required should not be beyond the capabilities of today's digital electronics.