HIFICRITIC ARCHIVE III

Pace, Rhythm, & Dynamics

Martin Colloms, Stereophile November, 1992

Martin Colloms suggests that the traditional ways of assessing hi-fi component problems overlook the obvious: does the component dilute the recording's musical meaning?

For all its quantifiable technical faults, easily identified in the laboratory when compared with the measured near-perfection of CD, for many listeners the vinyl LP disc possesses a powerful and effortlessly musical content, with an easy, fundamental rhythmic stability and solidity. Interestingly, this innate character seems to be quite robust, more so than digital. Subjectively rewarding results may be obtained from numerous analog sources without much trouble. Many well-established but not necessarily high-priced components may be assembled to produce musically satisfying results. With analog, one can listen through the blemishes and still be aware of a strong musical message, one in which the music's flow, pace, and tempo are well conveyed, and into which listeners are readily drawn.

By contrast, digital audio seems a fragile medium. Sonic greatness remains elusive, digital replay often seeming to get bogged down at an earlier stage, one where the listener's lack of instinctive involvement leads to substitute activity. The mind remains busy, but may now be cataloguing perceptual features and comparing them with previous experiences. This is an interesting abstraction, comparable in the realm of visual art with the analysis of the brush techniques of old masters. However an obsession with such technical minutiae can blind one to an appreciation of the whole. That easy, rhythmic grace inherent in competent analog replay points to one of the greatest paradoxes and weaknesses of digital replay.

Digital's technical advantages at low frequencies include low group delay, thanks to a highly extended bass response, in theory continuing down to DC. Technical appearances can be misleading, however. From my experience of more than 250 digital products, coherent, expressive, naturally explosive dynamics, and the ability to present good musical pace and a confident, upbeat rhythm are areas in which digital is surprisingly weak. If digital bass is agreed to be tighter-sounding, less coloured and less "phasey," then how on Earth can analog still be in the running when it comes down to providing a subjectively satisfying bass rhythm? Digital bass generally sounds laid-back and downbeat, even if it is highly neutral when viewed and auditioned purely in technical terms.

A listener who is well-trained in the analysis of sound quality may understandably be fooled into thinking that technically good bass automatically implies good rhythm. It does not.

While good rhythm is a key aspect of both live and reproduced music-making, it is not easy to analyze. It's as if the act of focusing on the technical details of a performance blinds one to the parameter in question. The subjective awareness of rhythm is a continuous event, registered at the whole-body level and recognized in a state of conscious but relaxed awareness. Once you've learned that reproduced sound can after all impart that vital sense of music-making as an event, that the impression of an upbeat, involving sense of drive can be reproduced again and again, you can't help but try to pursue this quality throughout your listening experience.

Scientifically trained, I failed to develop a proper awareness of this aspect of reproduction for many years, so committed was I to analytical methods of sound-quality assessment. My engineering background had taught me to reduce problems of sound quality to a series of quantifiable variables, each of which could then be rated in a fairly predictable manner. My objective was the production of more accurate, more consistent reviews. This analytic framework was largely based on my experiences during the development of a long line of superior monitoring loudspeakers for the BBC, where I learned much about live *vs* reproduced comparisons and developed a vocabulary to quantify perceived errors. Those obvious and easily described loudspeaker flaws allowed a quick entry into the field of sound-quality analysis.

What has emerged from my more recent work is the understanding that while a neutral, perceivably accurate sonic character is helpful to high-quality reproduced sound, it is not a prerequisite. This is similar to saying that though low distortion is a generally worthwhile goal for an amplifier, this parameter is not well correlated with subjective quality unless present to unusual excess.

Definitions
The definitions of "pace," "rhythm," and "dynamics" inevitably involve such related aspects as drive, timing, involvement, flow, and coherence. "Pace," for example, involves speed; indeed, the concepts "fast" or "slow" have often been applied to sound reproduction.

Pace: At the simplest level, pace is equivalent to tempo. While a listener may well have a good awareness of absolute tempo, there is a strong subjective element in the perception of the speed at which a musical work is performed. This is determined in part by what has come before. The same is true of the perceived velocity of a vehicle in which one is travelling. Exiting from a fast expressway, the transition to the lower speed seems surprisingly abrupt---one's judgment of speed has been dramatically affected by preceding experience. The way a conductor and/or musicians vary the tempo strongly affects the perception of pace. This is done deliberately as an element of musical expression and interpretation, and is vital to good performances. It doesn't correlate strongly with measured elapsed time. A performance that sounds rushed may takes longer in replay than one which sounds better paced.

Many listeners may be unaware that weaknesses in the audio chain can give rise to errors, which in combination give the impression that the musical pace is slowed. The impact is one of impaired listener interest. (Other classifiable component errors also reduce the listener's interest in the reproduced music---impaired clarity, for example---but the scope of this essay is restricted to the perception of time.) When replay is rendered less interesting, the perception of pace suffers and time may indeed appear to go more slowly.

Timing: This relates specifically to the musical characterization of a performer's ability to synchronize his or her playing accurately with respect to a given beat or rhythmic pattern. The ear has an extraordinary ability to recognize playing, which is not on or aligned to the beat. This includes deliberately time-shifted or syncopated playing, as unmusical errors here quickly destroy musical meaning.

It is a fascinating aspect of audio reproduction that hi-fi components, individually or in concert, can damage the subjective impression of good timing and of tight, coherent musicianship. While many familiar recordings have good timing, some audio components or systems conspire to give an aura of lassitude in which the musicians seem to be playing subtly out of time. This failing may be discerned on just a few notes of a single voice or instrument, enhanced by practice and acuity,. Here one may identify a nuance of uncertainty, a hint of nervousness, or a feeling that the steady, controlled flow of a performance is not as even or as secure as it should be.

With good reproduction of good performances, there is a feeling of confidence and drive, coupled with an awareness of the power of fundamental rhythms and their changing nature as the composition unfolds. Accurate portrayal of rhythm, though certainly very important for classical music, is absolutely vital for rock music. With its short presentation and simpler, more accessible structure, rock's rhythmic element is the foundation of listener involvement. Without that foot-tapping association, that invitation to dance, rock quickly descends to the boring and the banal. Only the most creative and expressive music---for example, the work of Joni Mitchell---can survive such damage; nevertheless this material benefits greatly from good replay timing.

Dynamics: Subjective dynamics play their part in the structure of musical pace and rhythm while carrying substantial power in their own right. Fundamentally, dynamics are associated with the technical definition of "dynamic range," the range of allowable, cleanly handled signal between a system's noise floor and its overload point. Thus CD can have a very wide dynamic range; even with 16-bit systems, a dynamic range of 110dB is possible and is ample for domestic use. However, this does not mean that CD in general has good subjective dynamics. Ironically, it generally does not.

Good dynamics are associated with an awareness of exciting lifelike contrasts between loud and soft sounds. Transients should be imbued with lifelike attack and sharpness, peaks really should sound explosively and dramatically loud. Those peaks should not be rounded, squashed, or compressed.

Dynamic dilution: Realism in reproduced dynamics goes even further than this. Comparisons with live sound repeatedly show that when it comes to reproducing music's inner dynamics, the recorded, or even just the directly amplified content suffers a significant loss of dynamic quality. While an engineer might instinctively accept the notion that an audio transmission system has a finite dynamic window and that audible limitations may well be audible when waveform peaks reach the limits of that window, the idea that information which is nicely placed in the middle of the working range could still suffer in terms of subjective dynamics is quite alien.

It's unfortunate that the subjective effect of all kinds of audio component errors is often a dilution of dynamic expression. More often than not, this weakness goes hand in hand with a loss in rhythm. Considering the complexity of perception, it may not be valid to attempt to separate the two.

Intuitively, one might expect that a perceptible softening of a system's dynamic quality would blur timing cues, due to its effect on the coherence and unity of the fast edges of transients and of dynamic contrasts. This would logically lead to a weakening in the presentation of rhythmic aspects in music. Weaken those, and the sense of drive and forward pace is also diluted.

It's ironic that you can enjoy an extended bandwidth, or high sound levels, or great stereo imaging, or very low coloration, or powerful, low-distortion bass, or several worthy combinations of these performance attributes, yet rarely can you obtain them in combination with a coherent, focused grouping of natural dynamics, of pace, and of rhythm. In High-End audio, we are often too busy examining the texture of the bark to see what kind of forest we are walking through.

It is undeniable that for many listeners dynamics and rhythm strongly affect their emotional response to the whole musical entity. They represent the structure of the musical house, to which we can add such details as windows and decoration. However, exceptionally clear glass in a window frame is of no use if there is no structure to support it.

Whether played loudly or softly, music that is reproduced with good dynamic and rhythmic content competes with external factors for a listener's attention. Unfortunately, the high-end goals of purity and tonal balance often result in a blandness of dynamic expression, with rather subdued dynamic contrasts. While the sound may be aesthetically attractive, participants often resort to disc changing and conversation. Their attention is not strongly held (Footnote 2)

In addition, the rhythmic delivery can be perceptibly leaden for high end systems, to the point where the sound seems more like superior acoustic wallpaper than a committed attempt to reconstruct the involvement of a live musical event.

In a contradiction of received wisdom, it turns out that some of the classic horn loudspeakers show greater musical integrity, judged in terms of natural pace and dynamics, than do the majority of low-sensitivity, low-coloration loudspeakers now produced. Come back, Klipsch and Voigt, all is forgiven! Those designers' belief in outright sensitivity, and the qualities of linearity and uncompressed dynamics which this single factor abundantly confers, are not sufficiently valued by the high-end industry.

Is beauty sufficient in itself?
There is a real danger that the audiophile community---manufacturers, critics, and customers alike---has become obsessed with the search for absolute beauty in reproduced sound and has lost sight of the underlying animal force essential to a truly musical experience. Drama, surprise, and dance elements are essential to most music at almost every level of taste.

For many years of hi fi development it was suspected that beauty and rhythm were irreconcilably opposed, that systems which were lively and rhythmic were also unacceptably coloured. Indeed, it was said that some products and systems only "sounded" as if they were fast and capable of rhythm, and that this was a result of deliberately skewed design, falsifying the music's tonality.

Colouration has been and remains a major flaw of loudspeakers, some listeners taking

the view that the presence of any significant coloration necessarily invalidates a design. Certainly many speakers are quite coloured because they necessarily involve mechanical components. These have intrinsic propensities to store and release mechanical and acoustic energies; *i.e.*, colourations. Yet if present to a mild degree, colouration may not make or break a loudspeaker. For many listeners, mild colouration will not be that great a problem, soon becoming part of the whole learned sound of that speaker in their room.

Interestingly, a number of loudspeakers which do manage to convey the music's rhythmic values well also survive the presence of moderately colouration. To some commentators, the two aspects would seem to be causally connected. However, there is an unfortunate tendency for audiophiles and audio engineers to jump to conclusions when analyzing audio problems and effects. On the limited evidence of just a few models which appear to have related phenomena and technology, two plus two might should make four but can often make five. Earlier generations of JBL, Linn, Rega, and Naim speakers, for example, were sometimes declaimed as "coloured," and it was said that their perceived realistic presentations of musical life and pace resulted from their design flaws. It is now clear, however, that in many of those products the goals of lifelike dynamics and good rhythm were foremost in their designers' minds, and that these goals could not be compromised in an attempt to deliver otherwise fashionably low coloration. (Footnote 3)

Footnote 2: I recall a blind listening test I took part in in the late '70s, in which one of the recordings used was an anechoic one of a jangling bunch of keys. Through one loudspeaker, which had the flattest measured response and the lowest coloration, it was if the number of keys recorded had been reduced to just one! Through a speaker, which turned out to be the overall winner in the tests, the keys recording sounded appreciably more accurate, if more colored.---JA

Footnote 3: Which is the worse loudspeaker: the one that makes a German bassoon sound more like a French instrument, or the one that makes the bassoonist sound as if he hadn't had enough coffee that morning?---JA

Designers who care about rhythm felt---and may still feel---that they possess some basis for a common understanding concerning the lifelike reproduction of recorded music. This understanding is not intentionally distanced from the main high-end thrust. However, whenever dialogue was initiated between these two camps, it frequently transpired that they were not on the same wavelength. Pieces of equipment from the two design schools even sounded uncomfortable when used with each other. At times insults were traded between the various proponents, while both took comfort from their allegiances to different kinds of music. The tonal purists as we might call them felt more comfortable and less threatened by classical material, while the rhythm practitioners became more closely identified with modern rock and jazz, where the better points of their systems would be more readily revealed. In the UK, the split has persisted for decades. It doesn't have to be like this.

There is no good reason why neutral, transparent systems cannot also reproduce dynamic and rhythmic elements well, particularly if designed to do so from the start. However, the specifications for such design do not yet exist in a quantifiable sense. At present, the specifications must, of necessity, be subjectively related, based on careful listening and the use of comparative references. Ultimately the quality of live music is the reference.

The technology of rhythm is not in the textbook

If an audio designer is truly aware of the properties typically found in good live music, he cannot help but try, to the best of his ability, to preserve them in his products. Such design is a painstakingly interactive process which must be continuously backed by critical listening. Auditioning must cover preliminary concepts, prototype studies, passive components, and finally working models.

Such knowledge has been hard-won by designers over many years of development, their findings often contradicting the conventional wisdoms found in electronic engineering textbooks. The latter, generally bound up with the classical engineering concepts of value and efficiency, do not recognize sound quality *per se*. In fact, the over-engineering often seen in top-quality

audio gear is generally scorned by the traditional electronic engineering fraternity who cannot see the excercise involved when audiophiles value sound quality so highly that they are willing to pay an extravagant engineering price to achieve it. For example, if at present the only way of significantly advancing the sound quality of a top-grade power amplifier is to double the size of its power transformers, so be it. If, later in our understanding of the relationships between the engineering, technical performance, and sound quality, we find a better, more cost-effective way to achieve it, that's fine too.

A loudspeaker example

A given moving-coil speaker is heard to suffer from a lack of dynamics---not in the global compressive sense, but in the expressive, inner-dynamics sense. Likely causes are poor transient definition resulting from some combination of unwanted energy storage in the driver and enclosure system, and/or major flaws in the energy arriving at the listener; for example, poor frequency and phase responses. Tightening up the acoustic driver integration and frequency response can work wonders here. Attention paid to energy decay problems will also be helpful. In addition, problems in dynamics, rhythm, and timing are often tied to hysteresis effects in the mechanical suspensions of the drivers, the cabinet and details of acoustic loading.

Hysteresis in a speaker drive-unit is a phenomenon wherein recovery from a transient is artificially delayed due to some visco-elastic or equivalent memory effect. The suspensions fail to act as pure, linear springs. That delayed recovery distorts subsequent waveforms and seems to be associated with weakened subjective timing. Specifically, the bass sounds sluggish, even "half a beat" behind, despite the suggested advantage of the extra damping afforded by such "lossy" low-Q suspension systems.

A neat example of bass rhythm differences is provided by the BBC-designed LS3/5a. years ago, This near-field monitor was revised to accommodate a later, more consistent bass unit, while the system's basic, closely toleranced sound was largely preserved. While the new system was generally a little cleaner in the midrange than typical examples of the earlier production, (Footnote 4) rock enthusiasts determined that one other difference had emerged: the older version was found to "time" better, to have more "rhythm."

Searching analysis revealed that the design feature most accountable was the choice of the type of front surround suspension for the bass driver. This had been high-Q, springy Neoprene in the old type, but became a low-Q, absorptive vinyl composite for the new. The latter had been specifically chosen for its loss factor to improve the cone's midrange termination, successfully linearising the response, but appaarently at the significant expense of the speed and fluidity of bass lines. The latter quality appears to rely on the principle of a linear spring, with simple pistonic motion uncomplicated by delay or hysteresis effects.

Footnote 4: See *Stereophile*, February & March 1989, Vol.12 Nos.2 & 3.---JA

It is an unfortunate fact that hysteresis problems are not restricted to the large-amplitude movements found in bass drivers. They can also affect subjective timing in the mid- and treble ranges, though not to the same degree. Analysis of many speaker reports suggests that tweeters with springy foam or fabric suspensions time better than those using vinyl or similar materials.

In addition, the potentially anomalous mechanical behaviour of ferrofluid has to be balanced against its benefit in terms of reduced voice-coil heating. The ferocity of vibration---small in amplitude but very fast---in a tweeter can hardly be underestimated. Under strong drive, mounting screws can be shaken loose, lead out wires fractured due to metal fatigue, and the ferrofluid in the gap can look as if it is boiling, the agitation sufficient to turn some of the ferrofluid into a magnetic mist floating between the poles. The randomness of the fluid distribution under drive may be viewed as a hysteretic effect.

Experience has shown that any kind of random movement in loudspeakers conspires against dynamic expression and good rhythm. It is as if the noises produced by such randomness are so out of context that the musical message is disturbed. Under heavy drive, loose absorbent fillings in a bass enclosure can flop about more or less randomly. That very randomness disturbs the continuity of the bass rhythm. UK critic

James Michael Hughes has even recommended removing *all* of a speaker's filling material as a matter of course for this likely reason.

My vote is still out concerning enclosure fillings. There is almost always a conflict between the need for acoustic volume absorption to moderate those internal standing waves which are capable of causing colouration, and the need for clean, fast bass. Ideally, the air trapped in the speaker chamber should be subject to adiabatic pressure changes, a quick if ultimately non-linear phenomenon. Dense enclosure fillings, however, are often touted for their ability to provide an approximation of isothermal operation, in which the enclosure's effective volume is increased by 20-30%. Here the filling moderates the natural almost instantaneous temperature changes in the air volume in the face of pressure drive from the bass unit. (The constant temperature which results gives rise to the term "isothermal.") The penalty is the slower transient response due to the small but significant delays present in the transition from adiabatic to isothermal operation. It takes just a little time for the air to give up its heat, then get it back.

Imprecision fin respect of the radiating unit's driving plane may also blur the music's rhythmic content. From experience of many examples, I have observed a clear association between good subjective dynamics and such fundamental aspects of speaker construction as the integrity of drive-unit frames, the strength of their fixing systems, and the strength and mass of the enclosures to which the drive-units are attached. Alone attention to these details will not guarantee a good speaker, but they are considered essential if the other aspects of design are to be heard to full effect.

Many reviewers and owners have heard hysteretic randomness in action when they experience the improvement wrought by judicious tightening of the fixing screws for loudspeaker drivers. This needs to be done with some care; it is only too easy to strip threads in wood-composition baffles where steel "T" nuts are not used. Over tightening can also fracture the driver frames. It is a fact that after manufacture, wood or wood-composition materials undergo a degree of compression; thus speaker fixings can loosen, also with time, even in the interval between manufacture and delivery.

The sound-quality difference between a moderate tightness, which allows for some random, time-delayed vibration patterns between the driver frame and the cabinet, and that when fully tightened, can be quite dramatic in both dynamic and rhythmic terms.

Loudspeaker sensitivity & dynamics

Another way of improving a loudspeaker's dynamics and rhythm, provided that care is taken to maintain a low level of energy storage, is to raise its sensitivity. This is achieved by using a larger, lighter cone which, being required to move less for the same loudness, needs much less electrical current in its voice coil to achieve the same spl. Lower current leads to lower levels of distortion, as well as less compression and less heating---both enemies of convincing dynamics.

One high-performance miniature I know well achieves quite good dynamics by virtue of a highly accurate acoustic response, in terms of both the energy balance with frequency and a quick decay. However, it can never reach beyond a known performance limit due to its low efficiency, and the corresponding need to drive it with comparatively high current.
Considering an alternative design with similar-sized working parts, here the bass response was deliberately sacrificed in favour of much higher sensitivity. The choice of a much lighter cone enables the revised design to achieve a new performance characteristic, namely substantially improved dynamics.

Amplifiers & dynamics

It's hard to extrapolate these concepts to electronics from mechanical and acoustic concepts, whose effects may be directly appreciated in physical terms expressed in the movement of sound-reproducing structures. In an amplifier, the sound pressure is represented by its electrical voltage analog due to currents flowing in wires and electronic components. However the task is not impossible. Data on electronic parallels with the acoustic rhythm experience is beginning to emerge. There are related types of uncertainty or randomness in electrical behaviour which can disturb the internal equilibrium of an electronic component. Such disturbances seem to relate well to subjective weaknesses in rhythm and dynamics.

One area increasingly familiar to amplifier designers is the effect of large transients on

conventional amplifier power supplies. A fast crescendo momentarily drains the reservoir capacitors faster than they can be refilled via the charging diodes, causing the main voltage rails to sag. Heavy ground currents also flow, which may inject additional disturbances according to the specific circuit design. Output tubes may suffer partial saturation effects, a loss of space charge, or heating of the plate/anode structure. In a solid-state unit, MOSFET or bipolar junctions will heat up, the rise in temperature correlated with the signal waveform. All of these effects result in altered operating characteristics. Now we have the recipe for a degree of chaos, the kind of rhythm-disturbing randomness discussed earlier with loudspeakers. (Footnote 5)

Putting aside the music-related waveform decay for a moment, consider the internal behaviour of an amplifier following a large transient signal. The temperatures of the output stage devices stabilize over their sigifiacnt time constants, these changes also associated with changes in device gain and bandwidth, operating point, and quiescent bias. The main supply rails have dipped and are now recovering their mean voltages, the speed of this latter process largely dependent on the surge capacity of the supply lines and the regulation of the mains transformer. The recovery proceeds in a sequence of high peak value current pulses of rectified 100Hz supply-line of semi-exponential form, these pulses possessing a wide noise bandwidth.

During the initial power rail dip and subsequent recovery, the amplifier circuit may fail to fully reject the supply-rail imbalances, and thus may show perturbations in its DC output level, this a particularly insidious error in respect of the bass/mid drivers of two-way speaker systems due to the resulting voice-coil offset residual. The recovery characteristic of the main supply has a particular time constant, but so do many other parts of the amplifier: for example, the negative feedback decoupling section; or, if fitted, the DC servo. Simpler amplifiers often have weak decoupling for their lower-level power lines serving earlier sections. These other sections of the amplifier contribute their own recovery delays.

Thus, following a big transient, both voltages and currents inside an amplifier are on the move, none directly related to each other or, more important, to the power envelope of the music.

The amplifier's overall negative feedback loop will largely mask this internal behaviour from the traditional laboratory tests, which in any case are essentially confined to the steady-state domain. However, the ear is certainly aware that all is not right. I have obtained some measure of proof that these internal effects are responsible. Interactive listening tests have been undertaken in which some of these subjective problems were specifically addressed in design. The results were well correlated with critical auditioning.

One parameter examined was the size of the amplifier's power transformer. A clear correlation emerged between improved dynamics and rhythm, and with increased transformer VI rating. One explanation is that the larger transformer provides superior regulation, hence more stable internal power rails. Even more important, a larger transformer helps the reservoirs recover their equilibrium more quickly after a transient. Consequently, the amplifier spends more of its time in equilibrium.

Similarly for an output stage, increasing its thermal capacity and/or the number of power output devices has the benefit of reducing the thermal and current variations in each device. The result is more stable output behaviour, more consistent bias levels and distortion. Once again, the payoff is often heard in improved rhythm and dynamics.

Footnote 5: See the second half of Ben Duncan's "Harmonic Convergence," *Stereophile*, Vol.15 No.10, October 1992.---JA

Such design practice goes far beyond simple engineering value considerations. Where high-quality audio is concerned, the conventional cost/watt ratio is no longer the prime consideration.

In this context other established design factors now also make sense. For example, operating an output stage in class-A largely stabilizes its operating characteristics. In this area we may also include full regulation of the power supply, which removes the uncertainties and randomness of power-supply behaviour.

Deleting various low-frequency time constants in the circuit where possible also appears to be helpful, these multiple sections can degrade the low frequency phase response impairing timing. Hence we

observe the trend to DC coupling, with servo circuits used to keep the amplifier's output terminal at mean ground potential.

The primary target
I have not yet touched on the primary target: digital audio. This is because the digital operating system is so complex. We have the interfacing of the digitized data, the digital signal-processing operations, and finally the variety of conversion techniques used to transform the data back to the analog domain. This system is not open to the kind of simple analysis so far seen for loudspeakers or even power amplifiers.

It's disturbing to realize that most digital audio systems are not designed by seasoned audio engineers but by digital theoreticians at chip level. Without a strong and critical audio influence, the ultimate sound quality of digital audio will itself have a random quality, lacking heart and direction. So far, the results obtained suggest that all a high-end designer can do is pick his way through the available technologies and try to devise applications which best express his audio goals. This is most definitely not the same as designing your own speaker or amplifier: within digital technology, the number of variables available to the designer has been severely reduced. Those vital system decisions have already been made at the keyboard of a large digital CAD system fundamentally tailored for the design of digital logic circuitry. (Footnote 6)

Considering the two primary DAC technologies, broad generalizations are now possible, notwithstanding individual designer variations. Low- or 1-bit, high-over sampling DA systems have a pleasant "undigitized" sound, "analog-like" in tonal quality and often capable of fine transparency and very good low-level resolution. In addition, good results are often obtainable at low cost. The weaknesses of such systems are in the areas of transient life, dynamic expression, and rhythm. In classical subjective terms, the sound quality of Delta Sigma MASH or BitStream devices may appear very plausible, like a very-low-coloration monitor speaker, but may ultimately fail to satisfy. A secure feeling of rhythmic, dance-like coherence is often absent, careful analysis of the reproduction frequently revealing bland politeness. High-profile proponents of low-bit D/A technology include Meridian, Deltec, Altis, and California Audio Labs, as well as Pioneer, Philips/Marantz, Sony, and Matsushita (Technics, Panasonic). (in 1992, but many more since)

While much mud has been slung at the alternative and older, high-bit, low-over sampling technique, multi-bi PCM, mainly by avid proponents of low-bit systems, the fact remains that multi-bit is still the system of choice for high-end CD replay. Handled well, it is capable of good timbre and good transparency, while it also has the potential for a very good dynamic and rhythmic performance, even if this is not yet up to the best analog standards. At the time of writing high-profile adherents of multi-bit technology in the High End include Accuphase, Mark Levinson, Stax, Linn, Naim, Theta, Audio Research, Krell, PS Audio, Audio Synthesis (UK), Mission-Cyrus, and Wadia, to name but a few.

Now that digital audio has matured sufficiently to overcome its initial harshness and mechanistic quality---"digititis," as it has often been called---it is time for us to advance its performance in the areas of pace, rhythm, timing, and dynamics.

The future
Rhythmic and dynamic qualities are fragile and easily diluted. They are precious yet vital aspects of the musical experience, and demand wider recognition and greater understanding. A stronger commitment is required from the audio industry as a whole to address their manifest deficiencies in this area.

Footnote 6: The conflict between circuit theory (and simulation) and the practicalities of design is expanded upon in an excellent collection of essays in the EDN Series for Design Engineers, *Analog Circuit Design: Art, Science, and Personalities*, edited by Jim Williams (Butterworth-Heinemann, 1992).---JA

Stereophile Readers Feedback

Pace & Rhythm: one listener's lament
Some years ago it struck me that British writers were increasingly discussing the "rhythmic" properties of the components they reviewed. (I now see the issue coming up slowly in *Stereophile* and *The Abso!ute Sound* as well.) Although I understood all the words used to describe the differences ("bass was a bit slow...the highs lagged by a considerable amount...," etc.), this message

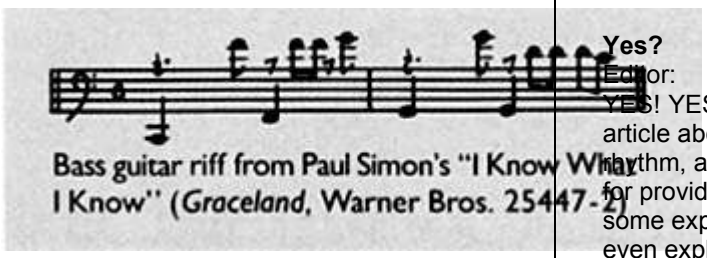
made no sense to me; I felt no recognition. Rereading didn't help, and reading more of the same didn't help.

So, on one of my annual trips to the *HFN/RR* Penta Show, I decided to devote five minutes of a lengthy discussion with Martin Colloms to the above-mentioned phenomenon.

When I came home, I decided to let the matter drop, but in the back of my head the process must have gone its way.

Then, some months ago, I was testing three mid-priced CD players for a Dutch magazine: a Pioneer PD-9700, a Denon DCD-900, and a Technics SLP-700. One of the discs I use for my auditioning is Paul Simon's *Graceland*. Though musically very interesting, this is by no means the ultimate recording in terms of sound quality; it can sound a bit hard and "processed" on a very high quality, very transparent system. When I played track 3, "I Know What I Know," on the Pioneer, it suddenly struck me that there was something rhythmically wrong.

I tend to listen in an analytical way, not only when I try to come to grips with the sound quality of a piece of equipment, but also when concentrating on the music itself. Exploring the musical structure, I identify with one instrumental line and try to understand the other "voices" from there on. In "I Know What I Know," I chose the bass guitar, which plays on its high strings an intriguing, almost perpetually repeated sequence which goes more or less like this:



Bass guitar riff from Paul Simon's "I Know What I Know" (*Graceland*, Warner Bros. 25447-2)

The bass guitar is played just slightly ahead of the beat, this "pulling" creating tension. Other elements playing important rhythmic parts are the bass drum, Simon's voice, a couple of electric guitars playing an Afro/Latin countermelody, and the chorus in the refrain, some of these syncopated. The rhythmic balance between these separate lines is not as tight as in much of today's sampled and thus computer-controlled music; it's looser, like what you'd hear from a live band. At least, that's how it should be.

The Pioneer made a mess of it. After hearing this same disc on other machines, the Pioneer made it sound like another take of the same music played by the same people, but from a different session in which the band had partied too much the night before. The Technics was better, and quite listenable, but the best of all was my reference machine: a Marantz/Philips CD80. I've tried many CD players since, but for rhythm the CD80 is by far the best, regardless of price.

You can hear these differences in rhythm on some classical music (*eg*, some faster Bach movements), but on many pieces of music it isn't that apparent, even when listened for. Still, I think it plays a role, even if a nearly subliminal one. It would explain, for instance, why I've always liked the CD80 so much, despite its harsh highs.

As for an explanation of the rhythm phenomenon, I've no idea. Some have suggested that low-bit converters are worse in that respect than the multi-bitters because of the noise-shaping used in the former (noise-shaping works by feedback and time-delay, and could thus be thought of as time-smearing), but in my experiences with 20-30 different machines I haven't seen such a relationship. Neither do I see a correlation between rhythmic performance and price. Even more confusing is the fact that, even when using the same outboard D/A converter, the rhythmic quality reflected the CD player used as a transport. What's going on here?---**Peter van Willenswaard**

Yes?

Editor:

YES! YES! YES! Finally somebody wrote an article about the stuff I like---namely pace, rhythm, and timing. Kudos to Martin Colloms for providing me (in November 1992) with some explanations for something I couldn't even explain to myself.

The salesman who first introduced me to the Linn LP12 invited me over to his house to listen to his system. I brought some records along with me that I thought "sounded good." His system consisted of a Linn LP12/Ekos/Asaka, Exposure electronics, and Linn's Kan II speakers on their dedicated stands. This was the first high-end system that actually impressed me. I had heard other (more expensive) systems in audio stores that "sounded good" but did not make me want to empty my bank account.

His system had a certain something that kept me transfixed in my seat wanting to hear more. It was definitely not anything I had previously associated with a good stereo system. I was seated about 5' in front of the speakers, far to the left of the center---definitely out of any sweet spot that may have been there. There was no soundstage or pinpoint imaging of any kind here. The speakers, being very small, would sound very stressed when trying to produce any relatively deep bass. They didn't bottom out, but were just never able to let go of the bass notes. They also did not play very loud. But---and this is a big but---none of this mattered in the least. What I heard was not "good sound," but *music*! Ever since then I had been trying to figure out why I liked this system so much. After reading some of the British hi-fi mags I noticed that a lot of them kept talking about pace and timing. This seemed to describe, for me at least, what I liked so much about that system. MC's article pretty much confirmed this.

One thing that I inferred from the article is that it is difficult to make a component that has both an abundance of good sonic qualities and good pace, rhythm, and timing. This seems to be true, at least among the products that I auditioned (and could afford). I tried to build a system that would give me some of each quality. My Linn LP12/Akito/K9 and the Linn Kan IIs provide the pace, rhythm, and timing, while Moth Series 30 electronics provide the openness, transparency, and soundstage. This is still a compromise, though. Even though the Moth electronics "sound" great, they don't quite let all of the musical excitement---*ie*, the pace, rhythm, and timing---come through. Hopefully, with this introduction by MC, you guys will include comments regarding pace, rhythm, and timing in your reviews. Then maybe I'll be able to find musical nirvana instead of compromises.
---*Michael Cole Federal Republic of Germany*

Yes!
Editor:
Martin Colloms's "Pace, Rhythm, and Dynamics" (*Stereophile*, November 1992) is a wonderful discussion of the musical experience. I hope it will help further the ongoing changes taking place in assessing the quality of audiophile equipment.

My own experience with the significance of pace and rhythm occurred several months ago. When I moved, I had to change my setup and increase the distance between my preamplifier and the power amplifier. My interconnect was not long enough, so I temporarily inserted a 3' one from Radio Shack to make up the difference. When I played the classical LP I had most recently listened to in my previous abode, the music sounded *slow*. The notes sounded disconnected and unrelated to each other. All sense of life and rhythm disappeared (yes, classical music has rhythm too!). It was as though the same music were being played by different and totally uninspired players. I checked my turntable speed and amplifier voltages and they were normal.

I was puzzled but wondered about the added interconnect. I temporarily moved my power amplifier out into the room so I could connect it without the Radio Shack insert. Sure enough, the music returned to "normal," with the same lively rhythm and faster pace I was used to. The happy ending is that I was inspired to upgrade and bought a higher-quality interconnect of proper length and significantly improved the sound quality of my system.

This experience made it clear to me that the pace and rhythm of reproduced music has little to do with clock measurements. It will be a great challenge for equipment reviewers to find a set of objective measurements which will correlate with this whole musical experience which Colloms has artfully described.
---*John L. Hodge Montpelier, VT*

Since 1992 I have found little to change in the above exploration of rhythm, perception and engineering. Experience of varied designs of audio equipment continues to suggest that there is a divide between those who are aware of these discussed musical values in sound reproduction and who can express them in equipment design and system setup, and those who are to all intents and purposes oblivious to their relevance and importance. MC 2006