ATTACHING THE ONSLAUGHT of Olympic athletes on world records this past summer, I wondered how such rapid progress from one generation to the next was possible, and whether we cannot find a comparable historical advance in skilled singing. Achievement in both sports and singing depends upon coaxing the human body to perform at an optimal level, yet there is little evidence that the body’s basic abilities advance as quickly as the world records. Is there a lesson in the Olympic Games that can be applied to singing?

Many factors contribute to the relentless advance of records in sport, but one that catches the eye of anyone following the Olympic Games is the explosion of available information providing precise feedback on performance: super accurate timing devices, multimedia simulations of races, slow motion and freeze frame video, all allowing coaches to address the smallest details of an athlete’s performance. This information, moreover, is available not only to the coach of the individual athlete, but to anyone who has enough knowledge to draw tactical conclusions from it. The advantage provided by Usain Bolt’s long stride can be calculated precisely by both his coach and potential imitators.

Might there be a similar advantage from detailed measurement of aspects of singing technique? To be sure, unlike running or swimming, the essence of singing eludes capture by quantitative measurement. We do not award medals to the singer who sings the highest note or the one who gets through a song the quickest, while touching all the bases. On the other hand, what we call singing technique can be approached quantitatively in important ways beyond the measurement of pitch, loudness, and duration.

Much of the new information that has advanced the coaching of sports is taken from analysis of precisely timed video. Because so little of the movement of the voice producing organs can be captured by noninvasive video, however, singing teachers have to rely on self-reporting of singers regarding what they “do” to achieve desired results. In comparison to coaching athletes, this is a little like a situation where both runners and their coaches are blind, relying on verbal descriptions to improve their performance.

Even if we are prevented from following the vibrations of the vocal folds and the movements of the vocal tract with the eye, however, there are ways of directly tracking the results of these movements. One particularly revealing
measurement of the singing voice that is now within reach for all is that of spectrum analysis. Briefly, by displaying the relative intensities of all frequency components (fundamental plus overtones) of a given sound, spectrum analysis gives detailed factual information on the singer’s use of resonance, which in turn is regulated by precise adjustments of the (largely invisible) vocal tract. This information is especially valuable as feedback in approaching critical climactic notes, where successful execution depends on delicate adjustment of the vocal apparatus optimally to enhance one or two of the (precisely located) frequency components.

As an exercise in the use of such feedback, let us look at a traditional teaching situation with the added power of spectrum analysis: the master class made available to all on YouTube, where Pavarotti works with a young tenor on the aria from Rigoletto, “Questa o quella” (http://www.youtube.com/watch?v=JM_ACiOuYkA). Pavarotti makes some nice observations about the use of legato and the need to “anticipate” the orchestra in this quick aria, but the primary problem he addresses, explicitly calling it “technical,” is the challenging high B♭ near the end of the second strophe, where the word “se” is sustained through a series of notes: A♭, B♭, A♭, and G.

The words he uses leave some doubt about just what he means. He says, “Keep your voice smaller—and more . . . trumpet.” Later he is more specific regarding the B♭: “The position of this [the A♭] must be the position of . . . later [the B♭]. Do not move your mouth.” What he means with these words becomes clear when we analyze his own performance of the passage, for example, in Jean-Pierre Ponnelle’s classic film of Rigoletto, from which “Questa o quella” is also available on YouTube (http://www.youtube.com/watch?v=nmUzPl0W1Fs).

Without going into the background knowledge needed to make this interpretation, we can point out that Pavarotti finds the resonance on the A♭ by aligning his second formant with the fourth harmonic, making it the dominant frequency component, more than ten decibels stronger than any of the others. When he moves on to the B♭, the

Figure 1. Spectrum of Pavarotti B♭4 (above) and A♭4 (below) from the aria “Questa o quella.”
second formant continues to follow the upward track of the fourth harmonic. Getting it that high is something of a stretch, and any further opening of his mouth would cause the second formant to fall. Thus he expressly warns the pupil, “Do not open your mouth.”

The pupil, however, has prepared an approach to the B♭ with another strategy: for the higher note, he changes the vowel from [e] to [a], lowering the second formant to the more accessible third harmonic. This strategy is not unprecedented for the aria in the recorded literature, but our tenor in this lesson misses the solid connection, delivering a tenuous B♭. Pavarotti does not pursue the matter further, but smiles and applauds as the pupil exits.

There is a failure of communication here that is perhaps inevitable in the typical master class situation, where there may be insufficient time to induce the desired acoustic change indirectly by asking the pupil not to open his mouth. The situation would be different, however, if the spectral display could be used as feedback to indicate both the desired adjustment and the degree of success the pupil has in achieving it.

The master class that opened the NATS National Conference in June 2008 was equipped for such feedback (spectrograms and power spectrums of the singer’s performances were projected onto display screens in real time). In this class, a young tenor—with an excellent voice—was performing “Che gelida manina,” and the spectrum of his climactic high C showed a dominant second harmonic, rather than the enhanced third harmonic typically found on that note in the recordings of the great Rodolfo’s. One of the teachers suggested that he “close” the vowel ([e]), moving the second formant higher to achieve the desired result of a dominant third harmonic. The pupil successfully followed that advice on the next attempt, with the results displayed on the projected analysis for all to see. (It should be noted that audience did not necessarily hear the sound of this acoustically tuned vocal production as significantly better than that of his first attempt.)
What he did with that information after the class has not been reported, but given the availability of spectral feedback, this improvement might readily have been practiced and made habitual, even without having the teacher present.

The master class in Nashville gave a hint of the contribution that technology can make to the ancient art of voice pedagogy, which, unlike sport, has scarcely begun to exploit the useful information that is potentially available from such sources. If we are to move forward on this, note that a few things must be brought together: understanding of the acoustics and physiology involved; affordable equipment, together with mastery of its use; and access to exemplary models. The last item is the easiest: recorded singing has been with us for over a century, and the Internet is making it all readily accessible, often with video. Affordable equipment for such things as spectrum analysis and electroglottography has a much shorter history, but the last decade has seen great advances, and in the future their availability will be taken for granted, just as personal computers are taken for granted today.

What is still missing is a widely shared understanding of how the signals relate to the traditional goals of voice building: extending the range in both pitch and dynamics, uniting the registers, improving quality and carrying power, optimizing vibrato and legato, and enhancing vocal beauty. This knowledge exists, but it neither has been available very long, nor has always been well disseminated. What hinders its spread is not so much its complexity, although that is challenge enough, but the fact that its practical application, as in the wired master class, also requires the traditional expertise and cultivated ear of the singing teacher. This builds slowly over years of teaching and is less common than many of us would care to admit.

The good news here is that understanding (and applying) the signals can greatly speed the process of acquiring the cultivated ear. Quantification and analysis help us to recognize specific patterns, which in turn are associated with subtle, but identifiable differences in sound. In this way advanced voice pedagogy takes us beyond the basics of breathing, posture, and vocal anatomy to critical adjustments in the sound of a voice.

In singing, as in the world of sport, practitioners are strongly motivated to emerge from the crowd and gain elite status, and they will use any means to get there. The person of the coach remains a large factor, even in the era of the technological assist. It seems irresponsible, however, not to acquaint the coming generation, now in graduate school, with the advantages of the technology that will soon be commonplace.

Donald Miller, who designed and developed the software program VoiceVista (Visual Feedback for Instruction in Singing), began his career as an opera singer and voice teacher. Having completed his formal studies at the Yale University School of Music in his native USA, he continued with singing lessons in Milan and Berlin, making stage appearances in both cities. After a further year’s engagement with the Wiener Kammeroper, he joined the faculty of the Syracuse University School of Music, where he taught for over two decades, rising to the rank of professor. During this time he was very active as a bass baritone, singing over twenty-five leading roles from the standard repertory, along with many roles in contemporary works.

His interest in the application of voice science to the singing voice grew in the late 70s, and in 1984 he spent a semester in Groningen, the Netherlands, on a project with Harm K. Schutte and the late Prof. Janwillem van den Berg. In 1987 he moved permanently to Groningen to devote himself to research on the acoustics and physiology of the singing voice as an associate of the Groningen Voice Research Lab. This has resulted in a number of scientific publications together with Prof. Schutte, as well as a doctoral monograph, “Registers in Singing,” published in 2000.

An important result of his work in Groningen has been the program VoiceVista, feedback for instruction in singing. VoiceVista was introduced in 1996, when personal computers became powerful enough to perform real-time spectrum analysis. Since then it has been further perfected and is now in use in voice labs and facilities for training singers, particularly in the US, Germany, and the Netherlands.