

**NATIONAL
Science/Health****The New York Times**
ON THE WEB

February 22, 2000

**Imbuing a Computer's Performance With Human Emotion
([diagram](#))****How Would Great Composers Play It? Some Clues**By **BOB TEDESCHI**

Anyone who plays Beethoven, Mozart or Bach faces issues that have plagued performers throughout the centuries: namely, the composer's score provides scant guidance on how to approach many facets of the music. Performers make educated guesses as to how loudly to play individual notes, for instance, or how to accent four consecutive quarter notes, but they remain guesses.



Susan Spann for The New York Times

Dr. Manfred Clynes, a neuroscientist and concert pianist, says "pulses" show how the masters would have wanted their works to be performed.

Now Dr. Manfred Clynes, a neuroscientist and concert pianist who lives in Sonoma, Calif., has discovered what he says are clues as to how exactly the masters would have wanted their pieces performed.

Dr. Clynes, a former neuropsychology professor at the University of Melbourne, who coined the term "cyborg" and has performed to the acclaim of people like Yehudi Menuhin and Albert Einstein, has identified what he says are patterns in the music of master composers.

Those patterns, or "pulses," show how a composer favors louder and longer notes at consistent points in a phrase, much as poets resort to patterns of phrasing or painters favor certain brush strokes. Dr. Clynes argues that similar patterns exist on higher levels in musical compositions, like the way composers stress certain bars in a movement.

Performances of Beethoven, for instance, carry his characteristic strength and intensity when, in four-note sequences, the second note is played shorter and softer than the others, whereas the notes in Mozart's sequences are more consistent in length and amplitude.

These discoveries were made in a series of experiments that built on the work of Gustav Becking, a German musicologist who first put forth the idea of composers' pulses in 1928. Becking himself had extended the theories of Eduard Sievers, who found he could mark the shift in the Bible's authors by following the rhythm of the writing with the movement of a finger. The loops that Sievers traced while reading each writer were distinct, he found.

Just as each writer evoked consistent finger patterns, Mr. Becking found, composers produced similar patterns. Dr. Clynes first measured those shapes in 1967 by recording how musicians like Pablo Casals reacted to certain pieces of music while using a device Dr. Clynes invented, called a sentograph. A person using the sentograph listens to music and touches a pad, which finely records finger pressure and translates that pressure into shapes. When several such musicians reacted to the same composers with similar shapes, Dr. Clynes said, "we knew we had something good."

In the early 1980's, using digitized performances of pieces by well-known Western composers, Dr. Clynes experimented with variations in each composer's pulse, and tested those pieces to see how true they were to the patterns he had established for each. In this way, he was able to chart the "micro-structure" of a composition -- the most subtle aspects of a score, like the attack on an individual note, which composers leave to performers and conductors to discern.

Dr. Clynes codified these findings in a computer program that allows users to experiment with the pulses of various composers -- say, what a Mozart symphony might sound like with Schumann's pulses -- and build interpretations of their own, using digitized music rendered by computer. That program, [Superconductor](http://www.superconductor.com), is now used at the Juilliard School and has won praise from musicians and from scholars at the Massachusetts Institute of Technology's Media Lab.

In so doing, Dr. Clynes has also given an air of legitimacy to music made by computer and has provided new tools for composers and musicians.

"For one thing, Manfred has shown that a computer simulation can be made good enough for many people to immediately take to it, and that's not a trivial feat," said Dr. Jerry Lettvin, professor of neuroscience at M.I.T.

"In fact, the difficulty of that is quite staggering."

Previous incarnations of digitized music "were a joke," said Alice Shields, a composer who is the former associate director of the Columbia-Princeton Electronic Music Center. "They were wooden and boring and had none of the emotional qualities that noncomputerized music has," she said.

Part of the reason, Ms. Shields and others said, is that computerized music often

plays every note virtually the same, with few subtle variations in aspects like tone or tempo found in performances. In his computer program and in 240 computer-generated pieces of works like Bach's Brandenburg Concertos, Dr. Clynes uses the pulse to avoid such an effect, but he also relies heavily on another of his theories: predictive amplitude shaping, which calculates the volume of notes in a phrase.

For many instruments, like a violin, individual notes can be shaped differently, depending on how the amplitude rises and falls during a note. A note can have a gradual build-up or can diminish quickly.

Dr. Clynes observed that the shape of a note's rise and fall is affected by the next note. If the next note is a higher pitch, then the amplitude will fall more sharply at the end. If the note that follows is lower, the amplitude will fall more gradually.

In addition, the shorter the time between the beginning of the first note and the beginning of the next, the more pronounced the rise or fall.

Dr. Clynes tested this idea by using time and amplitude equations that represented virtually every shape a musician could use for a note, and determining the formula that, to his ear, produced the most natural results. His findings were first published in 1983 by the Royal Swedish Academy of Music.

Those familiar with Dr. Clynes's findings agree. "A piece of music isn't a pure mathematical collection of formulas," said Donald Martino, a composer and an emeritus professor of composition at Harvard. "We write it down as if it is, as if each sixteenth note is the same, but in fact, when you measure them, they're all slightly different."

Certain collections of notes "suggest to players slight variants to the rhythm and volume" that the musical score cannot express, Mr. Martino said. "These are things you couldn't really do so well when just programming a piece by the formulas. Now with Manfred's findings, it's possible to make electronic music which is more human."

Dr. Clynes also theorizes that composers show patterns in how vibrato is ideally used. For instance, he said, performers of some composers should start the vibrato later in the note if the succeeding note is higher, and earlier in the note if the succeeding note is lower. This theory of vibrato has not been scientifically validated, but Dr. Clynes has incorporated it into the Superconductor program.

Dr. Clynes's software is useful in interpreting not just the works of great masters, but whatever music a user wants to perform with a computer, said Jeff Harrington, a composer who has had his music performed in recent years by the North Carolina Chamber Players and the Clemson University Symphony Orchestra, among others. Mr. Harrington said the software also allowed a composer to create a musical performance for many instruments and control that performance with a precision that conductors could never achieve.

"If you get a bunch of musicians together to play your music, there will be tons of places where it sounds bad," Mr. Harrington said. **"When I compose, I know**

what a piece sounds like in my imagination. So when it matches or sounds better than I imagined, as is the case with this, that's when it blows you away. I think it's miraculous."

Dr. Clynes said he hoped the software, which he released in the mid-1990's and continues to refine, will also appeal to music beginners. "People spend their lives learning an instrument, and they have to perform all kinds of acrobatics to play a piece, but that has nothing to do with the essence of music, which comes down to how someone interprets a piece," he said. "This enables the average person to take music and shape it to their own view of it, just like a virtuoso can."

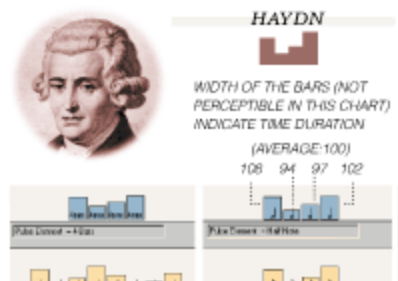
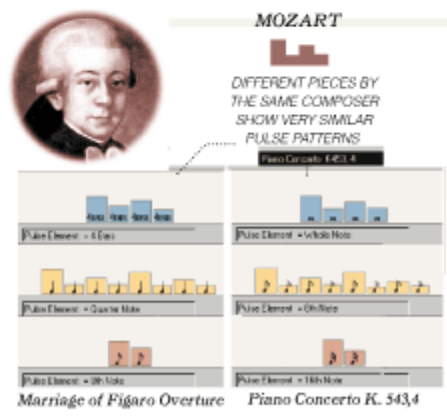
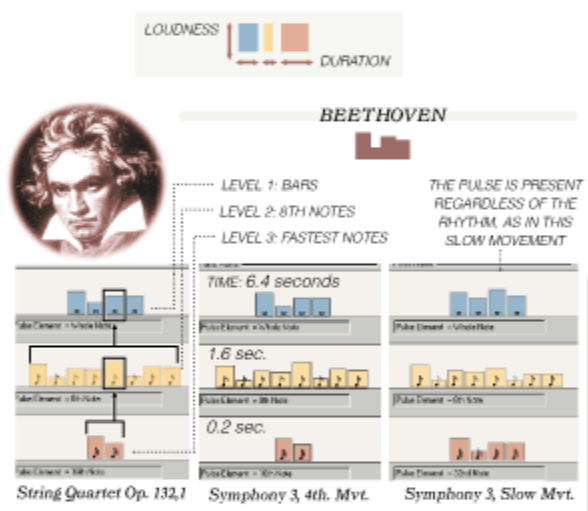
Diagram

Imbuing a Computer's Performance With Human Emotion

Dr. Manfred Clynes, a neuroscientist and pianist, wanted to create a computer program that would play music exactly as the composer would have wanted. In order to do that, he had to discern the subtle signatures that mark the work of each composer. These "human" aspects of the work, which make up its microstructure, do not appear in musical scores. But they can be found in the pattern or pulse of a composer's music, the shape of individual notes and the vibrato or modulation of the notes.

1 A Signature Pattern, or Musical Gait

The pulse is a combination of the loudness and length of time of the notes. Building on the work of a number of scientists, Dr. Clynes discovered that master composers have unique and consistent patterns or pulses throughout their body of work. This pulse, he said, is manifested on several levels, including fast 16th-note passages, longer eighth-note passages or even whole bars within a phrase.



Credit: Juan Velasco/The New York Times