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Inventor of celletto expands world of computer music

Chris Chafe is a cellist. He'd really like to be an orchestra.

Eight years ago, Chafe the researcher began to wonder if he could transform his cello skills into a smooth saxophone lick. Chafe the composer thought it also might be fun to mix the sounds of string and wind instruments.

So Chafe the handyman got a block of maple and started carving. He whacked and sanded until he had a scaled-down skeleton of a cello, minus a sound box, which he outfitted with a handful of gizmos that could pass for tailpipes. Chafe the engineer laid ceramic elements under the bridge for microphones and hot-wired his new hybrid to a synthesizer and computer.

When Chafe the performer draws his bow across the strings of his electronic instrument today, he can reproduce many of the sounds of a saxophone. By strapping a sensor to his bowing hand, he can even command "Lightning," an infrared device that powers a computerized accompaniment.

Chafe says his custom-designed celletto is his answer to all the fun keyboard players have with live computer synthesis.

"The idea is to take the gesturing I do with a bow and translate that bow speed into breath-pressure control of a sax," he begins, then breaks into a light, rippling laugh.

"One side of my brain is always saying 'bow speed' and 'bow pressure' because that's what my cello friends say," Chafe adds. "But another side of my brain tends to say 'bow velocity' and 'bow force' because that's what my physicist friends talk about. So I end up having to bridge those two worlds a lot."

The many worlds that Chris Chafe frequents are suggested in the five-minute trek he makes each day between the Braun Music Center, where he serves as chair of the music department, and the Knoll near Lagunita, where he is director of the Doreen B. Townsend Center for Computer Research in Music and Acoustics.

As a classically trained cellist, Chafe has spent some 40 years honing the technical skills that enable him to transform a sheet of music into a moving performance. As a computer buff, he is poised to type the magic commands that will open the door to technological adventures. The two personas combine in Chafe's fascination with making new and exciting music.

"When you put a piece of Mozart in front of a pianist, the notes are precise and mathematical, but if you play those notes rigidly into a computer it sounds like a robot," he says. "So what are the perturbations that a pianist adds to the music? Coded into them somewhere must be the feelings that make you say, when you walk away from a concert, 'Wow! That was great!'"

For a "thought game" Chafe likes to ask his composition students the following question: "So what's the difference between a sparkling, one-of-a-kind performance, and a concert where nobody makes a mistake but it just doesn't soar?

"If you knew something about that difference and could code it into your work," he continues, then stops in mid-sentence, momentarily subdued by the challenge. "But we are so far from knowing those things."

Some of the answers eventually may come from the work being done at CCRMA, or "karma" as it's dubbed with cosmic affection. One of the world's leading centers for research in the use of computers to make music and analyze sound, CCRMA is housed in a Spanish Revival mansion that overlooks the campus from a hill behind Florence Moore dormitory. The interdisciplinary haven attracts musicians, composers, engineers, computer programmers, psychologists and acousticians who fill white boards with calculus equations and trade cadenzas over lunch.

"The kind of work that Chris and his colleagues are doing at CCRMA is tying the tradition of performance to new music," says John Chowning, former director of the center and inventor of the software algorithm on the computer chip that powers Yamaha synthesizers. "Chris has some unique attributes in that he's not only trained as a composer, but he's also a very active and skilled performer and researcher.

"Being able to take the gestures that he would use in a Bach concerto and amplify, modify and transform them with computers is absolutely essential to moving music forcefully and convincingly and expressively into the future."

To accompany Chafe through the maze of hallways that connect CCRMA's fully wired, sound-proof studios is to step into the future of computer music in what composers like to call "real time."

Inside one studio Chafe throws the switch on a pearly-pink Yamaha KX88 keyboard controller that promptly breaks into an ethereal wail reminiscent of a scifi movie laser or perhaps an Indian sitar. A metallic drum splash follows, then some distorted feedback from a bass guitar before the controller eases into the deep, resonant tones of the saxophone Chafe has been waiting for.

"Now that's nice," he says, enjoying the mellow line. "And that's the whole message here."

Like the animation artists who worked to render in graphics the textures, gaits and personalities of objects in the movie Toy Story, Chafe says many of today's composers are aiming for a similar rendering of synthesized music.

"In music you have a prescribed score, but you also have an emotional conception something you can't even put into words," he says. "It's like the sound of a screech trumpet solo in jazz, or the powerful nuances in the timing of a note in a passage in Beethoven, or the way a particular phrase is played on a saxophone listeners pick up on the sound of the effort of the player."

That sound can't be copied or controlled with electronic switches or even with a computer mouse, Chafe says. Instead, he contends that to accurately mimic or recreate the human motions and emotions that combine to produce great music, the player needs to be directly connected to the computer accompaniment. In his quest for innovative ways to make those technological connections, Chafe has become an internationally recognized researcher and performer in the field of "gesture acquisition."

"The idea is to get a handle on the physics of the saxophone's acoustics and wave propagation so that you can code up a synthesis algorithm on the computer and start to play around with it," he says.

As composers discard pencils in favor of algorithms and performers turn to synthesizers to expand the range

of sounds at their command, computers are moving onto stages around the world. At CCRMA concerts at Frost Amphitheater and behind the Knoll, Chafe has worked with sophisticated sensors and affordable accelerometers to translate physical gestures into eloquent music.

"When it comes to hooking up humans to computers in real time, using the computer as an extension of the player, Chris has been at this about as long as it's been done," says Perry Cook, professor of computer science at Princeton University. "When Chris plays the celletto, he's controlling the algorithms in the computer accompaniment with his feet or with the position of his bow. You could say he's steering a bunch of other, not too smart players that live inside the computer."

Cook, Chafe and Ben Knapp, a professor of computer science at San Jose State University, co-taught a course in autumn quarter that drew more than 60 students from the music, electrical engineering and computer science departments at the three institutions. Stanford students who enrolled in Human Computer Interface Design gathered twice a week at Forsythe Hall and learned from guest speakers who were "beamed" into the videoconference room via an ISDN phone line. Classes on the three campuses met simultaneously, and assignments and lecture notes could be accessed on the Internet. Laboratory assignments were identical and made use of the same computer hardware and software.

At the final class meeting in December, Stanford students presented the results of their research to their peers in Princeton and San Jose. Projects included a record turntable outfitted with an optical shaft encoder to drive software; a set of "air drums" designed to replace drum pads; a wah-wah pedal that used a force-sensing resistor to drive an electric guitar; and a violin outfitted with a virtual fingerboard.

"I'm the real beneficiary of all this stuff that would have been special knowledge to electrical engineers before, but is now being very nicely portrayed for people with mixed backgrounds," Chafe said as he put the finishing touches on a paper about the course that he presented at a conference in Salzburg, Austria, on Jan. 6. "We also learned how important it is to pay your phone bill the day we lost Princeton for a while."

Chafe was instrumental in developing the Music, Science and Technology major that the music department offers in addition to a more traditional track. Each year he teaches Introduction to Composition and Programming Using MIDI-Based Systems for students who come to Stanford with experience in text editing and want to venture into more experimental areas.

The 70 declared music majors are a small percentage of the total number of students the department serves, however. Hundreds more are involved in instrumental study and play in the symphony or sing with one of the choral groups. With the recent hiring of Jonathan Harvey, Melissa Hui and David Soley, Chafe has added three prominent composers to the music faculty. He also has won approval from the provost for a new initiative that ultimately will bring five directors of programs in performance symphony, piano, choral, winds and band, and organ into more visible teaching slots.

"This is a new phase for the department and what we're doing is regularizing the way we treat performance - to keep it at an appropriately high level," he says.

While most music departments at major colleges and universities in the United States now have some computer-music component, research in the field is conducted largely by Stanford graduates with ties to CCRMA. They work at a handful of institutions nationwide Massachusetts Institute of Technology, the University of California-San Diego, the University of Illinois and Colgate University and the only comparable overseas center is IRCAM, the Institut de Recherche et de Coordination Acoustique-Musique in Paris.

Given the size of the field, it's not surprising that musicians' paths cross and re-cross frequently. Princeton's

Cook, a concert baritone who earned his doctorate in electrical engineering at Stanford, has performed with Chafe in several computer-assisted concerts.

"I'm a singer in general, but I also play musical seashells big snails with one end cut off so you blow them like a trumpet," Cook says.

Two summers ago, Cook joined in a performance of Chafe's 1991 work, *El Zorro*, at a computer music conference in Greece. The two played in a melodic trio with a NeXT machine, silhouetted against the evening sky on a cliff overlooking the Corinthian Sea in Delphi.

"I was wearing this velcro sensor on my hand," Cook recalls. "As I played various notes on the seashell by stuffing my hand into the bell and moving it back and forth, the sensor controlled sections of music on the computer we'd hauled along."

In 1992 and 1993, and again this year, Chafe won a Composer's Special Award from the American Society of Composers, Authors and Publishers for his work. *El Zorro*, scored for trumpet and the "Lightning" infrared sensor, is an impressionistic rendering of the film *Mark of Zorro* that features improvisation and computer-generated reactions as dueling forces. In 1995 he composed *Push Pull* with the support of a National Endowment for the Arts Fellowship. With Dexter Morrill, the Charles A. Dana Professor of Music at Colgate University, Chafe has composed *Improvisation for Trumpet, Celletto and Electronics*, which uses synthesizers to react to music that is being improvised by the performers.

"Chris hooked me indirectly to the computer," says Morrill, a jazz trumpeter who studied with Dizzy Gillespie and Stan Getz. "I had an infrared sensor on the bell of my trumpet and my movements on stage interacted with the computer to produce a different accompaniment. My speed and position basically determined the elements of the accompaniment I was playing with."

Morrill has toured with Chafe in Argentina, Brazil, Switzerland, East Germany, Czechoslovakia and Austria, and the two musicians also have recorded a CD together.

"The last time we went to Argentina we carried a NeXT machine and I had to get a rock 'n' roll company to build a case for it to travel in," Morrill adds. "Now the stuff is smaller, more portable."

Both Cook and Morrill say they could easily identify a Chafe composition, and CCRMA's Chowning tells how: "It's very understated music. It's not dramatic or aggressive at the auditory level, but very attractive in the detail. One becomes very involved with the unwinding of Chris' musical ideas."

Chafe's career course was largely set in fourth grade, when his dad picked an instrument for him the night before sign-up forms for music lessons were due.

"I wanted to play the clarinet, but my father already played clarinet and he said, 'No way. Why don't you play the cello?' "

In recent years, the oldest of Chafe's four children made a similar decision for herself.

"Zoe had started out on cello but switched to clarinet one day when I was out of town," Chafe says of his daughter who plays in the Gunn High School band. His daughter Molly is a violinist in eighth grade and son Sebastian plays string bass for a fifth-grade group. As for second grader Oriana, Dad says, "We haven't signed the form yet."

Chafe and his wife, June Holtz, a studio potter, have been remodeling their Palo Alto home for several years now, working around Holtz's kilns to the strains of North African ritual music and classical Indian CDs.

They've learned how to pour concrete and how to turn their architectural dreams into city council-compatible plans on the home computer Chafe uses for synthesizing music. In the process, he says, his relationship with PCs has improved considerably since his first experience with computers in seventh grade.

"Computers were a rarity then and we had only one in the entire school district," he recalls. "We took a field trip one day to see it and we each got to ask one question. My equation brought the computer down."

After majoring in music at Antioch College, Chafe went on to earn a master's degree in composition from the University of California-San Diego, and a doctorate in composition from Stanford in 1983.

"By the time I was a graduate student here, it was clear to me that the combinations of the various wanderings in my ear between improvisation and contemporary music were leading me into some of the new possibilities of electronics," he recalls. "I also had this other side, the science and engineering side, and I found Stanford was a really fine place to be."

Chafe became a tenured professor in 1994 after winning praise as a "committed and enthusiastic teacher." In 1994-95 he was awarded an NEA Composer's Fellowship and last year he won a Green Faculty Fellowship.

Chafe says the changes he has seen in computer music in the past 15 years range from the international to the compact. With the growth of the World Wide Web, more composers are now posting archives of their work on the Internet, making it possible for other musicians to download and perform it.

"Younger composers today are so adept at sharing things globally, and there's an emerging, software-based culture for the creation of electronic music," he says. "Often the framework of a piece of music includes a degree of software development, so those improvements are also shared.

"And the fact that you can walk into Tower Records and find music from anywhere in the world, any time, is fabulous."

Chafe is equally happy that he no longer has to buy an extra airline seat for his cello when he travels to gigs in Buenos Aires and Hong Kong. Instead, he can fold up his celletto in an electric bass guitar case and stow it in an overhead luggage bin.

"I sling the case over my shoulder and when I'm walking through an airport, people sometimes stop me to ask, 'What band do you play in? Have you got any albums out?'

"Then I open the case and pull out my celletto, and sometimes they're apologetic, like, 'Oh, sorry I asked.' "

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By Diane Manuel