

# Music Engineering at the University of Miami

Kenneth Pohlmann and Colby Leider

School of Music, University of Miami  
*email:* {pohlmann, cleider}@miami.edu

[www.music.miami.edu/mue](http://www.music.miami.edu/mue)

## Abstract

The Music Engineering Technology program at the University of Miami encapsulates a multidisciplinary undergraduate Bachelor of Music degree within a more traditional music school setting. The program also offers a Master of Science degree for students with undergraduate degrees in electrical engineering or computer science. The program's graduates have continued musical and technical pursuits in both industry and academia. Recent major equipment acquisitions and partnerships with industrial collaborators have positioned our program to expand its educational and research stature.

## 1 History and Overview

The University of Miami was the first university to offer a four-year undergraduate curriculum in Music Engineering Technology (MUE) culminating in a Bachelor of Music degree, and it was the first university to offer a two-year graduate curriculum culminating in a Master of Science degree in Music Engineering Technology. Today, the Music Engineering Technology program in the School of Music ranks among the University of Miami's most prestigious programs.

After research into appropriate curricula by Ted Crager, Associate Dean of the School of Music, who determined that a minor degree in Electrical Engineering was appropriate, the undergraduate degree program was first offered in 1975. Then as now, the undergraduate program was intended for musicians who wish to pursue careers in technology. The program has met the guidelines of the National Association of Schools of Music (NASM) since its inception and indeed set the NASM standard for music engineering technology studies. Majors are enrolled in music lessons and performing ensembles during their four-year study, complete four levels of music theory, and enroll in a strong complement of other music courses. In other words, their specialization in technology areas does not shortchange traditional music studies.

Inaugural program director Bill Porter, a preeminent recording engineer, emphasized recording studio skills, and most early graduates pursued careers as recording engineers. The second program director, John Woram, editor of *dB Magazine* and author, expanded the program's scope to include professional audio; in addition to employment in recording studios, many graduates pursued careers with audio manufacturers.

The MUE program was founded on the premise that it would teach recording technology. With the creation of many similar academic programs also focused on recording technology and the strong demand for audio engineers with more rigorous technical skills, the program expanded its curriculum. The third program director, Ken Pohlmann, thus further emphasized studies in electrical engineering and computer science; career options as hardware and software audio engineers became available.

A Master of Science degree was founded in 1986. A minor in Computer Science was added in 1997, and in 2002, this option was modified to provide a double major in Computer Science. Current degree offerings solidify the engineering content in its curriculum while maintaining expertise in contemporary recording skills.

Approximately 80 undergraduates each year from the United States and overseas combine the study of music, music engineering, electrical engineering, and computer science in a unique interdisciplinary program. The undergraduate program requires proficiency on a musical instrument or voice and development of performance skills. In addition, students learn engineering theory and practice associated with today's music and audio industries. The result is a Bachelor of Music degree with either a minor in electrical engineering or a double major in computer science.

Approximately ten graduate students from the United States and overseas pursue a Master of Science MUE degree each year. These students must have completed Bachelor of Science degrees in either electrical engineering or computer science to be considered for admission. Their curriculum combines studies in music engineering, sound synthesis, and psychoacoustics with graduate courses

in electrical engineering and computer science. No music performance proficiency is required, and music performance studies are not required. This degree program meets the general NASM requirements for a Master of Science degree in music. This program is primarily designed for engineering students who seek careers in digital signal processing and audio software design.

International students from China, France, Great Britain, Canada, India, Iran, Israel, Italy, Jamaica, Mexico, Norway, South Korea, Spain, Switzerland, Venezuela, Germany, Austria and other countries have enrolled in the program. The MUE program has experimented with Internet2 and expects to develop distance-learning capability in the future.

International applicants must score satisfactorily on the TOEFL and meet other admission requirements established by the University of Miami Office of International Admissions.

## **2 Facilities**

All students enrolled in the MUE program have access to restricted-use recording and production facilities on the University's Coral Gables campus. The L. Austin Weeks Center for Recording and Performance was completed in Spring 1994 at a cost of \$1.6 million. This facility features the 150-seat Clarke Recital Hall and a professional recording studio with a Euphonix System 5 digital mixing console, hard-disk recorder, Pro Tools, Genelec near-field and far-field monitors, as well as two 24-track analog multitrack recorders, several dozen professional studio microphones, and associated equipment. From a production standpoint, this studio is specifically designed for students to perform multitrack recording and remix sessions. In addition, this studio adjoins a workshop area and a computer laboratory containing audio/video workstations, hard-disk editors, synthesis hardware, and sound processors. This laboratory is used to post-produce audio recordings, create sound design for video and motion picture projects, author DSP assembly programs, design loudspeaker cabinets, and model room acoustics.

The 600-seat Gusman Concert Hall, completed in 1974, now contains a multimedia laboratory with two Yamaha O2R digital consoles, Pro Tools, a hard-disk recorder, and a Sonic Solutions DVD authoring system. In addition, the studio is equipped with timecode synchronizers, video recorders, synthesizers, and surround playback so that students can create and post-produce audio for video and motion picture programs. An adjoining recording studio managed by the Recording Services Program is used to record and edit live recordings of performances in Gusman Concert Hall.

The Weeks Music Library and Technology Center will be completed in the Fall of 2004; this complex will include a MUE multimedia laboratory classroom.

This room will feature 20 workstations, each with a networked computer, as well as video projection and surround playback facilities.

While the focus of the studios is the multitrack recording and post production of music performances, they are also used as working laboratories to develop new audio technology. Students are expected to participate fully in the maintenance, modification, installation, and design of both hardware and software systems. Extensive hands-on laboratories provide students with practical experience in real-life audio engineering situations, providing both reinforcement of theoretical education and practical skills.

## **3 Undergraduate Curriculum**

One of the distinguishing features of our undergraduate curriculum is the importance it places on students' simultaneous development of strong musical and technical foundations. Undergraduates in both majors are required to complete two semesters of calculus and courses in physics, computer science, electrical engineering, and several technical electives. Students must also pass an entrance audition for the School of Music on their principle instrument or voice and take a minimum of six semesters of private instrumental lessons in addition to six semesters of ensemble instruction. Furthermore, the undergraduate curriculum includes four semesters of music theory and sight-singing, music history, acoustics, transducer theory, audio electronics, and introductory digital signal processing.

### **3.1 Electrical Engineering Minor**

Students who declare an electrical engineering minor take a complement of courses in the Department of Electrical Engineering, including Electrical Circuit Theory, University Physics I, Logic Design, Electronics I, Electronics II, Electronics Laboratory, Digital Design Laboratory, and three approved electives.

### **3.2 Computer Science Double Major**

Students who declare a computer science double major must complete three semesters of Java and C++ programming courses, Assembly Language Programming, Discrete Mathematics I, Data Structures and Algorithm Analysis, Machine-Musician Interfaces, and two approved electives.

## **4 Graduate Curriculum**

The graduate curriculum incorporates 33 hours of coursework culminating in a research project. Coursework includes 13 credits in graduate-level music engineering, 8 credits in other music topics, and 12 credits in electrical engineering and/or computer science. The research project requires original work in a music engineering subject area;

this independent project provides students with in-depth knowledge of a specific subject area and provides experience in technical research and in original thinking.

Some examples of recent thesis papers are provided below.

<i>Spatially Relocated Frequencies and Their Effect on the Localization of a Stereo Image</i>	Robert Hartman	2003
<i>Sound Source Separation Using a 3-D Correlogram, Fuzzy Logic, and Neural Networks</i>	Eduardo Trama	2002
<i>The Effects of Cross-Modal Interaction in the Perception of Audiovisual Quality and its Application in Data Reduction Algorithms</i>	Rodrigo Ordonez	2002
<i>Beat Detection in Music Using Average Mutual Information</i>	Margarita Escobar	2001
<i>A System for Hybridizing Vocal Performance</i>	Kim Hang Lau	2001
<i>Hybrid Reverberation Algorithm Using Truncated Impulse Response Convolution and Recursive Filtering</i>	Sean Browne	2001
<i>Reducing Artificial Reverberation Requirements using Time-variant Feedback Delay Networks</i>	Jasmin Frenette	2000
<i>An Adaptive Time-Frequency Representation with Re-synthesis using Spectral Interpolation</i>	Abhijeet Tambe	2000
<i>Aural Phase Distortion Detection</i>	Daisuke Koya	2000
<i>Duffing's Equation as an Excitation for Guitar Models</i>	Justo A. Gutierrez	1999
<i>Minimum Weighted Norm Extrapolation of Digital Audio Using Frequency Domain Blocking</i>	Alex Souppa	1999
<i>Digital Watermarking of Audio Signals Using a Psychoacoustic Auditory Model and Spread Spectrum Theory</i>	Ricardo Garcia	1999
<i>Computational Improvements to Linear Convolution With Multi-rate Filtering Methods</i>	Jason VandeKieft	1998
<i>Five-Channel Panning Laws: An Analytical and Experimental Comparison</i>	James R. West	1998

The MUE program benefits from corporate support, principally for the funding of graduate research. Throughout its history, many companies have generously assisted our education efforts. Recently, Delphi funded a study on "High-Frequency Effects on Localization and Sound Perception in a Small Acoustic Space." A paper was presented to the Society of Automotive Engineers in Detroit, and final results presented to Delphi allowed new designs of automotive sound systems. In addition, Dolby Laboratories has recently awarded a five-year research project on topics of interest to the company.

## 5 New Courses

Through its history, the MUE program has vigorously revised its course offerings to best reflect developments in audio technology theory and practice. Dozens of new courses have been developed, and indeed many have been phased out because of obsolescence. Two recent examples of new courses are provided. In 2001, former faculty member Will Pirkle began offering a senior-level undergraduate course in audio plug-in design for digital audio workstations. Centered on the Steinberg VST API and the Microsoft DirectX architecture, the course addresses the details of each interface, teaches students to write various types of processing plug-ins, and culminates in a competition that awards grades based on various criteria, including user interface design, novelty of the processing algorithm, marketability of the plug-in, and, above all, musical usefulness of the resulting software. Introductory coursework in digital signal processing is a prerequisite.

In 2003, faculty member Colby Leider began offering an undergraduate seminar entitled Musician-Machine Interfaces that combines an overview of human-computer interface issues, a survey of the past century of novel and experimental musical instruments and controllers, and a laboratory practicum in which students design and build their own alternate controllers. The course culminates in a final design project.

## 6 Personnel

Ken Pohlmann, Professor, serves as the director of Music Engineering and teaches courses in studio production, digital audio, and acoustics; Colby Leider, Assistant Professor, teaches courses in audio signal processing, production, sound synthesis, transducer theory, and audio electronics; Joe Abatti, Lecturer, teaches courses in studio recording, mixing, and audio post production; and Paul Griffith serves as Director of Recording Services and oversees the recording internship program.

## 7 Scholarships and Financial Assistance

The University of Miami ranks among the leading American universities in funds budgeted for academic scholarships. Several types of scholarships are awarded to academically gifted undergraduate students without regard to financial need. For example, Isaac Bashevis Singer Scholarships provide full tuition, Henry King Stanford Scholarships provide half tuition, and Jay F. W. Pearson Scholarships provide about half tuition per academic year.

The University of Miami also participates in the National Merit Scholarship program, and School of Music scholarships are available for MUE majors. Additional financial assistance, awarded on the basis of need, is available in the form of loans and work-study grants. MUE majors who are Florida residents are uniquely eligible to receive funding from the State of Florida. A limited number of university assistantships and corporate funding help sponsor some graduate students.

## 8 Placement

Graduates pursue careers throughout the audio industry as recording engineers, audio systems engineers, software programmers, manufacturer's technical representatives, and audio designers. Some accept positions in sound reinforcement companies, audio and video postproduction studios, studio acoustical design companies, and installation firms. The overriding goal of the program is to fill the international demand for highly qualified music engineers through an emphasis on contemporary theoretical and practical skills.

Students are expected to work at the "cutting edge" of technology. For example, a design team of students, using hardware and software tools provided by Motorola, recently authored MPEG-1 Layer II data reduction software to achieve a 4:1 data reduction ratio on recorded audio signals as well as adaptive filtering to remove noise. Two corporations asked this student team to submit examples of their coded files for analysis and submit employment applications for employment after graduation.

Many students enroll in a summer internship course to acquire experience in professional environments; this is subject to availability and the student's proficiency. As interns, students work in recording studios, manufacturing companies, and other locations to develop the practical skills needed to excel in this creative profession. This practical experience makes them attractive to employers following graduation; indeed, many students are recruited while still enrolled in school. Of course, a percentage of undergraduate students elect to seek graduate work, often toward an M.S. or Ph.D. degree.

Other students have received degrees in law and medicine.

As noted, many MUE graduates are active in the professional music and film industries as recording and mixing engineers. Their credits are far too numerous to list. Recently, graduate Neal Avron produced and recorded a hit album *Sticks and Stones* for New Found Glory, which reached an Amazon.com sales ranking of 220. Myron Nettinga received an Oscar for Best Sound for his work on Ridley Scott's film *Black Hawk Down*. Adam Michalak works at the Sony scoring stage in Culver City; his film projects include work on the soundtracks for *Minority Report*, *Men in Black II*, and *Stuart Little II*, and his television projects include *The Simpsons*, *King of the Hill*, and *Futurama*.

The MUE program has also placed graduates with many prestigious audio engineering companies. A partial listing of their employers includes ADS, AKG Acoustics, Alesis, Analog Devices, Apple Computer, Aural, BGW, California State University at Chico, CBS, Claire Brothers, Cirrus Logic, Columbia University, Compaq, Crest Audio, Crystal River, Delphi, Denon, Dictaphone, Digidesign, Disney, Dolby Laboratories, DTS Digital Theater Systems, Ecole de Tech Musicale, Editel Chicago, EFX Los Angeles, Euphonix, Federal Bureau of Investigation, FMRTS Design, Fox Television, General Motors, George Massenburg Labs, Harman International, Hewlett-Packard, Jaffe Acoustics, JBL, Klark Teknik, Korg, Microsoft, Motorola, National Semiconductor, NBC, New England Digital, Norsk Rikskringkasting, Norwegian Caribbean Lines, Otari, Paramount Studios, Philips Dupont Optical, Polk Audio, PolyGram Group, Real Networks, Radio Caracas, RCA Records, Rockwell Aerospace, Roland, Rupert Neve, Sennheiser, Shure, Sonic Foundry, Sony Broadcast, Sony Classical, Sony Italy, Sony Professional Products, Spatializer Audio Labs, Studer Revox, Syracuse University, Tektronix, Telemundo, Texas Instruments, 3Com Corporation, 3M, Todd-AO, U.S. Optical Disc, Universal Studios, University of Southern California, Venevision, Wheatstone, and Yamaha.

## 9 Conclusion

The Music Engineering Technology program, at both the undergraduate and graduate levels, was innovative in its introduction of these unique curricula. Through its history, it has stayed current with developments in technology theory and practice. Its graduates, numbering in the hundreds, have contributed significantly to the music and audio industries.