

# A Pied Piper: Computer Music to Attract Students to Computer Science/Engineering

Patrick E. Mantey  
Baskin Center for Computer Engineering and Information Sciences  
University of California, Santa Cruz, CA

Ron Nolan, Digital Studios  
Aptos, CA

## Abstract

*Our recently released multimedia CD-ROM "Computer Music: an Interactive Documentary" was created as a vehicle to attract students, via the concepts of digital music, to pursue studies in computer science and engineering. "Computer Music.." explores some of the basic principles of computing. We selected computer music as the central theme because music is popular with today's youth and because it offers an excellent vehicle for illustrating some of the basic principles of computer science and engineering.*

*This CD-ROM for Macintosh and Windows platforms explains how computers "make music": the basics of analog to digital conversion, the effects of sampling rate and resolution, and employs over two hours of video and animation. It also offers detailed descriptions of the processing and flow of digital data in synthesis, sampling and MIDI music production. By investigating how computers are used to create, edit and perform music, students gain an understanding of how computers process and handle information.*

*The CD-ROM pioneers a new medium, the interactive documentary. A new feature called "Connex" allows the user to enter an underground labyrinth where they will find editorial comments that draw together the complex concepts of computer music and where interrelated ideas may be accessed independently.*

## Introduction

To the uninitiated, the fields of computing and music might appear to inhabit widely separated suburbs in the village of knowledge. In fact much of today's music could not be made without computers, while the drive to create totally new instruments, sounds and compositions

has stimulated tremendous advances in computer hardware and software.

The authors believe that it is vitally important to attract more young people into careers in technology. Could music, a highly valued component of youth culture, be used to open the door to an interest in computing and possibly a career in technology? This paper summarizes our efforts to develop a multimedia CD-ROM that uses the manifold technologies of computer music to familiarize students with selected fundamental principles in computing and to, hopefully, interest them in learning more about computing and technology. We also provide an overview of the developmental process, production time, and costs for educators considering producing CD-ROMs for their own instructional purposes.

## Computer Music Background

The field of computer music is a surprisingly diverse subject which is still actively expanding in scope. Originally limited to organizations with access to major computing facilities, computer music is now a standard technology in commercial recording and video production studios and is an essential tool for many performing musicians and also popular with hobbyists in the home. The electronic music laboratories of most universities now emphasize digital technologies.

Early institutional research was often focused upon sound synthesis using algorithms. The physical modeling of instruments using algorithms is currently receiving much attention today. Although FM synthesis microprocessors were once the standard audio source for computer game sound effects, the most common application of computer technology today is digital audio recording and sound sample playback.

In digital audio recording, sounds are converted from analog to digital data which is recorded on a hard drive. Once in digital form, the sounds can be edited, special effects applied, then the processed audio maybe output to compact disc (CD), digital audio tape (DAT) or converted to analog data for playback.

In sound sample playback systems, a sound produced by an instrument is digitized, for example, a note is played on a piano. The sample is looped to sustain its duration while minimizing sample size, then stored in ROM on the circuit board of a sound module or sound card. When a key is pressed on a controller instrument (e.g. a MIDI keyboard), the appropriate sample is triggered and very realistic sounding piano note plays.

There is obviously a great deal more to computer music than we can cover in this paper. However even in this abbreviated overview, it is apparent that many fundamental topics in computing can be well illustrated using computer music applications. For example,

- \* signal types
- \* analog to digital conversion
- \* sampling theory, rate, resolution
- \* digital signal processing and filtering

## **Project Motivation**

Is there really a need to attract more young people, and especially individuals from under-represented groups, to careers in technology? In recent years the projected shortage in personnel for positions in technology fields has been well documented. As early as 1990 twenty percent of the major science/engineering employing agencies reported a shortage of personnel for computer science and engineering. In the report Science and Engineering Personnel: A National Overview from NSF [1] offers predictions that indicate the continuing shortfall in computer-related fields.

*“During the 1988-2000 period, the occupational composition of industry jobs is expected to shift away from production and assembly-line jobs toward professional, managerial and technical occupations... The S/E occupation benefiting most from (this) trend has been and should continue to be that of the computer specialist. It is expected to have the largest employment*

*gain (197,000) jobs and the fastest growth (62 percent) of any S/E occupation.”*

Other studies such as that of Stair [2] support this trend:

*“Projected employment figures in the computer manufacturing industry show an increase from 85,000 in 1986 to 503,000 in the year 2000...Growth in demand for computer professions will continue through 2000. Bureau of Labor figures indicate computer careers are among the fastest growing. Over half of the new job openings for systems analysts and computer programmers are predicted to occur in the computer and data services industry.. Opportunities will continue to be abundant for computer professionals because supply will not keep pace with demand in most areas, particularly entry-level programmers. As demand grows, a percentage decline will occur in the young adult population between the ages of sixteen and twenty-four from thirty percent of the labor force in 1985 to sixteen percent in the year 2000. With competition from business, universities and the military, there will not be enough entry-level workers to go around...”*

Stair [2] also points out a critical factor in attracting youth to careers in technology. "Overall interest in college freshmen in computer careers declined 8.8 percent in 1982 to 2.2 percent in 1987."

Other studies, such as that of the US Dept. of Labor [3] reinforce the idea that new job openings in technology fields will become available by the year 2000 with growth rates as high as 48.1% for computer programmers and 53.3% for computer systems analysts for the period 1988-2000. And it is important to realize that none of the above studies predicted or took into account the explosion in technology related careers resulting from the recent multimedia and telecommunications explosion. Encouraging youth to pursue careers in technology is an essential undertaking for a variety of reasons. As the worldwide population continues to expand, more demands will be placed upon technological solutions to preserve and protect the environment and technology is an essential component to efficient food production and distribution, transportation, education and communication. A pool of trained and creative individuals ready to take on tomorrow's challenges will be a key component to increasing our competitive edge and of assuring this country's economic growth and international leadership into the next century.

## Project Underwriting

Originally we envisioned producing a comprehensive series of instructional materials including broadcast programming and laser discs for secondary schools, however our attempts to find corporate or government underwriting were unsuccessful. The National Science Foundation Undergraduate Education Course and Curriculum Development program did provide \$100,000 in funds for a much reduced undertaking which resulted in the production of the CD-ROM, *Computer Music: an Interactive Documentary*, described here.

Although some early educational CD-ROM titles have been favored with budgets as high as \$1,000,000, most titles today fall in the \$250,000 to \$400,000 range. Digital Studios, an educational software developer, contributed, and the Baskin Center for Computer Engineering and Information Sciences at UCSC contributed the balance of funds needed to complete the project.

## Delivery System Decisions

In 1991 when we first envisioned the project, educational laserdisc programs were becoming popular with schools. The level III laserdisc format offers the advantage of non-linear access to video frames and segments controlled by personal computers. Although laserdisc continue to be an excellent medium for group study, we were immediately attracted to the possibilities of CD-ROM with the arrival of Apple Computer Inc.'s *QuickTime* digital video playback technology.

CD-ROM software may be used by small groups, but it may be even more suited for individual use--a feature we felt could be an advantage in reaching students from under-represented groups. However, the major benefit offered by CD-ROM is the high level of interactivity made possible by authoring programs like *Macromedia's Director*.

One of the important advantages offered by *Director* is that during our development process, cross platform capabilities became available allowing us to port work that we had initiated on the *Apple Macintosh* to personal computers running *Windows*.

In retrospect, opting for CD-ROM rather than laserdisc and developing versions for both *Macintosh* and *Windows* systems were fortunate choices that have greatly expanded the dissemination potential for the final product.

## Project Design

*Computer Music..* employs digital video acquired especially for the project as the primary source of information content. Approximately 50 hours of original footage was acquired. Our location in Santa Cruz provided ready access to a number of leading computer music hardware and software manufacturing and research facilities. UCSC also has talented and knowledgeable faculty and staff in its Music Department, which offers introductory classes in computer music and which supports a well equipped electronic and computer music laboratory.

In addition to digital video, the program includes many animated sequences which describe key techniques and concepts used in the production of computer music.

The interface uses the metaphor of a high tech CD-ROM jukebox (the "VidBox"). It offers quick, non-linear access to all of the program movies. In addition, making selections progressing from left to right in all choice situations provides a structured approach in which ideas, concepts and information are accessed in a logical sequence.

The CD-ROM pioneers a new medium, the interactive documentary. A feature called *Connex* allows the user to enter an underground labyrinth where they will find editorial comments that draw together the complex concepts of computer music and where interrelated ideas may be accessed independently of the *Vid-Box*. A text transcript of each movie is also available which may be saved to disk or printed. Technical terms that may be unfamiliar to students are highlighted and when clicked provide definitions. The program also incorporates an on-line notebook enabling students to keep track of ideas throughout the program. And there is a comprehensive glossary of terms and a movie index which permits teachers to readily make assignments using a numerical code.

The CD-ROM also includes a Sound Lab in which students may experiment with audio waveforms, the relationship between pitch and frequency and digital signal processing effects.

## Methods

The video was digitized using a *Radius Video Vision* system and edited with *Adobe Premiere*. Although this system eventually gave satisfactory results, a great deal of experimentation was required to maintain audio-video

synchronization. Digital Studios now employs a *Data Translation Media 100* system for CD-ROM movie editing.

One of the most time consuming aspects of the development process was compressing the movies for CD-ROM play back. Short video clips require many hours to compress. Apple Computer Inc.'s *MovieShop* was used to compress the video footage.

*Macromedia Director* was used to develop the program software. This is an excellent authoring system, however, it requires a significant amount of time to reach proficiency and is generally regarded to have a high learning curve.

There are many tradeoff decisions that must be made during the development of a CD-ROM title. One of the primary concerns during the development of this project was the amount of RAM which would be available. Earlier versions of *Director* require less RAM than later versions, however later versions offer significantly faster performance. In order to reach users with minimal RAM, yet offer better performance to users with more RAM, we developed two *Macintosh* and two *Windows* versions of the program which greatly added to the development and testing time.

## Results

*Computer Music..* was published in November, 1995, and it is distributed by Digital Studios ([www.cyberlearn.com](http://www.cyberlearn.com)) and several national distributors of educational products. Although at the time this paper was authored we had only six months period of distribution for analysis, we have been surprised that the university and college music departments comprise the largest segment of early adopters. We believe that this may be due to what appears to be the long awaited arrival of this type of product by music educators and a focus of the early marketing efforts toward this group.

## Conclusions

We believe that the *Computer Music..* CD-ROM is a very successful application of multimedia as an instructional tool. In order to increase its usefulness in introductory computer science classes, we are expanding the scope of the project to include a teachers guide with suggested student activities, a series of laboratory exercises in the fundamentals of sound and synthesis and an additional CD-ROM dedicated to careers in computing.

The new CD-ROM features research projects in technology at the UCSC Baskin Center for Computer Engineering and Information Sciences. During video tape interviews, faculty and students explain their field of research and offer insights into the challenges and opportunities offered in the fields of computer engineering and information sciences in an academic environment and advice is offered on how to prepare for a career in technology. This effort is intended to serve as a pilot for a series of CD-ROMs that will explore technology careers in a wide variety of university, industry and government environments.

Although measuring the ultimate objective of our efforts is a long-term and difficult process, we believe that developing and publishing educational CD-ROMs like *Computer Music..* is a cost effective means of reaching and motivating a very large audience.

Whether it be composition, synthesis, recording or performance, every aspect of today's music has been touched by digital technology. The story of how computers have been incorporated into the world of music is a fascinating juxtaposition of time-honored tradition and technological innovation. Students get a taste for the astonishing palette of sounds created by digital instruments through movies that demonstrate the features of modern synthesizers. And they will learn powerful techniques from professionals and researchers in the fields of digital audio recording and editing as well as MIDI sequencing, editing and composing. It is our belief that this CD will attract some of its users to future studies in computer science and engineering.

## References

- [1] National Science Foundation, Science and Engineering Personnel: A National Overview. Division of Resource Studies., NSF, 1990.
- [2] Stair, Lila B. Careers in Computers. VGM Career Horizons, Series title: VGM professional careers, 1991.
- [3] U.S. Department of Labor. 1990 Occupational Projections and Training Data (1990 Edition).

