# Technology and Higher Education

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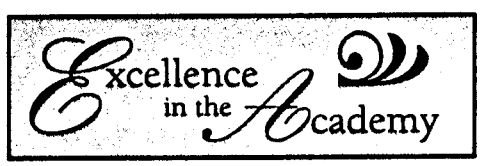


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# MUSIC TECHNOLOGY FOR THE 21ST CENTURY

by Gene Aitken

*Computers and information technology —it's easy for us to see their applications in fields like science, engineering, and statistics. But, the author shows us, technology is also transforming music instruction on campuses. Focusing on the integration of technology into the total music curriculum at the University of Northern Colorado, he provides specific examples of computer hardware, software, multimedia products, and communication technology that provide unique experiences for students. The future of music education, he argues, will be shaped by increased collaboration in the production of materials, movement beyond "drill and practice" methods, and increased student access to performance instruction and practice through new communication technologies. The challenges: complicated legal issues in ownership of materials, and perpetual obsolescence of hardware and software.*

## THE CHANGING EDUCATIONAL ENVIRONMENT

Technology has the power to enhance traditional teaching techniques, provide for individual differences in learners, and advance new ideas and approaches to learning. The forms of technology being used currently in higher education vary considerably by institutional funding level and individual faculty initiative. In some schools there are enough computers for use by an entire classroom of students, while in others there is just one computer—or no computer available for classroom use. Some faculty teach students how to use the computers while others integrate the technology into their daily instructional activities. Still other instructors merge multimedia technologies like modems, laserdisc players, CD-ROMs, and CPUs with video capture boards for classroom presentations and student course materials.

Experts in educational tests and measurements (see for example, Bloom 1984 and Richter 1991) find that incorporating multimedia technology into teaching is akin to learning in a tutorial situation, especially if the technology is interactive. Text—a relatively *inefficient* way to learn—is also relatively *ineffective.* The learner retains only about 10 percent of the information. When lecture is added to text, the retention rate increases to 20 percent. By adding visual information like still photos or video, retention jumps to 50 percent. Finally, with the addition of interactivity to text, lecture, and visual material, the retention skyrockets to 90 percent. Other benefits: a nonthreatening environment for learners, the ability to review and replay instructional materials, and opportunities for self-testing knowledge of the material.

## MUSIC TECHNOLOGY AT THE UNIVERSITY OF NORTHERN COLORADO

At UNC, we focus our attention on merging music technologies. Since there are no clear paths for integrating technology into the curriculum, the faculty incorporates technology in the classroom by both teaching and using the technology. As our dreams can far outpace the hardware or

software we have at our fingertips, we find that with a little creativity and the involvement of our dedicated students and faculty, great things are possible.

## *The First Step—Enhancing Traditional Pedagogical Methods*

Many instructors enhance their existing classroom lectures with simple computer-presentation programs that provide students with a visual version of material. This approach is an easy way for teachers to begin. Neither big changes nor too much of a commitment of resources are involved. Presentation programs can have a tremendous impact on both large and small classes. Students, statistical studies show, will retain more information if the instructors use visual aids. Instructor notes, outlines, flying text lines, *QuickTime* movies, and many other presentation ideas can bring technology into the classroom with a minimum of effort.

One of the premier presentation programs for classroom use is *Astound*, developed by Gold Disk, Inc. of Toronto, Canada. *Astound*, available on both IBM and Macintosh platforms, is one of the most user-friendly, inexpensive, powerful, and creative presentation programs available. The learning curve is easy and the auto-templates included with the program are quite good.

*Astound* and many other presentation programs allow the printing of outlines, slides, and notes so that they can be made available to the students. A quality presentation requires only a good overhead projector and the ability to project materials in color.

Other presentation programs such as *Persuasion* (Aldus) and *PowerPoint* (Microsoft) are very popular and provide instructors with a good choice of outstanding, easy-to-use programs. While authoring programs such as *HyperCard* and *MacroMedia Director* can be used as presentation programs, their learning curve tends to be quite steep. They are not recommended for the novice.

Another way to incorporate technology into traditional pedagogical methods is to help music students prepare their

music theory, counterpoint, and composition assignments using music notation and sequencing programs—the 'word processors' of music.

At UNC, required classes such as Music Theory and Counterpoint previously accepted hand-written assignments. But unless the students were also pianists, they rarely heard their compositions, though music is an aural art. We now require students to turn in their homework, including both hard copy and a disk, using standard notation or sequencing programs such as *Finale* (Coda), *Overture* (Opcode), *MusicShop* (Opcode) and *Vision* (Opcode). Today, UNC students can hear their compositions and make necessary corrections before their assignments are due. Music Theory and Counterpoint instructors now embrace the use of the computer as a means of enhancing their students' learning.

In Keyboard Proficiency, rather than leaving the students to figure out what an assignment sounds like (since most cannot perform it), students use a sequencing program—*Performer* (Mark of the Unicorn)—to preview assigned exercises or pieces. Once these assignments are "played in" by one of the instructors, students can listen to the assignments and know how they should sound.

Using the sequencer, students can slow the assignments down and, without changing key, play along. If the students can't play both hands together, they can turn off the left or right hand, slow down the tempo, and play the missing part. With MIDI keyboards, the students can also select a musical sound of their choice, other than the piano. The results of teaching piano for both majors and non-majors are very exciting. Since this keyboard program has been implemented, instructors have found that students learn more material in much less time. And at the end of the term, student attitudes about their keyboard experiences are much more positive than teaching keyboard proficiency in the traditional way.

## *Using Current Software to Supplement Teaching*

In the early use of mainframe computers, most computer use required writing programs in cumbersome languages

such as FORTRAN and COBOL. Now, personal computer software is widely available and easy for novices to use. With software distributed on CD-ROM, one program can include a vast amount of text, graphics, audio, and video. More and more outstanding off-the-shelf applications geared to education are finding their way into classrooms on this medium. Companies have learned that the education marketplace alone is a billion-dollar plus industry and have made a wide variety of programs available for the Macintosh and/or IBM platforms for educators in almost every discipline.

The need for good, educationally sound, commercial software in music is as great as it is in any discipline. In music, students come to the university with varying backgrounds of musical experience. To bring all students to a minimum level of expertise, despite different levels of musical background, we encourage students to use many of the commercially available ear-training and music theory software programs. *Practica Musica* (Ars Nova), *Inner Hearing* (TAP), and *Claire* (Opcode) are only a few of the many music theory and ear-training programs that do well at repetitive exercises and, at the same time, provide immediate feedback as well as record the users' progress. These tutorial programs are helping many students to increase their level of musical proficiency rapidly.

Another creative commercial software program popular among music students and educators is a program called *Band-in-a-Box* (PG Music). Using MIDI technology, this program provides educators and students with a 'music minus one' jazz trio consisting of keyboard, bass, and drums. The power of the program is in the ability of the users to control the tempo, key, styles, and selection of the instruments, as well as input any chord progression of their choice. With no computer background whatsoever, a user can 'type' in any chord progression within a few minutes, including an introduction and ending...and even print out a lead sheet and chord progression.

Many commercial CD-ROM music programs are informative, creative, and easy to use. Considering the amount of content, usage-rights, design concepts, and development process costs, plus the cost of marketing and distribution, it is

a wonder these programs can be purchased so inexpensively. From Voyager's Beethoven CD-ROM program in black and white, to the color of Microsoft's *Musical Instruments*, great strides have been made in design, navigation, content, and use of color. Although CD-ROMs can still be painfully slow with some computer hardware, the opportunity to incorporate non-linear learning and the exploration process far outweigh the lack of speed.

Another development applicable to both IBM and Macintosh platforms is an extension called *QuickTime*, that has helped make many of these CD-ROMs much more powerful. Using the *QuickTime* extension allows the user to play video clips recorded on CD-ROM disks. Depending on the power of one's computer and how the video was captured, a user can usually view anywhere from a one-quarter window at 10 frames per second to full-screen, full-motion video at 30 frames per second. Of course the larger the window and the faster the frame rate, the more computer memory is required. At this time, because of the amount of memory required and the lack of sophisticated compression, full-frame, full-motion color video on CD-ROM is not yet a reality for most students and faculty.

Although designed for teenage students, the new *Rock 'n Roll Your Own* (Compton's New Media) CD-ROM has a unique, attractive interface that will undoubtedly have an impact on the design of music education software. After users select a style of music from the menu, they can create a series of prerecorded beats, add prerecorded licks, and then record their own voice over the top of the song—and save their composition to cassette tape! This clever, creative, interactive approach will undoubtedly be used by other publishers, and extended to include other styles of music.

Finally, one of the most innovative commercial developments in music education is Coda's *Vivace*. This unique hardware unit, with an internal sound module, has the ability to follow, or accompany, almost any solo instrument (or solo voice) with a pre-recorded accompaniment. Coda is releasing many of the standard solo repertoire for beginning, intermediate, and advanced instrumental music students. Many of these

sophisticated programs in color. *Hypercard 2.2*, however, is a "memory hog"!

Using *HyperCard* as a basic authoring program and an audio CD of their own choice, teachers can design and create a discipline-specific series of cards and then enter text information about the artists, historical details about each composition, stylistic considerations, and specific themes and compositional devices. Instructors can also have the music notation 'scroll' across the screen as the artist performs it.

Kyle Gregory, a doctoral student majoring in Trumpet Performance with a secondary emphasis in Jazz Pedagogy, developed one very interesting program. Using the Miles Davis CD, *Birth of the Cool*, Gregory repurposed it using many of these techniques. On opening the program, users can choose one of the compositions and learn about the techniques the soloists are using. Users actively participate in the listening process. Students can also listen and listen again to acquire certain listening skills. In several cases, the notation scrolls across the screen so users can not only see the notes, but see and hear the chord progressions.

Very similar to this program is another CD-ROM project developed by doctoral student Tom Strait, a Trumpet Performance major with a secondary emphasis in Jazz Pedagogy. Developed on an IBM-compatible 486, the program's objective is to teach a student how to 'lift' or transcribe a jazz solo. Using the authoring program *Toolbook*, students are taught the concept of transcribing step by step, including how to sing and memorize phrases. This concise program allows students to use CD-ROM, not for learning information about the recording, but to learn a related concept—the art of transcribing a jazz solo. Throughout the program, students are asked questions to determine if they are learning the information.

In the area of laserdisc repurposing, several unique programs have been designed using Pioneer laserdisc players and authoring programs such as *HyperCard* and/or MacroMedia *Director*. The commercial Pioneer laserdisc *Piano Legends* is a compilation of some of the finest jazz piano artist video clips available. With an informative narration by Chick Corea, doctoral student Kevin Murphy, Choral Conducting

major with a secondary area in Jazz Pedagogy, designed this program using *HyperCard 2.2* with color XCMDs, to make an attractive, interactive, multimedia program. In addition to incorporating some of Chick Corea's narration, supplemental information on each artist has been added, including tips on what to listen for or to see when viewing the video clips. The video clips, some of them quite rare, make this one of the most popular programs the UNC Music Technology Center has developed. As no video capture board was used in the design, individuals using this program must use a Pioneer laserdisc player with a separate video monitor. If a RasterOps 24STV video capture board is installed in the computer, it is possible to play full-screen, full-motion video on the computer monitor.

Another excellent repurposing project, albeit quite different, was developed by Tracy Heavner, a doctoral student in Music Education with a secondary emphasis in Jazz Pedagogy. This program was designed using MacroMedia *Director*. When the program *Tenor Titans* opens, an attractive interface using still video frames, captured with a RasterOps 24STV board, pops up at specific places on the screen. Using *MacRecorder*, Heavner captured portions of the audio from the laserdisc to play behind the photos and titling. Once the index opens, users can go directly to the program or choose to learn how the program works. The hardware requirement of *Tenor Titans* is quite different than *Piano Legends*, in that users must have a RasterOps 24STV video capture card installed in their computer. When playing video segments approximately one-forth screen size, changing text accompanies the video as the artist performs. The program includes extensive information about the artists and their playing style in addition to a discography of the artists' well-known and available works.

## *Bar Code Technology*

Although not considered repurposing per se, the use of bar code technology is another very popular way to incorporate audio CDs and laserdiscs in teaching. Much like the bar code technology used in the local supermarket, the handheld Pioneer Bar Code Reader reads an instruction instead of

a price. Inexpensive bar code technology allows instructors to locate and play segments on any CD or any CLV or CAV laserdisc, and to make the actual bar code on any Macintosh computer.

An excellent way to use bar code technology is to listen to or view the audio CD or laserdisc and decide which segments to use in any given presentation. Any segment of a CD can be identified by minute, second, and block. Any CAV laserdisc can be identified by frame number and any CLV laserdisc can be identified by time code in hours, minutes, and seconds. Location information on any of these media can be displayed on the computer screen or video monitor. When all segments have been identified, the Pioneer *Bar 'N Coder* software allows users to input all the segments at one time. Instructors can then print the bar code on almost any document or print the bar codes on Avery labels that instructors can then paste on their notes or in a text. The *Bar 'N Coder* software also allows for two printed lines of text, allowing instructors to identify both the laserdisc and the segment. Depending on the speed of the laserdisc player, any segment on any laserdisc can be located in from 0.5 seconds to 5.0 seconds.

## *Original and Semi-original Software*

Many university music faculty want to develop software or hardware, but face the same issue: When will they have the time to devote to developing software in an already overloaded schedule? What are the incentives? And what are the rewards? Even with release time, unless grant money is available, there are usually no funds available to hire a replacement. One answer we've found is to work with graduate students and encourage them to develop programs. For their own future job prospects, it is useful for graduate students to be able to demonstrate projects they have developed. It also helps them learn the software programs.

For the past several years, UNC faculty in Educational Technology have been advising and working with many of our graduate music students in the design and development

of original software programs. Our students enroll in Educational Technology classes, and by the year's end they have gained considerable expertise in content and design and can create informative, instructional, interactive, multimedia software.

One of the very first multimedia projects graduate students at UNC designed and developed was a videotape recorded by the great drum set artist, Mel Brown. As a former student of Philly Jo Jones, the master of brush artistry, Mel was in a position to hand down the lost art of jazz drumming using brushes. So, several years ago, he recorded a fifteen-minute video, Drum Brushes, to preserve an important element of jazz history. With Mel's permission, and using the now discontinued NEC PC VCR and the NEC *Multimedia Toolkit*, students were able to stripe time code after the fact on a copy of the videotape and then use *HyperCard* and *HyperCard* color XCMDs to build a simple, but interesting, interactive multimedia software program using videotape. Although locating certain segments was time consuming because of the slow speed of the tape transport, students and instructors began to see the potential of using video to enhance the students' education. This project was instrumental in giving us the vision to develop other programs.

One innovative program was developed and designed by doctoral student George Hess, majoring in Theory/Composition with a secondary emphasis in Jazz Pedagogy. This was a freshman ear-training program that was tested using control and experimental groups to try to determine if the computer could replace current classroom instruction in the area of ear-training. The program was divided into three categories: tutoring, practice sessions, and drills. Using *HyperCard* as the authoring program along with an off-the-shelf *HyperMIDI* application, the program specifically addressed atonal intervals, chord qualities (with and without identifying outside voices), and harmonic progressions. Since many freshman music theory programs throughout the United States include ear-training, we felt the results of this testing could have a significant impact on how ear-training is taught. The testing proved that computerized ear-training outside of

class time produced essentially the same results as class time ear-training. In addition, the testing also proved that the computer program provided more consistent instruction and allowed students whose aural skills were not up to minimum standards to practice longer and to be able to review previously tried exercises in a friendly environment.

Another creative project was designed by Neal Finn, a doctoral student in Theory/Composition with a secondary emphasis in Jazz Pedagogy. Finn developed an interactive multimedia program, *Jazz Arranging*, from the ground up, including shooting and editing all the video, and recording a CD of his own music. After editing the videotape, Finn transferred the videotape to laserdisc. The users select any subject area in jazz arranging, from how to voice sax solos to how to plan arrangements. Finn's work includes excellent audio and video examples for the beginning to advanced arranger.

Another program, designed and developed by George Hess, is the *Great Sand Dunes* project, an informational kiosk that is now located in the newly remodeled Visitors Center at the Great Sand Dunes National Monument near Alamosa, Colorado.

This interactive video kiosk provides information about the culture, biology, and ecology of the Great Sand Dunes and the San Luis Valley. The program allows users to choose from among 13 topics ranging from Prehistoric Man and Native Americans to Plants and Wildlife or Theories of Formation. The program was created in MacroMedia *Director* and is presented on a Macintosh 660AV with CD-ROM and a Pioneer CLD-V220 laserdisc player. Materials were prepared using Adobe *Photoshop* and *Premiere*.

The program incorporates extensive existing materials, including historical and scenic still photographs, digital audio and video, and animation. The program was a cooperative venture between the UNC School of Music and Discovery Partnership, located in Colorado Springs, Colorado. Assisting in the authoring and development process was doctoral student Rich Macdonald, a Percussion Performance major with a secondary emphasis in Jazz Pedagogy. All the music for the

program is original and was composed and performed by UNC students.

Another creative and different project provides music educators with a few ideas on how to make use of old but educationally sound videotapes. At a jazz convention several years ago, jazz artist David Liebman, who had recently marketed a video called *The Saxophone Sound*, was approached by UNC and asked about the possibility of converting this outstanding, educational, two-hour-plus videotape to laserdisc. The preservation of the integrity of the material, the design of the program, and the editing of the videotape down to one hour so it could fit on one side of a CLV laserdisc was under the able guidance of Rich Macdonald.

## THE FUTURE OF MUSIC TECHNOLOGY

### *Collaboration*

Technology in the area of collaboration is still immature, but should prove, in time, to be highly important and successful. In music, many educators are great teachers with a great deal of discipline-specific knowledge to share with the world. This is where collaborative possibilities exist. As computers increase in speed, we are going to be able to shift from information media such as paper, film, and videotape to computer-based simulations of those media. Libraries, newspapers, and books will not disappear, but their presence and significance in our culture will decrease and they may be used differently.

In the collaborative process of developing educational materials to be delivered by CD-ROMs and video servers, we can visualize a music teacher communicating online with a graphic artist or content specialist somewhere else in the world. The artist or specialist can see and hear the teacher, and the teacher can see and hear the artist and specialist. The information the teacher is working on is displayed on the computer monitor. The specialist and/or artist assists the teacher in designing a friendly interface that presents informa-

tion in an informative and interesting way. Later, other specialists may be called upon to review the work being done—yet the teacher, the graphic artist and the content specialist have never left their office or homes.

Software today can turn a computer into a television, a CD player, or a telephone. The computer can transmit video images and music, snap photos, synthesize human speech, imitate a 16th-century harpsichord, organize databases and libraries full of books, and coordinate activities across space and time.

## *Beyond Drill and Practice*

The computer program of the future should not just be a drill and practice mechanism. Connecting to vast networks in the classroom will allow students and teachers to collaborate on different projects in different states and different nations. Imagine a jazz band online, performing one of the many Latin compositions of Clare Fischer, Matt Harris, or any of the other gifted Jazz composers. Using the resources of an online communication tool such as the Internet, we soon will be able to contact a master teacher in Brazil or some other part of the world and play a sound or video of the composition in question. Immediately, we will get visual and audio feedback on the authentic way to interpret the specific styles and rhythms of the Latin composition from a master teacher.

There are other exciting possibilities. Now, to have master teachers at our universities, we have to fly them in, put them up in a motel, pick them up, and then take them back to the airport so they can return home. Three days of wasted time for a one or two hour master class. In the not too distant future, we'll have master teachers online, interacting with our students, hearing our students perform, and then providing the special insight that master teachers can provide.

Our society, not technology, will determine how this will occur in the future. Technology tools are socially constructed. If we think this master teacher concept is important and valuable, then it will happen. Society will see to that. At

the same time, we must not forget that many of these tools are also shaped by tradition, politics, economic interest, history, and competing technologies.

## *The Performance Medium*

Due to the decline of funding at the elementary, secondary, and university levels, we know that a reality check will soon be demanded at institutions of higher education, especially in the area of music. As funds in public education are reduced and arts programs are phased out, we find that public school district administrators are making reductions, especially in elementary school music staff. Eliminating music at this level will have a significant negative impact on music students at the junior high, high school, and college levels and in the adult life of many individuals.

The level of musical proficiency of the average music student entering the universities seems to be declining. Many less-popular or more difficult musical instruments—oboes, bassoons, trombones, horns, violas, and double basses—are vital to the traditional and contemporary music ensembles, but they are becoming less visible to young people.

By incorporating technology in the university classroom, it is still possible to graduate a student today who is equal or better in caliber to those of past years. Universities that are not incorporating technology will, in time, be at a decided disadvantage. The potential to use telecommunication via the Internet, while not giving us an answer to the traditional ensembles as we know them, may provide an opportunity for students to participate in a virtualization—participating in a small ensemble or studying music privately via the telecommunications network. This possibility is almost upon us.

Let's say a student is a member of a brass quintet. Rather than going to the school to rehearse, the students will 'meet' at a predetermined time in their own homes, dorm rooms, or practice rooms for a rehearsal, using their computers with attached video cameras and microphones. Each student's computer will display all five members of the group, no

matter where they are. Each student will be able to see and hear the others in CD quality sound. And they will have an instructor or master teacher in attendance as a coach.

Another concept is that of teaching students musical instruments via telecommunications in the home. A student could not only take a lesson daily, but have an accompanist (such as Coda's *Vivace*), play with a band, and learn a musical instrument in a fraction of the time it now takes, and have fun doing it. If one thinks about it, taking 8 years to learn a few notes and rhythms on a musical instrument seems to be of questionable educational value. In the future, time, as well as immediacy, will be an even more valuable commodity.

## *The Cost Of Technology*

Two by-products of the Information Age are: (1) greater efficiency and more opportunity than ever to incorporate technology in one's teaching and, (2) decreasing prices of teaching technology. According to Moore's Law (Intel Corporation CEO Gordon Moore), we will see double the performance of the technology at any given price level every 12-18 months. This means that whatever we are using now, in a little over a year, doubled power and capacity will be available for the same price.

## *Legal Issues Facing Universities*

If university instructors or graduate students find the time to develop and create software and hardware, they may have to face issues that haven't been addressed by institutions or their faculty. What are the financial implications for instructors if software or hardware is developed using university equipment or developed on university time? Does a sabbatical leave to develop a project mean that the result of the instructors' work, if there is financial reward as a result of technological development, becomes university property? Do instructors market the product and perhaps give the university a piece of the action? Or does the university market it and share with the instructors? What about graduate students who don't own their

equipment but who are required to write a dissertation? What happens if the dissertation committee approves a proposal that involves the development of computer hardware or software that becomes a commercial item? Does the institution demand its fair share?

As academic computing staffs find positions in institutions of higher education, they are increasingly realizing that the assignment and distribution of funds is not their only responsibility. There are many issues, legal and educational, facing the university. Not the least is the concern of universities that want ownership of every successful hardware and software innovation, especially if the instructor receives financial gain as a result of using school-owned equipment or developing products on university time.

## *Perpetual Obsolescence*

Technology that is fast and powerful today will be passè tomorrow. As deregulation of the telecommunications industry make the phone, cable, and computer companies more competitive, we will see a decrease in the cost of having the latest in technology in our home and schools. Digital technology, the wave of the future, will change the way we work and live. It has already reshaped the business world and is making slow but significant headway into education.

According to Vice President Al Gore's article in this book, all schools will be on the Information Superhighway—not only those in Brentwood, but those in Watts as well. In order for this to happen and to exceed the four percent of schools who are currently online, additional taxes may have to be levied to ensure that every school has the essential services. If we think about this potential, we can already visualize a billion-dollar industry that will be created just to meet the needs of schools.

The government may be able to play an important part by coordinating the groundwork and promoting consensus among industries involved in setting standards for networking, switching, compression, and other technologies.

## FINALE

Incorporating technology in the classroom today is fairly easy and inexpensive. Faculty can use it merely to enhance traditional pedagogical methods or to delegate repetitious tasks to the computer. At another level, technology may alter the way faculty teach as they make technology programs central to the instructional effort. In general, most of today's technology emphasis at the university level is based on integration rather than courseware creation. Tools for courseware development have very steep learning curves and, for the most part, musicians are not yet involved in this part of technology. Instructors view computers as instructional tools that can be used to enhance the classroom presentation or do the drill-and-practice routines that involve repetition. And instructors are just beginning to use sophisticated interactive simulations that will be the foundation of the high-tech classroom of the future.

With so much information available, music teachers have the responsibility to teach students how to learn and how to access information. We are in perhaps the most exciting period of education of any time. Technology promises to make students excited about learning and to make faculty enthusiastic about teaching.

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