Music technology in higher education: different models, common issues and future trends

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Music technology is a subject that appears to be experiencing ever increasing interest. In Europe, the popular press has even begun to take notice of music technology as a topic of study in their schools. Last year, *The Times* of London featured two separate articles in their education supplemental magazines; one focusing on programs in secondary schools (Johnston 2002) and the other discussing programs at college and universities (Utley 2002). But this increased interest is more difficult to gauge in the United States.

Programs in music technology certainly have individual approaches to teaching their students, emphasizing different aspects of the field in their curriculum. However, the differences are magnified in part by the multiplicity names these departments and research centers use to identify themselves. Names and acronyms such as CCRMA, TIMARA, iEAR and CARTAH come to mind. With their differences in the foreground, it can be difficult to see what they have in common beneath the surface. This paper will examine the differences between specific music technology programs in an attempt to identify the similarities in their approaches to the topic, as well as common issues that face these programs. We will also synthesize our observations about these programs and attempt to develop a theory for comparing these emphases within the field.

Based on our findings and conclusions, we will then turn our discussion to how technology can act as a hub for arts pedagogy as a whole and not just music.

One question that we should address before diving into the topic is our motivation as authors and the unique perspective our experience allows us to bring to the topic. We are both, admittedly, young scholars at the beginning of our academic careers. But we are also part of a newer breed of students that have been able to pursue music technology as our subject of primary interest throughout our student careers. We were able to seek degrees up to the PhDs that we currently pursue that fall under the umbrella of music technology, a relatively new phenomenon for our field. It is from this perspective that we present our findings, as students who had to search through the myriad of schools offering programs fairly recently in order to choose the best fit for ourselves. We also present this paper as young academics, finding our way in our chosen field of study, and humbly submit it to those more established in the field in the hopes that it will encourage more dialog on these issues.

A. Different Models

We begin with a discussion of our findings from an investigation into specific university programs in which music technology courses are taught. To accomplish this, nine schools were selected and there programs investigated. Contact was made with a faculty member at each school about the possibility of conducting an interview over email for the purposes of this paper's investigation. The premise of the paper was explained and the persons were made aware that

other schools would be participating as well. The faculty members had full knowledge that they were being interviewed and that they would be quoted without anonymity. Some schools volunteered more than one faculty member to be interviewed and all were allowed to participate.

Each interview subject was asked the same series of questions as all other interview subjects (see Appendix A). There was no variation in the original questions. If there was the need for any clarification or follow-up questions, contact was once again made through email to request further explanations. These follow-up questions did vary from subject to subject, since the need for clarification varied according to the responses that each person made to the original questions.

In addition to these interviews, information about each of the programs was obtained from the Internet site maintained on the World Wide Web by both the host institution and the department or program in question. We chose this method of investigation because of the increasingly important role that the Internet has played in recruitment over the last decade. As early as 1997, an article in the *Journal of College Admissions* warned colleges of the impending importance of their web sites (Hartmann 1997). A survey of colleges and universities in 2000 by TMP Worldwide found that web sites had become useful tools in recruiting. John Meagle, who oversaw the survey, was quoted as saying, "Clearly, the world of higher education has recognized the value of offering prospective students both online and offline venues for communication (Hudson Valley Business Journal 2001)." With its increased role in the admissions

process, colleges have begun to place volumes of information about their school on their websites. This abundance of information was useful in our quest to learn more about each school. The likelihood that potential students or those not familiar with the program would use similar methods to learn about the school made it an ecologically valid method as well.

We begin by recounting our findings about each school. In describing each of the programs, we attempted to focus on the unique qualities they possess and avoid any inclination to compare them at this point in our investigation. The programs in alphabetical order are the University of Miami, Mills College, Northwestern University, Oberlin College, Renssalaer Polytechnic Institute, Stanford University, Stetson University, the University of Virginia and University of Washington.

1. University of Miami

The University of Miami in Coral Gables, Florida offers both a bachelors and masters as part of its program in music engineering technology. The undergraduate program was the first of its kind in the United States when it was established in 1975. The degrees are “designed for students who desire a career in audio engineering, music recording, audio equipment design, sound reinforcement, broadcasting, audio sales, or studio maintenance (University of Miami 2002a).” Courses offered by the department include topics such as acoustics, synthesis and audio production techniques. In addition, undergraduate students are required to maintain proficiency on a musical

instrument and take the usual courses in music theory, history and literature that are required for a bachelor of music degree. The graduate degree on the other hand is meant as an advanced engineering degree for those that have completed an undergraduate program in electrical engineering. The focus of this masters program is more on the research end of the field and students must complete a major research project as part of the requirements for graduation.

Ken Pohlmann is the program director at Miami and has been teaching at the university for over twenty years. In that time he has published several books and magazine articles on digital audio, becoming a recognized authority on the subject. He thinks the technical instruction that the students receive helps to give the students additional expertise that other programs may be lacking. He said, "We require a minor degree in electrical engineering or computer science. This additional technical edge is very useful to our graduates (Pohlmann 2002)." In addition to technical training, the undergraduate requirement that students maintain their skills on traditional musical instruments ensures they are musicians as well as technicians. The program at the undergraduate level is very much rooted in the requirements of a typical Bachelor of Music degree with additional technical courses for the major.

Today around the country, there are far more schools offering certificate programs in audio engineering than there were when Miami's program was started. The key difference between Miami and those programs stems from the School of Music connection, ensuring that it is not exclusively about audio engineering. The undergraduate students are musicians first. By marrying those

creative skills with technological knowledge, the results are engineers and technicians who are capable of contributing to projects on multiple levels. It is this blend of science and art as part of a four-year degree program that makes Miami's program stand apart from the aforementioned certificate programs.

The size of the music school and the university provides the students with plenty of opportunities to gain practical recording experience. Mauricio Ardila, who graduated from the undergraduate program at Miami, recalls that the different ensembles within the school offered many chances for him to learn skills through practice. In his opinion, the variety was only possible because of Miami's size, which "permitted the school to offer many different performance ensembles from jazz to Latin to classical (Ardila 2002)." Students also participated in the administrative tasks of running the facilities. Ardila recalled, "[m]ost simple administrative tasks were run by students. For example, studio licensing, maintenance, studio booking, music archives of recording, recording services (copies of recordings, dubs, etc.) which were open to the university community as well as the public (Ardila 2002)." This kind of experience would most likely have an equal value to the technical coursework, if not greater, in the eyes of potential employers.

Like other programs, the program at Miami is beginning to diversify the course topics required by its program. As Pohlmann notes, "We are increasing studies in computer animation, web design, and computer music applications (Pohlmann 2002)." This trend undoubtedly helps the students diversify their areas of expertise and remain competitive in the job market. Still, the main

emphasis at Miami is on the studio and recording techniques supplemented with specialized engineering or computer science knowledge in the form of a minor. As the department web site states, “Our overriding goal is to fill the international demand for highly qualified music engineers, through an emphasis on contemporary theoretical and practical skills (University of Miami 2002b).” By not losing site of this goal, Miami continues to build on its distinguished reputation in the field.

2. Mills College

Mills College is a small liberal arts school located in Oakland, California, that has a history of being a major player on the contemporary music scene. Its undergraduate programs admit only women, however programs at the graduate level are coed. Included among these graduate programs are three masters programs offered by the music department. The MFA in electronic music and recording media is a degree program that focuses on composition within the context of electronic and computer music, as well as other forms of media. The other degrees, an MA in composition and an MFA in performance and literature, sound more traditional, but even students in these programs take their share of courses from the technology curriculum.

The school’s history with experimental music is long and rich, going back to the days when Henry Cowell, Lou Harrison and John Cage taught classes at Mills in the 1930s. The addition of electronic music to the curriculum was made in the late 1960s when a grant allowed the San Francisco Tape Center to move

to the campus, where it was later renamed the Center for Contemporary Music. This history is continued by the presence of Alvin Curran, Chris Brown, John Bischoff, Maggi Payne, Fred Firth and David Bernstein on the current list of faculty. In addition, the school has various artist-in-residence programs that have brought in such guests as Maryanne Amacher, George Lewis, Christian Wolff, and Gordon Mumma. The students in these programs enjoy access to many of the top names in contemporary and electronic music.

The Masters of Fine Arts in Electronic Music and Recording Media degree seems to emphasize more of the creative application of technology. Students take seminars in computer music, electronic music performance and composition in addition to electives in areas such as recording techniques and video production. One of three concentrations is possible:

"Composition and performance utilizing electronic media;

Instrument-building and systems design for interactive electronic music;

Intermedia work based in music, but also involving a variety of other time-based forms such as video, interactive CD-ROMs, Internet and installation-based works. (Mills College 2001)"

The department also works with the other fine arts programs on campus to foster an atmosphere of collaboration.

Maggi Payne is currently the co-director of the Center for Contemporary Music and is also a graduate of Mills College. She sees collaboration as a vital part of their program and says, "It is still a rather unique program in that we strongly encourage our graduates to work in the arts - video, sculpture, dance,

theatre, etc. or to collaborate across disciplines (Payne 2002a)." The students are encouraged to take advantage of the many resources available to them from these various departments. Payne continues by saying, "The art, dance and music department faculty members have had well-established relationships for many years, and we have strongly encouraged our students to develop relationships across disciplines and to work in other disciplines as well. These cross-disciplinary relationships seem so natural to our way of thinking, that it would seem uncommon not to develop them (Payne 2003)."

Mills is certainly a school that is helping to develop new approaches to the teaching of music technology, but it is important to remember the size of this school. As Maggi Payne pointed out, "Mills is a very small school, with only 1200 or so students (Payne 2002b)." The prominence of this program in the field of music technology is even more amazing when put in this perspective. Payne added, "One of the benefits of Mills being such a small institution is that the campus is relatively small, with the dance department and music department across the street from each other, and the art department is only a block away. One of the disadvantages is that the departments have only so many professors and those professors need to teach core curricula for their majors (Payne 2003)."

Despite any disadvantages, the work of the professors and students continues to keep them at the forefront of experimental music. In order to maintain this position, they see it as important to remain active. Payne wanted to make it clear that "Mills is intensely active, with a weekly student run series (Thursday night specials), a Concert Series, Signal Flow Thesis Festival (this

year there are 23 composers presenting work in this four day festival…), and many junior and senior recitals. Last year we also had our '8 Sound Festival' as we had eight undergraduate composers graduating. (Payne 2003)." And they show no sign of slowing down.

3. Northwestern University

Northwestern University has one of the oldest music schools in the United States, but it has clearly evolved over the years to meet the changing needs of music scholarship. Part of this evolution was the development of degree programs in music technology at the graduate and undergraduate levels. The music school is located on the university's main campus in Evanston, Illinois on the shores of Lake Michigan. The campus is just a few miles north of downtown Chicago, which provides many cultural opportunities for the students enrolled. The School of Music is divided into two departments, one in music performance and the other in music studies. It is the Department of Music Studies and its reputation for outstanding research and scholarship that provides the backdrop for the program in music technology. The technology faculty includes Peter Webster, Scott Lipscomb and Maud Hickey, who also teach in the music education, as well as Gary Kendall, Steve Syverud and Virgil Moorefield, who teach courses focused on creative uses of technology.

Gary Kendall is the coordinator for the music technology program and has been teaching at Northwestern for over twenty years. He describes the focus of the program as being "sound design" in a broad sense of the term. As he

explains, "Creative skill in the construction, manipulation, and assembly of component sounds, especially in the context of combined arts and multimedia, is for us the most exciting work for students and faculty (Kendall 2003)." This is achieved through courses that thoroughly cover technical concepts while providing vehicles for the students to apply these ideas within the context of creative assignments. Kendall also sees it as crucial that the program has relevance. "Relevance to the world of today, to the society as a whole, and to the real world of musicians today," said Kendall. "I don't mean this as 'double speak' for 'job training.' The only aspect of the job market which is easy to predict is that technological change is will continue to be rapid and that job definitions are will undergo constant change (Kendall 2003)."

In order to ensure that the program stays relevant, Northwestern has implemented several degrees and certificates related to music technology. The Bachelor of Music program in music technology is one that current music students can select as a major emphasis instead of the more typical offerings such as performance or composition. At the graduate level, both Masters and Doctor of Philosophy degrees are offered, but the target student for each is quite different. The masters degree is intended to be a terminal degree for those that wish to seek a career in the entertainment or computer industries. The doctorate is designed to be a degree for those looking for an added foundation in the techniques used for research and academic pursuits.

In addition to its own degrees, the music technology program has co-sponsored the creation of two cross-disciplinary programs in recent years,

certificates in sound design and art & technology. These programs help facilitate the coordination of the music technology faculty's efforts with those of their colleagues in other disciplines such as communications, art and computer science. The certificates offer specialized programs that are of interest to the students from each of the component disciplines. They are quickly developing into exciting incubators for collaborative projects and bringing new students into the music technology classroom that may not have enrolled otherwise. One additional development in these efforts is a new interdisciplinary undergraduate major in Cybernetic Arts which Northwestern will be piloting this year.

One of the things that often surprises people is the fact that Northwestern's graduate programs do not require an applicant to have an undergraduate degree in music. As Gary Kendall put it, "[W]e look for sufficient musical background that the applicant will be able to thrive in out graduate music courses. This usually translates into at least the equivalent of a music minor (Kendall 2003)." This leads to some interesting diversity within the department's student population. Students with degrees in speech, computer science and engineering have been admitted to the Masters and Doctorate programs and done quite well. By sharing their different viewpoints on common problems, this variety of backgrounds provides another means for the students to learn from each other.

With this diversity of students and courses of study, does the name "music technology" still capture essence of the program? Kendall believes it does, because it addresses the heart of the program. He explains, "The program has

always encompassed the use of technology in a wide range of musical disciplines. It seems particularly important to us that technology has a major role to play in education and disciplines of musical research in addition to composition and creative media." He continued by saying, "Being a program within a School of Music with a significant emphasis on music performance has meant that work within the program will be musically relevant and that our students have a high level of musical background (Kendall 2003)." This focus on the concept of relevance, both internally toward the aims of the music school which hosts them and externally to the changing climates of the world in which its students must eventually succeed, have helped put Northwestern in the music technology spotlight and will help ensure that it stays there.

4. Oberlin College

Oberlin College is an independent school located in a small Ohio town that shares its name with the college and is home to both a College of Arts and Sciences and a Conservatory of Music. The conservatory is grounded in performance something they see as “central to all of the curricula including music education, history, theory, composition, and technology (Oberlin College 2003).” This foundation in performance is evident in the concert schedule for the year, which they tout as having over 400 concerts by its approximately 600 students, 75 faculty and various guest artists (Oberlin College 1999). This emphasis on performance is coupled with a full compliment of required courses in theory and history and other necessary components of the conservatory experience. It is

within this setting that one can find a group of undergraduates studying music technology under the tutelage of expert faculty. The technology department at Oberlin has been given the name Technology in Music and Related Arts (or TIMARA) and its faculty and includes Gary Lee Nelson and Tom Lopez.

Gary Lee Nelson has been teaching at Oberlin since 1974 and is the chair of the TIMARA program. He takes pride in how unique the program is. Nelson said, “We accept students directly from high school and put them to work on music technology from their very first semester. We are not adjunct to a composition department. Let me know if you find another place with the same offerings (Nelson 2003).” Their alumni have certainly had their share of successes. Graduates of their program have gone on to work in various recording studios and software development firms. In addition, many of them have gone on to graduate programs such as Mills, Northwestern, Princeton, Dartmouth and MIT, with a few now teaching at Eastman and the Art Institute of Chicago.

Nelson's own creative work and research has involved the development and use of a custom MIDI horn interface. It was designed and built by John Talbert, Oberlin's music engineer, in consultation with Nelson and when coupled with a group of MIDI synthesizers form the basis of Nelson's performance system. With this "hyperinstrument", as he calls it, he "has performed more than 200 times around the world since 1987 (Nelson 2002)." Nelson's active performance life is one that students seem eager to model, with many current and former students working to maintain performance schedules of their

electronic music. Also, while at Oberlin, students are required to take lessons on a traditional music instrument of their choice. This serves to further reinforce the conservatory's belief in the importance of music performance.

Tom Lopez is a graduate of the program and after some time doing graduate work at the California Institute of the Arts and University of Texas at Austin has returned as a professor in the program. During his years away, he was also the recipient of numerous composition commissions and fellowships. As a program in music technology, Lopez feels Oberlin is "most distinctive" in its "explicit inclusion of the arts outside of music. In this regard, faculty and students live up to the acronym [TIMARA]; work here often involves video, film, animation, internet, dance, theater, written and spoken word, and so on (Lopez 2003)." Whatever they choose to focus on, the faculty and students continue to do it well and help to maintain Oberlin's position as a leader in the field many years after the founding of TIMARA.

5. Renssalaer Polytechnic Institute

Renssalaer Polytechnic Institute has several well-known electronic music composers on its faculty, even though the school does not offer a major in music. They are all part of a unique program called the Integrated Electronic Arts at Renssalaer, or simply iEAR. This program brings together several creative disciplines that use electronic media, allowing video, computer animation and musical artists to interact in an environment that fosters collaboration. Students are encouraged to work together on projects leading to results that are naturally

multimedia, drawing on the experience of the individual students involved. The iEAR Studios features both studio courses and history/theory courses culminating in either an undergraduate or graduate degree in the electronic arts. The faculty specializing in electronic music includes Neil Rolnick, Curtis Bahn and Pauline Oliveros.

Curtis Bahn teaches courses in computer music, acoustics and interactive arts programming, as well as serving as director of the iEAR Studios. His artistic focus is as a performer and composer of electronic music, especially pieces involving performance on custom designed instruments. He notes that the name iEAR "reflects the design of the department as being interdisciplinary at the core. It is formed within an Arts department and consists of musicians, installation artists, digital graphics artists, animators, video artists, a painter, sculptor, 'media intervention artist' and theoreticians specializing in contemporary arts and culture (Bahn 2002)." This approach is one that lets students broaden their focus and branch out into areas of electronic media production that they may not have studied before. Admitted students may have prior musical training, even graduate degrees in the subject, but they are encouraged to try new things as part of the program. "We try to accept interesting, committed artists," said Bahn, "and let them extend their practice in new areas (Bahn 2002)."

It is fascinating to find such a program at an institution where most of the resources are focused on studies within the science and engineering disciplines. This technical university found in upstate New York has schools of architecture, science, engineering and management. Among these others, a School of

Humanities and Social Science may seem like the odd man out, but it enriches the academic community with a creative element that might be otherwise lacking. This school is home to the iEAR studios, which "boasts some of the university's fastest growing programs (Knight 2001)." In addition to their bachelors and masters programs in the electronic arts, they offer undergraduate programs that combine this major with additional coursework information technology or communications to form joint majors.

Although the faculty from the department each has their own specialized technical experience, they can also draw from the knowledge of their colleagues and students in the other schools. Neil Rolnick, who teaches computer music, was quoted as saying, "what's remarkable about this environment is that there are wonderful scientists and engineers here who want to be engaged in artistic endeavor and projects that allow us to function as artists on teams with engineers and scientists (Knight 2001)." But the institution's focus on research can have other effects on the artists on iEAR's faculty. Bahn said there is the potential for "pressure to be involved in projects which can bring in external funding. This is sometimes at odds with the artistic focus of the tradition of experimental arts within the department (Bahn 2002)."

These drawbacks seem to be minor however, as evidenced in their ability to attract world-class faculty members. And the funding is coming as well. The school recently broke ground on a new $50 million building project called the Experimental Media and Performing Arts Center. The center will continue "to build on Rensselaer's reputation for excellence in the electronic arts and enrich

the student experience by creating a more lively and intellectually stimulating campus environment (Knight 2001)." RPI recently named Johannes Goebel the new artistic director of the center, who brings with him leadership experience from his previous work at the Zentrum für Kunst und Medientechnologie in Karlsruhe, Germany and Stanford's CCRMA. Rensselaer President Shirley Ann Jackson was quoted as saying that Goebel will help to "create a center that is unprecedented as a site of new knowledge in disciplines that range from art and architecture to physics and information technology (Ackerman 2002)."

The students and faculty at RPI remain active through a variety of programs on-campus and in the surrounding community at venues such as the Deep Listening Space and Impulse Response performance series. Program members also keep busy with collaborative projects and student thesis projects that set high standards for innovation and artistic merit. Pauline Oliveros, who is currently starting her third year at RPI, said, "I am particularly excited to be participating in [such] a revolutionary program…The program is meeting a great need among students who want to work with electronic media (Oliveros 2003)." There is no doubt that this program provides an environment for students to develop their skills in music and other arts through the various ways these media intersect with technology.

6. Stanford University

Stanford University in California is home to a program that brings researchers from engineering backgrounds and musicians together to form the

basis for its department of music technology. The department is known as CCRMA (pronounced like karma), an acronym that stands for Center for Computer Research in Music and Acoustics. It is a place “where composers and researchers work together using computer-based technology both as an artistic medium and as a research tool (Scavone and Schroeter 2001).” Although part of the music department, the program also draws students from the engineering programs at the university with its courses in audio synthesis and signal processing. The faculty boasts many important names found in the research literature on music technology including Max Matthews, John Chowning, Julius Smith and Bill Verplank.

Julius Smith is an associate professor at Stanford and teaches courses covering various topics within signal processing. He feels the program is truly unique within the United States. When asked what programs he sees out there that are like Stanford’s CCRMA, he replied, “[T]here are several other programs in the U.S. that have similar program elements, but not the same combination of elements.” He views IRCAM as the closest institution to CCRMA "in that perhaps all components of the CCRMA program have at least approximate counterparts in the IRCAM program (Smith 2003)."

The center has been very successful in terms of leveraging its research success to obtain a certain degree of autonomy at the university. Smith notes, “We are self-supporting financially. Our research topics are guided primarily by the interests and goals of those of us participating in the research (Smith 2002).” If the past research conducted at the center is any indication, there will be many

more exciting results from the faculty and students at this program. Current research projects include efforts to translate complex sets of parameters from other domains of study (such as oceanographic research or stock values) into sound (Berger 2003) and a project to digitize and catalogue a large collection of early wax cylinder recordings (Berger 2002), both of which are supported by external funding.

CCRMA serves as Stanford's hub for undergraduate and graduate degree programs in "Music, Science and Technology". In addition to the degrees directly attached to the center, Stanford also offers a Doctor of Musical Arts in composition. Although students in this program can focus on more traditional forms of music, there are also a number of them that emphasize electronic music as their primary mode of creative output. For them, CCRMA is an invaluable resource in learning new techniques that they may incorporate into their work. Their role is not passive either, since they also contribute to the research themselves in the process of collaborating with the students working more directly with the center.

With such a well-known audio research facility on campus, students from the engineering disciplines often take advantage of the courses offered by CCRMA in order to get a different perspective on the techniques they learn in their own departments. This can sometimes require the instructor to cover some minor musical terminology in order for them to keep up with the class. Smith notes, "Sometimes I get questions like 'what's a semitone?' from some engineer sitting in on the course primarily to learn applied signal processing (Smith 2002)."

Although this kind of thing would be helped by some kind of musical prerequisites, Smith would not consider limiting the students' access to his courses. "My courses receive students from all over campus, and I accept all of them (Smith 2002)," he said. For him the benefits of having a diverse population in the classroom outweighs the need for standardized prerequisites on musical training. It is the way they bring together these two worlds, engineering and music, that shapes the program at Stanford. The collaboration between artists and researchers provides fertile ground for the projects conducted by CCRMA.

Smith's observations on Stanford's program do provide an interesting issue that other departments around the United States must also consider. As he put it, "How do we structure our courses to best serve the needs of musicians, engineers, and others having widely varying technical and musical backgrounds (Smith 2002)?" An important part of being at a liberal arts institution is how your department serves the larger university or college. Addressing the needs of non-majors in courses is part of that service, but we will return to this idea later in our analysis of common trends.

7. Stetson University

Stetson University is a small liberal arts college located in DeLand, Florida, a small town about halfway between Orlando and Daytona Beach. The oldest private university in the state, Stetson is home to a college of arts and science as well as schools of business administration and music. This school of just over 2,000 undergraduates is also home to an exciting interdisciplinary

program called Digital Arts with support from the art, computer science and music programs at the school. The program is an integrated, undergraduate-only arts and technology program where students select an emphasis track in one of the supporting departments. Their faculty includes Matt Roberts, Larry Santaw, Cyriaco Lopes, Brian Smithers, Michael DeMurga and Michael Branton.

Michael DeMurga studied music composition at the Boston University and the Eastman School of Music and serves as chair of the Digital Arts department at Stetson University. When asked about the name of the program, he responded by saying that it "reflects the interdisciplinary aspect of the program." However, he added that that there are "significant music requirements within the Music tracks of the Digital Arts degree (DeMurga 2003a)." Looking over the requirements helps to illustrate the point he makes. The students in the music track may choose to pursue and Bachelor of Music or Bachelor of Arts degree sequence. Both degree sequences draw on the resources of the School of Music and require students to take two years of music theory, ear training and other courses typical of a music degree. The main difference between them lies in the requirement of a senior recital from the BM degree and a senior project from the BA degree.

This grounding provides students in the music track with a solid foundation for the students' collaborative work and specialized music technology courses within the department. All majors must take the same core introduction courses regardless of their chosen track. Although the "music technology" department title is missing, there are plenty of courses offered with topics directly related to

the field such as recording techniques, computer music, scoring for video and interactive sound programming. These classes are required of the students in the music track, but may be taken as department electives by any student in the Digital Arts program. Similarly, the department courses from the other tracks can be taken as electives by the music track students. In all of the department's courses, students focus on completing creative projects while learning technical skills. Whether it is composing tracks for compact disc or producing parts for a piece to be recorded by the string orchestra, the creative product is always the primary emphasis.

The size of the school is an asset according to DeMurga, who said, "As a small liberal arts school, we are able to move quickly when making changes to our curriculum [and] interdepartmental communication is facilitated (DeMurga 2003a)." They are also proud to be an undergraduate-only program, a remarkable fact that one may easily forget when looking at the quality of the work produced by their students. This quality persists outside the classroom. Students from the school have been very successful in applying to graduate programs around the country, including those at Mills College, New York University, University of Southern California and Northwestern University. Others have completed their studies and used their newfound skills to start their own businesses specializing in new media. Whatever their goals, Stetson's Digital Arts program seems able to help their students achieve them.

8. University of Virginia

The University of Virginia has a long and rich history that began with its design and founding by Thomas Jefferson. He conceived of an "academic village" where students and professors would live and study their subjects together. Because of its famous architecture, the campus has even been designated a World Heritage site by UNESCO (UNESCO 2002). The university has lived up to its proud history in recent years by consistently being recognized as one of the nation's leading public universities. Virginia's music department is found in the College of Arts and Sciences and has offered courses in electronic and computer music for a number of years. The Virginia Center for Computer Music was founded in 1988 to promote "a creative atmosphere, providing a wide variety of tools to aid the engineer, programmer and composer (Topper and Burtner 2003a)." Judith Shatin has been teaching at Virginia since 1979 and is the current director of VCCM. Matthew Burtner joins her on the center's faculty.

Through the VCCM, Virginia recently began offering a PhD in Composition and Computer Technologies in fall of 2002. Shatin feels the new PhD program has "strong support from the institution. The fact that we established the first PhD in music in the state of Virginia has enabled us to create a dynamic program with reasonable support (Shatin 2003)." It appears to be off to a good start, attracting healthy interest from applicants and bringing in quality students.

The VCCM has proven itself to be an effective place for the development of creative and research projects. In the fall of 1999, a CD of electronic music by faculty and graduate students was released on the Centaur label as part of the CDCM's series focusing on music created at various university programs. Each

year, Virginia organizes concerts as part of two annual series that highlight new creative works. The first is Technosonics, a "premiere computer music event bringing the best of international guests and music" to the school, and the second is Digitalis, "an exciting evening of computer music featuring music by graduate and undergraduate students working in the Virginia Center for Computer Music (Topper and Burtner 2003b)."

The research that is conducted at Virginia revolves mainly around the development and use of open-source software solutions for new methods of sound manipulation and other forms of media creation. Shatin points out that the department is one that believes strongly in the "[i]mportance of open source programs (Shatin 2003)." The facilities at VCCM make use of Macintosh G4 and PC Linux workstation running a variety of software to fulfill the needs of the students and faculty. Current research projects include the development of Spatio-Operational Spectral (s.o.s.) synthesis, which is described as being "an approach to digital audio effects using recombinant spatialization for signal processing. This technique relies on recent theories of auditory perception (Topper and Burtner 2003c)." Also, a new GUI for RTcmix is being pursued under the name Graphical Audio Interface Application, or GAIA, in order to create a standard method for working with that synthesis language graphically. This balance between creativity and research should make Virginia's young PhD program an exciting one to watch as it develops and continues to add more students.

9. University of Washington

The University of Washington, located in Seattle, has offered studies in computer music to its students for a number of years. It also home to a research center that provides an example of cross-discipline cooperation in the arts and technology. In the early 1990s, the university launched the Center for Advanced Research Technology in the Arts and Humanities, or simply CARTAH, with Professor Richard Karpen as the founding director. The center brought together faculty from across the university to foster an atmosphere of collaboration on projects between the more technology-oriented departments and those departments that are rooted in the arts and humanities. These diverse projects at CARTAH have included multimedia museum installations, database building and language preservation (University of Washington 2003a). However, the center has served more as a hub for these projects and not as the home department for a major in arts and technology.

More recently Washington has become home to a new program known as the Center for Digital Arts and Experimental Media or DXARTS. The program, which offers both BFA and PhD degrees, brings together faculty from music, art, computer science and other departments in the task of administering a more unified curriculum where students can learn about the creative application of techniques associated with art and technology. It is described as a place where "[a]rtists working with digital technologies are redefining art, music, theater, film, and architecture, dissolving the boundaries between these traditional forms (University of Washington 2003b)" and is the new home for computer music

studies at the University of Washington. The computer music faculty and staff at Washington includes Richard Karpen, Juan Pampin and Bret Battey.

Richard Karpen is the director of DXARTS program and teaches composition and computer music. He explains that the program is interdisciplinary at its foundation and students are able to specialize as they choose. "Students can focus on specific areas, but they will often be in classes and in labs with students from Art, Music, Engineering, Architecture, [and] various Humanities (Karpen 2003)." In addition to a beginning sequence of courses where students are exposed to core issues of theory, history and practice, students also enroll in an advanced seminar course that requires students to propose and execute projects with the help of their colleagues. Other advanced classes offer more specialized topics ranging from audio synthesis and digital video to robotics and new science-based art forms. With students from different backgrounds in constant contact with each other throughout their curriculum, collaborations are fostered more naturally.

Karpen also offered a reminder of their separate composition program at Washington, stating that "[s]tudents can apply to our Composition program and focus almost entirely on computer music…We have a very strong program in Composition." However, he added, "most of the graduate students in this program are heavily involved in DXARTS (Karpen 2003)." Maintaining a separate composition program helps provide the students with more options in choosing the degree path that is right for them and their career path.

The DXARTS program at Washington is relatively small compared to some of the other departments on the campus of this large research institution. Karpen highlighted the advantages that such a university provides the program, stating that they "can draw upon a diverse, world-class faculty and a wide array of facilities. As a research university, we can focus on experimental art and research even at the undergraduate level (Karpen 2003)." And he sees no conflict between art and research, saying they're "a program of artists who see their art work as experimental research as well as experiential for audiences (Karpen 2003)." Striking this balance has helped them to fashion a program that fosters not only cutting-edge art, but also technical innovations that natural rise from the preparation of such work.

B. Common Trends

We turn our attention now to the issues that we feel these programs have in common, using the materials gathered on each school to inform our conclusions. We will discuss the relationship of these departments to each other, our theory of program "anchors", their relationship to the respective host institutions, and the future needs of music technology pedagogy.

1. Comparing programs

As we said near the outset, our intention with this examination is not to rank these programs or imply that any one is better than the others. We present the topic of comparison as part of the self-reflection our subjects underwent

during the interview process. As part of their interviews, the faculty members mentioned before were all asked, “What department/program in music and technology at another academic institution within the United States do you feel is most like your own?” Representatives from the two undergraduate-only programs, Stetson and Oberlin, both flatly replied none despite of our prompting that they should not do so. However, each qualified that response in a different way. Oberlin’s Gary Lee Nelson stated, “Let me know if you find another place with the same offerings (Nelson 2003),” while Stetson’s Michael DeMurga explained, “Our program is relatively young and still evolving – I hesitate to make comparisons (DeMurga 2003b).” The other program representatives all mentioned similar programs, but qualified their statements in some way. For example, Maggi Payne ensured us that Mills “is still a rather unique program (Payne 2002a)” and Tom Lopez called Oberlin’s program “most distinctive (Lopez 2003).” They wanted to be sure to point out what they do differently; not better, but differently.

This serves to strengthen our original point that a lot of work goes into drawing attention to the unique in each program, which is manifested externally in the name differences. Only one school that we studied actually has a department called music technology and offers degrees in the subject and that is Northwestern. The next closest would be Miami’s music engineering degrees and Stanford’s “Music, Science and Technology”. The more interdisciplinary programs obviously have names that do not emphasize the music technology aspect of their programs, but prospective students may find that the course

offerings at these school is just as rich as those schools with programs focused exclusively on our field of study. It would be ideal to have more clarity in identifying programs that offer instruction in music technology. Once identified we hope that the concept of anchors put forth in this paper will be a useful aid in comparing these programs to each other.

2. "Anchors"

Each program seemed to have there own primary emphasis within the field of music technology. This is perhaps most easily understood as the thing for which the department is most well known or for which they would like to be known. Examples of this include Miami being best known for its education of audio engineers, Stanford being widely regarded as an important research center in the field, Mills being known as a place where creative experimentation is fostered and RPI as a place where interdisciplinary project are encouraged. Some do overlap, such as those that are known for their focus on the composition of electronic music or integrated arts and technology, but beyond this we wanted a means of expressing these common emphasis at a higher level. For this we propose the concept of "anchors" as a means of expressing the idea that programs greater emphasis on certain aspects of the field of music technology. We propose two primary anchors in music technology: *creativity* and *technology*.

This obviously begs the question, what characteristics does one see that leads to a labeling of either creativity or technology? With creativity, a program

will emphasize the creation of original art using technology. This may take the form of composition projects and a faculty comprised of composers that teach both private lessons and coursework, like we find at Mills College's CCM. It may also involve an emphasis on performance with technology and encouraging students to develop work that they perform themselves, like we find at Oberlin College's TIMARA. At these schools, one is more likely to find degrees that are designated as BM, BFA, MFA and DMA. This by no means translates into a lack of technical instruction, however the public perception of these programs is clearly an appearance of more emphasis on creativity.

With a technology anchor, we see programs that place more emphasis on research and innovation that builds upon existing body of knowledge in the field. This may take the form of a research center that works with composers at the university to develop new forms of synthesis and processing, such as Stanford's CCRMA. It may also take the form an audio engineering program that focuses on acoustics and circuit design, such as Miami's MS program. Other technical topics that a program may emphasize include audio engineering and computer programming. These programs are more likely to offer BS, MS and PhD degrees.

Again, we must stress that these anchors are in no way mutually exclusive. To be anchored in technology does not mean a program does not require the creative application of this knowledge by their students. Furthermore, to make such an assertion would be absurd. However, programs must realize that the perception among outsiders is often that one anchor is given more

weight. The faculty and staff at a program need to acknowledge this perception and analyze whether or not it is a true picture of their program. If it is inaccurate, they should work to develop a plan for changing the perception so that it better reflects the program. Programs ideally should be working to instruct their students in both technology and creativity, but it does not always happen, nor does it have to. Acknowledging the strengths of each program, allows for a clearer comparison between them. It assures us that we are not comparing apples to orange, to use a popular expression, and allows potential students to better judge which program is best suited for their needs.

We would also like to propose a third anchor that we will call *integration*. The programs that we investigated all seem to be taking steps to integrate elements from non-musical arts that would have in the past been considered outside the discipline. This is perhaps most easily implemented by the addition of requirements for the students to take courses outside the department, such as was noted about Miami. The faculty seems aware of the need to direct their students to focus on the bigger picture of arts and technology. Gary Kendall of Northwestern said in his interview, "Many of our music technology students need to be awakened to their context within the broader arts community (Kendall 2003)." Judith Shatin of Virginia expressed her vision of a new home for collaborative work at her school, saying that she "would like to see a new facility for experimental work in digital music that would encompass dance and other multi-media performance (Shatin 2003)." Even Gary Lee Nelson of Oberlin's TIMARA (Technology in Music and *Related Arts*) program said he sees the

potential for improvement by offering "[m]ore classes in collaboration…with visual artists (Nelson 2003)."

The more drastic approach is the total integration of music technology with other arts technology courses in the formation of a new department, such as Stetson and Washington's digital arts programs or the iEAR program at Renssalaer. It is also interesting to note that a majority of the programs from this category at which we looked had directors who were musicians. It may be evidence that musicians are taking an important role in this integration of arts under the impetus of technology. We will address more specific issues that arise as part of this integration in the third and final section of this paper.

At first glance, it may seem that integration belongs as a topic beneath the creativity anchor due to its concentration on other arts. However, it seems to be gaining enough mass that we feel compelled to separate it from the other two and establish a third anchor. These proposed anchors of creativity, technology and integration serve to help us categorize programs according to their perceived strengths and better facilitate appropriate comparisons among programs that often fall under the single heading of music technology.

3. Host institutions

In the interviews, all subjects were also asked, “How has the size and makeup of your host institution affected your department?” The trend that we noticed in these answers is that those respondents from larger schools expressed a belief that the resources, both financial and people from other

departments, were more easily available. Richard Karpen of Washington said, “We can draw upon a diverse, world-class faculty and a wide array of facilities (Karpen 2003).” Those at smaller schools expressed the feeling that they could respond to changes more quickly, such as curricular changes and had close relationship to faculty in other departments. Michael DeMurga of Stetson said, “As a small liberal arts school, we are able to move quickly when making changes to our curriculum (DeMurga 2003a).” Maggi Payne of Mills said, “One of the benefits of Mills being such a small institution is that the campus is relatively small, with the dance department and music department across the street from each other, and the art department is only a block away (Payne 2003).”

Both of aspects of size have positive attributes for a program in music technology. With rapid changes in technology, one cannot have access to the latest tools without the availability of needed resources. In addition, the changes in technology need to be reflected in a curriculum that is current and up to date. Neither condition is necessarily a direct result of the host institutions composition and technology departments should work to ensure that they have both an adequate level of resources and flexibility, without neglecting one for the other.

An issue that did arise without a direct question posed on the subject is the issue of non-majors in the music technology classroom. Julius Smith of Stanford noted, “My courses receive students from all over campus, and I accept all of them (Smith 2002).” Richard Karpen of Washington noted, “as many as 50% of the students in our classes will be non-majors (Karpen 2003).” A

department in music technology, or any department for that manner, does not typically survive by offering courses for only its own students. It is important to attract and encourage those that may come from outside disciplines to study the topics covered by the faculty. Although there is some outsider influx in other departments around the university, it seems to happen more often in a music technology classroom. It is not one overarching thing that appeals to these outsiders, but some aspect of a course that can apply to their own discipline. Synthesis and signal processing have much to do with what those in electrical and computer engineering study. Audio production techniques are important secondary skills for those in the video production. And of course there will always be a number of traditional music students that take classes to learn additional skills that may help them in the job market. It is not always easy to make courses manageable for such a broad range of students, but it seems to have become a necessity based of the appeal other students find in music technology courses.

4. Perceived needs

It is certainly a promising sign for our field that we have a high level of interest from non-major students. It certainly helps to illustrate the relevance of music technology and provide a purpose beyond the confines of our departments. However, with the level of interest that is exhibited by non-majors for the topic of music technology, perhaps more programs should consider the addition of courses geared specifically toward these students. Non-major

courses are found in other departments and but seemed to be rare in the programs at which we looked. These students are expected to "jump in" at various levels, causing two problems. First, the non-major must play catch up and try to learn foundational information that they missed by not taking a more basic class. Second, the instructor must dedicate resources to helping the student catch up, possibly leading to the neglect of more advanced students. Having a non-major prerequisite to advanced topics would potentially help to alleviate these problems.

Admittedly the issue of non-major classes is compounded when a program has been integrated into the general topic of arts and technology. At Stetson, for instance, there is a music technology course for non-majors, but the curriculum lacks a non-major course in the more general topic of digital arts. This further complication only makes the issue more urgently in need of examination.

Another topic that seems to be looming on the horizon for our field is the issue of history. So much has changed in the relatively short history of music technology that there is a certain amount of disconnect between current students and the techniques and methods that were used only twenty and thirty years ago. Our interview subjects offered some acknowledgement of this in their responses. Tom Lopez of Oberlin mentioned that he "would like to find a way to teach our students a stronger appreciation for the history of music and technology (Lopez 2003)." Michael DeMurga of Stetson listed "history and aesthetics" among the areas in which he would like to see their digital arts program strengthened

(DeMurga 2003a). Gary Kendall of Northwestern recognized that "it is becoming increasingly important for students to have a sense of history (Kendall 2003)." The future will hopefully see more energy devoted to development of classes that address this need for instruction on the history of our field.

We should note that neither of these issues was specifically addressed in our interview questions. They however arose out of the subjects' responses independently. A follow up questionnaire addressing these issues is a possible means of shedding more light on these topics in the future.

C. Future Trends

At this point in the conference presentation, the floor was handed over to Peter so that he could address his research on *post-disciplinary hybridity* and what it means for the study of music technology, as well as the larger subject of arts and technology. We refer readers to Peter's web site (Swendsen 2003) where they may obtain examples of Peter's writings on the topic, especially his MFA thesis (Swendsen 2002).

Appendix A. Questions asked of interview subjects.

Please understand that this is an interview, not a survey. Your answers WILL NOT be anonymous. Answers do not have to be very lengthy. One or two sentences will suffice in most cases.

1) What aspect of music and technology do you feel is the strongest emphasis of your degree program? (Please list only one)

2) What additional aspects of music and technology are covered by your degree program?

3) In what area of study within music and technology would you like to see your degree program strengthened?

4) Programs and departments focusing on music and technology go by many different names across the United States. How is the name of your department an accurate reflection of the work done by faculty and students? How is it inaccurate?

5) How has the size and makeup of your host institution affected your department (in areas such as financial support, research requirements or curriculum changes for example)?

6) On average, how many applicants does your program receive each year? How
many are accepted?

7) What guidelines on prior musical training does your graduate degree program have for applicants?

8) Are any of your students required to study a "traditional" musical instrument as part of your degree program?

9) What department/program in music and technology at another academic institution within the United States do you feel is most like your own? Why? (Please refrain from replying "none")

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