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A Revised Approach To Teaching Audio Mixing Techniques: Applying The Deliberate Practice Model

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ABSTRACT

An overview of the Mixing Techniques course currently offered at Middle Tennessee State University. The course was designed to help students develop substantive foundational knowledge and technological competencies regarding the aesthetic and technological aspects of audio mixing techniques by applying the principles of the Deliberate Practice model. Relevant studies in human performance, characteristics of Millennial students, and pedagogy for developing mental models of audio engineering systems are considered as they apply to recording arts course and curricular design. The results of this study suggest that implementing rigorous, formal practice of foundational skills in audio mixing courses significantly improves students' capabilities.

1. INTRODUCTION

In many ways, pedagogy for the recording arts is still in its early developmental stages, given that formal audio recording programs were not introduced in Europe until the 1960s [1] and in the United States in the early 1970s [2, 3]. Today, audio education is a rapidly expanding segment of the recording industry, with more than 10000 students enrolled in collegiate recording industry programs in the US alone [4]. In 2000, the Mix Magazine Audio Education Directory listed 107 unique audio programs [5] expanding to 226 programs listed in 2006 [6].

As a hybrid discipline combining technology and aesthetics, music engineering requires competency in a range of skills, facts and procedures that can be taught in a variety of ways. Programs or courses emphasizing the science and technology of audio often rely on instructional methods like lectures and lab exercises. In conservatories and schools that emphasize artistic production, instruction based on experiential learning, master-classes and individualized coaching may be more commonplace. While there is a place for various pedagogical styles, all of these should be contributing to an extensible mental model as held by successful practitioners of the recording arts.

Unsurprisingly, rapid expansion of audio education programs has not been without its challenges. For both

new and established schools, course and curriculum development may lack a comprehensive, cohesive vision, especially since the commercial recording industry is experiencing a period of unparalleled economic and technological transition, changing the way music is both produced and consumed [7]. In addition, too great a focus on specific hardware and software platforms distracts from the larger purpose of adequately preparing students for the myriad issues they will face as audio professionals.

The challenges of finding balance and vision extend to individual course design as well. In both graduate and undergraduate mixing classes, the author encountered a significant gap between students' ability to comprehend fundamental concepts in the classroom and then apply these successfully in the studio. Students demonstrated marked differences in core mixing competencies and experience, despite similar educational backgrounds.

A systematic teaching and practice approach referred to as Deliberate Practice may prove useful to audio education, especially in teaching mixing techniques. This model can serve as the basis for effective overall curricular design as well. Foundational audio concepts are consistent across a wide variety of musical mixing styles, and students and young professionals strongly desire professional guidance and constructively critical analysis of their work. Presented effectively, courses in audio mixing can serve as an opportunity to address weaknesses early in a student's development and establish professional work practices.

2. BACKGROUND

2.1. Recent Studies

At the 127th AES Convention, Jan-Olaf Gullö of the Royal College of Music in Stockholm presented a paper about teaching desktop audio production to *Millennials*, individuals born between 1980 and 1995. In his conclusions, Gullö noted that these students have radically different technological references from the previous generation of students, many of whom are now teachers. Specifically, he observed that Millennials are not focused on recording technologies, since access to high-end audio equipment was more commonplace during their formative years. Instead, they are more interested in how equipment can be applied successfully toward their own projects [8].

In 2010, David Tough surveyed experts in the field of the recording industry to determine their recommendations of essential competencies required for audio recording programs by the year 2019. In the results, eighteen of the twenty top recommendations were related to professional competencies and demeanor, as opposed to technological or scientific concerns. In the experts' opinion, the overwhelming requirements for success in the 21st century recording industry were substantive work habits and approaches to career-related tasks and situations [9].

Nonetheless, Barry Hill posited that students must comprehend core audio engineering fundamentals, presented and reinforced as accurate system models throughout their training. "Instructional models must be simple enough for the novice to understand, yet accurate and faithful to the larger system or content area so that learners can fill in the details as their structural knowledge develops. Solid foundations can better facilitate transfer to more complex and novel problems, but the experiences must be authentic and extendable to real applications" [10]. These models can be maintained and expanded using assignments that are legitimate, meaningful, and challenging [11].

Recent studies of human performance, especially concerning the formative experiences of high-achieving individuals, determined that superior performance levels required consistent, rigorous practice. The most capable performers had accumulated more than twice the number of hours of practice in their area of focus than their less-accomplished peers [12]. A British study of top violinists concluded that "… the sheer amount of formal practicing appears to be the best single predictor of a player's level of accomplishment" [13]. Further, evidence has shown that expert performers across a wide variety of fields developed their skills by engaging in a specific type of practice, referred to as Deliberate Practice [14].

In theory and application, the principles of the Deliberate Practice model satisfy all of these requirements for audio engineering development. A successful audio engineering program must develop students' solid foundational knowledge, which is then reinforced through experience. Following a rigorous, guided practice regimen will help motivate students to establish substantive practical skills coupled to a widely applicable methodology.

2.2. Deliberate Practice

In an article for the *Harvard Business Review*, K. Anders Ericsson, Michael Prietula and Edward Cokely noted that exceptional performance ability is the result of diligent practice methods and is not based on innate talent or skills:

> "To people who have never reached a national or international level of competition, it may appear that excellence is simply the result of practicing daily for years or even decades. However, living in a cave does not make you a geologist. Not all practice makes perfect. You need a particular kind of practice – Deliberate Practice – to develop expertise. When most people practice, they focus on the things they already know how to do. Deliberate Practice is different. It entails considerable, specific, and sustained efforts to do something you can't do well – or even at all. Research across domains shows that it is only by working at what you can't do that you turn into the expert you want to become" [15].

Deliberate Practice requires students to approach tasks in three stages: prepare in advance, perform the activity to their highest level of focus, and then reflect on the activity after the fact. By considering their own performance before, during, and after the work, students become more aware of their own working processes, referred to as metacognition [16]. Students require a supportive environment and circumstances to encourage this practice style [17] as well as unbiased feedback from a mentor to address any issues and provide appropriate practice techniques at each level of development, which change over time and with achievement [18]. Finally, Deliberate Practice requires a high level of concentration and consistent motivation, which may initially be external but must eventually become intrinsic to the student [19].

With its focus largely on fundamental skills and intensive training on one area of specialty, the effect of Deliberate Practice is cumulative. If a student were to practice a craft or skill for three hours per day, she would accumulate 10950 hours of practice over a period of ten years. This is considered the minimum time investment required for mastery of a craft, an observation is so prevalent that it is often referred to as the Ten Year Rule [20]. Some fields may require twenty or more years of focused practice to reach the highest levels of achievement.

Over time, the cognitive processes of students who follow this practice model are fundamentally different than their peers. With intensive practice, students can perceive a greater level of detail. As a result, they are capable of predicting the results of a given situation more accurately and can make finer discriminations than average performers [21].

To master a craft, students must move beyond simply repeating an experience: retrying a task without consideration before, during, and after the fact does not guarantee improvement. Instead, the student must work with their instructor to set specific, measurable goals in advance and analyze their own performance once the work is complete. In addition, students should seek out feedback on their work from a variety of trusted sources, providing additional knowledge before reattempting the task [22].

As students invest time in their craft, they will begin to devise a personal mental model of their area of focus. Initially suggested by Kenneth Craik in 1943, a mental model is a "small scale model" of reality that individuals use to explain interactions in the real world and provide the framework on which they may expand their understanding and anticipate situational outcomes [23]. Regarding the development of knowledge based for recording systems in particular, Hill noted that:

> "…the key is to help [students] learn correct fundamentals in order to reduce misunderstanding while providing extended experiences that force them to see when their inadequate models will not work. These correct fundamentals come from presentation and reinforcement of appropriate system models during instruction. This increases the likelihood that students will base continued experiences and instruction on grounded foundation. If left on their own, individual perceptions will dominate model development, almost ensuring inadequate and inaccurate system models that will hamper performance" [24].

Ultimately, students must develop problem-solving skills to test and expand their individual mental models of audio engineering systems. After attempting and failing to accomplish an unfamiliar task or situation, students with poorly developed mental models may blame the failure on external forces and choose not to repeat the activity, offering no chance for improvement [25]. Alternatively, they may simply try again without acquiring additional knowledge, with a small chance for

improvement but more likely failing again and developing bad habits which can be difficult to correct [26]. In contrast, students who fail but employ the Deliberate Practice model will reattempt after acquiring new knowledge and adopting revised strategies. Geoff Covin observed that these students' "…well-founded belief in their own effectiveness helps give them the crucial motivation to move forward, powering a self-reinforcing cycle" [27].

3. NEW COURSE DESIGN

3.1 Original course structure

When a dedicated mixing techniques course at MTSU was offered in the spring semester of 2008, its original design achieved only limited success at improving students' audio mixing performance. Students were required to perform mixes of complete songs without developing foundational skills first: the author presumed their prior mastery of these abilities. Students were not required to reattempt assignments after the instructor's critical analysis was available. Assignments were not customizable based on the individual student's capabilities or needs. Students received limited critical analysis, with only the final stereo mix being reviewed instead of the overall DAW session. No written component was required with each lab, so students were not required to reflect on their own mix process or results.

3.2 Revised course designs

Since student mastery of audio mixing techniques was (and is) the ultimate goal of the course, the author chose to redesign the discussions, materials, and assignments following the tenets of Deliberate Practice. Classwork is now structured to be germane to students at widely differing levels of competency with significant individual attention and specific practice objectives recommended for each student, based on their current level of understanding and proficiency. Reinforced by readings and in-class discussions, assignments are designed to be challenging and repeatable, with critical analysis available from the instructor and the student's peers.

Initially, course topics are approached through reading assignments that are supported by open forum discussion. In-class demonstrations provide context for the underlying concepts and explanations of specific technologies and skill sets involved. Exercises are assigned after each discussion so that students practice the core competency of each lab or exercise. Mixing labs each require a written self-analysis of individual thought processes throughout the assignment and a self-assessment of the final results. Critical reviews from the instructor provide guidance and can help expand the student's mental model of mixing techniques, which can then be applied to future projects.

Since a single semester is a limited time to assess and develop each student's mixing capabilities, the course includes twenty assignments due over twenty-six class meetings. As a whole, these are intended to motivate students to establish consistent working habits and serve as the basis to assess student progress and recommend prescriptive practice approaches. Course projects include:

1. Assembling a collection of reference mixes, used to evaluate monitoring systems and serve as references for aspects of the mix process (e.g. spectral balance, use of effects, etc.),
2. Perform a series of ten exercises (*see Table 1, below*) each of which focuses on a foundational mixing competency,
3. Perform mixes of complete songs, allowing students to apply fundamental skills in a larger context,
4. Written analysis papers for each lab project to encourage students' self-reflection on their work processes and results,
5. DAW session preparation and delivery, following the NARAS DAW Guidelines and Recommendations for Delivery of Recorded Music Projects [28],
6. Reviewing their peers' work to develop critical listening and effective communication skills, and
7. Proficiency exams to demonstrate individual competence with recording software and hardware.

The sum total of materials, discussions, and assignments are designed to accelerate the development of accurate individual mental models as well as reinforce and expand their pool of knowledge within this framework.

Ideally, the course will encourage students to adopt a regular, consistent practice schedule, given that occasional practice is largely ineffective [29].

Table 1. List of the course's foundational exercises

- Soundstage
- Equalization for clarity
- Equalization for size/harmonic weight
- Dynamics: compression of individual elements
- Dynamics: buss compression
- Dynamics: expansion/gating
- Serial processing: equalization and dynamics
- Pitch and timing editing
- Time-based effects
- Foundation mixing: kick and bass

4. OBSERVATIONS

4.1 Course history and revisions

Since the spring of 2007, the Mixing Techniques course has been offered fourteen times, with a total of 98 undergraduate students and 42 graduate students enrolled during that time.

The course curriculum was revised incrementally beginning in the fall 2009 semester when the foundational labs were first introduced, first as a ten-part exercise and then as ten separate assignments, providing more time for students to focus on the successful completion of each. Peer reviews were added in the spring of 2011 and the mixing exercises were again revised for the fall 2011 semester, adding the requirement that students reattempt each exercise after receiving critical analysis from the instructor.

For this study, the instructor's critiques of student mixes were available from eight sections of the course. To determine the effect of the Deliberate Practice model on the course's design, the author performed a qualitative review of a select group of available data, researching all of the reviews of a single assignment to determine which comments appeared most often.

One lab assignment ("Believe") was chosen because it used the same audio and session files, had been assigned to every section of the course, and was offered at roughly the same relative date in the course schedule for all sections. The comments that appeared most frequently in each semester's critical reviews were compiled to determine if there were notable differences between sections offered *before* the inclusion of a formal practice regimen and those offered *afterwards*.

4.2 Comparison of Mix Critical Analyses

In the semesters *prior* to the course revision (spring 2009 and earlier), the five most frequent comments involved errors in fundamental mixing techniques. Specifically, students struggled with session signal flow, application of basic signal processing like equalization and dynamics, poor level management (clipping, excessive stereo buss compression) and limited use of automation, resulting in mixes that sounded too static. Disappointingly, these weaknesses appeared despite the fact that the lab under review was an advanced assignment submitted in the last two weeks of the term.

By contrast, the five most frequent reviews in mixes performed *after* the course redesign focused on finer mixing details. In particular, comments centered most often on relative level balances (e.g. cymbals too loud compared to the rest of the kit,) insufficient contrasts between sections of the song, focal mixing techniques (making sure the central focal element of the song is heard clearly at all times) and spectral balance issues (e.g. vocal needs more "air", piano sounds too harsh for this style, etc.)

These results were extremely encouraging. Significant time invested in rigorous, guided practice appeared to have measurably improved students' performance of core mixing skills and allowed them to concentrate on higher-level mix refinements.

Mitigating circumstances may have included improved pedagogical approach in the semesters after the course revisions, since the instructor had more experience presenting the materials and concepts. Individual students also perform differently on average from one semester to the next. However, the results were consistent across multiple semesters, both before and

after the course was revised to include more rigorous practice methodology.

4.3 Course adjustments for *Millennial* students

According to recent studies, students born between 1980 and 1995 are the most educated generation in a century but were the only group surveyed who did not cite "work ethic" as a defining characteristic [30] and often have difficulty accepting criticism [31]. Addressing these concerns directly, the first class meeting includes a discussion of Deliberate Practice techniques and the requirement of consistent practice times every day for the duration of the course. All critical analyses are designed to help students overcome obstacles and move forward to the next level of accomplishment, and reviews are written to offer praise first and then support and criticisms with relevant examples.

Millenials also prefer the speed and access of online communications [32] so all grades and mix analyses are posted at the university's *Desire2Learn* site (D2L), a secure course-management online portal. The site includes all course materials and assignment guidelines, and provides ample opportunities for ongoing dialog.

5. CONCLUSIONS

Looking forward, the author hopes to continue to refine the Mixing Techniques course design by developing quantifiable criteria to gauge student mixes, similar to the precocity index used to measure virtuosity in studies of performing musicians [33].

Ideally, the course will offer exercises that better target and improve specific audio engineering fundamentals. A series of progressive assignments could be developed that correspond more appropriately to the student's level of proficiency throughout their schooling. Systemically, this pedagogical approach could encompass a range of recording courses to reinforce and expand students' mental models of audio recording systems.

For audio engineering programs to succeed, teachers and schools must strive to develop course materials that encourage consistently superior performance from students. Recording arts courses focused on practical subjects like mixing techniques could be taught more like music instrument lessons, with students working with one instructor over a period of months or years to provide consistent guidance and better understanding of the individual student's capabilities and needs.

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7. REFERENCES

[1] Pritts, R. (2007). "A Global Look At Audio Education." Retrieved August 2, 2011 from http://www.aes.org/education/pritts4.cfm

[2] Berklee College of Music. (2011). "MP&E Department History." Retrieved August 14, 2011 from http://mpe.berklee.edu/about/history/

[3] University of Miami. (2011). "MuE: Music + Engineering." Retrieved August 14, 2011 from http://mue.music.miami.edu/

[4] MEIEA. (2011). "MEIEA 2010-11 Member Statistics." Retrieved August 9, 2011 from http://www.meiea.org/docs/Member_Statistics.html

[5] Mix Online. (2001). "2001 Audio Education Directory." Retrieved August 12, 2011 from http://mixonline.com/news/audio_mix_audio_education/

[6] Mix Online. (2006). "2006 Audio Education Directory." Retrieved August 12, 2011 from http://www.mixonline.com/education/directory/

[7] Recording Industry Association of America. (2011). "Music Industry Reports: Annual Music Shipment Data." Retrieved on August 12, 2011 http://www.riaa.com/keystatistics.php?content_selector=research-report-industry-reports

[8] Gullö, J. (2009). "Desktop Music Production and the Millennials: a challenge for educators, researchers, and the audio equipment and music

software industry." Audio Engineering Society Convention Paper 7833.

[9] Tough, D. (2010). "Shaping Audio Engineering Curriculum: An Expert Panel's View of the Future." Audio Engineering Society Convention Paper 8304.

[10] Hill, B. (2006). "Teaching With ProTools? Proceed With Caution! The Development of Mental Models for Recording Engineering Instruction." Retrieved on January 23, 2010 from http://www.meiea.org/Journal/html_ver/Vol06_No01/2006_Vol_6_No_1_A2.htm

[11] Ibid.

[12] Howe, M. (1999). *Genius Explained*. Cambridge University Press.

[13] Ibid. p.4

[14] Colvin, G. (2010). *Talent Is Overrated*. Portfolio, pp.65-82.

[15] Ericsson, K., Prietula, M., and Cokely, E. (2007). "The Making of an Expert." *Harvard Business Review*. Retrieved on July 21 2011 from http://hbr.org/2007/07/the-making-of-an-expert/ar/1

[16] Colvin, G. (2010). *Talent Is Overrated*. Portfolio, p.118.

[17] Rose, Charlie. (2008). "A Conversation With Geoff Colvin." Retrieved on July 20, 2011 from http://www.charlierose.com/view/interview/9856

[18] Colvin, G. (2010). *Talent Is Overrated*. Portfolio.

[19] Ibid.

[20] Gladwell, M. (2011). *Outliers: The Story of Success*. Back Bay Books, pp.35-82.

[21] Colvin, G. (2010). *Talent Is Overrated*. Portfolio, pp. 84-94.

[22] Rose, Charlie. (2008). "A Conversation With Geoff Colvin." Retrieved on July 20, 2011 from http://www.charlierose.com/view/interview/9856

[23] Johnson-Laird, P. (2005). "The History of Mental Models." Retrieved on July 25, 2011 from http://mentalmodels.princeton.edu/papers/2005HistoryMentalModels.pdf

[24] Hill, B. (2006). "Teaching With Pro Tools? Proceed With Caution! The Development of Mental Models for Recording Engineering Instruction." Retrieved on January 23, 2010 from http://www.meiea.org/Journal/html_ver/Vol06_No01/2006_Vol_6_No_1_A2.htm

[25] Colvin, G. (2010). *Talent Is Overrated*. Portfolio.

[26] Hill, B. (2006). "Teaching With Pro Tools? Proceed With Caution! The Development of Mental Models for Recording Engineering Instruction." Retrieved on January 23, 2010 from http://www.meiea.org/Journal/html_ver/Vol06_No01/2006_Vol_6_No_1_A2.htm

[27] Colvin, G. (2010). *Talent Is Overrated*. Portfolio. p.120.

[28] National Academy of Recording Arts and Sciences. (2008). "Technical Guidelines for Producers and Engineers." Retrieved on April 18, 2011 from http://www.grammy.org/recording-academy/producers-and-engineers/guidelines

[29] Howe, M. (1999). *Genius Explained*. Cambridge University Press.

[30] Pew Research Center. (2010). "The *Millennials*: Confident, Connected, Open to Change." Retrieved on August 8, 2011 from http://pewresearch.org/pubs/1501/millennials-new-survey-generational-personality-upbeat-open-new-ideas-technology-bound

[31] Levit, A. and Licina, S. "How The Recessions Shaped Millennial and Hiring Manager Attitudes About Millennials' Future Careers." *Career Advisory Board.* Retrieved August 8, 2011 from http://newsroom.devry.edu/images/20004/Future%20of%20Millennial%20Careers%20Report.pdf

[32] Ibid.

[33] Lehmann, A. and Ericsson, K. A. (1998). "The Historical Development of Domains of Expertise: Performance Standards and Innovations in Music."

Genius and the Mind. Oxford University Press, pp. 67-94.