# Course Syllabus

## ENT3320-E946 — Interactive VR, Music, Sound, and Memory

## I. Contact Information

**Location + Time:** Mondays + Wednesdays 6:00-8:30 PM V103A
**Professor:** Louis Goldford
**Email:** LGoldford@citytech.cuny.edu
**Office Hours:** by appointment
**Office Location:** V203
**Course Website:** https://einbahnstrasse.github.io/Goldford-ENT3320/
**Course Slack:** http://goldford-ent3320.slack.com/

## II. Course Description

In this technical production course, students will collaborate on a team to create an immersive VR environment with interactive sound and music. Our goal will be an expressive VR experience with interactive audio rather than simply a game with fixed sound files.

Emphasis will be on sound and music within VR, and not sound that merely *accompanies* a visual world. We'll consider excerpts from film and periodic readings to better understand the role sound plays in any audio-visual experience. Our soundtracks will become vital components of the virtual experience, and as such we'll be using tools for real-time music generation alongside those that allow us to shape recorded and environmental sounds, etc.

The theme for this semester's project will be MEMORY. Together we'll develop a narrative around how a person's daily activities can be interrupted and shaped by their memories and their dreams. To do this, we'll be embedding a real-time music and sound synthesis program called *RTcmix* inside *Unity*. We'll briefly visit the concepts of spatialization and physical modeling synthesis using the programs *Spat* and *Modalys*.

## III. Course Goals

To create an immersive VR experience with algorithmically-generated audio and music while:

1. Introducing students to the *RTcmix* sound synthesis programming language
2. Refining students' workflow/workspace in MaxMSP, especially as related to the development of polyphonic synthesizers and in composing scheduled sequences of music and audio
3. Adding new libraries for synthesis and spatialization to students' creative "toolkits"
4. Embedding *RTcmix* within *Unity*; to import composed/sculpted sound into a gaming engine
5. Storyboarding and designing a narrative around a central theme

## IV. Learning Outcomes

By the end of the course students will be able to:

- ***Create*** original music and sound sequences using *MaxMSP, RTcmix,* and *Modalys*.

- ***Understand*** the fundamentals of poly~ design in Max.
- ***Implement*** a personal workspace for creating sound using the *bach* Library for Max.
- ***Spatialize*** and ***Localize*** audio sources inside *Unity* using *Spat* and *RTcmix*.
- ***Record, Edit***, and ***Chroma Key*** video clips to be used as assets in *Unity*.
- ***Establish*** a personal creative vision, and communicate it to your team member(s).
- ***Implement*** a shared workspace repository and develop work collectively.
- ***Respect***, and ***Respond*** to the ideas and the critique of peers and team members.

## V. Software + Other Course Resources

*See the SOFTWARE TAB on our Course Website for download and documentation links.*

- MaxMSP
- Unity
- RTcmix (algorithmic sound language with MaxMSP external for synthesis prototyping)
- uRTcmix (Unity package)
- the bach Library for Computer-Assisted Composition in MaxMSP
- Spat
- Modalys
- Apple Logic Pro
- Adobe After Effects
- DSLR camera / green screen for recording video assets in Unity (supplied)
- Slack
- GitHub
- Flash drive & other portable drives or Dropbox/Google Drive account to back up files
- Occasional short readings (supplied as downloadable PDFs or links)

## VI. Expectations

- **Arrive on time** and attend all classes — See Attendance + Participation Policy below.
- Spend at least **1-4 additional hours a week** *(outside of class)* on the timely completion of all class assignments, readings, and your contributions towards our final project *(i.e. developing and revising your sounds, animation and/or video elements, etc.).*
- **Back up and organize your work REGULARLY** on external media and/or your preferred cloud. *Catastrophic loss of materials is no excuse for missed deadlines!* Some tips...
    - Use **GIT** where appropriate — e.g. for your Max patches and other text files, etc.
    - Adopt an **incremental backup** file-naming system of your choice, as appropriate (e.g. *MySound-v856.wav* is more effective than *MySound-FinalVersionThisTimeIPromise.wav*).
- **Bring headphones and an appropriate audio jack** to all classes. You will need these for all work in Max, Unity, etc.
- **Push yourself creatively and technically.** Be ambitious. Work hard. Stay open and curious!
- **Please do not modify desktop settings** and do not leave any files on the desktop.
- No installation of software unless directed by your instructor.
- Listening to or watching any media in class (other than what is assigned) is strictly prohibited.
- **No smartphones or mobile devices**. You may charge them out-of-sight.
- Personal laptops may be used only for related class activities.

- **No food in V103A,** except beverages in a capped/sealed bottle.

## VII. Communication

- Our City Tech email accounts are the official line of communication in this course, but we may also use Slack for group discussion and collaboration, developing ideas, etc.
- **Requests to the instructor for assistance**: send an email. It will be responded to during normal working hours. After hours requests will be answered ASAP on the next weekday.
- **Actively participate** in our class discussions & group critiques. **Thoughtfully contribute to a positive classroom environment,** while supporting and challenging your colleagues' ideas.
- **Check Slack** regularly for group and private messages.
- If you have a question that may be relevant to the group (about assingments, etc.), post in the #general channel on Slack for all to see and comment on.
- Use Slack for easy communications with your classmates as well — you can DM individuals or selected groups.

## VIII. Attendance + Participation Policy

- Your participation will form the bulk of your grade in this class.
- Students are expected to arrive promptly to all class sessions and to participate and engage in our activities, discussions, group project work and individual assignments.
- Follow this **Procedure for Absences:**
    1. Contact a classmate for notes on what you missed (e.g. on Slack).
    2. Check our Course Website for assignments.
    3. After these 2 steps, contact the instructor for any additional questions.
- **Excused absences/lateness must be accompanied by documentation** and/or include advance notice with the instructor where possible. Excused absences/lateness will not impact on your grade. Absences may be excused in cases of: documentation of illness provided by a doctor, religious observance with advance notice, official school-related activity (always with documentation and advanced notice), and on a case-by-case basis for other critical events with similar advance notice, at the discretion of the instructor.
- *A lack of communication with the instructor about any planned absence will therefore be treated as unexcused.* Be in touch early about any such absences.
- **Unexcused absences/lateness result in lowered participation grades**. Prompt 6:00 arrival earns you an immediate 5 points (i.e. full participation) but is subject to your engagement in class. For arrivals after 6:00, the following weighted score system will be adopted:

| | |
|---|---|
| 6:01-6:10 | 4 points |
| 6:10-6:30 | 3 points |
| 6:30-7:00 | 2 points |
| after 7:00 | 1 point |
| absent | 0 points |

- Your engagement in class will be corroborated with points incurred by your arrival time for the complete participation score in each session (out of 5 points total). In other words, to a limited extent points can be *earned back through active engagement and contribution*. So for a 7:00 arrival, for example, positively contributing can still increase your score beyond 1 point.
- **Three (3) unexcused absences** will lower your final course grade by 10% (i.e. one letter grade).
- **Each additional unexcused absence** will further lower it by 5%.
- Quietly and occasionally excuse yourself for restroom breaks or to take an important phone call. Frequent and recurring self-excusals, or those made for any other reason (e.g. to get food from the vending machine) will also result in lowered participation marks.
- We depend on everyone's presence and full participation because our work is collaborative. *Your participation will therefore impact everyone else in the class*.
- **Assignment critiques are mandatory** and cannot be made up. Missing a critique will result in a deduction of one letter grade for the corresponding assignment.

## IX. Academic Integrity Policy

Students and all others who work with information, ideas, texts, images, music, inventions, and other intellectual property owe their audience and sources accuracy and honesty in using, crediting, and citing sources. As a community of intellectual and professional workers, the College recognizes its responsibility for providing instruction in information literacy and academic integrity, offering models of good practice, and responding vigilantly and appropriately to infractions of academic integrity. Accordingly, academic dishonesty is prohibited in The City University of New York and at New York City College of Technology and is punishable by penalties, including failing grades, suspension, and expulsion. The complete text of the College policy on Academic Integrity may be found in the catalog.

***Instructor Note:*** *Code borrowed from another source must be attributed as a comment within the code of your Max patch, Modalys script, RTcmix~ score, Unity project, etc. If you are unsure of whether or not your work may constitute plagiarism, please check with the instructor before submitting. Where applicable and where marked within our course materials, follow the provisions of the Creative Commons Attribution-ShareAlike 4.0 International License.*

## X. General Grading Rubric for Project Work

| Score | Grade | Description |
|---|---|---|
| 90-100% | A | **Outstanding**; pushing the limits of both the student's creativity and the assignment. |
| 80-89% | B | **Thorough**, thoughtful, and creative approach to the assignment. |
| 70-79% | C | **Average**; submitted on time, completed according to minimum requirements. |
| 60-69% | D | **Poor**; does not meet minimum requirements. |
| < 60% | F | **Fail**; not turned in, excessively late, or incomplete assignment. |

*For a detailed list of assignments, points, and deadlines as they evolve and change throughout the semester, see the GRADING TAB on our Course Website.*

## XI. Course Accommodations for Students with Disabilities

In order to receive disability-related academic accommodations students must first be registered with the Student Support Services Program (SSSP). Students who have a documented disability or suspect they may have a disability are invited to set up an appointment with Ms. Linda Buist, the program manager of SSSP (Phone: 718–260–5143, e-mail: lbuist@citytech.cuny.edu). If you have already registered with SSSP, please provide your professor with the course accommodation form and discuss your specific accommodation with him/her/them.

## XII. Inclusivity

### 1. Name + Pronoun Usage

This course consists of group work and discussion. We must therefore strive to create an atmosphere of inclusion and mutual respect: all students will have their chosen gender pronoun(s) and chosen name recognized. If the class roster does not align with your name, gender, and/or pronouns, please inform the instructor.

### 2. Inclusion Statement

*It is my intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that the students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally, or for other students or student groups.*

## XIII. Weekly Schedule

*See the SCHEDULE TAB on our Course Website for updates to the following plan as things materialize over the course of our semester.*

**Week 1: January 27th & 29th**

### Orientations, Introduction to the *bach* Library, and Review of *poly~*

START-OF-SEMESTER BUSINESS

- Personal Info Form DUE NOW!
- Intro. Survey Due by end of Week #1!
- Review Syllabus + course policies.
- Review Detailed Breakdown of Grading.

ICE-BREAKER + DISCUSSION

- Godzilla, Kubrick, and Ligeti: *How Do We Hear this Music?*

VOICE ALLOCATION IN MAX USING THE *BACH* LIBRARY

- PDF of Patches as Screenshots
- Download the Starter Patches Here

- review of a basic & dirty monophonic synthesizer
- a Max *poly*~ template
- the bach.roll editor
- making bach.roll speak to poly~

Week 2: February 3rd & 5th
## Introduction to RTcmix~

### ICE-BREAKER + DISCUSSION

- *What sorts of sounds do you remember?*
- *What sorts of sights do you remember?*
- Brainstorm — e.g. create a word cloud, Venn diagram, etc.!

## Assignment #1: Due Sunday 2/9!

### INTRODUCTION TO *RTCMIX*

- Overview of RTcmix.org
- Scorefile commands + functions vs. *RTcmix* instruments
- the *RTcmix*~ Max external

### SOME BASIC PATCHES + *RTCMIX* SCRIPTS

- the STRUM and WAVETABLE instruments
- Using a for loop to generate a sequence of notes

Week 3: February 10th Only
## Intermediate *RTcmix*~

*No Class Wednesday; City Tech is closed for Lincoln's Birthday.*

### ICE-BREAKER + DISCUSSION

- Listening + Review of Assignment #1 Patches (on Monday 2/10)

### READING: ASSIGNED FOR WED. 2/19

Ritchey, Marianna. "Intel Beethoven: The New Spirit of Classical Music." In *Composing Capital: Classical Music in the Neoliberal Era,* 114-139. Chicago: The University of Chicago Press, 2019.

### SOUND FILE TREATMENTS WITH *RTCMIX*~ (C3)

- What is a "sound treatment"?
- Introduction to the STEREO and MIX Instruments
- the TRANS Pitch-Transposition Instrument
- the MOOGVCF 24dB/octave Resonant Lowpass Filter
- the GVERB Gigaverb-type and FREEVERB Schroeder/Moorer Reverb Models
- the PVOC Phase Vocoder
- AM, i.e. apply amplitude or ring modulation to an input source

Week 4: February 19th Only
## Connecting RTcmix~ to bach

*No Class Monday — City Tech is closed for President's Day.*

### Assignment #2: Due Tuesday 2/25!

ICE-BREAKER + DISCUSSION

- Group discussion of the Ritchey chapter assigned on 2/10
- Intel Beethoven Experience Amazing Ad #1
- Intel Beethoven Experience Amazing Ad #2

MIDI SEQUENCE —> *RTCMIX~*

- bach.roll as a MIDI sequencer / DAW / Event Manager
- *RTcmix~* for Synthesis + Voice Allocation: in place of *poly~*

Week 5: February 24th & 26th
## Sampling and Physical Modeling Synthesis Using *Modalys~*

ICE-BREAKER + DISCUSSION

- Listening + Review of Assignment #2 Patches (on Wednesday 2/26)

### Short Assignment #3: Due Sunday 3/1!

INTRODUCTION TO *MODALYS~*

- *modalys~* for physical modeling synthesis in Max/MSP
- *ModaLisp* for creating + naming batch samples

A LOGIC SAMPLER MADE FROM *MODALYS~*

- Keymap our samples in Logic's EXS24 Sampler
- Compose a sequence in Logic's MIDI piano roll editor

Week 6: March 2nd & 4th
## The *Unity* Environment + Algorithmic Composition

INTRODUCTION TO SOUND IN *UNITY*

- Overview of basic tools for scene creation
- Overview of basic tools for sound manipulation
- Create a basic scene, add a user perspective asset, an Audio File asset, add an 'invisible wall.'
- When the user crosses a threshold, i.e. where the wall has been drawn, trigger the soundfile playback.

SIMPLE ALGORITHMIC COMPOSITION (C4)

- Basic algorithmically-generated musical sequences
    - Scale generation

- Loops
- Random notes from a reservoir (array of notes)
- automated FX — e.g. moving filters
- real-time control over FX

#### CONNECTING YOUR *RTcmix* SCORES TO UNITY : INTRODUCTION TO *uRTcmix*

- uRTcmix Video Tutorials
  - Basic Installation, Setup and Use of uRTcmix
  - Repeating/Re-Triggering Scores with MAXBANG()
  - Reading RTcmix Scores into Unity
  - Reading Soundfiles

- *Scoralizer* for MAC or Windows

### Week 7: March 9th & 11th
## Chaos, Motion, and Density

#### ADVANCED ALGORITHMIC COMPOSITION (C4+)

- More intricate algorithmically-generated musical sequences
  - Simple Quadratic Note Generation
  - Arpeggiator with real-time timbre control
  - Chaotic Attractors
    - Henon Map
    - Lorenz — 2D flow of fluid, uniform depth
    - Logistic Map (a.k.a. Population Growth)
- Introduction to the noise types + colors:
  - NOISE, i.e. white noise
  - PINK
  - BROWN
  - CRACKLE, i.e. chaotic
  - DUST, i.e. random impulses
  - LATOOCARFIAN
  - HENON
  - IINOISE, i.e. IIR filtered noise

#### USING *MAX* AND *RTcmix~* TO PROTOTYPE GENERATIVE MUSIC PROCESSES FOR *UNITY*

- real-time control over density parameters
- modeling real-world motion and noise

#### ADVANCED SYNTHESIS TOOLS IN *RTcmix*

- Physical Modeling (i.e. in *RTcmix*)
  - MBLOWBOTL, i.e. simple Helmholtz resonator
  - MBLOWHOLE, i.e. waveguide clarinet
  - STRUM, i.e. Karplus-Strong (“plucked string”) + distortion + feedback
  - MBANDEDWG, i.e. bars/modal things, struck & bowed
  - MMODALBAR, i.e. modal-bar physical model

    - MSITAR, i.e. sitar model
- Granular synthesis:
    - GRANSYNTH
    - JGRAN, i.e. FM or wavetable granular synthesis
    - SGRANR, i.e. stochastic granular synthesis
    - STGRANR, i.e. decomposing an input soundfile or real-time sound source
- Modulation Synthesis:
    - AMINST, i.e. amplitude modulation
    - FMINST, i.e. frequency modulation
    - MULTIFM, i.e. multi-oscillator FM synthesis instrument
    - WAVESHAPE, i.e. waveshape distortion synthesis
- Additive + Subtractive Frequency-Based Synthesis:
    - MULTIWAVE, i.e. additive synthesis
    - FILTERBANK, i.e. multi-band resonator

Week 8: March 16th & 18th
## 3D Audio Spatialization

### Midterm Assignment #4: Due Sunday 3/22!

SPATIALIZATION IN *SPAT~*

- spat~ for Max/MSP: download is NOW FREE!
- simple binaural spatialization of a single sound source in Max/MSP

SPATIALIZATION IN *RTCMIX~*

- LOCALIZE, i.e. distance-based amplitude panning (DBAP)
- Quick demo of how to do DBAP spatialization inside of Unity.

ICE-BREAKER + DISCUSSION (3/18)

- Brainstorming, Revisited…
- Further consider as a group how these advanced audio tools might be used in conjugation with our theme of “memory,” towards our final project.

Week 9: March 23rd & 25th
## *Unity* Particle Systems, Chroma Keying, and Video Assets

*Midterm grades will be available by 3/26.*

ICE-BREAKER + DISCUSSION

- Listening + Review of Midterm Assignment #4 (on Monday 3/23)

PARTICLE SYSTEMS IN *UNITY*

- Unity Tutorials: Particle Systems
- Unity Documentation: Particle Systems
- Unity Scripting API: Particle Systems

#### CHROMA KEYING + VIDEO ASSETS

- A Walkthrough: Simple Video Shoot —> Keying —> Semi-Transparent Video in *Unity*
- Unity Chroma Key Shader: $8
- Video Tutorial: AR Video with alpha ch.: Premiere CC 2017, Unity3D 2017.3, Vuforia 7
- Vuforia Blog on Alpha/transparent video

### Week 10: March 30th & April 1st
## Storyboarding + Project #5 Prep

*Prof. Goldford will be absent on April 1st; a substitute professor will be present.*

#### ICE-BREAKER + DISCUSSION

- Develop a storyboard for any number of elements + short scenes that our collective project might include.
    - Video Tutorial: How to draw A-grade storyboards (even if you can't draw!)
    - Video Tutorial: Create wireframes and mockups in draw.io
    - Other Ideas for Storyboarding Apps or Utilities?
- Decide on a *"division of labor"* among team members:
    - Who will compose?
    - Develop sounds?
    - Develop characters?
    - Landscapes?
    - Shoot/edit video content?

## Assignment #5: Due Sunday 4/19!

- Create a simple *Unity* scene using recently-acquired synthesis and spatialization tools.
- As a "test" of the basic setup for our final project.
- Note: These will be SHORT sketches in which EACH STUDENT writes a short scene in Unity and attaches their own sounds to it.
- Students may begin to collaborate and consult one another, but this project is still individual. We will work on teams towards our final project.

### Week 11: April 6th Only
## AR in Unity (Time Permitting) + Teamwork Towards Final Project…

*Spring break Wednesday 4/8 — Thursday 4/16. (Skip next week!)*

#### CREATING AUGMENTED REALITY IN *UNITY*

- Creating AR Content With *Vuforia*
- Getting Started with *Vuforia* Engine in *Unity*
- Building an AR app for mobile

**Week 12: April 20th & 22nd**
**Teamwork Towards Final Project...**

**Week 13: April 27th & 29th**
**Teamwork Towards Final Project...**

**Week 14: May 4th & 6th**
**Teamwork Towards Final Project...**

**Week 15: May 11th & 13th**
**Teamwork Towards Final Project...**

- Talkback and Evaluation After Launch?