



# Storytelling in Mixed Reality

Professor Christian Grewell

Spring, 2017 - 14 Weeks, Interactive Media Arts

Weds 09:45 - 12:45 [Session]

Room 900 + 950

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## Course Slack Channel:

<https://mixed-reality-2017.slack.com/signup>

### Course Description:

Stories are an intrinsic part of our societies and culture. Technologically supported mediums of expression, - radio, television and now the Internet have not only enabled the story to spread beyond the campfire but also to help increase access and impact. This course asks the question: What will the world of storytelling look like in 10 years? Is it one devoid of human input and interaction dominated by CG artificial intelligence supported by machine learning, or is it one in which the relative strengths of human and machine coalesce to bring about an even better result?

Students will explore storytelling and communication by combining the ancient art of storytelling with the state-of-the-art medium of mixed reality. Topics include the history of storytelling through mediums and modes and technologies of expression, development and design for mixed reality devices, reality reconstruction techniques, applications of computer vision, volumetric video production, motion capture and spatial audio.

The contents of this course are framed within the context of the Living Stories Through Technology research project at NYU, which investigates the use of augmented reality for storytelling. Students will work in teams to document and produce a final project and/or technical framework designed to teach and inspire others to tell their stories and to add to the Living Stories Through Technology showcase of work in Shanghai, New York and Abu Dhabi.

### Office Hours & Availability:

Room 950 (PCI Live Lab), Tuesdays 9:45 - 12:45 or by appointment

Please feel free to contact the professor by email ([christian@nyu.edu](mailto:christian@nyu.edu)) if you need additional help outside of office hours.

### Learning Assistant Office Hours & Availability:

Sean Kelly

[seangkelly@nyu.edu](mailto:seangkelly@nyu.edu)

Office Hours: Thursdays 3 - 8PM

## Course Objectives:

Students will:

- develop augmented reality experiences (games, apps and interventions) for mobile and head-mounted devices;
- work on applications at the service of research and exploration;
- professionally document their projects for inclusion in a portfolio;
- conceptualize and prototype complex networked systems involving hardware and software at the forefront of today's technology frontier;
- author content that illustrates a multi-disciplinary approach to technology beyond implementation, including implications for the humanities, policy, privacy and economics;

## Learning Outcomes:

Through lectures, readings, media and project work, students will learn:

- how to manage complex software engineering projects involving multiple contributors by using source control and collaboration tools;
- about the history and current state of technology-supported storytelling with a focus on current and potential applications of augmented reality technologies;
- the state-of-the-art in marker-based and markerless augmented reality, including motion tracking, computer vision and depth mapping;
- the importance of creativity-by-combination and how to design complex and powerful augmented reality prototypes;
- how to juggle the requirements of authoring and publishing work to a wide audience across multiple technology platforms;

## Course Structure

The course meets once per week for 3 hours each session. In general, the session is devoted to a brief discussion of the weekly materials (readings, video, audio), followed by a group critique of the homework due that day, a short lecture and ending with hands-on tech tutorials. The professor will also be available during office hours and by appointment to provide support and guidance to students in the development of their projects.

This is an advanced project-based course, where students will develop small prototypes in the first half of the semester (one prototype every week), to then focus on combining elements of each to develop a larger project within the requirements of the Living Stories project.

Students must come prepared to work and remain focused throughout the entire course. They are also required to complete homework for each and every session without exception.

At the end of this course, students will be able to think critically and wholistically about what makes AR unique as a medium of expression. Students will gain a strong understanding of the power of AR as a storytelling medium and future areas of opportunity. Additionally, the course will introduce students a bevy of complementary state-of-the-art technologies, which when combined with each other will let students create new AR applications at the very fringes of the recently possible.

## Course Requirements:

- **Programming Experience:** This course does not require advanced programming experience, but basic experience with 3D graphics and game engines will be very helpful. We will use prototyping techniques such as appropriation of pre-made 3D models in order to streamline the content creation process wherever possible.

- **Technology Requirements:** One of the primary learning outcomes of the course is to teach you how to juggle the requirements of authoring and publishing your work to a wide audience across multiple platforms. This will require you to set up and manage a localized development pipeline on your laptop. Maintenance of your development environment is critical to success in the course.
- **Device Requirements:** We will be publishing applications for mobile devices. It's highly advisable that you have an Android or iOS mobile device. A PC or Mac is also required to complete the majority of the course assignments. The Hololens module will require a PC in order to develop experiences. IMA has 4 PCs available in the IMA quad on the 9th floor that are open to students in the course.

### **Grading Components:**

20% participation ; 30% homework ; 20% documentation ; 30% final project

#### **Homework:**

The first 12 weeks of the course consists of short assignments designed to allow students to become familiar with AR technology and its potential. Each assignment for the prior week is due at the beginning of the next week's session. The assignments are supported by written, step-by-step technology templates and tutorials, designed to both teach students the basics, but to also leave enough room for experimentation and creativity. The homework assignments are graded on the basis of their use of technology and originality. Assignments that are direct copies of the technology templates without modification will receive a zero.

#### **Documentation:**

Students must document each assignment including documentation on the IMA Blog to receive full credit for both their homework as well as the final project. This documentation should be professional in it's quality, which means that students should be sure to document each critical step of their project. Students should be self-critical of their documentation and seek to improve it throughout the course.

#### **Final Project:**

Students will work in small teams to produce a final project that will exist as professional documentation and contribute to advanced research. The development of the final projects needs to take place within the requirements of the Living Stories Through Technology project. This includes working on a short lucidic narrative game or experience that tells a story about NYU Shanghai and its presence in Shanghai. There will be a number of milestones that teams must meet in order to ensure their projects are on-schedule. The last two weeks of the course will be devoted to tuning and finalizing the projects.

Students must document their process carefully both by keeping a detailed development diary and a finished video. The documentation is a large part of the final project grade, so teams should be sure to coordinate early to produce effective documentation of their project. The documentation is a large part of the grade, so be sure and spend ample time documenting. The documentation should have a narrative to go along with the media and lead the viewer through your thought process.

### **Course Resources**

- **IMA Emerging Media Lab:** Students enrolled in the course have priority seating in the IMA emerging media lab. This lab currently contains 4 powerful PCs with the course development environment configured, one mobile development PC, one Microsoft Hololens development kit, 5 Project Tango development kits and a number of android mobile phones.
- **PCI Live Lab:** The PCI Live Lab is a new purpose built workshop for augmented and virtual reality development and production. The lab contains a green screen 3D compositing system, full Optitrack motion capture camera system, Perception Neuron body tracking suit,

HTC Vive and a number of powerful development PCs. This lab will be available for students during the course after appropriate systems training.

## Course Schedule

### **Week 1: Course Introduction, Overview of Augmented Reality**

The session begins with the standard course introduction and syllabus overview, followed by a storytelling exercise and critique. I will hand out and describe the first of many technology templates designed to help bootstrap projects with key technology and software engineering frameworks and course technologies.

#### **Readings + Watch:**

- I. E. Sutherland, "[The Ultimate Display](#)," Proceedings of IFIP Congress, 1965.
- Mark Ferrari, "[8 Bit & '8 Bitish' Graphics-Outside the Box](#)," Terrible Toybox, GDC Vault, 04-Nov-2016. [Online]. Available: <http://www.gdcvault.com/play/1023586/8-Bit-8-Bitish-Graphics>.

#### **Exercise:**

The storytelling exercise doubles as the first IMA documentation blog post. Each student will find something interesting, note its coordinates and nearby features, take 3-5 photos, then return and author a short photo narrative, share and critique with the group.

#### **Tech Template:**

The first tech template will instruct students on how to set up a proper mobile AR development environment and connect to the class source control system.

#### **Homework:**

Set up your dev environment and register for course service providers. I will be free the whole week for those that are struggling (but struggle first!).

### **Week 2: The History of Storytelling**

The first half of the session will be spent going over the homework and testing our apps to ensure they work on as many devices as possible. We will then investigate the history of storytelling with a particular focus on investigating how humans used technology to augment their stories and affect their audience throughout history and the present day.

#### **Read + Watch:**

- J. Lasster, "[Technology and the Evolution of Storytelling](#)," 02-Jun-2015. Medium.com [Online]. Available: <https://medium.com/art-science/technology-and-the-evolution-of-storytelling-d641d4a27116#.fsgbuhbpc>.
- N. K. Sanders, [The Epic of Gilgamesh](#). Assyrian International News Agency, 2017. [Online]. Available: <http://www.aina.org/books/eog/eog.pdf>. **Read Prologue and Chapter 1**
- T. News, "[Facebook built censorship tool for China: Ad Revenue Trumps Human Rights for Zuckerberg](#)." TomoNews Funnies, Youtube, 04-Nov-2016. [Online]. Available: <https://www.youtube.com/watch?v=26eBlqefN2E>.
- U. Libraries, "[Always Jolly, Movable Book by Lothar Meggendorfer for the Baldwin Exhibit](#)." UF Libraries, 02-Sep-2008. [Online]. Available: <https://www.youtube.com/watch?v=yWzrGpp7DGo>.

#### **Tech Template:**

The tech template will introduce [Blippar](#), a software development kit for augmenting print and online media.

**Homework:**

The homework for next session is to use the Blippar SDK to augment a piece of signage or media in or around the NYU Shanghai campus in order to inform and educate. Document your work on the IMA blog, including a screenshot or video of your intervention and include instructions on how to find the exact location of where your sign can be found.

**Week 3: Past, Current and Future State of Augmented Reality Technologies**

The session will begin with a critique of the homework, including a group tour to and critique of each AR intervention site followed by a lecture on the history of AR technologies, including fundamental enablers of past and current generation AR tech and an introduction to live video compositing technologies in preparation for our advanced 3D depth-compositing workshop.

**Read + Watch:**

- R. T. Azuma, "[A Survey of Augmented Reality](http://www.cs.unc.edu/~azuma/ARpresence.pdf)," Presence, vol. 6, no. 4, pp. 1–18, Jul. 1997. [Online]. Available: <http://www.cs.unc.edu/~azuma/ARpresence.pdf>. **Read pages 1 - 18**
- "[First-Hand:Recollections of the development of the FoxTrax hockey puck tracking system](http://ethw.org/First-Hand:Recollections_of_the_development_of_the_FoxTrax_hockey_puck_tracking_system)," Engineering and Technology History Wiki. [Online]. Available: [http://ethw.org/First-Hand:Recollections\\_of\\_the\\_development\\_of\\_the\\_FoxTrax\\_hockey\\_puck\\_tracking\\_system](http://ethw.org/First-Hand:Recollections_of_the_development_of_the_FoxTrax_hockey_puck_tracking_system).
- "[EARLY REPORTS NOTE SOME BUGS IN FOX'S TECHNO-PUCK](http://www.sportsbusinessdaily.com/Daily/Issues/1996/01/17/Leagues-Governing-Bodies/EARLY-REPORTS-NOTE-SOME-BUGS-IN-FOXES-TECHNO-PUCK.aspx)", Sportsbusinessdaily.com, 2017. [Online]. Available: <http://www.sportsbusinessdaily.com/Daily/Issues/1996/01/17/Leagues-Governing-Bodies/EARLY-REPORTS-NOTE-SOME-BUGS-IN-FOXES-TECHNO-PUCK.aspx>.
- "The Making of Football's Yellow First-and-Ten Line," Engineering and Technology History Wiki, 28-Sep-2015. [Online]. Available: [http://ethw.org/The\\_Making\\_of\\_Football%27s\\_Yellow\\_First-and-Ten\\_Line](http://ethw.org/The_Making_of_Football%27s_Yellow_First-and-Ten_Line).

**Play:**

- **Adventure:** <http://www.web-adventures.org/cgi-bin/webfrotz?s=Adventure> (make it through the grate)
- **Unmanned:** <http://unmanned.molleindustria.org/>

**Exercise:**

The session exercise will be to work in small groups to conceptualize and create content for a live AR narrative video with 3D or tracked augmented reality elements, with special attention paid to how we might augment and add interactivity to traditional live broadcast and recorded video.

**Tech Template:**

This week's tech template will introduce video compositing and chroma keying techniques for use in OASIS (950).

**Homework:**

Return to one of the team-member's locations used in HW #2 and imagine how it might be augmented with live action designed to trick the average person into believing an untruth. Each team should come prepared to the next session with (1) a simple sketch or storyboard outlining how the scene should be augmented and the story you'd like to tell (2) background video and photos of the scene taken from a fixed position, noting background lighting conditions and (3) one or more found or created 3D assets that help to augment your live broadcast.

**Week 4: Live Broadcast Augmented Reality**

*Special Location: PCI Live Lab, Room 950*

The session will be devoted to live broadcast augmented reality video production, viewing and recording. Each group will get a maximum of 15 minutes to complete their video. Groups will rotate roles in order to assist with production and editing.

**Read + Watch:**

- "[Four Heads are better than one, \(Un Homme De Tête\).](https://www.youtube.com/watch?v=RzsdqsiJQ6Y&feature=youtu.be)" Four Heads are better than one, (Un Homme De Tête). December 10, 2012. [Online]. Available: <https://www.youtube.com/watch?v=RzsdqsiJQ6Y&feature=youtu.be>.
- E. S. Porter, "[The Great Train Robbery.](https://www.youtube.com/watch?v=Bc7wWOMEGGY&feature=youtu.be)" The Great Train Robbery, 16-Jan-2007. [Online]. Available: <https://www.youtube.com/watch?v=Bc7wWOMEGGY&feature=youtu.be>.
- Mary Poppins. Performed by Julie Andrews. 1964. March 26, 2010. Accessed January 16, 2017. [Online]. Available: <https://youtu.be/zy7XEMeBROQ>.
- ILMVisualFX. "[Behind the Magic: Building a Digital New York for "The Avengers".](https://www.youtube.com/watch?v=p6NNQ3VAb3w)" YouTube. February 19, 2013. [Online]. Available: <https://www.youtube.com/watch?v=p6NNQ3VAb3w>.

**Tech Template:**

The tech template is an introduction to the Unity game engine, including a simple game designed to show you how to access your mobile device's sensors (GPS, magnetometer, gyro and camera) and perform an action based on some criteria.

**Homework:**

Document your team's live broadcast augmented reality video IMA blog, including uploading a video. Design a game to be played in a specific location in Shanghai. Follow the steps in the tech template and publish it for your device.

**Week 5: Modern Augmented Reality Development**

We'll begin with a short playthrough and critique of each game, followed by an overview of modern, mobile AR technologies and their current and potential applications. This lecture will introduce the key concepts and technologies that enable all of the mobile and HMD AR technologies that we will employ in the remainder of course. The exercise will be an introduction to novel reality-capture methodologies, including panoramic scene capture and photogrammetry.

**Read + Watch:**

- Mann, Steve. "[Steve Mann: My "Augmediated" Life.](http://spectrum.ieee.org/geek-life/profiles/steve-mann-my-augmediated-life)" IEEE Spectrum: Technology, Engineering, and Science News. March 01, 2013. [Online]. Available: <http://spectrum.ieee.org/geek-life/profiles/steve-mann-my-augmediated-life>.
- Abrash, Michael. "[Why You Won't See Hard VR Anytime Soon.](http://blogs.valvesoftware.com/abrash/why-you-wont-see-hard-ar-anytime-soon/)" Valve. [Online]. Available: <http://blogs.valvesoftware.com/abrash/why-you-wont-see-hard-ar-anytime-soon/>.
- Kenneth Brown, Andrew Hamilton, "[Photogrammetry and 'Star Wars Battlefront.'](http://www.gdcvault.com/play/1023272/Photogrammetry-and-Star-Wars-Battlefront)" DICE, GDC Vault, 04-Nov-2016. [Online]. Available: <http://www.gdcvault.com/play/1023272/Photogrammetry-and-Star-Wars-Battlefront>.

**Exercise:**

I will introduce reality reconstruction techniques, including a short tutorial on photogrammetry technologies and how to use the resulting assets in your AR projects.

**Tech Template:**

The tech template as an introduction to photogrammetry techniques and a sample asset creation pipeline and how to use these in your project.

**Homework:**

Homework is to return to one your narrative's locations and create one captured reality asset, then modify your mobile game to add these objects and have them respond to the player's mobile device sensors.

### **Week 6: Location-Based Mobile Gaming**

Begin with a critique of the homework and an introduction to location-based and AR gaming, including Pokemon Go, Ingress and others, paying special attention to the privacy implications of location-based gaming and augmented reality.

#### **Read:**

- Prüfer, T. and Mondial, S. "[When Google Plays Games in a Concentration Camp.](http://www.zeit.de/zeit-magazin/leben/2015-07/ingress-smartphone-game-google-anti-labs-nazis-concentration-camp)" 2015. ZEITmagazin. [Online]. Available: <http://www.zeit.de/zeit-magazin/leben/2015-07/ingress-smartphone-game-google-anti-labs-nazis-concentration-camp>
- Hulsey, N. and J. Reeves. [The Gift that Keeps on Giving: Google, Ingress, and the Gift of Surveillance.](http://ojs.library.queensu.ca/index.php/surveillance-and-society/article/view/gift) (2014). Surveillance & Society, 12(3), 389-400. [Online]. Available: <http://ojs.library.queensu.ca/index.php/surveillance-and-society/article/view/gift>
- Romano, Aja. "[Pokémon Go Might Kill You. Here's How.](http://www.vox.com/2016/7/14/12167088/pokemon-go-societal-breakdown-chaos-explained)" 3 July 2016. vox.com. [Online]. Available: <http://www.vox.com/2016/7/14/12167088/pokemon-go-societal-breakdown-chaos-explained>

#### **Exercise:**

Download, install and join the class Ingress team, then leave campus to attack and take over a nearby location.

#### **Tech Template:**

This week's tech template is a game design document framework, intended to help you better prepare for managing complex team-based design and software tasks.

#### **Homework:**

[Teamwork] Draft a design document for a location-based augmented-reality narrative game and a 2.4 minute pecha kucha style presentation for presentation to your peers in the next session. This is the first of many iterations on your final project.

### **Week 7: Marker-Based Augmented Reality**

Begin with team pecha kucha presentations and review and critique of the design documents, followed by an introduction to computer vision and fiducial-marker tracking technologies and implementations.

#### **Read:**

- Owen, Charles. "[What is the best Fiducial?](http://debian.cse.msu.edu/CSE/pub/multimedia/charles-owen-art02.pdf)" Media and Entertainment Technologies Lab. Michigan State University. [Online]. Available: [debian.cse.msu.edu/CSE/pub/multimedia/charles-owen-art02.pdf](http://debian.cse.msu.edu/CSE/pub/multimedia/charles-owen-art02.pdf).

#### **Exercise:**

We will develop and play a simple card game in Augmented reality using the Vuforia SDK, Unity and creative-commons 3D assets.

#### **Tech Template:**

The tech template is a simple Unity and Vuforia project that can act as a scaffolding for you to build various marker-based augmented reality experiences for mobile.

#### **Homework:**

Use the Vuforia SDK and Unity sample project to develop a more-advanced AR version of the original narrative you presented in the second class, adding interactivity and additional augmentation through object or marker recognition (you may create for placement around the scene). Document your work on the IMA blog, with extra attention to how you describe both the progress of your technical skills, but also your understanding of the current gap between what you imagine, and what you feel is possible.

### **Week 8: Markerless Tracking and SLAM**

We begin by playtesting each of our AR narratives, followed by a critique. Next, we will be introduced to augmented reality devices that use computer vision, rather than fiducial markers to understand their position relative to the world around them. We will be introduced to the Tango Tablet Development Kit and HoloLens, both have wide-angle camera and depth sensing cameras, accurate sensor timestamping, and a software stack that enables us to make markerless augmented reality experiences. We will cover fundamental concepts in computer vision, as well as motion tracking, area learning and depth sensing.

#### **Read:**

- Smith, Randall C., and Peter Cheeseman. "[On the Representation and Estimation of Spatial Uncertainty](#)." *The International Journal of Robotics Research* 5, no. 4 (1986): 56-68. [Online]. Available: <https://pdfs.semanticscholar.org/df26/f9822785b07e787d43429ee5fdd2794ac7f8.pdf> **Read Abstract and Parts 1 - 2**

#### **Tech Template:**

This session's tech template will teach you how to develop a simple game in Unity that takes advantage of the HoloLens and Tango's hardware.

#### **Homework:**

Use the Unity sample project to make an experience that acts as a window into another dimension, such that when the player is present in a particular space in the NYU Shanghai campus, he or she is able to use their movement to explore the virtual scene.

### **Week 9: Motion Capture**

*Special Location: PCI Live Lab, Room 950*

This session introduces part 1 of advanced systems for mixed reality multi-user design. We will begin with an introduction to high-end motion capture, and discuss AR use cases and applications.

#### **Watch:**

- Official Avatar, "[Avatar Featurette: Performance Capture](#)," Avatar Featurette: Performance Capture, 19-Jan-2010. [Online]. Available: <https://youtu.be/OJ1JzYPjci0>
- Method Studios, "[OFFICIAL 2016 AICP Sponsor Reel Director's Cut by Method Studios](#)," OFFICIAL 2016 AICP Sponsor Reel Director's Cut by Method Studios, 10-Jun-2016. [Online]. Available: [https://www.youtube.com/watch?v=fd\\_9qwpzVBQ](https://www.youtube.com/watch?v=fd_9qwpzVBQ)

#### **Exercise**

In the class exercise, we will be creating an asset in Unity to represent a real-world rigid body and learning how to configure and network our tracking system to track the object in real time.

#### **Tech Template:**

The tech template will be a framework for easily assigning an asset in Unity to a motion tracked real-world rigid object.

#### **Homework:**

Revisit the 2D video compositing narrative, and design a motion-tracked interactive element to be composited into your narrative in real time.

### **Week 10: Advanced Augmented Reality Compositing**

*Special Location: PCI Live Lab, Room 950*

We will begin by producing, recording and editing our 3D composited, motion-tracked augmented reality videos. Next we will discuss applications of augmented reality as an assistive technology for the blind. The class exercise will be to design an augmented reality interface to help the blind better understand new surroundings.



**Tech Template:**

This week's tech template is an overview of MAX MSP and how to create spatially accurate 3D soundscapes using advanced signal-processing and head-related transfer functions. This template will help students begin to think about sound as an important contributor to immersion in augmented reality experiences.

**Homework:**

Homework is an audio sketch of your narrative, including identifying appropriate sound assets and documenting their location and properties on the IMA blog and using the EML computers to author a 3D soundscape.

**Week 11: Spatial Audio**

*Special Location: PCI Live Lab, Room 950*

We will begin with a playthrough and critique of the homework, followed by a lecture on 3D sound concepts, including design and their importance in adding immersion and impact to narratives.

**Listen + Read:**

- Lovely Virus. "[Virtual Barbershop](https://www.youtube.com/watch?v=IUdTIvqjJA)," May 05, 2007. [Online]. Available: <https://www.youtube.com/watch?v=IUdTIvqjJA>.
- The Verge. "[New York City in 3D audio](#)", February 12, 2015 [Online].
- Jcmajor2012. "[Virtual Dentist Binaural Recording](https://www.youtube.com/watch?v=NncADNIFHXQ)," May 02, 2012. [Online]. Available: <https://www.youtube.com/watch?v=NncADNIFHXQ>.
- Saxe, Godfrey. "[The poems of John Godfrey Saxe/The Blind Men and the Elephant](#)." The poems of John Godfrey Saxe/The Blind Men and the Elephant - Wikisource, the free online library. [Online]. Available: [https://en.wikisource.org/wiki/The\\_poems\\_of\\_John\\_Godfrey\\_Saxe/The\\_Blind\\_Men\\_and\\_the\\_Elephant](https://en.wikisource.org/wiki/The_poems_of_John_Godfrey_Saxe/The_Blind_Men_and_the_Elephant).

**Exercise:**

The class exercise will challenge each student to design a soundscape to augment their AR narrative. Including recording our own room impulse responses in order to recreate the sound profiles of individual spaces. We will introduce key audio pipelines, software and online resources for 3D sound design.

**Tech Template:**

The tech template will be a Unity project which makes use of spatial audio and fiducial markers in order to provide accurate 3D sound cues.

**Homework:**

Build upon the tech template to design an augmented reality spatial sound interface to augment and assist the blind.

**Week 12: Augmented Reality for the Blind**

*Special Location: PCI Live Lab, Room 950*

We will begin with a blindfolded playtesting and homework critique, followed by hands on demos and workshop combining the motion-capture system, Unity and audio spatialization in order to create a motion-tracked 3D soundscape.

**Read + Watch:**

- Grewell, Christian. "[Wavefront - Spatialization Mix Test](#)," July 7, 2016. [Online]. Available: <https://www.youtube.com/watch?v=0I17-xugGlk>
- Gougoux, Frédéric, Franco Lepore, Maryse Lassonde, Patrice Voss, Robert J. Zatorre, and Pascal, Belin. "[Neuropsychology: Pitch discrimination in the early blind](#)." Nature 430, no. 6997 (2004): 309. [Online]. Available: <http://www.nature.com/articles/430309a.epdf>

**Exercise:**

Hands on demos and workshop combining the motion-capture system, Unity and audio spatialization in order to create a motion-tracked 3D soundscape.

**Homework:**

Prepare your final project draft, asset list and level-of-effort matrix for critique during the next session.

**Week 13 - 14: Final Project Workshops**

The final two sessions are devoted to working with the professor and your team preparing your final project.

**Policies**

**Absences:**

One unexcused absence is permitted. Any unexcused absence after that will count as half a letter grade off your **final grade** (A to A-, A-to B+, etc.). 3 unexcused absences will result in failure of the course. If you miss a session it is your responsibility to find out what happened that day in class (i.e. Obtain hand-outs distributed assignments, etc.)

**Classroom Conduct:**

**Lateness:**

To fully benefit from this course, it is important that you come to class on time. More than two times of being late will count as 1 absence. If you come late it is your responsibility to come see me after class make sure you are marked present.

**IMA Equipment**

This course may require the use of equipment from the IMA Equipment Room or Emerging Media Lab. Policies and procedures for checking out, caring for, and returning equipment will be discussed during IMA Orientation as well as in class.

Keeping IMA equipment past due dates, abusing the equipment or failing to adhere to the policies of the IMA Lab will affect your grade in this course.

**Academic Integrity**

The presentation of another person's words, ideas, judgment, images or data as though they were your own, whether intentionally or unintentionally, constitutes an act of plagiarism.

Students must retain an electronic copy of their work until final grades are posted on Albert. They must be prepared to supply an electronic copy if requested to do so by NYU Shanghai. Not submitting a copy of their work upon request will result in automatic failure in the assignment and possible failure in the class.