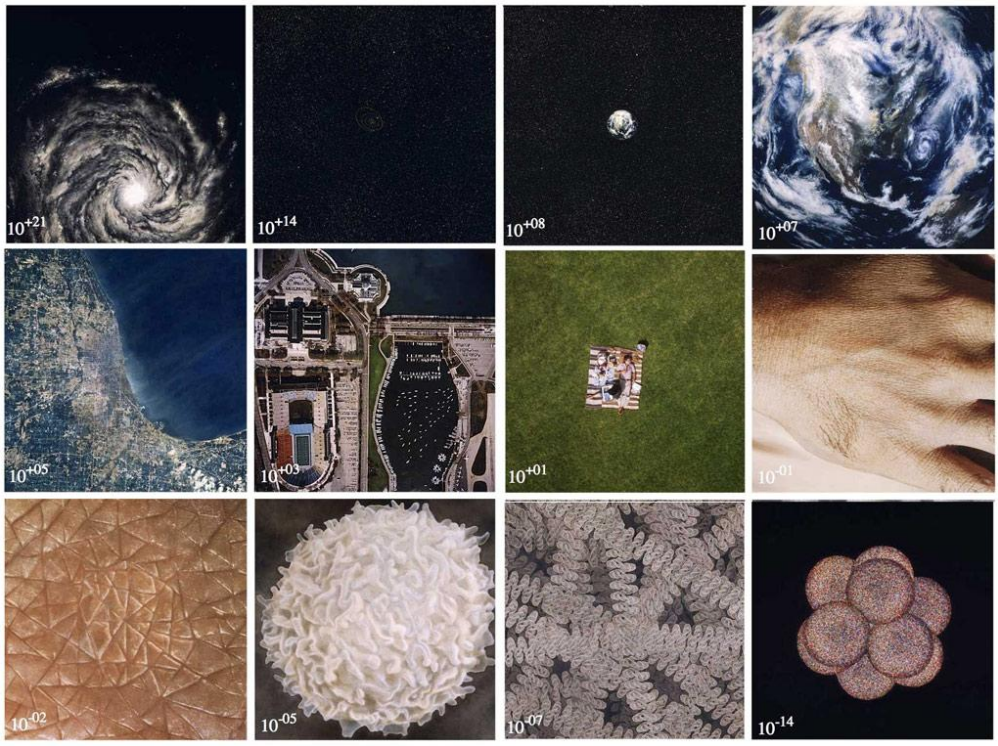
4.110: Design Across Scales

MIT Spring 2023



Film stills from *The Powers of Ten* by Charles and Ray Eames (1968)

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TAs	Alejandro Medina jamedina@mit.edu Mariana Medrano marmedr@mit.edu Ellen Marie Reinhard rellen@mit.edu Katie Rotman krotman@mit.edu

Credits	2-2-8 (UG)
Lectures	Mondays, 10 AM- 12 PM. E14-633 (with the exception of April 3 & May 1, in 7-429)
Lab Sessions	Wednesdays, 7 - 9 PM. 9-451

Syllabus

COURSE DESCRIPTION

Design Across Scales exposes salient, contemporary design challenges and gives design tools to approach them. Its scalar structure emphasizes that design today thrives on s opportunities from the molecular to the planetary.

The class is built around the contributions of guest speakers from across the design disciplines—from architecture, to the design of materials and computational systems, to the design of cities and landscapes. Taking a cue from the 1977 Eames Office film *Powers of Ten: A Film Dealing with the Relative Size of Things in the Universe and the Effect of Adding Another Zero*,[1] the speakers are (roughly) ordered and situated in scale from that of the human body to the largest and smallest scales at which design operates. With their contributions, we will approach some of the key questions design disciplines need to address today.

Our session's movement between disciplines and scales will introduce us to the multiple areas shaped by contemporary design practices, and will help us make connections between them. Today, design doesn't only concern the creation of isolated objects, but the consideration of the different systems and externalities associated with them. To do so, we designers need to think, more than ever, across disciplines and scales. We need to situate our design intentions within broader social and environmental concerns. We need to consider how design addresses different publics and cultures, different economies and ecologies. The course's full commitment to cross-disciplinary practice aspires to build a shared design culture across MIT—from engineering, to architecture to planning; from science, to computing, to the arts—capable of responding to design's evolving responsibilities.

With that goal, you will engage with the class in two ways;

- Dialoguing with our speakers. This requires: 1) finding engaging information about the speakers and the scale of design they are engaged in; 2) reading background materials and discussing them with your peers and class TAs; and 3) introducing the speakers, and then conversing with them.
- Participating in a series of design explorations. These consist in a series of weekly assignments staged throughout the semester, intimately related to our class topics. These assignments will allow you to work through different scales and media.

Our team of Teaching Assistants will support both activities during Wednesday's lab sessions. The TAs will help you prepare the conversations with our speakers, provide feedback on your design explorations, and instruction on the techniques and resources you may need.

Design is a highly interactive and iterative endeavor. Conversation, feedback, and critique are the media where design grows and improves. Our combination of talks and design explorations aims to produce a space of open conversation for the interchange of design ideas; one where we learn about design constantly and through different means.

[1] The film was based on a 1968 black and white prototype, *A Rough Sketch for a Proposed Film Dealing with the Powers of Ten and the Relative Size of Things in the Universe*, reportedly inspired by the book *Cosmic View* (1957) by Dutch educator Kees Boeke.

WEEKLY CLASS STRUCTURE

The class meets for two hours each session, twice per week.

Monday, main meeting
10 AM- 12 PM. E14-633 (with the exception of April 3 & May 1, in 7-429)

Time	Activity
10:00 am	Welcome to students - Each TA shares (x4) one example of student work-in-progress or finished work from the previous week's design exploration. - Instructors introduce privately the guests and their relation to the class.
10:30	Public portion of class begins.
	Public Introduction of the guest lecturers, by a leading student group.
10:40	Lecture by guest 30-45 minutes
10:20	Questions/Discussion 30-40 minutes
12:00 pm	Class concludes

Wednesday, lab meeting
7 - 9 PM. E14 - 648 (TBC)

Time	Activity
7:00 pm	Working session, review or class discussion of design exploration assignments with TAs. Depending on the nature of the assignments, students may work individually or in teams.
8:00	Preparation for the following week's guest speaker student introduction. This includes discussion of the readings and background information on the speaker to shape the introduction.
8:40	Introduction of the following week's design exploration assignment by TAs
9:00	Lab concludes

CLASS EXPECTATIONS

Students are required to fulfill the following requirements for participation and grading.

Participation

Design is a social art, and so it is essential that it be taught and studied in groups, and substantially in person. Therefore, attendance will be taken by yourTA during the lectures and lab sessions. It is your responsibility to ensure your TA sees you during lecture; attendance may be taken at any time during the class period. If you have a documentable conflict, you can get credit for the session through a makeup arrangement ahead of time with your TA. Except for true emergencies (supported with documentation from a dean or doctor), no makeups will be given after the class in question.

We recognize, however, that life can involve the unexpected. You can miss one session in the semester (either section or lecture) without notice, and with no negative consequences for your grade. Further unexcused absences, however, will lower your final grade for the class by one grade (eg, Ato A-, B- to C+).

A final note relates to the class' no-screen request. This is hard for all of us in a connected age! But it substantially improves the focus and quality of our discussions, and the work that results from them. If you find yourself truly needing to respond to a call or other phone-related emergency, please feel free to do so but leave the classroom quietly.

Presentation of guests and discussion

We want to have vibrant conversations with our very interesting guests. This implies that you know a little about their work in advance, and also that you start thinking about the topic of their lecture. We have devised two systems that will allow you to achieve both goals.

First, you need to investigate who our guests are, what they do, what interests them, and then share that information with your class peers and TAs during the lab sessions. To do this well, you should go beyond the conventional information you may get from a wikipedia page. Look for other sources: interviews, articles about them, social media and find a relevant clue to engage with their work. Every week, a selected team of students will be in charge of presenting the guest lecturers and adopting a leading position in the talk.

Second, you need to read about the topics we will cover in the class. Our reading list is short—just two readings per week—and we expect you to read both in depth. During the lab sessions you will discuss these readings with your peers and TAs, connecting them to your findings about the guest and to your own interests.

Every week you will present the guest(s) and lead the class discussion with a team of classmates. Together, the team will create a comprehensive outline, including a minimum of 10 questions for class discussion. The point of this format is to allow you to make connections between your own individual experiences and disciplines, and the material that we are working with as a class. You might be studying something in another subject, for example, which you can relate to something covered in the reading. Or perhaps you have observed something in your own environment, present or past, which might illustrate (or contradict) a point presented by the author. All of this is fair game. You will produce one comprehensive outline per group, to be submitted to your TA by 12:00 midnight of the Sunday prior to your discussion. The students who are not participating in the leading team should equally prepare at least one question per lecture.

Design Explorations

Every week you will work, either individually or in collaboration, in a design exploration related to the scale and topic we are considering in the class. The design explorations are your opportunity to start testing design ideas and methodologies, and to dialogue with your peers, TAs and instructors about your key interests. We will provide materials and specific instructions aimed at helping you structure the work, as well as guidance and feedback about your production. Although these explorations vary from week to week, they also build upon each other in a cumulative way. Our intention is that, by the end of the term, you will have been able to clearly locate which are your design interests, and to understand which are the main media that allow you to work on them.

To the extent that the neurology of design and creativity are understood, there is a direct analogy between the neurology of play, creativity, and ultimately design, that involves both active/sensing parts of the brain and the ability to literally or cognitively 'repurpose' existing or previously experienced objects and situations to fit a novel or urgent situation.[2] Taking a cue from one of the earliest designed systems for integrating education in form and color, learning and creativity, the so-called "Spielgabe" or "play-gifts" developed by educator Friedreich Froebel for his first Kindergarten starting from 1837, the goal of each assignment cycle will be to re-organize / re-use or interpret the result of a 'gift' – an object handed to the student or student group – to re-structure or re-arrange another object or situation.

Following the scalar sequence of the class, the assignments will start at the scale of the body. In the second week of classes we will give you your primary gift: a lab coat that you will then manipulate, testing its relation to, and value for, the many scales we will address in the class.

Course Tools

In this course, we will introduce you to two important tools that will support your design process and facilitate the presentation and archiving of your work. Our intention is that you will acquire the habit of documenting the entire process of designing, while incorporating reflection into your practice. Thus, we will encourage you to write about what worked, what did not, what was difficult, the roadblocks you hit, questions you encountered, and what surprised you in each exercise.

<u>The Design Journal:</u>
Through the Design Journal, you will share the lab work with the DAS TAs and fellow classmates. The Journal will act as a digital notebook, where you can gather and curate sketches and inspiration, documentation, and written reflections on the weekly tests. The Journal will be reviewed weekly by the TAs and presented in class as part of both the midterm and final project for this course. The format of the Design Journal is google slides.

[2] See Chrysikou, Evangelia G., and Sharon L. Thompson-Schill. "Dissociable Brain States Linked to Common and Creative Object Use." *Human Brain Mapping* 32, no. 4 (June 9, 2010): 665–75. https://doi.org/10.1002/hbm.21056.

The Sketchbook:
The physical sketchbook will function in tandem with the digital Design Journal. This class celebrates the relationship between analog and digital. Each student will receive a physical sketchbook to use for homework exercises, recording early ideas, sketches, and developing your work. You will need to upload key sections from the sketchbook to the online Design Journal for review before each Wednesday lab.

Failure to bring your digital slides, sketchbook and materials to the lab will have the same requirements and consequences as absence of your own body; that is to say, you will get one free pass per semester, but otherwise failure to bring these to the section will result in a deduction from your final grade.

Required Office Hours (with the instructors)

In addition to the lab sessions and work with the TAs, students are required to meet at least twice during the term with each of the instructors. The instructors will be also available for additional office hours directly requested by the class students.

GRADING AND ACADEMIC OBJECTIVES

Grading

25%—Preparation of conversation with the speakers. Consisting in: 1) Research about their work and design interests; 2) Discussion of readings during the lab sessions - the readings will give you a conceptual framework to address the guest's talk; and 3) Elaboration of questions for speakers.
25% — Active participation in class sessions.
50%—Design explorations. Consisting in: 1) Elaboration of weekly design tests, sketching in the journal and translation to the slides (20%); 2) Conversation with your assigned TA to get feedback in advance to the class; (15%); and 3)Presentation of work in the midterm and final review (15%).

Grading definition

A. Exceptionally good performance demonstrating a superior understanding of the subject matter, a foundation of extensive knowledge, and a skillful use of concepts and/or materials.

B. Good performance demonstrating capacity to use the appropriate concepts, a good understanding of the subject matter, and an ability to handle the problems and materials encountered in the subject.

C. Adequate performance demonstrating an adequate understanding of the subject matter, an ability to handle relatively simple problems, and adequate preparation for moving on to more advanced work in the field.

D. Minimally acceptable performance demonstrating at least partial familiarity with the subject matter and some capacity to deal with relatively simple problems, but also demonstrating deficiencies serious enough to make it inadvisable to proceed further in the field without additional work.

F. Failed. This grade also signifies that the student must repeat the subject to receive credit.
NE. No record will appear on the external transcript.

Student Performance Criteria. NAAB

Realm A: Critical Thinking and Representation

• A1. Communication Skills: Ability to read, write, speak and listen effectively• A2. Design Thinking Skills: Ability to raise clear and precise questions, use abstract ideas to interpret information, consider diverse points of view, reach well-reasoned conclusions, and test alternative outcomes against relevant criteria and standards.• A3. Visual Communication Skills: Ability to use appropriate representational media, such as traditional graphic and digital technology skills, to convey essential formal elements at each stage of the programming and design process.• A5. Investigative Skills: Ability to gather, assess, record, apply, and comparatively evaluate relevant information within architectural coursework and design processes.

CLASS LECTURE SCHEDULE AND READINGS

WEEK 01
Monday February 6. Class Introduction.

In-class film

Eames, Charles and Ray. *Powers of Ten: A Film Dealing with the Relative Size of Things in the Universe and the Effect of Adding Another Zero*, 1977.

Background readings and materials

Colomina, Beatriz. "Enclosed by Images: The Eameses' Multimedia Architecture," *Grey Room* 02 (2001): 6-29.

Eames, Charles and Ray Eames. "Powers of Ten." Eames Office LLC, 1977.

Morrison, Philip and Phylis Morrison. *Powers of Ten: About*

the Relative Size of Things in the Universe and the Effect of Adding Another Zero (Redding, CO: Scientific American Library, 1982).

Museum of Modern Art. "Design and the Elastic Mind." Museum of Modern Art.

Ruparell, Rajeev. "Powers of Ten—A Rough Sketch (1968)." March 6, 2012. Originally released 1968 by Charles and Ray Eames. https://www.youtube.com/watch?v=7f5x_dRKIF4

WEEK 02
Monday February 13. Design for All Bodies.
Guest: Sara Hendren

Design researcher, artist writer, and professor at Olin College of Engineering.

Readings

Aldersey-Williams, Hugh, Peter Hall, et al. *Design and the Elastic Mind*. Edited by Paola Antonelli (New York: Museum of Modern Art, 2008): 14-27.

Waldman, Katy. "When the World Isn't Designed for Our Bodies." *The New Yorker*, 3 Sept. 2020, https://www.newyorker.com/books/page-turner/when-the-world-isnt-designed-for-our-bodies

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WEEK 03
Tuesday February 21. Design for Structural Forces.
Guest: Caitlin Mueller

Structural designer, Associate Professor of Civil and Environmental Engineering, Associate Professor of Architecture at MIT, and director of the Digital Structures Lab.

Readings

Songel, J. M. "*SUSTAINABILITY LESSONS FROM VERNACULAR ARCHITECTURE IN FREI OTTO'S WORK: TENTS AND GRIDSHELLS*." International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XLIV–M–1–2020. Gottingen: Copernicus GmbH, 2020. Pgs. 233–240.

Leslie, Thomas W. "*Energetic Geometries: The Dymaxion Map and the Skin/Structure Fusion of Buckminster Fuller's Geodesics*"(London: Arq, 2001), 161–170.

Recommended lecture outside class:

Tuesday February 21. Fernanda Viegas and Martin Wattenberg. *AI and Data-visualization*. Offered in collaboration with the Morningside Academy for Design and the Human-Computer Interaction Group. At the Stata Center Star Conference Room. 32-D463.

WEEK 04
Monday February 27. Design for Public Space and Cities.
Guest: Kim Yao

Architect. Principal of Architecture Research Office, and Adjunct Assistant Professor of Architecture at Columbia University Graduate School of Architecture, Planning and Preservation.

Readings

Latour, Bruno, "From Realpolitik to Dingpolitik or How to Make Things Public," in Latour, Bruno and Peter Weibel, ed. *Making Things Public : Atmospheres of Democracy* (Cambridge, MA: MIT Press, 2005): 2-34.

Hauderowicz, Dominique and Kristian Ly Serena, *Age-Inclusive Public Space* (Berlin: Hatje Cant, 2020), excerpts.

Recommended lecture outside class:

Friday March 3, 5 pm. Doris Tunstull. *Decolonizing Design.* Offered in collaboration with MIT Press, the School of Architecture and Planning and the MIT Morningside Academy for Design. At the School of Architecture and Planning Long Lounge. Room 7-429.

WEEK 05
Monday March 6. Design for the Planet.
Guest: Hashim Sarkis

Architect. Principal of Hashim Sarkis Studios, and Dean, MIT School of Architecture and Planning.

Readings

Tresch, John, "Around the Pluriverse in Eight Objects. Cosmograms for the Critical Zone," in Latour, Bruno, and Peter Weibel, ed. *Critical Zones : the Science and Politics of Landing on Earth* (Karlsruhe, Germany: ZKM/Center for Art and Media, 2020).

Escobar, Arturo, "Out of the Studio and into the Flow of Socio Natural Life," in *Designs for the Pluriverse: Radical Interdependence, Autonomy, and the Making of Worlds* (Durham: Duke University Press, 2018), 25-49.

WEEK 06
Monday March 13. Design for Space.
Guest: Dava Newman and Danielle Wood

Dava Newman. Director of the MIT Media Lab and Apollo Program Professor of Astronautics. Former NASA Deputy Administrator and thus, designer of space missions.

Danielle Wood. Assistant Professor in the MIT Program in Media Arts & Sciences and in the MIT Department of Aeronautics & Astronautics. Director of the Space Enabled Research Group.

Readings

De Monchaux, Nicholas, " *Spacesuit : Fashioning Apollo"* (Cambridge, Mass: MIT Press, 2011), excerpts.

Grush, Loren, "Why it took so long for NASA to do the first all-female spacewalk," in *The Verge* (2019, October 21). https://www.theverge.com/2019/10/21/20920790/nasa-first-all-female-spacewalk-christina-koch-jessica-meir-spacesuit-design-bias

Videos

Adam Savage Tested. (2023, Jan 26). *The Original Spacesuits from Horizon* [Video]. Youtube. https://www.youtube.com/watch?v=YpCvViXtKHg

TED Archive. (2018). *How to create a spacesuit, Dava Newman* [Video]. Youtube. https://www.youtube.com/watch?v=lZvP_URAjmM

WEEK 07
Monday March 20. Design for World-Building.
Guest: Adam Savage TBC

Special effects designer and TV host.

Readings

Dunne, Anthony, and Fiona Raby, *"Speculative Everything: Design, Fiction, and Social Dreaming"*(Cambridge, Massachusetts: The MIT Press, 2013,)excerpts.

Jameson, Fredric, "Varieties of the Utopian," *Archaeologies of the Future: The Desire Called Utopia and Other Science Fictions,* (London Verso, 2005), 1-9.

Videos

Discovery. (2017). *"Can Gummy Bears Be Used as Rocket Fuel?"* [Video]. Youtube. https://www.youtube.com/watch?v=fXf9-2JM7lM
->See Mythbusters Youtube Channel for more experiments

Monday March 27.
Spring Break. No class.

WEEK 08
Monday April 3. Design for Processes.
Guest: Skylar Tibbits

Designer and computer scientist. Associate Professor of Design Research in the MIT Department of Architecture, and founding director of the Self Assembly Lab.

Readings

Dade-Robertson, Martyn. "Chapter 2: The Designs of the Natural" from *Living Construction* (Abingdon, Oxon ; New York: Routledge, 2020), 12-28.

Ingold, Tim. "Chapter 2: The Materials of Life" from *Making: Anthropology, Archaeology, Art and Architecture* (London; New York: Routledge, 2013), 17-31.

WEEK 09
Monday April 10.
Midterm Review

Recommended lecture outside class

Monday April 10, 6 pm. Jae Rhim Lee. *Human Centered Design, Death, and Psychedelics.* Offered in collaboration with ACT and the Morningside Academy for Design. At the ACT Cube. Room E15-001.

Monday April 17.
Holiday for Patriot's Day. No class.

WEEK 10
Monday April 24. Design for Society.
Guest: Jennifer Pahlka

Founder of Code for America.

Readings

Rawsthorn,Alice. "Prologue?" and "Out of Control," in *Design as an Attitude* (Zurich: JRP Ringier Kunstverlag AG, 2018), 4-16, and 108-120.

Manzini, Ezio. "Making Things Happen: Social Innovation and Design." *Design issues* 30.1 (2014): 57–66.

WEEK 11
Monday May 1. Design for Cognition.
Guest: Arvind Satyanarayan

Designer of digital and data visualizations. Associate Professor of Computer Science at MIT, and director of the Visualization Group at MIT CSAIL.

Readings

Williams, Sarah. "Hack it! Using Data Creatively," in *Data Action: Using Data for Public Good* (Cambridge, MA: MIT Press, 2022), p. 89-135.

Kurgan, Laura. "Close up at a Distance: Mapping, Technology, and Politics: Mapping Considered as a Problem of Theory and Practice," (New York: Zone Books, 2013). p. 9-18 & "Close up at a Distance: Mapping, Technology, and Politics: Representation and the Necessity of Interpretation," (New York: Zone Books, 2013). p. 19-36.

WEEK 12
Monday May 8. Design for Communicating.
Guest: Matthew Carter

Type designer, and creator of the MIT logo.

Readings

Bringhurst, Robert, *The Elements of Typographic Style* (Point Roberts: Hartley & Marks, 2008), 16-24, 119-142.

Tufte, Edward. *Envisioning Information* (Graphics Press, 1990),, excerpts.

Lupton, Ellen. *Thinking with Type: a Critical Guide for Designers, Writers & Editors* (New York: Princeton Architectural Press, 2004), excerpts.

WEEK 13
Monday May 15. Design for Future Challenges.
A conversation with Holly Jean Buck, Llisa Demetrios, John Cary and Susan Hockfield
Final Review
***Note: This class will run from 10-1 pm.**

Holly Jean Buck. Writer. Assistant Professor Department of Environment and Sustainability College of Arts and Sciences. Author of *After Geoengineering. Climate Tragedy, Repair and Restoration*.

Susan Hockfield. President Emerita of MIT and Professor of Neuroscience.

John Cary. President of the Eames Institute for Infinite Curiosity.

Llisa Demetrios. Chief Curator of the Eames Institute for Infinite Curiosity.

Readings

Ghosn, Rania. "Carbon Re Form," *Log 47 Overcoming Carbon Form* (2019): 107-117.

Myers, William, and Paola Antonelli. *Bio Design: Nature, Science, Creativity* (New York: Museum of Modern Art, 2012), excerpts.

ADDITIONAL INFORMATION & RESOURCES

Land Acknowledgement Statement

We acknowledge Indigenous Peoples as the traditional stewards of the land, and the enduring relationship that exists between them and their traditional territories. The lands which MIT occupies are the traditional unceded territories of the Wampanoag Nation and the Massachusett Peoples. We acknowledge the painful history of genocide and forced occupation of these territories, as well as the ongoing processes of colonialism and dispossession in which we and our institution are implicated. Beyond the stolen territory which we physically occupy, MIT has long profited from the sale of federal lands granted by the Morrill Act, territories stolen from 82 Tribes including the Greater and Little Osage, Chippewa, and Omaha Peoples. As we honor and respect the many diverse Indigenous people connected to this land from time immemorial, we seek to Indigenize our institution and the field of planning, offer Space, and leave Indigenous peoples in more empowered positions.

Inclusive Class and Classroom

MIT values an inclusive environment. I hope to foster a sense of community in this classroom and consider this classroom to be a place where you will be treated with respect. I welcome individuals of all backgrounds, beliefs, ethnicities, national origins, gender identities, sexual orientations, religious and political affiliations – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for every other member of the class. If this standard is not being upheld, please feel free to speak with me.

Special Accommodations

MIT is committed to the principle of equal access. Students who need disability accommodations are encouraged to speak with Disability and Access Services (DAS), prior to or early in the semester so that accommodation requests can be evaluated and addressed in a timely fashion. If you have a disability and are not planning to use accommodations, it is still recommended that you meet with DAS staff to familiarize yourself with their services and resources. Please visit the DAS website for contact information. If you have already been approved for accommodations, class staff are ready to assist with implementation. Please inform Professor Ryan at bdr@mit.edu who will oversee accommodation implementation for this course.

Academic Integrity and Honesty

MIT's expectations and policies regarding academic integrity should be read carefully and adhered to diligently. Plagiarism is a major academic offense. Read: http://integrity.mit.edu.

Writing and Communication Resources

The WCC at MIT (Writing and Communication Center) offers *free* one-on-one professional advice from communication experts. The WCC is staffed completely by MIT lecturers. All have advanced degrees. All are experienced college classroom teachers of communication. All are all are published scholars and writers. The WCC helps you strategize about all types of academic and professional writing as well as about all aspects of oral presentations (including practicing classroom presentations & conference talks as well as designing slides). No matter what department or discipline you are in, the WCC helps you think your way more deeply into your topic, helps you see new implications in your data, research, and ideas. The WCC also helps with all English as Second Language issues, from To register with our online scheduler and to make appointments, go to https://mit.mywconline.com/. To access the WCC's many pages of advice about writing and oral presentations, go to http://cmsw.mit.edu/writing-and-communication-center/. Check the online scheduler for up-to-date hours and available appointments.