Soft Responsive Architectures

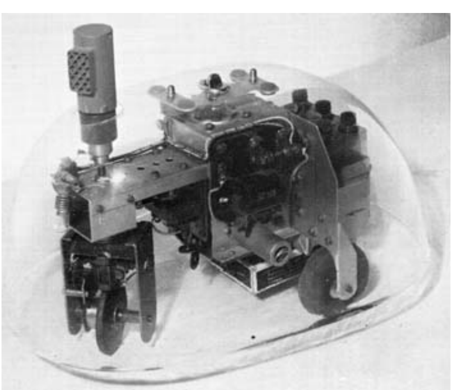
Type of Course: Advanced Studio ARCH 86101 / 51000 / 91102
Class Meetings: M, Th 2:00-5:50pm
Instructor: Frank Melendez, Assistant Professor, fmelendez@ccny.cuny.edu
Location: SSA, Room TBD
Semester/Year: Fall 2018

Studio Overview

Recent advances in computation, sensing, and actuation technologies provide opportunities for designers to measure ephemeral, biotic and abiotic, phenomena. This collected data can be used to drive dynamic behaviors into architectures that are responsive and adaptive to human interactions and environmental conditions. This advanced architectural design studio will critically examine the role and potential for using these technologies to design responsive architectural systems, through the use of physical computing and simulation technologies. The studio will focus on the design of these responsive and adaptive systems through a series of lectures, readings, discussions, workshops, and team-based projects, with a focus on the following topics; cybernetics, computing, and softspace.
CYBERNETICS - through the design of responsive and adaptive machines that are performative
COMPUTING - parametric/algorithmic, physical computing, simulation, and virtual reality technologies
SOFTSPACE - spatially as ephemeral, environmental phenomena and physically with elastomer materials

Cybernetics

In the 1950's Norbert Wiener coined the term cybernetics, which he defined in the title of his book, *Cybernetics, or Control and Communication in the Animal and the Machine.* Stemming from the field of psychology, pioneers in cybernetics, such as Norbert Wiener, Grey Walter and Gordon Pask, were interested in understanding the brain as an organ of performance (tied to the body's ability to survive and adapt). [1]. In *The Cybernetic Brain*, Andrew Pickering defines cybernetics as the postwar science of the adaptive brain. [2]. Although cybernetics emerged from psychiatry, it has influenced many other fields, including robotics, politics, engineering, architecture, music, and more. Early cybernetic experiments used electromechanical devices, such as Walter's autonomous robots (which he called the tortoises) that could respond to stimuli. (Figure 1). These early experiments and concepts in cybernetics influenced theater producer Joan Littlewood and the architect Cedric Price, to collaborate in their design of the *Fun Palace*, an architecture that could respond to the varying needs of individuals. (Figure 2).



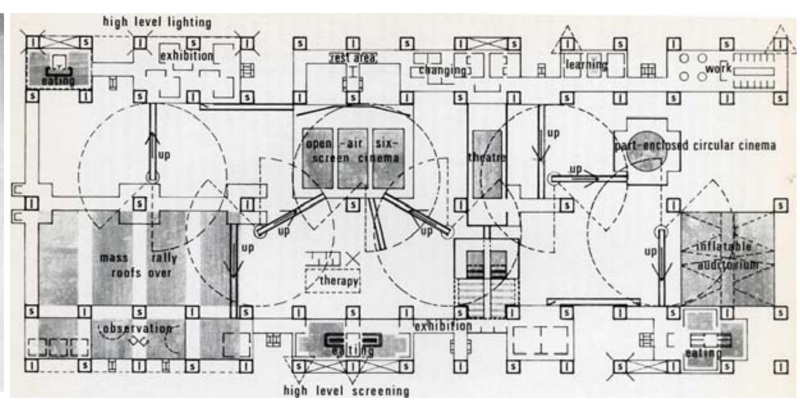


Figure 01 (left): *Machina speculatrix*, 1948-49, Grey Walter
Figure 02 (right): Plan of the *Fun Palace*, 1962, Joan Littlewood and Cedric Price

Computing

In 1963 the computer scientist and engineer, Ivan Sutherland, while a PhD student at MIT, developed the first interface for drawing two-dimensional geometry with parameters and constraints through the use of a Graphic User Interface (GUI). (Figure 3). These develops eventually led to the replacement of hand drafting with computer-aided drafting, and the development of 3D digital parametric modeling. In 1968, Sutherland also developed the first head-mounted display (virtual reality), *The Sword of Damocles*, that would project geometric wireframe images onto a lens, while the movement of the user's head was tracked. (Figure 4). This lead to the development of current Virtual Reality (VR) and Augmented Reality (AR) systems that provide users with the sensation of being present in the digital model as an *immersive* experience. [3]. Today, these platforms are used in multiple disciplines and are available through devices such the Oculus Rift and Microsoft's HoloLens. During this same time of Sutherland's inventions, the architect Nicholas Negroponte founded the Architecture Machine Group (1968), now known as the MIT Media Lab, where experimental design projects such as *SEEK* were developed. In SEEK (1970), an encased environment, inhabited by gerbils, contains stacked blocks, that were knocked down and shifted by the movement of the gerbils. A computer controlled mechanical arm was programmed to realign and restack the blocks that were moved. (Figure 5). This resulted in a continuous feedback loop and confronted the ability for machines to handle changes to their environment. [4].



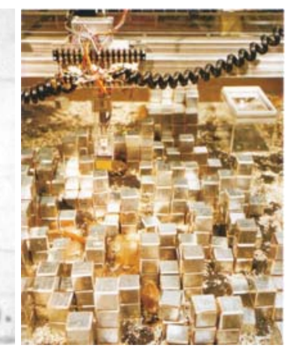


Figure 3 (left): *Sketchpad*, Ivan Sutherland, MIT
Figure 4 (middle): *Sword of Damocles*, 1968, Ivan Sutherland, MIT
Figure 5 (right): SEEK, 1970, Nicholas Negroponte, Architecture Machine Group, MIT

As Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) systems continued to develop, 3D digital parametric modeling and digital fabrication techniques opened up new possibilities for architectural design. During the 1990's and 2000's architects explored the use of digital models, parametric design, algorithmic procedures, and simulation methods, as tools for generating new architectural forms, modes of fabrication, and performance optimization. Digital models provide new environments for designing geometry and form through continuous surfaces, topology, parameters and simulations. These design technologies led to a shift from industrial processes of mass production, to digital processes of mass customization, such as Greg Lynn's *Embryonic House*, where users can choose from a matrix of parts to customize the design of their digitally fabricated house. (Figure 6). Additional digital design tools included computational simulations, which were primarily used to evaluate and test geometric forms as a means of optimizing their performance. Simulations were also used as generative design tools for exploring emergent geometries and forms that were based on input parameters. For example, in Zaha Hadid's *Kartal-Pendik Masterplan*, computational simulations of bundling curve networks, influenced by Frei Otto's bundling wool-thread models, were used to design urban path systems. [5]. (Figures 7 and 8).

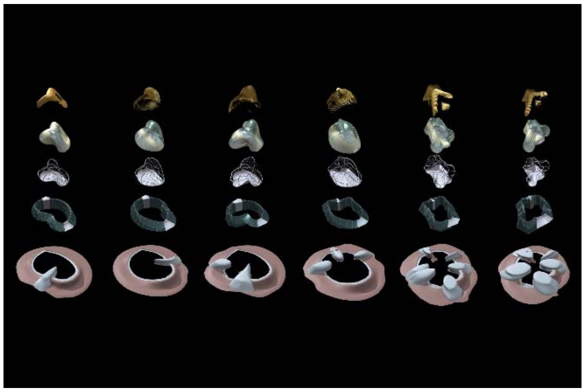
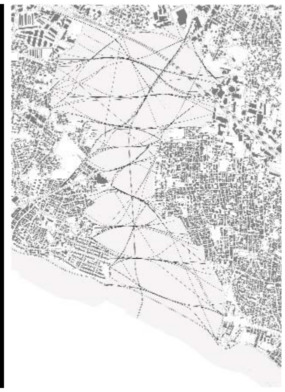




Figure 6 (left): *Embryological House*, Greg Lynn FORM
Figures 7 and 8 (middle and right): *Kartal-Pendik Masterplan,* 2006, Istanbul, Turkey, Zaha Hadid Architects

Softspace

In addition to exploring geometry and form in architecture through the use of computational design processes, this studio will also focus on the design of architecture through the study of ephemeral, environmental phenomena, or, 'softspace'. This provides an emphasis on the integration of energies, such as light, heat, and airflow, as materials that guide the design of geometries, forms, and boundary conditions of architecture. [6]. (Figures 9 and 10). Using Usman Haque's analogy comparing architecture to a computer; architecture consists of 'hardware', elements such as walls and roofs, and 'software', the dynamic and ephemeral smells, sounds, and temperatures of a space. [7]. The studio will focus on designing architectures that are based on both hardware and software, as a means of producing an ecologically driven symbiosis between users and their surrounding environment.

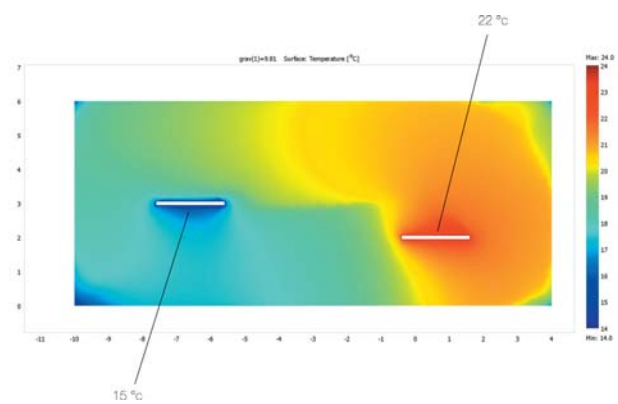



Figure 9 (left): *public plaza*, 2012, Weathers / Sean Lally
Figures 10 (middle and right): *Interior Gulf Stream,* 2008, Philippe Rahm

Design Project and Methodology

This advanced design studio intends to study the three previously described topics; cybernetics, computing, and softspace, to create a foundation of knowledge and a strategical approach, to build off of and expand upon, current design research in responsive and adaptive architectural systems. (Figures 11-14). This research will drive the design of experimental and speculative architectural projects that utilize current technologies in the design of architectural interventions located within New York City that respond and adapt to users and environments. These nascent technologies allow for methods of architectural design that enable the input of data-driven information into computational tools for measuring, understanding, and organizing complex networks and interactive systems. The ability to sense and convert nuanced fluctuations in biometric and environmental phenomena into data, supports the use of responsive systems by providing designers with the means to implement these metrics in the design of human-machine-environment interactions. This paradigm shift requires architects and designers to think dynamically and consider the adaptive potentials of architectures as cybernetic and closed-loop systems. Sensing, actuation, biometric and environmental data, and the fabrication of kinetic, physical prototypes are key topics of this studio.

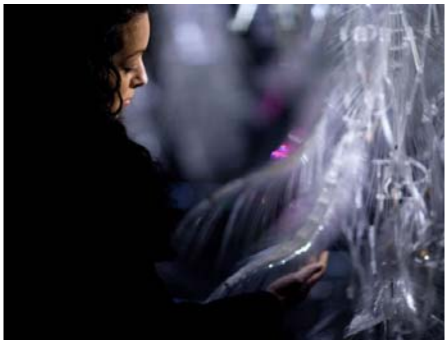
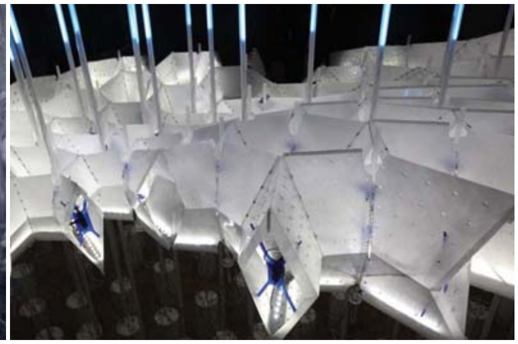



Figure 11 (top left): *Hylozoic Ground,* 2010, Phiip Beesley
Figure 12 (top right): *Aurora*, 2009, Future Cities Lab / Jason Kelly Johnson and Nataly Gettegno
Figure 13 (bottom left): *Soft Robotic Architectures,* 2016, Augmented Architectures / Nancy Diniz and Frank Melendez
Figure 14 (bottom right): *Alloplastic Architectures*, 2013, Behnaz Farahi

Participants in this studio will work in teams to design responsive architectural interventions / installations that use sensors to measure real-time data, and drive the kinetic, responsive, interactive aspects of the intervention / installation, as a means of enhance the relationship between humans-machines-environments. The primary mode of idea development will be working unit to system, at various scales, and merging analog and digital fabrication techniques. The prospect of this studio is to connect design thinking and technological prowess, and instill a culture of architectural design at the intersection of computation, electronics, simulation, and prototyping. The studio is intended to foster a team-based design environment that seeks and promotes innovation and the generation of new ideas through experimentation, making, tinkering, and hacking.

SITE - Each team will select their own site, within New York City, by determining and analyzing an existing urban condition / space, that demonstrates an ecological condition that might be improved/enhanced through the use of responsive systems. The ‘performative’ criteria for each project will be developed through research and based on a site analysis, of visible / invisible, tangible / intangible, acquiring data, and determining methods for improving existing conditions.

PROGRAM - This information will be used to design the architectural interventions that mediate and improve the interactions, or ‘mutualism’ [8], between individuals and their environment. The architectural program / function of the responsive architectural interventions will be determined by each team on an individual basis. Each team will determine the ‘feedback’ of each project and how it plays into / affects, larger ecological, urban, and architectural systems.

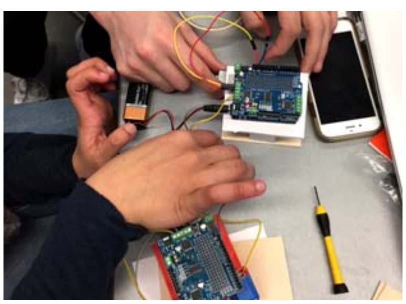
‘LIVE’ PHYSICAL MODELS - The architectural interventions / installations will be designed primarily through the use of physical computing technologies to create ‘live’ physical models. These architectural models will be considered prototypes for the intervention / installation that is embedded with sensors, actuators, and electronics to create kinetic devices that are interactive and responsive. This requires a method of working that promotes experimenting, tinkering, and hacking, code and electronics.

VIRTUAL REALITY (VR) SIMULATIONS – The architectural interventions will be explored ‘as experienced’ at the site through the use of digital models viewed within a VR environment, to create a responsive, *immersive* experience. The VR environment will also be used as a visualization, and simulation, tool to view live data, connecting physical computing workflows with VR, using the Oculus Rift.

Workshops

The studio will focus on working prototypes and physical computing workflows that can be tested through the implementation of various technologies, including parametric and algorithmic design software, microcontrollers, sensors, actuators, electronics, and VR. Students are encouraged to have a basic knowledge and understanding of working within digital and parametric modeling environments, however, a series of workshops will be provided in the first half of the semester. These workshops include; algorithmic design (Rhino + Grasshopper), physical computing (Arduino + Processing) and electronics basics, silicone casting, and VR overview (Oculus Rift + Unreal).

PHYSICAL COMPUTING - Physical computing technologies allow for connecting physical and digital environments. This is achieved through the use of microcontrollers, sensors, actuators, and electronics. One popular platform for exploring physical computing processes is Arduino, which consists of hardware and software. Using the Arduino microcontroller (hardware), and text based code in the Arduino IDE (software), sensed analog data can be converted into digital data that can control mechanical devices. There are a variety of sensors available, both environmental and biometric, that measure ephemeral phenomena such as light, sound, air quality, hear rate, etc. This data can be ouput through actuators, such as LEDs, servos, and motors. Creating prototoypes with microcontrollers, sensors, and actuators requires a basic understanding of electronics, which will be covered in the workshops.



Example of physical computing hardware; microcontroller, jumper wires, breadboards

SOFT, ELASTOMER MATERIALS (SILCONE) - Architecture consists of building in materials such as wood, stone, brick, concrete, and steel. The design of responsive, kinetic systems, coupled with recent advances in composite, bio, and synthetic material technologies, provides a basis for this studio to speculate on future architectures that bend, stretch, twist, and behave in ways that traditional architectural materials do not. In order to speculate on these scenarios, the studio will explore the role of animation, kinetics, and movements, with a focus on 'soft' elastomer materials, in particular silicone. Each team will be provided with a small supply of silicone to explore and test the material (which has been donated to the studio by a major manufacturer). The use and application of silicone will vary for each team, in each project, but will be integrated, considered and discussed as a material that allows for change in geometry and topology. Other materials (responsive, traditional, emerging) can be combined with the elastomer (silicone) material to explore the theme of responsive design.

VIRTUAL REALITY (VR) - Digital models are typically experienced as flat two-dimensional projections on a screen or monitor. Virtual Reality platforms allow users to experience digital models as *immersive* environments that simulate standing within the digital model through the use of head mounted displays. This studio will use VR in a novel, and experimental way, by integrating physical computing tools, to sense information and display the data within the VR environment. In addition to the immersive experience, users can view responsive, real-time data, in the form of numerical values, projections, and changes in the digital model, through the use of lighting, colors, and geometric transformations.

Virtual Reality simulation using Oculus Rift and Unreal

Bibliography:

[1]. Pickering, Andrew. *The Cybernetic Brain: Sketches of Another Future*, Chicago and London: The University of Chicago Press, 2010.
[2]. Ibid.
[3]. Aukstakalnis, Steve. *Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR*. USA: Pearson Education, Addison-Wesley, 2017.
[4]. Silicone Valley Artificial Intelligence Message Board, *SEEK: MIT's Machine Architecture Group goes Gerbil*, Posted 09/20/10. https://www.meetup.com/silicon-valley-artificial-Intelligence/messages/boards/thread/9766574
[5]. Schumacher, Patrik. "Parametricism: A New Global Style for Architecture and Urban Design", AD: Digital Cities, Vol 79, No 4, July/August 2009, guest editor: Neil Leach, general editor: Helen Castle.
[6]. Rajagopal, Avinash. *"Sean Lally: Energy as Architecture", Metropolis*, November 2014.
[7]. Hauqe, Usman. *Hardspace, softspace and the possibilities of open source architecture.* 2004.
[8]. Menges, Achim and Sean Alquist, ed. *AD Reader: Computational Design Thinking*. "The Architectural Relevance of Cybernetics" by Gordon Pask. United Kingdom: John Wiley & Sons, Ltd., 2011.

Schedule

Week 01 08.27.18	Studio introduction and overview
Week 02 09.03.18	M 9.03, College Closed, W/Th, research / discussions / presentations
Week 03 09.10.18	M 9.10, no classes, Th, research / presentations / digital workshops
Week 04 09.17.18	desk crits / physical computing workshops
Week 05 09.24.18	**Project 01 Due**
Week 06 10.01.18	desk crits / casting workshops / simulation workhops
Week 07 10.08.18	M 10.08, College Closed, Th, desk crits
Week 08 10.15.18	**Project 02 Due**
Week 09 10.22.18	desk crits / pin ups
Week 10 10.29.18	desk crits / pin ups
Week 11 11.05.18	**Mid Review**
Week 12 11.12.18	desk crits / pin ups / workshops
Week 13 11.19.18	Th, 11.22-11.25, College closed
Week 14 11.26.18	desk crits / pin ups
Week 15 12.03.18	desk crits / pin ups
Week 16	

12.10.18 **studio review week - Final Review**
[Last day of classes 12.12.18]

Week 17
12.17.18 **final exam week**

*please note that the schedule is subject to change

Projects
The spring semester will proceed in three phases with a corresponding project for each phase.
Project 1 - Research and Physical Computing exercises
Project 2 - Site Analysis and Prototypes ('live' models)
Project 3 - Responsive Architectural Intervention / Installation

Readings
A series of readings from the following publications will be distributed throughout the semester, as assigned readings for discussion.

- Aukstakalnis, Steve. *Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR*. USA: Pearson Education, Addison-Wesley, 2017.
- Banzi, Massimo. *Make: Projects, Getting Started with Arduino, 2nd Edition*. Sebastopol, CA: O'Reilly Media, Inc., 2011.
- Beesley, Phillip, and Omar Khan. *Situated Technologies Pamphlet 4: Responsive Architecture / Performing Instruments*. New York: Architecture League of New York, 2008.
- Brooks, Rodney A. *Flesh and Machines: How Robots Will Change Us*. New York: Vintage Books, 2002.
- Gerber, David Jason, and Mariana Ibanez. *Paradigms in Computing: Making, Machines, and Models for Design Agency in Architecture*. Los Angeles, CA: eVolo Press, 2014.
- Hauqe, Usman. *Hardspace, softspace and the possibilities of open source architecture.* 2004.
- Kurzweil, Ray. *The Age of Spiritual Machines: When Computers Exceed Human Intelligence*. New York, NY: Penguin Books, 1999.
- Menges, Achim and Sean Alquist, ed. *AD Reader: Computational Design Thinking*. "The Architectural Relevance of Cybernetics" by Gordon Pask. United Kingdom: John Wiley & Sons, Ltd., 2011.
- Negroponte, Nicholas. *Soft Architecture Machines*. Cambridge, Massachusetts and London, England: The MIT Press, 1975.
- Noble, Joshua. *Programming Interactivity: A Designer's Guide to Processing, Ardunio, and openFrameworks*. Sebastopol, CA: O'Reilly Media, Inc.,2009.
- O'Sullivan, Dan and Tom Igoe. *Physical Computing: Sensing and Controlling the Physical World with Computers*. Mason Ohio: Course Technology, 2004.
- Peters, Brady and Xavier De Kestelier. *AD, Computation Works: The Building of Algorithmic Thought*. West Sussex, UK: John Wiley & Sons Ltd., March/April 2013.
- Pickering, Andrew. *The Cybernetic Brain: Sketches of Another Future*, Chicago and London: The University of Chicago Press, 2010.
- Platt, Charles. *Make: Electronics*. Canada: Helpful Corporation, 2009.
- Reas, Casey and Chandler McWilliams. *Form + Code: In Design, Art, and Architecture*. New York, NY: Princeton Architectural Press, 2010.

Grading & Attendance Policies and Studio Culture

Course Expectations

- That students will develop a high level of independent thought and rigor and a willingness to go beyond both basic project requirements and their own perceived limits and abilities.
- That students will successfully complete all project requirements. No make-up or postponed project submissions will be accepted except in the case of medical emergencies or other extraordinary circumstances. Excused absences and project delays must be officially cleared by professor in advance in order to be considered valid.

Methods of Assessment

- Attendance and participation in class discussions: 20%
- Projects development in response to semester schedule: 50%
- Projects presentation, completion and resolution: 30%

Key Areas of Grading Assessment

- Studio Performance & Work Habits Ability to respond to studio criticism & discourse in a consistent & clear manner throughout the course of the semester as demonstrated in the evolution and development of design work.
- Clarity of Representation & Mastery of Media Ability to utilize both digital and manual drawing and model-making techniques to precisely and creatively represent architectural ideas.
- Pre-Design: Ability to prepare a comprehensive program for an architectural project that includes an assessment of client and user needs; an inventory of spaces and their requirements; an analysis of site conditions (including existing buildings); a review of the relevant building codes and standards, including relevant sustainability requirements, and an assessment of their implications for the project; and a definition of site selection and design assessment criteria.
- Research: Understanding of the theoretical and applied research methodologies and practices used during the design process.
- Integrated Evaluations and Decision-Making Design Process: Ability to demonstrate the skills associated with making integrated decisions across multiple systems and variables in the completion of a design project. This demonstration includes problem identification, setting evaluative criteria, analyzing solutions, and predicting the effectiveness of implementation.
- Studio & Lecture Series Attendance
- Completion of Portfolio and Attendance at all scheduled portfolio related events

Grading Criteria

Note: C is the lowest passing grade for M Arch I and M Arch II students.

A (+/-) work meets all requirements and exceeds them. Presentations are virtually flawless, complete, and finely detailed. Work exhibits professional, "museum quality" level of craft. Student has developed an individual design process that shows a high level of independent thought and rigor. Work shows evidence of intense struggle to go beyond expectations, and beyond the student's own perceived limits of their abilities.

B (+/-) work meets all requirements. Presentations are complete and finely detailed. Work exhibits professional level of craft. Student has developed an individual design process that shows a high level of independent thought and rigor.

C (+/-) work meets minimum requirements. While presentations may be complete, student has struggled to develop an individual design process and/or is lacking in craft or design resolution

D (+/-) work is below minimum requirements. Presentations are incomplete, student has struggled to develop an individual design process and/or is lacking in craft or design resolution.

F work is well below minimum requirements. Student does not develop adequate design process, and
/ or does not finish work on time.

INC grades of "incomplete" are not given under any circumstances unless there is evidence of a medical or personal emergency. In such cases, instructor and student develop a contract to complete work by a specified date, as per CCNY policy. Classes / work missed due to illness must be explained with a physician's note.

NOTE: Working in teams does not guarantee the same grade for each team member; grades are based on a range of criteria for each student.

For more information on grading guidelines and other CCNY policies and procedures, consult the current
CCNY Academic Bulletins: http://www.ccny.cuny.edu/registrar/bulletins.cfm

Office Hours

Office hours are set by appointment. If a student needs to speak in private with a studio critic they must email in advance to request a meeting time. Students may seek office hour appointments to discuss any matters of concern including personal, private matters and general inquiries about course related work, grading, assessment and content.

Probation & Dismissal
For program specific information related to grades, academic standing, probation and dismissal, please see your program academic advisors:
B. Arch.: Arnaldo Melendez & Sara Morales
M. Arch.: Hannah Borgeson

Studio Culture
Working in the studio is mandatory. Studio culture is an important part of an architectural education. Please see the Spitzer School of Architecture Studio Culture Policy, which can be accessed on the SSA website here https://ssa.ccny.cuny.edu/about/policies/ for more information.

Absence & Lateness
Arriving more than ten minutes late to class will constitute an absence. Two unexcused absences will result in a whole letter grade deduction from a final grade; three will result in a failing grade. It is expected that all students will participate in all scheduled working, midterm and final reviews and contribute constructively to the discussion.

Absences due to Religious Observances
Students who will miss any class sessions, exams, presentations, trips, or the like due to a religious observance should notify the instructor at the beginning of the semester so that appropriate adjustments for observance needs can be implemented. This could include an opportunity to make up any examination, study, or work requirement that is missed because of an absence due to a religious observance on any particular day or days.

Noise Policy
The studio environment should be a quiet and respectful place where all students can work and think in peace. At no time may students play music out loud in studio, even at a low volume. If you desire to listen to music, either during class hours or after hours, headphones are a requirement. Conversations must also be kept to a reasonable volume to respect classmates and those students in adjacent studios.

Readings & Journals
Students are expected to keep a journal or sketchbook throughout the duration of studio to document their thought process & take notes of any texts, books, terms or references that are mentioned by either the studio critic or fellow classmates and to selectively follow up on these and any other assigned readings before the next class.

Academic Dishonesty
As a student you are expected to conduct yourself in a manner that reflects the ethical ideas of the profession of architecture. Any act of academic dishonesty not only raises questions about an individual's

fitness to practice architecture, but also demeans the academic environment in which it occurred. Giving or receiving aid in examinations, and plagiarism are a violation of an assumed trust between the school and the student.

Plagiarism, i.e. the presentation as one's own work of words, drawings, ideas and opinions of someone else, is a serious instance of academic dishonesty in the context as cheating on examinations. The submission of any piece of work (written, drawn, built, or photocopied) is assumed by the school to guarantee that the thoughts and expressions in it are literally the student's own, executed by the student.
All assignments must be the student's original work. Any copying, even short excerpts, from another book, article, or Internet source, published or unpublished, without proper attribution will result in automatic failure of the entire course.

CCNY Academic Integrity Policies
http://www.ccny.cuny.edu/academicaffairs/integritypolicies.Cfm
In particular, consult the Academic Integrity Brochure for students:
http://www.ccny.cuny.edu/academicaffairs/upload/BrochurePDFVersion.pdf
For more guidance about understanding standards for plagiarism in the digital age, see:
http://www.nytimes.com/2010/08/02/education/02cheat.html?_r=1&emc=eta1&pagewanted=print For citations, use the Chicago Manual of Style "Notes and Bibliography" method:
http://www.chicagomanualofstyle.org/tools_citationguide.html

AccessAbility Center (Student Disability Services)
The AccessAbility Center (AAC) facilitates equal access and coordinates reasonable accommodations, academic adjustments, and support services for City College Students with disabilities while preserving the integrity of academic standards. Students who have self-identified with AAC to receive accommodations should inform the instructor at the beginning of the semester. (North Academic Center 1/218; 212-650-5913 or 212-650-6910 for TTY/TTD).

Library
The school's library is a shared resource that is necessary supplement to all research and design work. Please direct questions to the library staff or the architecture librarian Nilda Sanchez.

NAAB (National Architectural Accrediting Board)
The National Architectural Accrediting Board (NAAB) is the sole agency authorized to accredit US professional degree programs in architecture. Since most state registration boards in the United States require any

applicant for licensure to have graduated from a NAAB-accredited program, obtaining such a degree is an essential aspect of preparing for the professional practice of architecture. While graduation from a NAAB-accredited program does not assure registration, the accrediting process is intended to verify that each accredited program substantially meets those standards that, as a whole, comprise an appropriate education for an architect.

More specifically, the NAAB requires an accredited program to produce graduates who: are competent in a range of intellectual, spatial, technical, and interpersonal skills; understand the historical, socio-cultural, and environmental context of architecture; are able to solve architectural design problems, including the integration of technical systems and health and safety requirements; and comprehend architects' roles and responsibilities in society.

The following Student Performance Criteria are addressed in this course:
Realm B: Building Practices, Technical Skills, and Knowledge. Graduates from NAAB-accredited programs must be able to comprehend the technical aspects of design, systems, and materials and be able to apply that comprehension to architectural solutions. In addition, the impact of such decisions on the environment must be well considered.

B.1 Pre-Design: Ability to prepare a comprehensive program for an architectural project that includes an assessment of client and user needs; an inventory of spaces and their requirements; an analysis of site conditions (including existing buildings); a review of the relevant building codes and standards, including relevant sustainability requirements, and an assessment of their implications for the project; and a definition of site selection and design assessment criteria.

Realm C: Integrated Architectural Solutions. Graduates from NAAB-accredited programs must be able to demonstrate that they have the ability to synthesize a wide range of variables into an integrated design solution.

C.1 Research: Understanding of the theoretical and applied research methodologies and practices used during the design process.

C.2 Integrated Evaluations and Decision-Making Design Process: Ability to demonstrate the skills associated with making integrated decisions across multiple systems and variables in the completion of a design project. This demonstration includes problem identification, setting evaluative criteria, analyzing solutions, and predicting the effectiveness of implementation.

Students should consult the NAAB website www.naab.org for additional information regarding student performance criteria and all other cond*itions for accreditation.*