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Spring 2024: Elective Course

# AI / VR in Architecture

NJIT SPRING 24 ARCH 689

Mondays 6:00 – 8:50 PM

INSTRUCTOR: Taro Narahara | Associate Professor | [narahara@njit.edu](mailto:narahara@njit.edu) | Weston 677

OFFICE HOURS: Monday or Thursday after class hours and by appointment  
(Students should remind the instructor by sending an email).

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## Syllabus (Tentative: Revised on 2024\_0101: The schedule is subject to change)

(Human) Reference Images



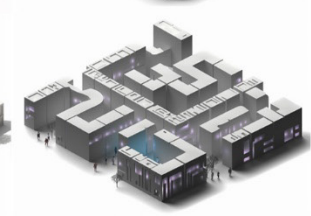
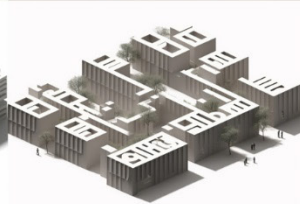
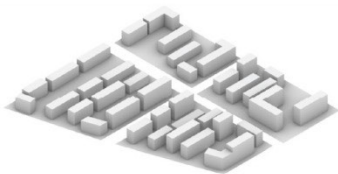
(AI) Eco-friendly



(AI) Market /Timber



(AI) Neo-Future /Metal



## Course Description

This course will focus on Artificial Intelligence (AI) and Virtual Reality (VR) in the context of Architecture and Urban Design. The recent progress in data science technologies allows us to understand the correlations between artistic designs and their implicit qualities in a quantitative data format, and such data can be further used to extract features related to the attractiveness of artistic expressions using methods such as deep neural networks. Furthermore, the use of immersive VR technologies could help the extraction of such datasets beyond the representations of architectural spaces.

During the first half of the semester, the course will require students to learn new computational techniques to conduct research on analyzing the quality of small-scale residential spaces through several assignments, and students will have the opportunity to engage in research across the fields of data science and architecture. During the latter half, students will explore and apply the techniques to the architectural programs related to their interests.

Using various digital design tools, we will analyze spatial quality based not only on environmental issues, such as solar exposure and airflows, but also on subjective criteria based on aesthetics and attractiveness, such as the level of comfort inside the space. The digital design tools that we will explore include the Head-Mounted Displays (HMD), Game Engines, Rhinoceros Grasshopper (GH), and its various Plugins such as Ladybug and Programming (no knowledge in coding required, but some basic knowledge in Python would be great.) This is an excellent advanced course for 4th or 5th-year architecture students willing to learn digital tools, 4th-year digital design students, or advanced-level students from any college.

## Course Objectives

- Learn novel techniques using advanced tools in drawings, analysis, and VR.
- Develop a design methodology that operates at multiple scales.
- Develop a quality of craft with multiple digital tools.
- Develop the ability to present a design proposal graphically.
- **Learn how to communicate through virtual media.**

### OVERVIEW SCHEDULE & Assignments: **(All schedules & scoring weights are subject to change)**

Assignment 1	10%
Assignment 2	10%
Assignment 3	10%
Assignment 4	10%
Assignment 5	10%
Assignment 6	10%
Final Project (Project based on the instructor's direction)	30%
Demonstrated Initiative, Engagement, and Class Participation (See the section below for the attendance requirement.)	10%

## Class Policies

**All lectures will be online using Google Meet.**

Assignments:

Assignments are due at the beginning of class. Assignments that are not clearly labeled will not be accepted or graded. Late homework will be graded down one letter grade for every class late. **(All submission materials will have digital formats and will be submitted to the shared folders in Google Drive.)**

Data Backups:

You are expected to keep multiple backups of all course data and have your current project files available during class time. Lost, unavailable, or inaccessible data will not be a valid reason for project extensions or Incomplete grade issuance.

Lab Policies:

No food or drink is allowed in the computer lab. Lab door codes are to be kept private within the roster of enrolled students. Lab projectors and speakers are only for instructor use. You are expected to use good judgment in setting lengthy rendering tasks using lab facilities. Failure to adhere to these policies can result in your being locked out of the labs.

Academic Warning:

Students who do not complete and submit assignments on time and to a satisfactory standard will fail the class. It is the student's responsibility to obtain missed assignments from other classmates and make up work in time for the next class.

Class Policies:

Cell phones, email, music players, social networking, and music streaming software should not be used during class. Usage of these devices or applications will result in your being asked to leave the class and marked absent for that class session.

## Instructor Expectations

At all classes, you are expected to bring new computer models, renderings, and hand drawings (sketches) relevant to the project in progress. You are expected to work each and every day on the projects assigned. If for any reason you doubt your ability to do so, you should consider whether you belong in this studio.

While this course introduces and uses several software packages, you should not rely only on this course to teach them to you. Make use of all available resources to learn the software, books, online help, instructors, and fellow students.

# Weekly Outline (Tentative)

The preliminary schedule for the semester is as follows:

Specific dates, including assignment due dates and contents, may be adjusted.

Jan 22	Week 1:	Introduction, TN Lecture, 2-D, 3-D Drawing representations
Jan 29	Week 2:	Procedural Approaches in Design, Rhinoscript, Grasshopper <b>Due: Assignment 1-part 1, Your Introduction (Group 1)</b>
Feb 5	Week 3:	Environmental Analysis 1 (Solar radiation analysis <a href="#">Ladybug Tools</a> ) <b>Due: Assignment 1-part 2, Your Introduction (Group 2)</b>
Feb 12	Week 4:	Environmental Analysis 2 (DeCodingSpaces) Isovisit analysis using DeCordingSpacesTools <b>Due: Assignment 2</b>
Feb 19	Week 5:	Environmental Analysis 3 (Butterfly Tool) Air Flow Analysis using GH & Butterfly Tool <b>Due: Assignment 3</b>
Feb 26	Week 6:	VR Integration 1 (Twinmotion or your selected 3D tool)
March 4	Week 7:	VR Integration 1 (Quest2, TBD: Not sure how far we go this year) <b>Due: Assignment 4</b>
March 11	Week 8:	Spring Recess
March 19	Week 9:	Optimizing your design patterns using the Octopus plugin Assignment 5 instructions: <b>Due: Mid Semester Submission Due</b> <b>(Compile all your assignments in a specific format)</b>
March 25	Week 10:	Project Proposal Presentations 1 <b>Due: Assignment 5</b>
April 1	Week 11:	Project Proposal Presentations 2
April 8	Week 12:	Project Development Sessions with TN
April 15	Week 13:	Guest Lecture(s) (Dates & Locations TBD)
April 22	Week 14:	Project Development Sessions with TN
April 29	Week 15:	<b>Final Class Date</b> , Wrap up <b>Due: Final Project Presentation</b>
May 6	Week 16:	<b>Final Submission Due</b>  Guest Lecture(s) (Dates & Locations TBD)

Learning New Tools

Creative Projects



## NAAB Shared Values

The National Architectural Accrediting Board accredits NJIT's architecture program. The NAAB has Shared Values of the Discipline and the Profession that must be covered by any architectural curriculum to attain their approval. This course satisfies the following shared values:

**Design:** Architects design better, safer, more equitable, resilient, and sustainable built environments. Design thinking and integrated design solutions are hallmarks of architecture education, the discipline, and the profession.

**Environmental Stewardship and Professional Responsibility:** Architects are responsible for the impact of their work on the natural world and on public health, safety, and welfare. As professionals and designers of the built environment, we embrace these responsibilities and act ethically to accomplish them.

**Knowledge and Innovation:** Architects create and disseminate knowledge focused on design and the built environment in response to ever-changing conditions. New knowledge advances architecture as a cultural force, drives innovation, and prompts the continuous improvement of the discipline.

**Lifelong Learning:** Architects value educational breadth and depth, including a thorough understanding of the discipline's body of knowledge, histories and theories, and architecture's role in cultural, social, environmental, economic, and built contexts. The practice of architecture demands lifelong learning, which is a shared responsibility between academic and practice settings.

## NAAB Student Performance Criteria

The National Architectural Accrediting Board (NAAB) accredits NJIT's architecture program. The NAAB has Program and Student Criteria that must be covered by any architectural curriculum to attain their approval. This course satisfies the following criteria in full or partially:

- **PC.5 Research and Innovation** – How the program prepares students to engage and participate in architectural research to test and evaluate innovations in the field.

- **SC.4 Technical Knowledge** – How the program ensures that students understand the established and emerging systems, technologies, and assemblies of building construction, and the methods and criteria architects use to assess those technologies against the design, economics, and performance objectives of projects.

## **Grading**

In almost every case, dramatic improvement of both understanding and ability through hard work, commitment, and initiative will be positively supported in terms of assessment. In an effort to further clarify the grading policy, below are brief summaries of the kind of work appropriate to each grade based on the NJIT undergraduate grading scale:

A (Superior): Work demonstrates an advanced understanding of learning objectives and a high level of execution in terms of production abilities. Work is reflective of an intensive process of development that goes above and beyond expectations. Work is connected to larger architectural discussions and pursuant to specific architectural aims. Products demonstrate a high level of sophistication, craft, attention to detail, and willingness to explore a wide range of production techniques. Work is further supported by advanced levels of independent initiative and research. Work excels in response to the criteria for integration described above.

B+ (Excellent) / B (Very Good): Work demonstrates a good understanding of learning objectives and a good level of production abilities. Work is reflective of a process of development that generates multiple alternatives, assesses, selects, refines, and so on. Products demonstrate a high level of sophistication, craft, attention to detail, and willingness to explore a wide range of production techniques. Work is further supported by independent initiative and investigation, as well as active participation in the studio and consistent engagement of course material. Work demonstrates a sophisticated understanding of integration criteria.

C+ (Good) / C (Acceptable): Work fulfills the requirements of the studio in terms of conceptual understanding and technical ability, including the integration requirements. Work takes few risks and has some engagement with an iterative design process. Products demonstrate a good level of craft and are carefully made. E.g., drawings are legible and correct, models are carefully cut and cleanly assembled. Work demonstrates a basic level of independent initiative. Work improves over the course of the semester and reflects a genuine effort to improve in ability and understanding.

D (Minimum): Work barely fulfills the requirements of each phase of the studio in terms of conceptual understanding and technical ability. The work process is not evident. Products demonstrate poor development of craft and/or do not demonstrate improvement over the course of the semester. Work demonstrates no additional initiative or engagement.

F (Failing): Work is incomplete and does not demonstrate an understanding of the course content or abilities related to required skills.

Evaluation of studio work will take place through design reviews and by each studio critic in discussion with other faculty. Incompletes are only granted in the event of a documented medical or family emergency and must be approved by the instructor, coordinator, and advisor.

NJIT issues mid-term warnings for students who are not performing at a satisfactory level. Any student issued a warning will be required to have a conference with the instructor to evaluate satisfactory completion of the work for the semester. At any point during the semester, students can arrange to meet with the instructor to inquire how their performance is progressing and how they may improve.

Students must complete all assignments on time and must be present and active in all class sessions. Students will be counted absent if they are not in the studio 15 minutes after the scheduled start time. If a student is late for any reason, it is his or her responsibility to notify their instructor.

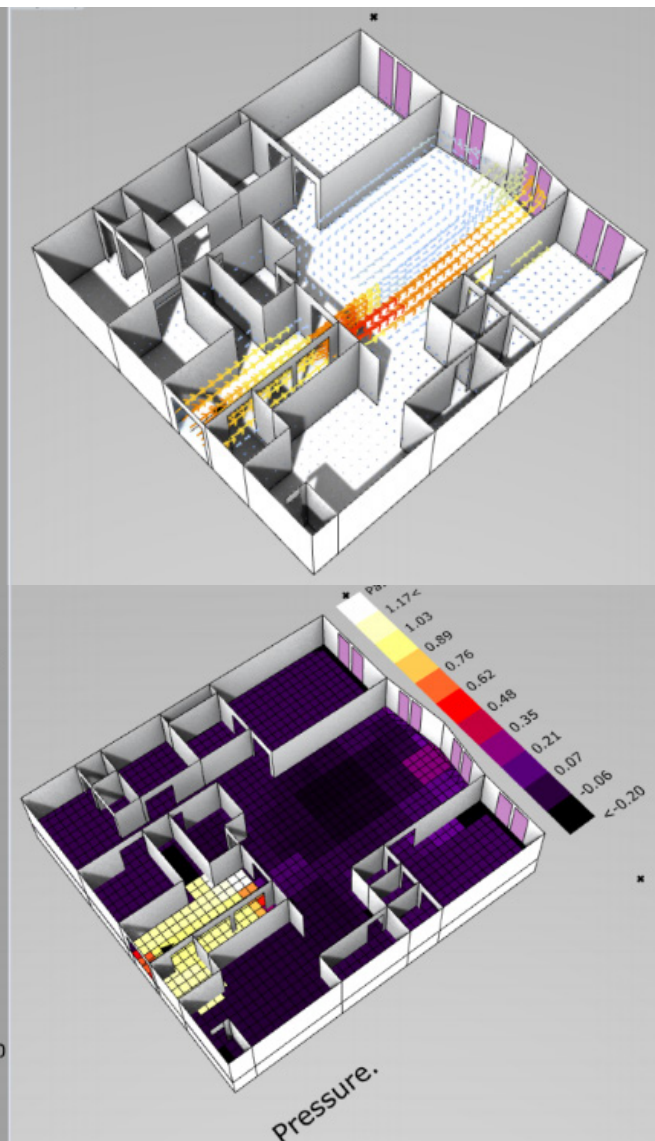
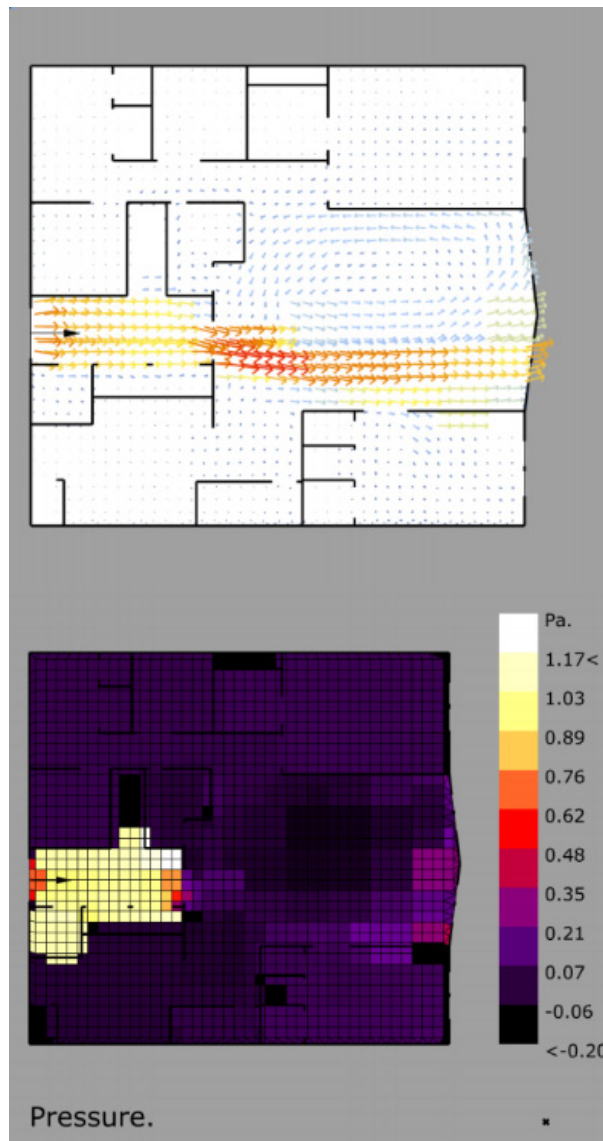
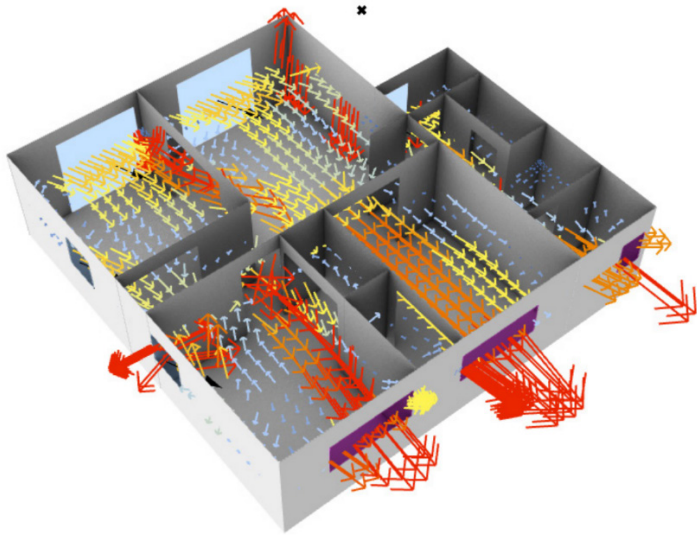
## **ATTENDANCE POLICY**

Students with either freshman or sophomore standing also have an attendance requirement overlaid on the grading criteria. No more than three unexcused absences are permitted without a grade reduction. Each unexcused absence above the three (starting with the fourth) will result in a letter grade reduction for the semester. In other words, four absences would result in a maximum grade of B (assuming everything done is of "A" quality), five absences would result in a maximum grade of "C," six in a maximum grade of "D," etc. Students do NOT receive extensions for submission of work due to any unexcused absences. Acceptance of late work is at the discretion of the individual instructor. Absences for illness in order to be excused MUST be accompanied by documentation from professional medical personnel who are NOT members of your family. Since religious holidays are known in advance, students who expect to be absent due to religious holidays must notify their instructor by the second week of class.

## **Accommodations:**

"Any student who, because of a disability, may require special arrangements to meet course requirements should contact the professor as soon as possible to make necessary accommodations. Students should present appropriate verification from the Disabled Student Services Dean of Students Office. No requirement exists that accommodations be made prior to completion of this approved University process." [TTU-Faculty Handbook, August 98].

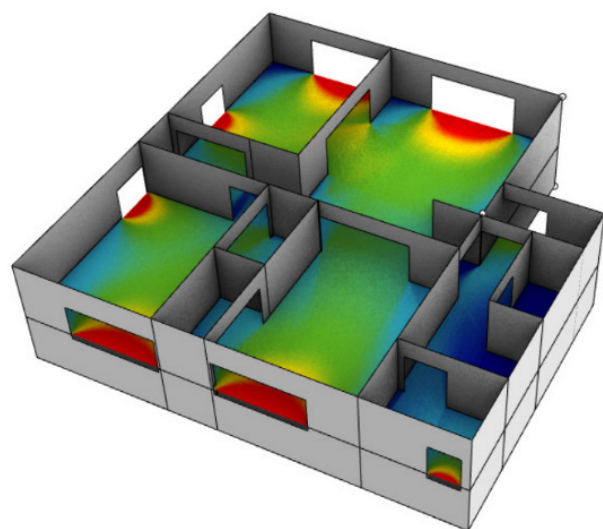
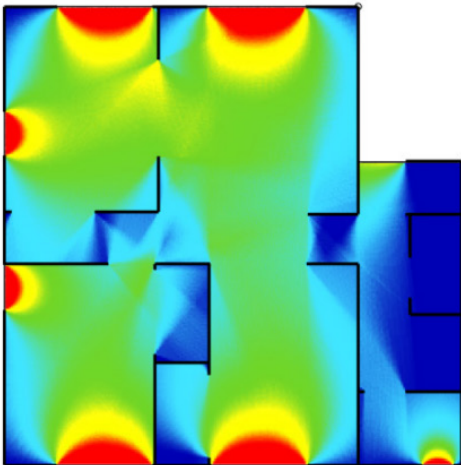
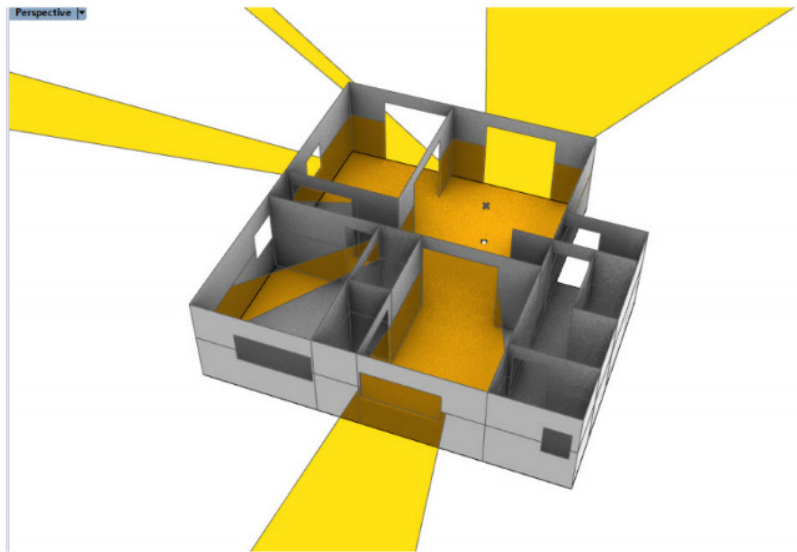
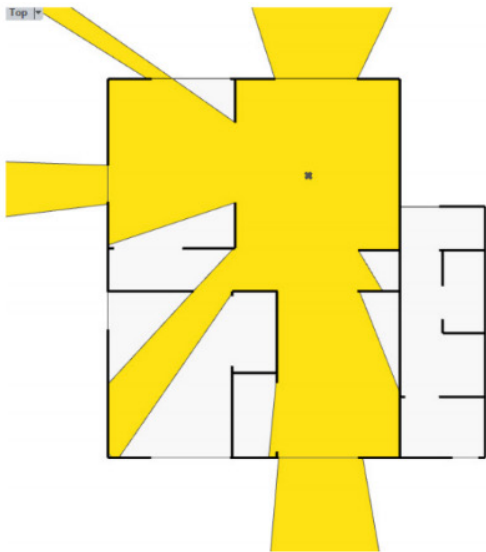




Examples of airflow analysis using the Butterfly plugin from last year



A screen capture from the VR video by one student from last year



Examples of analysis based on Isovist (visibility) analysis using DeCordingSpacesTools



## ACADEMIC INTEGRITY:

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at:

<http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf>.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F and/or suspension or dismissal from the university. If you have any questions about the Code of Academic Integrity, please contact the Dean of Students Office at [dos@njit.edu](mailto:dos@njit.edu)

## KEPLER POSTING:

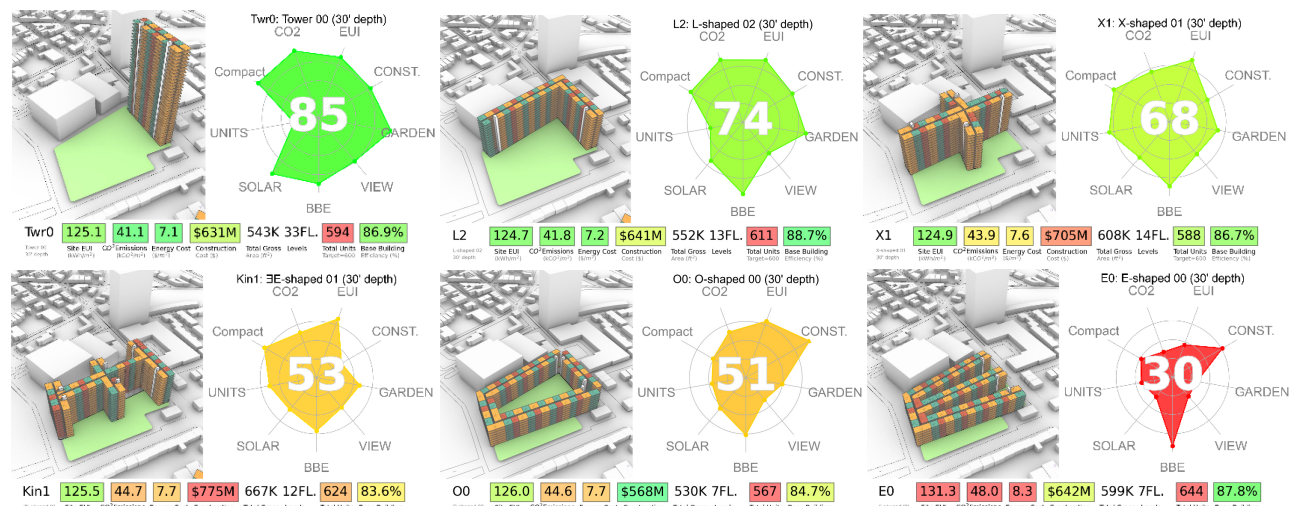
All files must be resized and renamed. Please fill out all of the metadata information. The maximum size is 2000 x 2000 pixels. Images must retain their original proportions without being enlarged. In cases where the width-to-height ratio exceeds 3:1, you may resize the short dimension to 2000 pixels. To distinguish PROCESS documents from FINAL documents, be sure to enter labeling information in the pull-down metadata section built into each Kepler file. The filename should be saved according to the following naming convention: < **Firstname Lastname ##.jpg**>. The guidelines described here are in place to promote economic representations of student work and to ensure the sustainability of the Kepler system. Grossly oversized images will be deleted without notice and will not be considered for grading purposes. All final presentation material (including PDF files of presentation boards, PowerPoint files, etc.) must be submitted on your Kepler DVD only. You must submit your slides to Kepler as .jpgs and ensure the file size is reasonable (<10 MB). You will not receive your final grade until you submit your Kepler DVD. Please consult Kepler's FAQ for further details.

## BACKUP YOUR WORK:

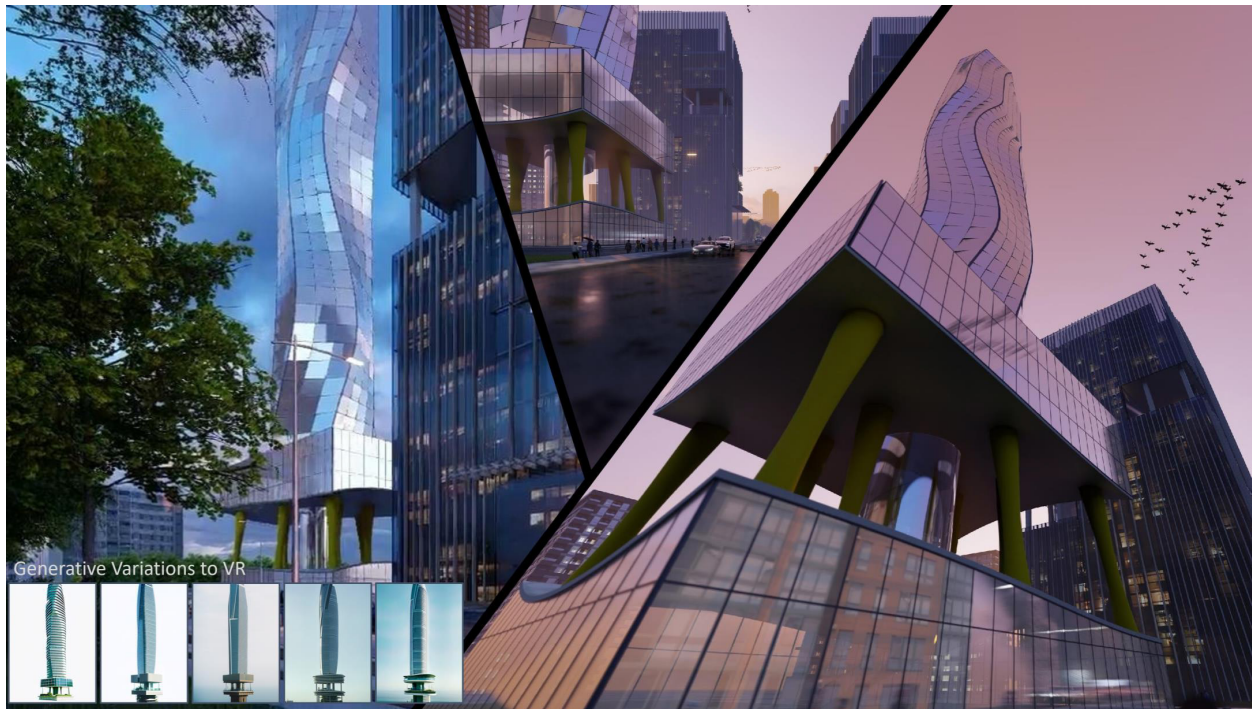
Students are required to maintain and complete backups of all their computer-based work. It is the responsibility of each student to restore or recreate any work that is lost for any reason, including the failure of University-provided software and hardware. All backup files should be stored on two independent external locations (not local or CoAD networked locations as they are subject to reformatting without notice). For suggestions on backup processes, please contact the NJIT HelpDesk ([ist.njit.edu/support/index.php](http://ist.njit.edu/support/index.php)). If you have questions, please contact Taro Narahara at [narahara@njit.edu](mailto:narahara@njit.edu).

## Online Resources & Pluralsight (aka Digital-tutors)

You are encouraged to use any online resource in terms of learning skills and techniques for software. Also, check out new programs from Pluralsight, with tutorials on tons of [software](#) and [subjects](#). Click [here](#) to get to the login page. Registration will only work with your NJIT email address. Once you're registered, you can use the Digital Tutors program for one hour at a time from campus-wide IP ranges only.







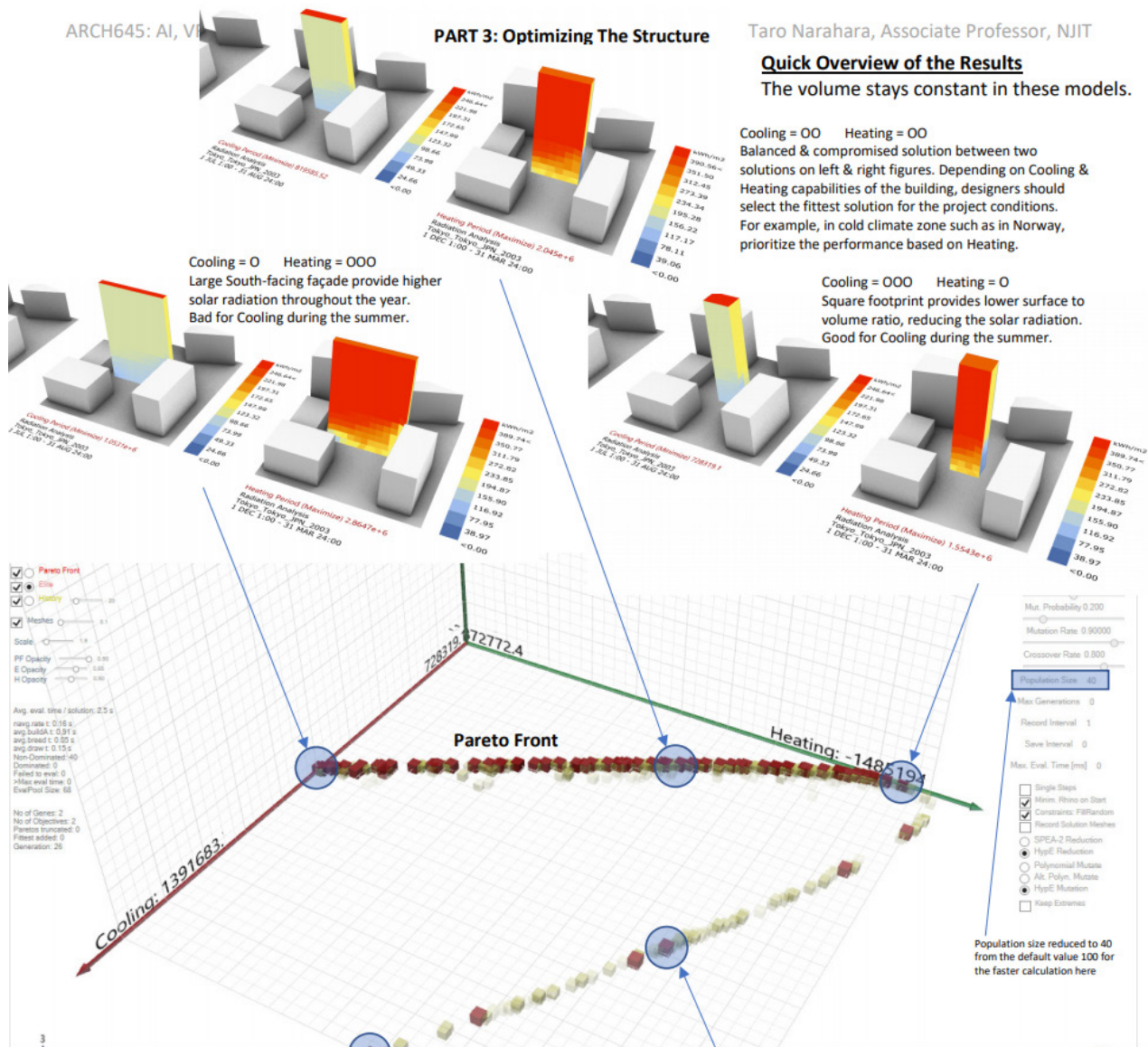
ARCH645: AI, VR

### PART 3: Optimizing The Structure

Taro Narahara, Associate Professor, NJIT

#### Quick Overview of the Results

The volume stays constant in these models.



Sample images of the projects from last year