ARCH 5501/02/03: Advanced Architectural Design Studio
College of Architecture, Texas Tech University
Spring, 2021

Instructor: Assistant Professor Dr. Peng Du (peng.du@ttu.edu)
Time: M,W,F, 1:00-4:50pm
Attributes: Face to Face + Online
Classroom: ARCH 602

Generative Urban Design:
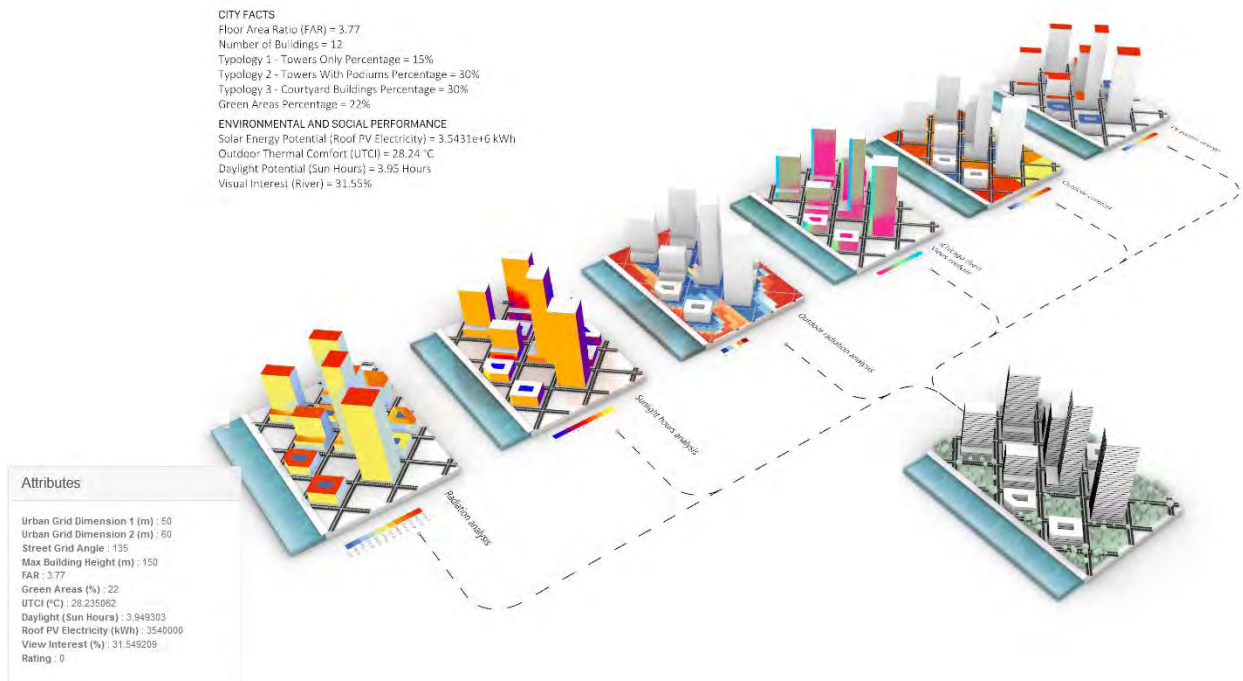# Optimizing Urban Form, Environmental and Social Performance

Figure: Generative Urban Design – Optimizing Urban Density, Green Space, Outdoor Comfort, Daylight Potential, Solar Energy Potential, and Visual Interest. Best Option for Daylight Potential. @ Prof. Peng Du

I. COURSE INFORMATION

Course Title

Generative Urban Design: Optimizing Urban Form, Environmental and Social Performance

Catalog Description

5 Semester Credit Hours

Topical studio that explores design, theoretical and/or technological issues that affect current architectural thought and practice. F, S.

Course Description

This forth semester graduate studio is an exploratory design studio with an emphasis on growing contemporary practice instead of single project design. Students are introduced to design practices all engaged with contemporary forms of research and innovation. Students are encouraged to engage different theoretical stances and to align those stances with methods of research and practice. This course prepares students to form self-guided contemporary design methods and processes in their own work.

Studio Brief

With more than a million people moving to urban areas every week, and the global population projected to be 70% urbanized by 2050 – set against a backdrop of extreme environmental challenges relating to climate change and resource depletion - cities are facing profound challenges for substantial portions of their citizenship. Now is the time to rethink the future of how cities are designed.

Generative Design is a framework that involves the integration of a rule-based geometric system, a series of measurable goals, and a system for automatically generating, evaluating, and evolving a very large number of design options. This studio will use data-driven and simulation-based tools for generative urban design, in the context of compact, high-density cities. Particularly, the studio will examine the nature and extent of relationships between the urban form (e.g., street grid, floor area ratios, and building typologies), environmental parameters (e.g., building energy use intensity, daylight availability, outdoor thermal comfort, and solar energy potential), and social parameters (e.g., accessibility, walkability, green spaces, and visual interest).

Named "The 78", the project site is located on a 62-acre parcel of land just south of Downtown Chicago and north of Chinatown. The area is bordered by Roosevelt Road to the north, Clark Street to the east, 16th Street to the south, and the South Branch of the Chicago River to the west. The name "The 78" refers to the existing 77 community areas in Chicago and the mega-development is to increase that number by one. This massive extension of the Chicago Loop is expected to establish a dynamic new residential, commercial, academic, civic, cultural, and recreational mixed-use neighborhood.

Figure: Project Site: "The 78" @ sloopin

Figure: Proposed urban space at "The 78" @ SOM

Students will work in pairs to develop a generative design methodology capable of producing hundreds or even thousands of urban design schemes, assessed by various environmental and social parameters, and to further develop the optimal design scheme to improve the quality of the urban and architectural

spaces. The iterative analytical explorations of the city models in this studio will allow students to not only determine the schemes with the optimum performance satisfying individual parameters, but also to explore the nuances of balancing trade-offs.
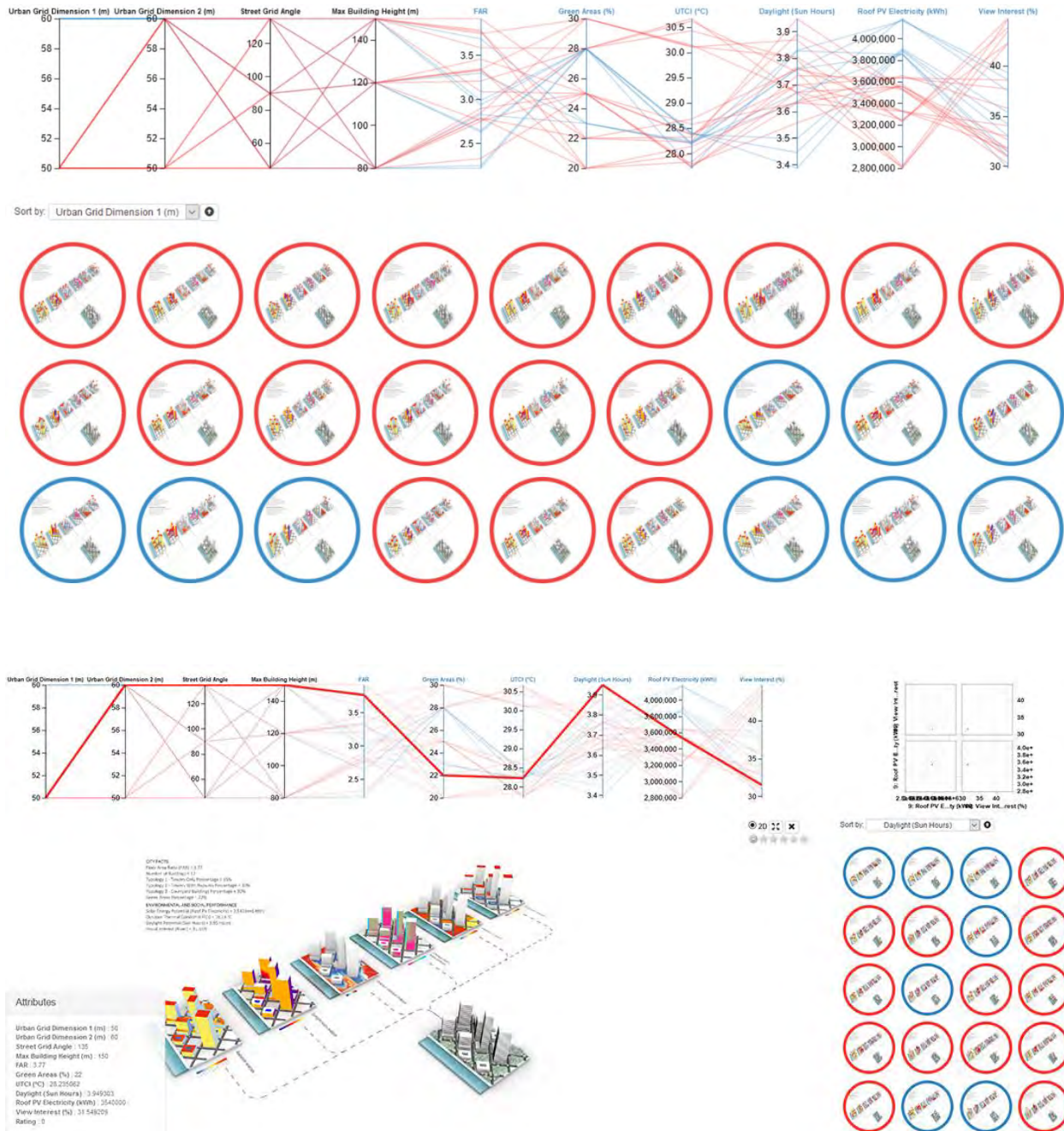

Figure: Generative Urban Design – Optimizing Urban Density, Green Space, Outdoor Comfort, Daylight Potential, Solar Energy Potential, and Visual Interest @ Prof. Peng Du

Student Learning Objectives

Upon the completion of the studio the student will:

1. be introduced and engage in a range of contemporary architectural design practice.
2. be fostered a critical attitude towards design practices within multivariant contexts.
3. be encouraged voice within the discipline of architecture and introduced modes of design as architectural discourse.
4. develop a rewarding attitude towards advanced and innovative techniques and processes.

Student Performance Objectives

Upon the completion of the studio the student will:

1. Acquire the understanding and knowledge required to critically discuss / present sustainability of cities.
2. Design systems which encode the full range of possibilities of a particular urban design concept, in terms of urban form, environmental and social parameters.
3. Measure and quantify the performance of these systems so that each design can be evaluated automatically by the computer.
4. Create automated evolutionary processes which will allow the computer to search through the design systems to find high-performing design schemes.
5. Evaluate and determine the schemes with the optimum performance satisfying individual parameters, and explore the nuances of balancing trade-offs.
6. Modify the design options generated by the computer, and improve the quality of the urban and architectural spaces.

Means of Evaluation:

Deliverables:

1. Well-crafted concepts, diagrams, drawings, models, animations, analysis, and rigorous development of an urban design idea
2. Comprehensive evaluation and optimization of design options
3. Accurate and well-organized scripts for the computational design and simulation

Methods of Assessment:

Expectations of the deliverables set forth above shall be completed in a timely manner, assessed through regular interaction, participation, and criticism of the output with the instructors. Students are expected to develop their design through a process which is not necessarily linear, but flexible (somewhat circular) design process as each design iteration leads to greater clarity, resolution, definition, and specificity. It is important to note that this process does not always move from general to specific, as design processes will often require iteration, testing, and re-design throughout the semester.

Teaching Methods / Studio Methods

The studio will introduce fundamental design strategies and approaches of sustainable cities, and advanced techniques to model, simulate and analyze the performance of the cities from both environmental and social perspectives. The course will lean heavily on digital modeling within the Rhinoceros 3D and Grasshopper modeling environment to perform simulations and analysis. Students will learn state-of-the-art tools to automatically search through their design models for high-performing solutions, and also to evaluate the search process to derive new knowledge about their design. All the tools will be taught through hands-on tutorials by the instructor and guest to tutors.

In addition to the specific materials required for this studio, students are expected to develop their own process and position within the fields of architecture and urbanism. As an ongoing critical search, students should not be seeking off-the-shelf answers, but instead asking better questions. The studio inculcates a high standard of proficiency, pride, and confidence in producing high-quality work.
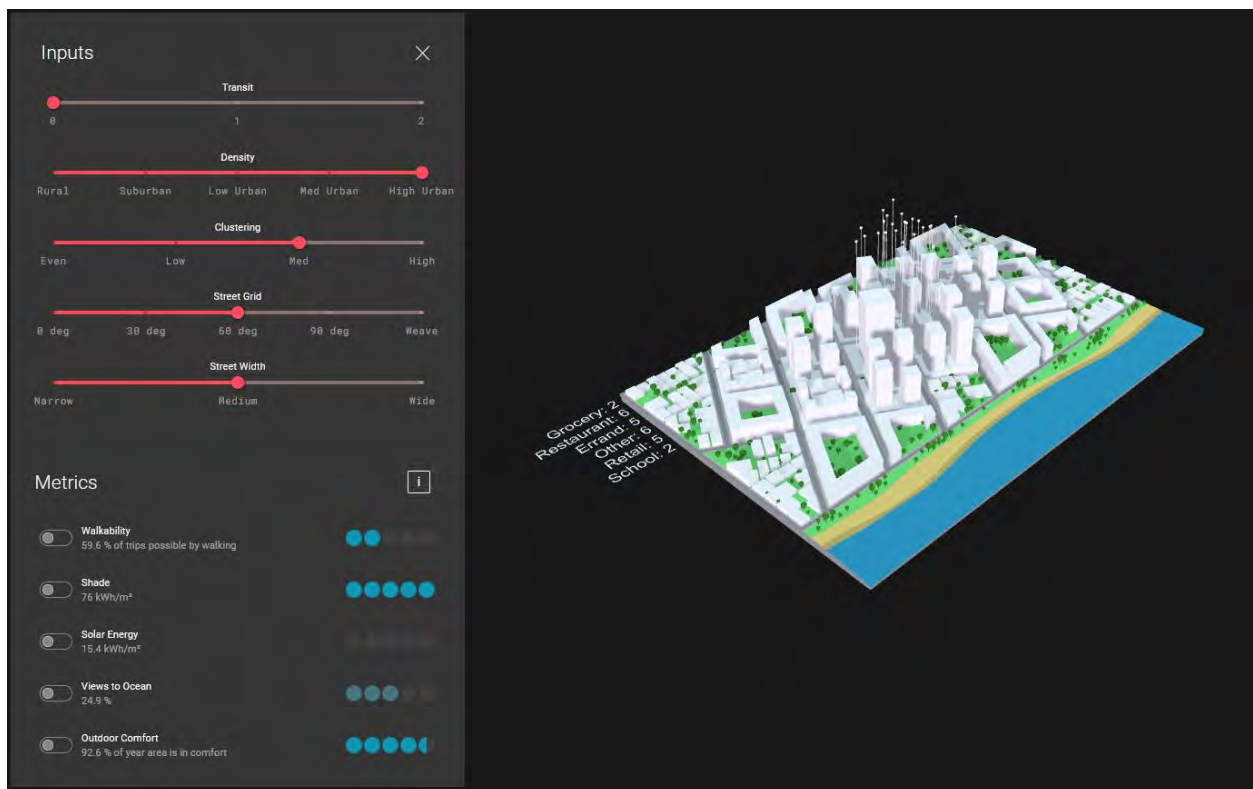

Figure: Generative Urban Design, Visualized by Scout @ KPF Urban Interface

Course Schedule

WK1	1/22	F	Studio Introduction

1. Urban Form: Design for the Building Typologies and Urban Networks

WK2	1/25	M	Guest Lecture (1:30pm): Lucien Wilson, Director, Urban Interface, KPF
			Studio Day: Site Analysis
	1/27	W	Guest Lecture: James Parakh (3:00pm), Urban Design Manager, City of Toronto Planning Division
			Studio Day: Site Analysis
	1/29	F	Guest Lecture: Philip Enquist (1:30pm), Consulting Partner, Urban Design and Planning, SOM
			Studio Day: Site Analysis
WK3	2/1	M	Software Tutorial 1: Street Grid Modeling // Studio Day: Street Gird and Building Typology Research
	2/3	W	Software Tutorial 2: Building Typology Modeling // Studio Day: Street Gird and Building Typology Research
	2/5	F	Software Tutorial 3: Urban Structure Modeling // Studio Day: Street Gird and Building Typology Research
WK4	2/8	M	Studio Day: Urban Massing Design
	2/10	W	Studio Day: Urban Massing Design
	2/12	F	Software Tutorial 4: Generative Design (Basic Level – Design Explorer)

2. Urban Performance: Simulation and Optimization of the Environmental and Social Performance

WK5	2/15	M	Studio Day: Generative Design and Analysis
	2/17	W	Software Tutorial 5: Simulation I – Daylight, Comfort and Visual
	2/19	F	Software Tutorial 6: Simulation II – Energy
WK6	2/22	M	Studio Day: Urban Modeling and Simulation
	2/24	W	Studio Day: Urban Modeling and Simulation
	2/26	F	Wellness Day (No Class)
WK7	3/1	M	Software Tutorial 7: Generative Design (Advanced Level - Scout)
	3/3	W	Studio Day: Generative Design
	3/5	F	Studio Day: Generative Design
WK8	3/8	M	Studio Day: Generative Design
	3/10	W	Studio Day: Generative Design
	3/12	**F**	**Midterm Review**
WK9	3/15	M	Software Tutorial 7: Reflection
	3/17	W	Studio Day: Generative Design and Analysis
	3/19	F	Wellness Day // No Class

3. Urban Space: Improvement of the Design Quality of the Urban and Architectural Spaces

WK10	3/22	M	Studio Day: Design Optimization and Modification
	3/24	W	Studio Day: Design Optimization and Modification
	3/26	F	Studio Day: Design Optimization and Modification
WK11	3/29	M	Studio Day: Design for Urban and Architectural Spaces
	3/31	W	Studio Day: Design for Urban and Architectural Spaces
	4/2	F	Studio Day: Design for Urban and Architectural Spaces
WK12	4/5	M	Wellness Day (No Class)
	4/7	W	Studio Day: Design for Urban and Architectural Spaces
	4/9	**F**	**Pre Final Review**
WK13	4/12	M	Studio Day: Design Optimization and Modification
	4/14	W	Studio Day: Design Optimization and Modification
	4/16	F	Studio Day: Design Optimization and Modification
WK14	4/19	M	Studio Day: Design Optimization and Modification
	4/21	W	Studio Day: Design Optimization and Modification
	4/23	F	Studio Day: Design Optimization and Modification
WK15	4/26	M	Studio Review Week // No Class
	4/28	W	Studio Review Week // No Class
	4/30	F	Studio Review Week // No Class
WK16	**5/4**	**T**	**Final Review** (all day) // Last Day of Class
	TBD	TBD	Final Submission

Note: These dates are subject to change at the discretion of the instructor, guest speakers, and/or the College of Architecture.

Recommended Texts

Books on Reserve COA Library. The resources below are by no means complete, but should give you a basis for supplementing your existing knowledge on architecture, structure, environmental systems, programming, detailing, and assemblies. Other readings may be assigned by the instructor throughout the semester.

Books / Research Papers:

1. Sim, David, and Jan Gehl. *Soft City: Building Density for Everyday Life*. Illustrated edition. Washington ; Covelo ; London: Island Press, 2019.
2. Initiative, Global Designing Cities, and National Association of City Transportation Officials. *Global Street Design Guide*. 2nd None ed. edition. Washington D.C.: Island Press, 2016.
3. Oliviera, Sonja, Bill Gething, and Elena Marco. *Energy Modelling in Architecture: A Practice Guide: A Practice Guide*. 1st edition. London: RIBA Publishing, 2020.
4. Wilson, Luc, Jason Danforth, Carlos Cerezo Davila, and Dee Harvey. "How to Generate a Thousand Master Plans: A Framework for Computational Urban Design." In *Proceedings of the Symposium on Simulation for Architecture and Urban Design*, 1–8. SIMAUD '19. San Diego, CA, USA: Society for Computer Simulation International, 2019.
5. Zhang, Ji, Le Xu, Veronika Shabunko, Stephen En Rong Tay, Huixuan Sun, Stephen Siu Yu Lau, and Thomas Reindl. "Impact of Urban Block Typology on Building Solar Potential and Energy Use Efficiency in Tropical High-Density City." *Applied Energy* 240 (April 15, 2019): 513–33.
6. Shi, Zhongming, Jimeno A. Fonseca, and Arno Schlueter. "A Parametric Method Using Vernacular Urban Block Typologies for Investigating Interactions between Solar Energy Use and Urban Design." *Renewable Energy* 165 (March 1, 2021): 823–41.
7. Natanian, Jonathan, Or Aleksandrowicz, and Thomas Auer. "A Parametric Approach to Optimizing Urban Form, Energy Balance and Environmental Quality: The Case of Mediterranean Districts." *Applied Energy* 254 (November 15, 2019): 113637.

Software / Tools:

1. [Learning Resources @ Ladybug Tools](#)
2. [Publications @ Ladybug Tools](#)
3. [Presentations @ Ladybug Tools](#)
4. [Hydra: example files from Grasshopper and Dynamo](#)
5. [Design Explorer](#)
6. [Scout](#)

Course Requirements

Required Computer + Internet Connectivity: Students must provide and maintain their own laptop computer in and after classes. See the college website for minimum specifications. With much of the class being digital, including design review and desk critiques, a laptop with camera and microphone will be extremely important for conveying design ideas. Technical difficulties, viruses, corrupted files,

crashes, server, or print bureau problems will not be accepted as excuses for not producing assigned work. All digital work should be regularly backed up.

Required Software:

1. AutoCAD or Rhino can be used for general 2D drafting.
2. Adobe Photoshop, Illustrator, InDesign, Acrobat, and Illustrator are required for all other 2D drawing and diagram output.
3. Rhino and Grasshopper will be used in the 3D modeling and parametric design. Grasshopper proficiency is not required, but a basic understanding will help.
4. Numerous grasshopper plugins (free of charge) will be used for modeling, simulation and analysis, such as Ladybug Tools for the performance simulation, Colibri for the generative design, etc. Detailed software installation instructions and support will be provided in class.
5. Design Explorer (open web platform developed by Thornton Tomasetti) and Scout (platform developed by KPF Urban Interface) will be used to explore and analyze design options
6. Blender or similar software (free of charge) will be used to create animations.

Dimension / Measurement:

The course will use International System of Units, e.g., meter or square meter, instead of the Imperial (English) system, e.g., foot or square foot.

Note: Due to the COVID-19 pandemic, and the computational design approach for this studio, no physical models will be required.

Grading

Grading certifies that the student has clearly demonstrated a level of expertise for the design process and product, as required for each studio phase. Studio grading is not an exact mathematical assessment. It is based on years of experience and expertise in the criticism and judgment of student design process and final work. Production and hard work lead to improvement, and demonstrated improvement is a key component in final grading.

Grade Definitions:

1. A (excellent) exceptional work, exceeding the requirements of the course, showing strong understanding, skills, effort, initiative, and independent resourcefulness.
2. B (good) performance above the norm; work demonstrates adequate understanding, skills, effort, initiative, and improvement beyond the minimum requirements of the course.
3. C (average) meets minimum requirements and demonstrates satisfactory understanding, skills, and effort; little initiative to investigate the problem without substantial prodding from the instructor; work shows minimal improvement.
4. D (inferior) work that does not satisfy minimum requirements, understanding, skills, and effort; initiative lacking; improvement not noticeable.
5. F (failure) does not meet requirements to the extent the student must repeat the course.

Plus and minus marks may be used to indicate higher and lower rating in each grade division for the purposes of averaging progress reports and final grades. A student who has shown clear successful improvement throughout the semester may be given the advantage in the case of borderline final grade averages.

More on grading: TTU OP. 34.12 on Grading https://www.depts.ttu.edu/opmanual/OP34.12.pdf

The instructor will issue three progress evaluations during the semester, after each studio phase. The following criteria will be utilized within this assessment:

1. Process/Rigor (development and articulation)
2. Craft/Precision (analog-digital representation)
3. Resolution (curricular integration)
4. Critical Ideology (research and critical thinking)
5. Professionalism (passion, dedication, timely submission of work, and attendance record)

Grading Criteria:

Performance-based grade evaluations will be made by the instructor, and based on student participation and projects weighting below:

1. Participation in Class / Computational Design = 20%
2. Midterm Review = 40%
3. Final Review = 40%

   Total = 100%

Retention of Student Work:

Retention of Student Work. The College of Architecture reserves the right to retain, exhibit, and reproduce work submitted by students. Work submitted for a grade is the property of the college.

Attendance Policy

1. Students are responsible for attending all scheduled class meetings for the full class period. This applies to face-to-face AND virtual meetings.
2. Attendance requires each student to have their computer, tools, materials, and supplies available for all studio activities.
3. When you are absent you miss important course content that effects student performance. You will have to work harder to make up for any absences.
4. Absences will affect the final grade at the instructor's discretion
5. Violating a maximum of four absences for studio will require the student to drop the class or receive a grade of "F" in compliance with drop deadlines (see COA Attendance policy).
6. Absences are only for reasonable unforeseen circumstances such as getting sick or emergencies. If you are sick, please stay home. Inform the instructor directly.

7. Any absence is considered UNEXCUSED, unless it meets the criteria discussed in the TTU Student Handbook, Part II Com-munity Policies, Section D: Class Absences (page 62) for the following:
    a) Illness requiring an absence from class for more than one week.
    b) Religious Holy Day Absences.
    c) Student Absence due to Sponsorship of Student Activities and Off-Campus Trips.
    d) See section II on specific COVID-19 Instructions related to attendance.

NAAB Criteria Met (NAAB 2014)

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. Student learning aspirations for this realm include

- Comprehending the importance of research pursuits to inform the design process.
- Evaluating options and reconciling the implications of design decisions across systems and scales.
- Synthesizing variables from diverse and complex systems into an integrated architectural solution.
- Responding to environmental stewardship goals across multiple systems for an integrated solution

II. COVID-19 INFORMATION

Face coverings are required. Texas Tech University requires that students wear face coverings while in classes, while otherwise in campus buildings, and when social distancing cannot be maintained outdoors on campus.

Signage. Be attentive to signage posted at external and some classroom doorways that indicates entry and exit ways, gathering and queuing spaces, and availability of masks and hand sanitizer.

Seating assignments. The purpose of assigned seating is to assist in contact tracing, if necessary, and to augment social distancing. Students are expected to sit at a minimum of six feet apart. A required seating chart will be created once everyone is positioned with appropriate social distancing. There will also be an orderly procedure, designed to ensure social distancing, for exiting the classroom.

Illness-Based Absence Policy
If at any time during this semester you feel ill, in the interest of your own health and safety as well as the health and safety of your instructors and classmates, you are encouraged not to attend face-to-face class meetings or events. Please review the steps outlined below that you should follow to ensure your absence for illness will be excused. These steps also apply to not participating in synchronous online class meetings if you feel too ill to do so and missing specified assignment due dates in asynchronous online classes because of illness.

1. If you are ill and think the symptoms might be COVID-19-related:
    a) Call Student Health Services at 806.743.2848 or your health care provider.

b) Self-report as soon as possible using the ttucovid19.ttu.edu management system. This website has specific directions about how to upload documentation from a medical provider and what will happen if your illness renders you unable to participate in classes for more than one week.

c) If your illness is determined to be COVID-19-related, remaining documentation and communication will be handled through the Office of the Dean of Students, including notification to your instructors.

d) If your illness is determined not to be COVID-19-related, please follow steps 2.a-d below.

2. If you are ill and can attribute your symptoms to something other than COVID-19:

a) If your illness renders you unable to attend face-to-face classes, participate in synchronous online classes, or miss specified assignment due dates in asynchronous online classes, you are encouraged to visit with either Student Health Services at 806.743.2848 or your health care provider. Note that Student Health Services and your own and other health care providers may arrange virtual visits.

b) During the health provider visit, request a "return to school" note;

c) E-mail the instructor a picture of that note;

d) Return to class by the next class period after the date indicated on your note.

Following the steps outlined above helps to keep your instructors informed about your absences and ensures your absence or missing an assignment due date because of illness will be marked excused. You will still be responsible to complete within a week of returning to class any assignments, quizzes, or exams you miss because of illness.

III. UNIVERSITY REQUIRED STATEMENTS

ADA STATEMENT:
Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services during the instructor's office hours. Please note: instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided. For additional information, please contact Student Disability Services in West Hall or call 806-742-2405.

ACADEMIC INTEGRITY STATEMENT:
Academic integrity is taking responsibility for one's own class and/or course work, being individually accountable, and demonstrating intellectual honesty and ethical behavior. Academic integrity is a personal choice to abide by the standards of intellectual honesty and responsibility. Because education is a shared effort to achieve learning through the exchange of ideas, students, faculty, and staff have the collective responsibility to build mutual trust and respect. Ethical behavior and independent thought are essential for the highest level of academic achievement, which then must be measured. Academic achievement   includes scholarship, teaching, and learning, all of which are shared endeavors. Grades are a device used to quantify the successful accumulation of knowledge through learning. Adhering to the standards of academic integrity ensures grades are earned honestly. Academic integrity is the foundation upon which students, faculty, and staff build their educational and professional careers. [Texas Tech University ("University") Quality Enhancement Plan, Academic Integrity Task Force, 2010]

RELIGIOUS HOLY DAY STATEMENT:

"Religious holy day" means a holy day observed by a religion whose places of worship are exempt from property taxation under Texas Tax Code §11.20. A student who intends to observe a religious holy day should make that intention known in writing to the instructor prior to the absence. A student who is absent from classes for the observance of a religious holy day shall be allowed to take an examination or complete an assignment scheduled for that day within a reasonable time after the absence. A student who is excused under section 2 may not be penalized for the absence; however, the instructor may respond appropriately if the student fails to complete the assignment satisfactorily.

DISCRIMINATION, HARASSMENT, AND SEXUAL VIOLENCE STATEMENT:

Texas Tech University is committed to providing and strengthening an educational, working, and living environment where students, faculty, staff, and visitors are free from gender and/or sex discrimination of any kind. Sexual assault, discrimination, harassment, and other Title IX violations are not tolerated by the University. Report any incidents to the Office for Student Rights & Resolution, (806)-742-SAFE (7233) or file a report online at titleix.ttu.edu/students. Faculty and staff members at TTU are committed to connecting you to resources on campus. Some of these available resources are: TTU Student Counseling Center, 806- 742-3674, https://www.depts.ttu.edu/scc/(Provides confidential support on campus.) TTU 24-hour Crisis Helpline, 806-742-5555, (Assists students who are experiencing a mental health or interpersonal violence crisis. If you call the helpline, you will speak with a mental health counselor.) Voice of Hope Lubbock Rape Crisis Center, 806-763-7273, voiceofhopelubbock.org (24-hour hotline that provides support for survivors of sexual violence.) The Risk, Intervention, Safety and Education (RISE) Office, 806-742-2110, https://www.depts.ttu.edu/rise/ (Provides a range of resources and support options focused on prevention education and student wellness.) Texas Tech Police Department, 806-742- 3931,http://www.depts.ttu.edu/ttpd/ (To report criminal activity that occurs on or near Texas Tech campus.)

CIVILITY IN THE CLASSROOM STATEMENT:

Texas Tech University is a community of faculty, students, and staff that enjoys an expectation of cooperation, professionalism, and civility during the conduct of all forms of university business, including the conduct of student–student and student–faculty interactions in and out of the classroom. Further, the classroom is a setting in which an exchange of ideas and creative thinking should be encouraged and where intellectual growth and development are fostered. Students who disrupt this classroom mission by rude, sarcastic, threatening, abusive or obscene language and/or behavior will be subject to appropriate sanctions according to university policy. Likewise, faculty members are expected to maintain the highest standards of professionalism in all interactions with all constituents of the university (www.depts.ttu.edu/ethics/matadorchallenge/ethicalprinciples.php).

LGBTQIA SUPPORT STATEMENT*:

I identify as an ally to the lesbian, gay, bisexual, transgender, queer, intersex, and asexual (LGBTQIA) community, and I am available to listen and support you in an affirming manner. I can assist in connecting you with resources on campus to address problems you may face pertaining to sexual orientation and/or gender identity that could interfere with your success at Texas Tech. Please note that additional resources are available through the Office of LGBTQIA within the Center for Campus Life, Student Union Building Room 201, www.lgbtqia.ttu.edu, 806.742.5433."

*If you prefer to list campus resources rather than a statement about ally status, you might include the following among other campus resources you wish to share:

Office of LGBTQIA, Student Union Building Room 201, www.lgbtqia.ttu.edu, 806.742.5433
Within the Center for Campus Life, the Office serves the Texas Tech community through facilitation and leadership of programming and advocacy efforts. This work is aimed at strengthening the lesbian, gay, bisexual, transgender, queer, intersex, and asexual (LGBTQIA) community and sustaining an inclusive campus that welcomes people of all sexual orientations, gender identities, and gender expressions.