ARC 574 Parametric Design, USC School of Architecture

3 Units, Spring 2022
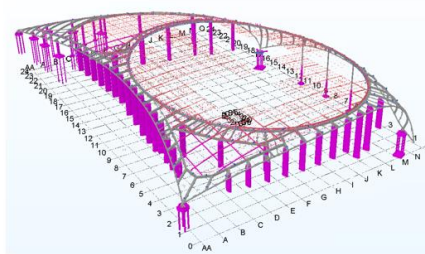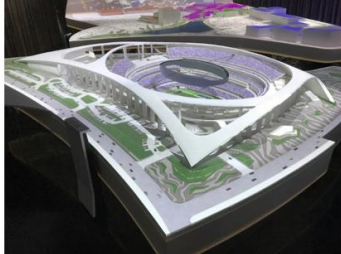Instructor: Kais Al-Rawi, AIA
Day and Time: Tuesday 6:00-8:20 PM
Location: WPH B36, unless noted otherwise.

The Digital Twin

Parametric design workflows in professional practice, with a focus on Complex Facades and Structures

SoFi Stadium Los Angeles – from design vision to virtual construction to execution. Courtesy of Walter P Moore
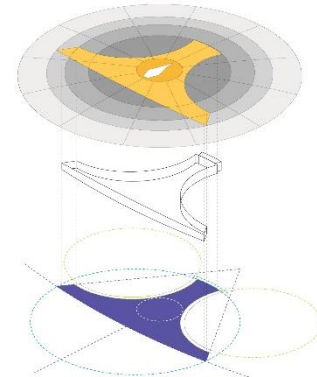
Course Description

The *Digital Twin* is a virtual 3D representation model which is developed to a level of detail (LOD) that creates a counterpart to the physical project. It is becoming an increasingly important design and collaboration instrument to the successful delivery of architectur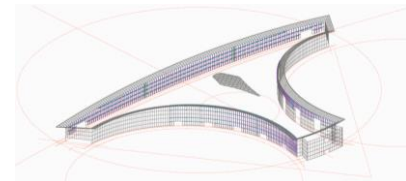al projects of various scales and typologies. Parametric design and computational workflows have enabled streamlined processes to attain a digital twin – which ultimately results in elevated design collaborations and processes to analyze, design, engineer, integrate, coordinate, document, and construct projects.

This course will introduce students to the state of the art in the use of digital workflows in professional practice through a series of case study presentations on recent major projects in the US. Furthermore, the course will include hands-on software seminars introducing data structures, interoperability workflows and best practices on parametric model setups. The relationship between the digital and physical twins will be explored through project assignments that utilize digital fabrication and the concept of assemblies, fostering an understanding of tolerances, indexing and level of detail.
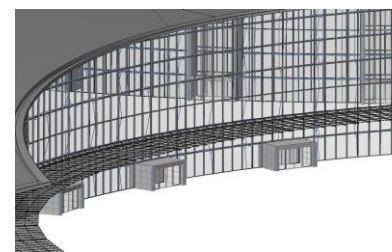
Workflows Concept to Construction

Geometry Control

Panelization

BIM Coordination

Learning Objectives

+ To gain an understanding of the applicability of digital workflows in architecture, engineering, and construction practices.
+ To develop ability to use of parametric design software and technologies.
+ To gain ability in linking the digital model to physical elements and digital fabrication
+ To test, improve, represent, and effectively communicate and collaborate between multiple individuals, and multiple platforms.
+ To situate and critically appraise parametric design methods and modes of design research, within the current discourse of architecture.
+ To conduct independent research and resolve evolving problems.
+ To indicate understanding and resolve aesthetic, tectonic, structural, and material problems.

Technological Proficiency and Software Required

Prior knowledge of 3D modelling in Rhino is required.

Primary:
Rhinoceros 7; Grasshopper Plug-in; Rhino Inside
MS Excel

Secondary:
MS Powerpoint or Keynote; Adobe CC including
Photoshop, Illustrator, InDesign

Miro will be used for course notes and progress review.
https://tinyurl.com/arc574miro

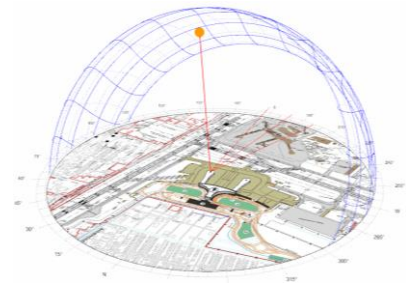## Instructor Contact Information & Office Hours

Instructor: Kais Al-Rawi, kalraw@usc.edu
Office Hours: Friday 3-5PM, by appointment only.

Class Assistant: Zheng Li
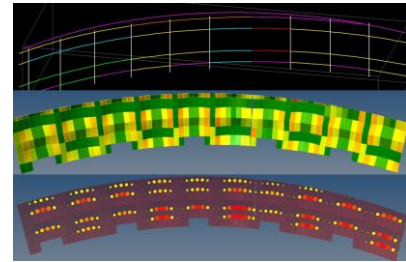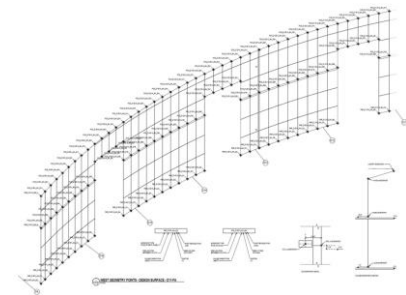Lab Hours: Thursday 11-1PM, virtual – by zoom.
https://usc.zoom.us/j/98758419968?pwd=VXRjK010d05oelVMN
VRaaDFBSC8vUT09

Environmental Analysis

Engineering Analysis

Documentation & Geometry Definition

Fabrication Modelling

Construction

Course Readings

Bedrick, J., & Ikerd, W., & Reinhardt, J. (2021). *BIM FORUM Level of Development (LOD) Specification*. BIM Forum

Garber, R. (2017). *Workflows: Expanding architecture's territory in the design and delivery of buildings*. John Wiley & Sons, Inc.

Hesselgren, L. (2018). *AAG2018: Advances in architectural geometry 2018*. Klein Publishing GmbH.

Iwamoto, L. (2010). *Digital Fabrications: Architectural and material techniques*. Princeton Architectural Press.

Kolarevic, B., & Klinger, K. R. (2010). *Manufacturing material effects: Rethinking design and making architecture*. Routledge.

Menges, A., & Ahlquist, S. (2011). *Computational design thinking*. John Wiley & Sons.

Morris, M., & Aling, M. (2021). *Worldmodelling: Architectural Models in the 21st Century*. John Wiley & Sons.

Schumacher, P. (2016). *Parametricism 2.0 Rethinking Architecture's agenda for the 21st century Ad*. John Wiley & Sons, Inc.

Assignments

Assignment 1 – LOD 100 Case Study Parametric Twin (Individual)

Assignment 2 – LOD 400 Parametric Components (Group)

Grading Breakdown

Attendance and Participation – 15%
Assignment I (Individual) – 35%
Assignment II (Group work) – 50%

Course Schedule

Date		Notes
Week 1: January 11th 2022	Course Introduction	
Week 2: January 18th 2022	Technical Seminar I	
Week 3: January 25th 2022	Technical Seminar II	
Week 4: February 1st 2022	Technical Seminar III	
Week 5: February 8th 2022	Assignment I workshop	Assignment I issued
Week 6: February 15th 2022	Technical Seminar IV	Assignment I due 2/18
Week 7: February 22nd 2022	Technical Seminar V	
Week 8: March 1st 2022	Technical Seminar VI	
Week 9: March 8th 2022	Assignment II workshop	Assignment II issued
Week 10: March 15th 2022	No Class – Spring Recess	
Week 11: March 22nd 2022	Case Study Presentation	Class will be virtual
Week 12: March 29th 2022	Technical Seminar VII	Class will be virtual
Week 13: April 5th 2022	Technical Seminar VIII	
Week 14: April 12th 2022	Course Site Visit – Location TBC	Assignment II due
Week 15: April 19th 2022	Assignment III presentations – Final Review	

Attendance
It is essential and required for all students to be on time and present for all seminar meetings, class lectures, and reviews. Lateness and absences will be recorded and can seriously affect course grades. **Two unexcused absences will result in a failing grade.** Dates called out in the syllabus as review dates are considered examination periods. Absences on project review dates may lead to automatic failure of the assignment unless pre-approved by the instructor. Such an absence may only be due to personal illness, family emergency, or religious observance.

Classroom Norms
Netiquette refers to etiquette on computer networks. Students are expected to treat the online class community as a safe, engaging, and professional space. Netiquette expectations are as follows: use course content to support responses; strive for clarity; exercise professionalism on camera and in all assignments; think and reflect before responding; stay on point; avoid yelling (e.g., ALL CAPS!!!); strive for quality over quantity.

Since the class will meet on Zoom, please follow this protocol to maximize your ability to concentrate and participate with minimal distractions: participate in class with web camera on, if possible; clear background of any visual distractions; keep microphone on mute unless speaking; use a headset to limit outside noises; alert others in their household not to disturb; follow established class norms for contributing to class discussion (e.g., raising hand; using chat; unmuting/muting when called upon; collaborating with small groups; presenting original work).

ADDITIONAL POLICIES

ACADEMIC INTEGRITY

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. Campus, the Student Guidebook, contains the Student Conduct Code in Part B, while the recommended sanctions are located in Appendix A: https://policy.usc.edu/scampus-part-b/. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The review process can be found at: https://sjacs.usc.edu/.

RELIGIOUS OBSERVANCES

The University recognizes the diversity of our community and the potential for conflicts involving academic activities and personal religious observation. The University provides a guide to such observances for reference and suggests that any concerns about lack of attendance or inability to participate fully in the course activity be fully aired at the start of the term. As a general principle students should be excused from class for these events if properly documented and if provisions can be made to accommodate the absence and make up the lost work. Constraints on participation that conflict with adequate participation in the course and cannot be resolved to the satisfaction of the faculty and the student need to be identified prior to the drop/add date for registration. After the drop/add date the University and the School of Architecture shall be the sole arbiter of what constitutes appropriate attendance and participation in a given course. Any student concerned about missing class for a recognized religious holiday should bring this matter up with your instructor in the first week of classes. A list of recognized religious holy days may be found at: http://orl.usc.edu/life/calendar/.

DISABILITY ACCOMMODATIONS

The University of Southern California is committed to full compliance with the Rehabilitation Act (Section 504) and the Americans with Disabilities Act (ADA). As part of the implementation of this law, the University will continue to provide reasonable accommodation of academically qualified students with disabilities so those students can participate fully in the University's educational programs and activities. Although USC is not required by law to change the "fundamental nature of essential curricular components of its programs in order to accommodate the needs of disabled students," the University will provide reasonable academic accommodations. The specific responsibility of the University administration and all faculty serving in a teaching capacity is to ensure the University's compliance with this policy. The general definition of a student with a disability is any person who has "a physical or mental impairment which substantially limits one or more of such person's major life activities," and any person who has "a history of, or is regarded as having, such an impairment." Reasonable academic and physical accommodations include but are not limited to: extended time on examinations; substitution of similar or related work for a non-fundamental program requirement; time extensions on papers and projects; special testing procedures; advance notice regarding book lists for visually impaired and some learning disabled students; use of academic aides in the classroom such as note takers and sign language interpreters; early advisement and assistance with registration; accessibility for students who use wheelchairs and those with mobility impairments; and need for special classroom furniture or special equipment in the classroom. Obtaining Accommodations: General: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to your studio instructor as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776. Physical Accommodations: DSP will work with classroom scheduling, the course instructors and their departments, and the students to arrange for reasonable accommodations. Academic Accommodations: Students seeking academic accommodations due to a physical or learning disability should make the request to the course instructor prior to or during the first week of class attendance, as well as registering with DSP as early in the semester as possible. Course instructors will require that a student present verification of documentation when academic accommodations are being requested.

WRITING CENTER

For assistance with academic writing, students may wish to take advantage of the Writing Center maintained by USC. Evaluation of paper clarity, organization, syntax and grammar is available by appointment, free of charge. If you'd like to improve your writing and your ability to communicate your ideas, consider using this valuable resource. See their website at http://dornsife.usc.edu/writingcenter/ for more information.

SUSTAINABILITY INITIATIVE

The School of Architecture has adopted the 2010 Initiative for Sustainability, which includes the following language: "The design should engage the environment in a way that dramatically reduces or eliminates the need for fossil fuel." This intention impacts our design process in a number of ways, including: orientation of buildings and site development to minimize negative environmental force impacts and take advantage of positive ones building modestly: providing the minimum space necessary to handle required programmatic needs maximum practical use of daylighting; careful use of orientation and provision of control/shading mechanisms to handle associated heat loads maximum practical use of passive solar techniques for heating and cooling maximum practical use of natural ventilation techniques; selection of hybrid systems for ventilation, heating and cooling which permit this. No school can lay a claim to Sustainability sensitivity that does not institute and vigorously pursue a recycling program. This recycling

program is in force at all times. We pledge to provide adequate, well-marked recycling containers for each section and to provide a posted, printed recycling protocol so you know what goes where.

ACCREDITATION STATEMENT

The USC School of Architecture's five-year Bachelor of Architecture program and the two-year Master of Architecture program are accredited professional architectural degree programs. All students can access and review the NAAB Conditions of Accreditation (including the Student Performance Criteria) on the NAAB Website, http://www.naab.org/accreditation/.

SUPPORT

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the American Language Institute http://ali.usc.edu/, which sponsors courses and

workshops specifically for international graduate students. The Office of Disability Services and Programs http://dsp.usc.edu/ provides certification for students with disabilities and helps arrange the relevant accommodations.

If an officially declared emergency makes travel to campus infeasible, USC Emergency Information http://emergency.usc.edu/ will provide safety and other updates, including ways in which instruction will be continued by means of Blackboard, teleconferencing, and other technology.

ACADEMIC CONDUCT

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

SUPPORT SYSTEMS

Student Counseling Services (SCS) – (213) 740-7711 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling

National Suicide Prevention Lifeline – 1 (800) 273-8255

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-4900 – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender-based harm. engemannshc.usc.edu/rsvp

Sexual Assault Resource Center

For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: sarc.usc.edu

Office of Equity and Diversity (OED)/Title IX Compliance

 (213) 740-5086

Works with faculty, staff, visitors, applicants, and students around issues of protected class. equity.usc.edu

Bias Assessment Response and Support

Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. studentaffairs.usc.edu/bias-assessment-response-support

The Office of Disability Services and Programs

Provides certification for students with disabilities and helps arrange relevant accommodations. dsp.usc.edu

Student Support and Advocacy - (213) 821-4710

Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. studentaffairs.usc.edu/ssa

Diversity at USC

Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. diversity.usc.edu

USC Emergency Information

Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime.

Provides overall safety to USC community. dps.usc.edu