USC School
of Architecture

PRELIMINARY
(in-progress, last updated 8//17)

Architecture 507: Theories of Computer Technology
Fall Semester, Units: 3
Mondays: 9 am – noon in WPH B36

Instructor: Karen Kensek
Office: Harris 208
Office Hours: send email for appointment
Contact Info: kensek@usc.edu (preferred); 213-740-2081 (office)

Class Assistant: Lingyan Yu
Office: MBS studio, Watt Hall, third floor, south side
Office Hours: to be arranged
Contact Info: lingyany@usc.edu

IT Help: Enrique Barajas, School of Architecture
**Contact Info:** ebarajas@usc.edu; 213-740-3602

Ouside class time lecture: There might be one lecture that is given outside class time. I am in the process of setting it up. When I know more, I will inform you about it.

A computer-aided design system is most useful when the structured design inside the computer can be used for something besides merely producing a picture. As soon as the process of computer-aided design is considered as building a description of the object being designed rather than as a process of simply drawing the object, horizons become tremendously expanded.

<div align="right">Ivan E. Sutherland (1973)</div>

What remains hard is modeling. The structure inherent in three-dimensional models is difficult for people to grasp and difficult too for user interfaces to reveal and manipulate. Only the determined model three-dimensional objects, and they rarely invent a shape at the computer, but only record a shape so that analysis or manufacturing can proceed. The grand challenges to three-dimensional graphics are to make simple modeling easy and make complex modeling accessible to far more people.

<div align="right">Robert Sproull (keynote speech, SIGGRAPH 1990)</div>
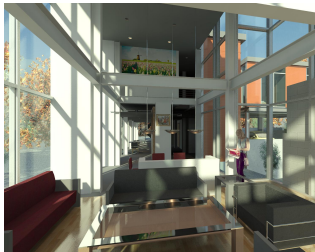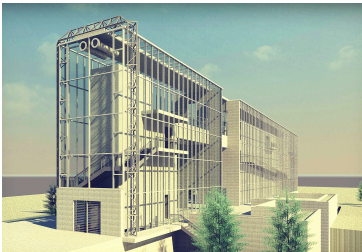
Images from students rendering homework assignment: Ji Wu, JaeYong Suk, Michael Makris

Course Description and Learning Objectives

Architecture 507 is a three unit course that meets once a week for three hours. The course will focus on the quote from Ivan E. Sutherland. Essentially what Sutherland was proposing is a system similar to a fairly recent development in computer software called building information modeling (BIM). BIM is a critical topic in the architecture profession. Learn what it is, how to apply it, innovative uses, and how it relates to sustainable design issues and the AEC industry in general. This course also relies heavily on the knowledge already in the profession: guest speakers will be used to enrich the class content with up-to-date information. It is important that you attend class on-time! In addition to many hands-on computer sessions by the instructor, there will also be guest lecturers from both the profession and the software industry. They have spent considerable time and effort to come talk with the class. Listen, be attentive, and ask appropriate questions. They are valuable resources.

This course is applicable to upper division undergraduate students and graduate students who have a strong background in traditional CAD and three-dimensional modeling. The course applies to the MBS graduate certificate if you are a graduate student. The primary software programs used will be Revit Architecture and Dynamo. Other programs such as Fuzor, Insight, Enscape, and Navisworks may also be used. Because of the rapid advancements expected in the technological underpinnings of the course, every effort is made to provide instruction that adjusts to current conditions and is generic to computer hardware and software platforms. Although offered in the School of Architecture, the techniques taught are equally applicable to others with an interest in the applications of building information modeling. Building science majors, structural engineering students, construction management students, and others are strongly encouraged to enroll. It is assumed that students have a basic understanding of 2D CAD and 3D digital modeling. Please contact the instructor if you have questions.

Prerequisite(s): upper division standing or graduate student
Co-Requisite (s): none
**Concurrent Enrollment:** none
Recommended Preparation: ability to create a 3D digital building

Course Notes

Please note that you are required to attend all the lectures, keep up with the required readings, and complete all the assignments on-time.

Technological Proficiency and Hardware/Software Required

Download **Autodesk Revit 2018** from http://students.autodesk.com . You will also be using Dynamo and Insight. More instructions will be provided on how to access them later in the semester. Contact Enrique if you have problems (ebarajas@usc.edu). **Autodesk Revit** is available on computers in the University labs and in the School of Architecture. These programs only run under Windows and are free for student use.

http://dynamobim.org/
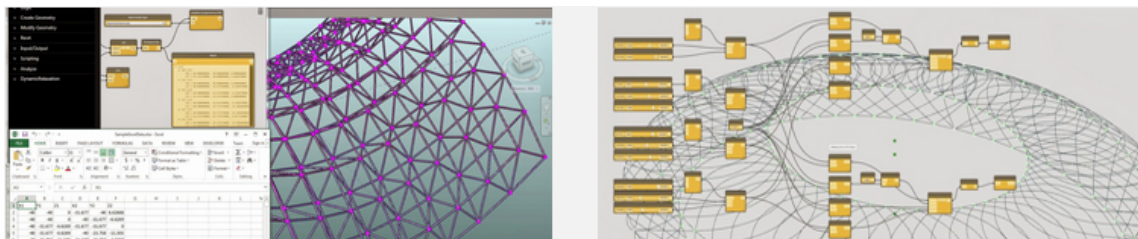
Required Readings and Supplementary Materials

Specific due dates for the readings are listed on the syllabus. You are required to have read the material **before** class. There may be in-class quizzes on the readings. There will be other readings posted on Blackboard or put on reserve in the AFA library as necessary.

There are one required textbook for this course. Please buy the Routledge book at the bookstore or order them on-line immediately from the publishers or any other place (like amazon.com). The **Routledge** book is critical for understanding the professional issues of BIM. You will be reading most of this entire book. Readings from the **Wiley** book are optional. They are intended to give you a much broader insight into research topics in BIM.

Required
> *AECbytes -Got Macros.pdf* (on Blackboard)

ROUTLEDGE
Technical Design Series: Building Information Modeling (Routledge 2014)
http://www.routledge.com/books/details/9780415717748
Karen M. Kensek, LEED AP BD+C, Assoc. AIA

Introduction

Chapter 1: BIM Overview
> Parametric modeling and the virtual building model, BIM "dimensions," Level of development, Summary

Chapter 2: Stakeholders and BIM's Many Roles
> Architects, engineers, consultants, Construction managers, contractors, sub-contractors, Fabricators, Facilities managers and owners, Summary

Chapter 3: Data Exchange and Interoperability
> Interoperability, Data exchange workflows, Single model and federated model systems, Data and communication formats, Summary

Chapter 4: BIM Implementation
> Transforming the office to BIM, Delivery methods, Legal issues, Office standards, BIM Execution Plan (BEP), Metrics for BIM maturity, Summary

Chapter 5: Beyond Basic BIM
> BIM analytics, Cloud computing, Computational design, Increased sophistication of owners, Summary

Application: Project Case Studies
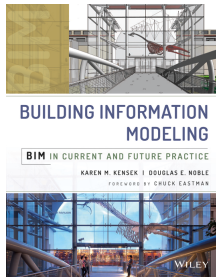> designLAB architects: Small BIM Tames Big Brutalism
> ZGF: BIM in Transition: Making the Leap at a Large Firm
> CASE: Building Information Coordinators
> Mortenson Construction: Outstanding Project Success Through Collaboration

Conclusion

Optional

WILEY
Building Information Modeling: BIM in Current and Future Practice (Wiley 2014)
http://www.wiley.com/WileyCDA/WileyTitle/productCd-111876630X.html
Karen M. Kensek, LEED AP BD+C, Assoc. AIA
Douglas E. Noble, PhD, FAIA

Foreword by Chuck Eastman

Introduction

Chapter **1**: Smart Buildings/Smart(er) Designers: BIM and the Creative Design Process
    Glenn Goldman and Andrzej Zarzycki, New Jersey Institute of Technology

Chapter **12**: Analytical BIM: BIM Fragments, Domain Gaps, and Other Impediments
    Karen M. Kensek, University of Southern California

Chapter **13**: One BIM to Rule Them All: Future Reality or Myth?
    Brian R. Johnson, University of Washington

Chapter **14**: Component-Based BIM: A Comprehensive, Detailed, Single-Model Strategy
    Anton C. Harfmann, University of Cincinnati

Chapter **16**: BIM, Materials, and Fabrication
    Christopher Beorkrem, UNC Charlotte School of Architecture

BIM Analytics (I recommend reading ONE of these six chapters)

Chapter **5**: Parametric BIM SIM: Integrating Parametric Modeling, BIM, and Simulation for
    Architectural Design
    Wei Yan, PhD, Texas A&M University

Chapter **6**: Models and Measurement: Changing Design Value with Simulation, Analysis, and
    Outcomes
    Phillip G. Bernstein and Matt Jezyk, Autodesk

Chapter **7**: Energy Modeling in Conceptual Design
    Timothy Hemsath, University of Nebraska—Lincoln

Chapter **8**: Performance Art: Analytics and the New Theatre of Design Practice
    Daniel Davis and Nathan Miller, CASE

Chapter **10**: Urban Energy Information Modeling: High Fidelity Aggregated Building Simulation
    for District Energy Systems
    Nina Baird, Shalini Ramesh ,and Khee Poh Lam, Carnegie Mellon University
    Henry Johnstone, GLHN Architects & Engineers, Inc.

Chapter **11**: BIM and the Predesign Process: Modeling the Unknown
    Michael Donn, Centre for Building Performance Research, Victoria University of Wellington

Optional readings on Blackboard
aiab095712 - AIA BIM contract documents.pdf
National Building Information Modeling Standard (NBIMSv1_p1.pdf)

Reference Documents
PDF and Zip files for Software References on Blackboard
Please download all the files in the Content section on Blackboard.

the syllabus, all the homework assignments, and the final project
AECbytes -Got Macros.pdf
aiab095712 - AIA BIM contract documents.pdf

Dynamo – **extremely useful for homeworks 9, 10, and the final project**
Dynamo Primer - http://dynamoprimer.com/
Dynamo - http://dynamobim.org/
Dynamo - http://dynamobim.com/learn/
Colin McCrone's Dynamo Language Guide - http://dynamobim.org/wp-content/uploads/forum-assets/colin-mccroneautodesk-com/07/10/Dynamo_language_guide_version_1.pdf
UNC Professor Jeremy Roh is teaching similar concepts in his course and records himself (scroll down a bit to see him explore solar facades – he actually covers these over a few classes): https://www.youtube.com/user/zedjr01/videos .
Automatic shading design - http://autodesk.typepad.com/bpa/2013/08/more-fun-with-dynamo-for-bpa-automatic-shading-design.html
Zach Kron - https://www.youtube.com/watch?v=h0Sk1w7xU4Q

Miscellaneous
http://www.youtube.com/results?search_query=dynamo+autodesk
https://www.youtube.com/watch?v=HWI1KUhhaJs (Vasari, Dynamo adaptive louver)
https://github.com/DynamoDS/Dynamo/wiki/How-To-Create-Your-Own-Nodes (custom nodes)
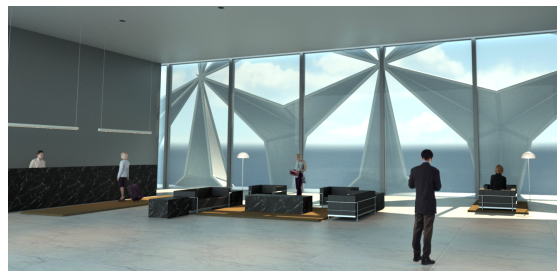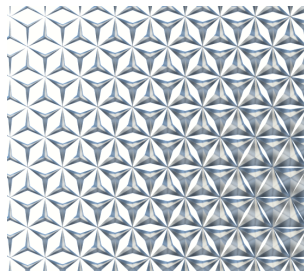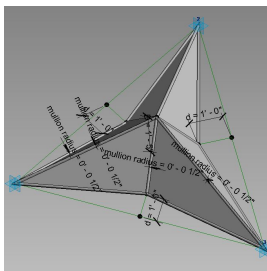Rhynamo by Nathan Miller is a class library for reading and writing Rhino files in and out of Dynamo and Revit. https://www.youtube.com/watch?v=rJVMm-d3PwE
Sign up to participate in the private beta: http://content.case-inc.com/rhynamo
Nate's blog for more about Dynamo and Rhino: http://www.theprovingground.org/

Parametric panel responding to the position of the attractor. (Ilaria Toldo and Dennis Chow)

On-Line Reference Documents

Interesting blogs that also link to other interesting blogs
Phil Lazarus - http://bimtroublemaker.blogspot.com/
Zach Kron - http://buildz.blogspot.com/
Nathan Miller - http://www.theprovingground.org/ , http://wiki.theprovingground.org/revit-api
LA RUG - http://losangelesrevitusersgroup.blogspot.com/
Marcello Sgambelluri - http://therevitcomplex.blogspot.com/
   http://therevitcomplex.blogspot.com/2012/07/creating-walls-that-follow-site.html
   http://therevitkid.blogspot.com/2013/07/revit-tutorial-massing-and-adaptive.html
Jay Zallan - http://cad-vs-bim.blogspot.com/
Troy Gates - http://revitcoaster.blogspot.com/
Jon Mirtschin - http://geometrygym.blogspot.com/
Jeremy Tammik - http://thebuildingcoder.typepad.com/blog/
Tim Meador – Hummingbird - http://ghhummingbird.wordpress.com/author/meadort/

A community-driven collection of apps for the AEC industry - https://aec-apps.com/
Not BIM, but interesting tools - http://andrewmarsh.com/

Autodesk
http://sustainabilityworkshop.autodesk.com/
http://sustainabilityworkshop.autodesk.com/design-strategies/net-zero-energy-buildings
http://sustainabilityworkshop.autodesk.com/software-tutorials
Glenn Katz - http://www.bimtopia.com/
http://bimcurriculum.autodesk.com/
http://students.autodesk.com/
http://resources.autodesk.com/Architecture/Revit_Architecture/Webcasts
http://seek.autodesk.com

More references for Autodesk products including Revit are available at
http://www.revitcity.com/index.php
http://autodesk-revit.blogspot.com/
http://www.augi.com
http://designreform.net/tag/revit-familes/
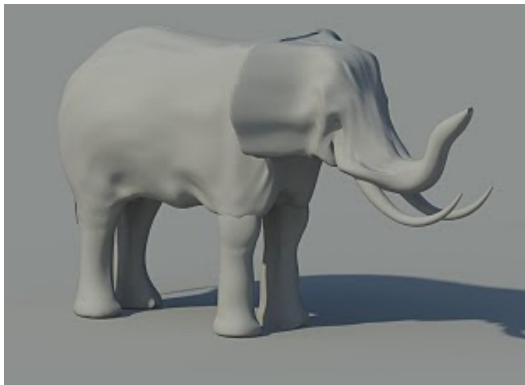
Marcello Sgambelluri, Revit parametric elephant
http://buildz.blogspot.com/2010/04/elephant-in-room.html
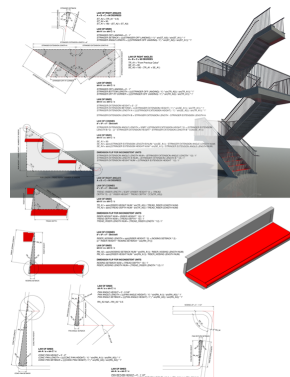
Fuzzy Math session at AU, parametric stair
http://jasongrant.squarespace.com/

Lynda (accessible from Blackboard)

http://www.lynda.com/Revit-Architecture-2011-tutorials/essential-training/62086-2.html
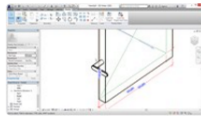
VIDEO

▶ **What is a Revit family?** (3m)

From: Revit: MEP Families

- Let's get started by explaining what a **Revit family** actually is. For you AutoCAD users, it's a block that you insert into a drawing. Basically,...
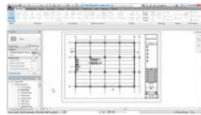
COURSE

Revit: Families with Eric Wing

Covers the process of creating a family and adding parameters, 3D elements, symbolic lines, and materials.

2h 4m   Intermediate   Views: 139,727   See Related Courses ⌄
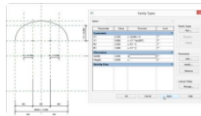
VIDEO

▶ **Understanding Revit families** (3m 39s)

From: Revit Structure 2013 Essential Training

A **Revit family** is an object that has information built into it. Some will people define this as being an intelligent component, because it has...
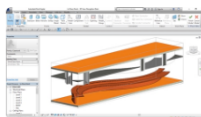
COURSE

Revit: Family Curves and Formulas with Paul F. Aubin

Tame unruly parametric curves with the Revit Family Editor, and start controlling circles, arcs, arches, splines, and even complex curves like cyma moldings.

3h 51m   Intermediate   Views: 53,893   See Related Courses ⌄

COURSE

Revit: Architectural Families with Eric Wing

Improve your Revit workflow with Revit families. Learn how to model reusable features such as chair rails and baseboards, doors, cabinets, and shelving with Revit architectural families.

3h 32m   Appropriate for all   Views: 60,677   See Related Courses ⌄

COURSE

Revit: Tips, Tricks, and Troubleshooting with Paul F. Aubin

Get a new tip, trick, or troubleshooting technique for Revit 2017 every Tuesday. This weekly series offers workflow enhancements, customizations, and shortcuts for both Revit beginners and seasoned users alike.
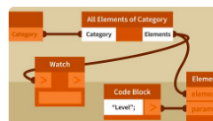
▶ Place multiple elements with Dynamo (8m 4s)

▶ Using Dynamo to rename sheets (8m 3s)

▶ Using Dynamo to rename views (7m 2s)

11h 3m   Appropriate for all   Views: 155,999   See Related Courses ⌄

COURSE

Dynamo: Revit Workflow with Ian Siegel

Use Dynamo to apply basic visual programming concepts to architectural design in Revit. Learn how to automate everyday tasks such as numbering rooms and calculating occupant loads.

▶ Highlight Revit elements with Dynamo (4m 14s)

▶ Calculate occupant loads with Dynamo (5m 12s)

▶ Concatenate lists of strings with Dynamo (4m 26s)

+ Show More

1h 29m   Appropriate for all   Views: 23,493   See Related Courses ⌄

COURSE

Dynamo Essential Training with Ian Siegel

Learn how to use Autodesk Dynamo with Revit. Generate algorithms to analyze data, read and edit data from outside sources, create geometry in Dynamo itself, or edit the geometry in Revit files.

▶ What is Dynamo? (5m 35s)

▶ Placing Revit families with Dynamo (7m 36s)

▶ Placing adaptive components with Dynamo (3m 29s)

+ Show More

3h 3m   Appropriate for all   Views: 93,157   See Related Courses ⌄

Description and Assessment of Assignments

Homework assignments are usually one or two weeks in length. If an assignment is two weeks in length, it is because you need the additional time to complete it. Late assignments will not be accepted; turn in what you have on the due date at the beginning of class (9:00 AM). You will receive partial credit. Successful students read the entire homework assignment before starting, read it again as they are working on it to refresh their memory, and read it yet again to verify that they have the correct elements to turn in. Grades will be posted on Blackboard. There is also a final project and questions on the readings in this course.

LATE ASSIGNMENTS WILL NOT BE ACCEPTED; TURN IN WHAT YOU HAVE ON THE DUE DATE.   There are no "make-up" assignments or extra credit. Do the absolute best that you can on each assignment and turn it in on time. Usually you will be turning in printouts and uploading files on Blackboard.

> PLEASE NOTE THAT YOU ARE EXPECTED TO COMPLETE ALL HOMEWORK ASSIGNMENTS BY YOURSELF USING THE SOFTWARE THAT HAS BEEN ASSIGNED. COPYING OTHER PEOPLE'S FILES OR TURNING IN WORK THAT YOU DID NOT COMPLETE YOURSELF WILL RESULT IN A FAILING GRADE.

Make backups of everything!!!

Accounts
A USC e-mail account is also required for this course. Go on-line and verify that your USC account and Blackboard is working. Call 740-5555 if you have problems accessing your account. Read your e-mail at least once a day! You will also need an **Autodesk account** to download software: students.autodesk.com .

Grading Breakdown

	Percentage of Grade	Assignments	Number of points
Homeworks	75%	Homework 1 – Introduction to BIM	20 – time consuming!
		Homework 2 – Understanding Families	10
		Homework 3 – 2D / 3D Coordination	20 - difficult
		Homework 4 – Schedules and Details	10
		Homework 5 – Rendering and VR	10
		Homework 6 – Conceptual Modeler and Curtain Walls	10
		Homework 7 – Adaptive Components	10
		Homework 8 – BIM Analytics	10
		Homework 9 – Introduction to VPL	10
		Homework 10 - Dynamo	10
Final Project	20%	Final Project	100
Participation	5%	Pop-quizzes	varies
		Questions on readings	varies
		Other	varies

Assignment Submission Policy
Assignments will usually be turned in both on Blackboard and as print-outs. The are due **before the beginning** of class. There are **no make-ups** on assignments, quizzes, or participation responses.

Course Schedule: A Weekly Breakdown: *readings are due at the beginning of the week*

	Lecture	Homework	Required Readings & References
Week 1 Aug. 21	Introduction to BIM		hwk1 GSG_Revit_Architecture_2015.pdf
Week 2 Aug. 28	Introduduction to Families		Routledge – *Introduction* Marcello Sgambelluri Revit hardscape handout.pdf
Week 3 Sept. 4	**Labor Day**		
Week 4 Sept. 11	Loadable Parametric Components	**HWK 1 due**	Routledge – *Chapter 1*
Week 5 Sept. 18	Understanding Families	**HWK 2 due**	Routledge – *Chapter 2*
Week 6 Sept. 25	Conceptual mass vs. detailed building; parametric components		Routledge – *Chapter 3*
Week 7 Oct. 2	BIM as a Database, Interoperability, Schedules	**HWK 3 due**	Routledge – *Chapter 6*
Week 8 Oct. 9	Rendering and Animation – VR	**HWK 4 due**	Routledge – *Chapter 7* **Lynda.com (optional)** (login from Blackboard on the left side of the screen); search on "Revit rendering" 3. Materials – about an hour 5. Lighting – about 20 minutes 6. Rendering – about an hour 7. Cloud Rendering – about 15 minutes 8. Walkthroughs – about 30 minutes
Week 9 Oct. 16	Conceptual Modeler and Parametric Pattern Based Curtain Walls	**HWK 5 due**	Routledge – *Chapter 8* Marcello Sgambelluri mass family handout.pdf http://therevitkid.blogspot.com/2013/07/revit-tutorial-massing-and-adaptive.html
Week 10 Oct. 23	Parametric Adaptive Components	**HWK 6 due**	Routledge – *Chapter 9*
Week 11 Oct. 30	BIM Analytics - Insight	**HWK 7 due**	Routledge – *Chapter 4*
Week 12 Nov. 6	Visual Scripting – attractors and solar controls	**HWK 8 due**	Routledge – *Chapter 5* Dynamo Visual Programming for Design Overview.pdf Dynamo Primer - http://dynamoprimer.com/ Dynamo - http://dynamobim.org/ Dynamo - http://dynamobim.com/learn/ Colin McCrone's - http://dynamobim.org/wp-content/uploads/forum-assets/colin-mccroneautodesk-com/07/10/Dynamo_language_guide_version_1.pdf
Week 13 Nov. 13	Visual Scripting – DesignScript and Lists Description of final project	**HWK 9 due**	Dynamo_language_guide_version_1.pdf https://www.youtube.com/watch?v=h0Sk1w7xU4Q
Week 14 Nov. 20	Visual Scripting – Packages	**HWK 10 due**	*AECbytes -Got Macros.pdf*
Week 15 Nov. 27	Conclusion or Guest Lecture		Routledge – *Conclusion*
FINAL PRESENTATIONS, Monday, December 11, 11 am – 1 pm			

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 Section 11, Behavior Violating University Standardshttps://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/. 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/.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the Office of Equity and Diversity http://equity.usc.edu/ or to the Department of Public Safety http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us. This is important for the safety whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. The Center for Women and Men http://www.usc.edu/student-affairs/cwm/ provides 24/7 confidential support, and the sexual assault resource center webpage sarc@usc.edu describes reporting options and other resources.

Support Systems

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://dornsife.usc.edu/ali, which sponsors courses and workshops specifically for international graduate students. The Office of Disability Services and Programs http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.htmlprovides 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.

Religious Holidays

The University of Southern California 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.

Please contact **Karen Kensek at kensek@usc.edu by the end of the second week of class** if you anticipate conflicts with religious holidays including missing lectures, inability to finish homework assignments on-time, or other items that may hinder your work in this class.

Accreditation Statement

The USC School of Architecture's five year BARCH degree and the two year M.ARCH degree 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/2009_Conditions.aspx .

The Master of Landscape Architecture degree program (for USC's +3 students with no prior design education, and our +2 for students admitted with advanced standing) is currently in "Candidacy Status" for accreditation by the Landscape Architecture Accreditation Board. All students can access and review the LAAB accreditation standards/process at http://www.asla.org/Education.aspx .