CIVE 5705 – Advanced Building Characterization, Conservation and Rehabilitation [0.5 credit]

Instructor:

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Class Lectures: Wednesday 8:30 am - 11:25 am – Classroom: Mackenzie Building 3165 and Carleton Immersive Media Studio (CIMS)

Calendar description

The intent of this course is to provide graduate students with a fundamental technical understanding of the concepts and techniques governing the study, conservation and rehabilitation of existing (historic) buildings. The course content is split into two parts:

1) the fundamentals of conservation; and
2) the rehabilitation of existing buildings.

The course includes lectures and seminars from a diverse group of multidisciplinary experts.

Part 1 will introduce the concepts and guidelines that govern the study, conservation and rehabilitation of existing buildings, emphasizing the conservation of Heritage Places in Canada and the technical aspects of this activity.

Part 2 comprises three technical topics: Building Digitalization, Building Simulation and Building Rehabilitation.

In the module on Building Digitalization, students will learn about techniques for capturing (or mapping) detailed physical characteristics of historic structures. Students will conduct a study of an existing building using terrestrial and low-cost aerial surveying (e.g. 3D scanning, thermal photography and photogrammetry), building information modelling (BIM), coupling of life cycle assessment with BIM, real-time simulation, geographic information system (GIS), scene and motion capture, as well as possible augmented reality applications.

In the Building Sustainability Simulation module, students will focus on building simulation to assess the impact of design, rehabilitation and retrofit options using computer-assisted approaches. This module will go from modelling heritage buildings to assessing the potential for cost-effective retrofits to achieve long-term sustainability. Required interventions (new materials, design retrofits, etc.) that consider energy

efficiency in order to safeguard both environmental and heritage values will be investigated.

In the third module, on Building Rehabilitation, students will learn how to evaluate the condition of an existing building (building envelope, materials deterioration and structural integrity), design monitoring strategies and implement effective rehabilitation mitigation strategies for conservation. This module involves learning about approaches for the timely identification of decay, deterioration, and mitigation of defects, to help prevent major consequential damage. Systems-based techniques will be utilized, including: the use of standardized condition terminology and graphic representation, modeling and analysis (identification of types of deterioration, determination of load paths, collapse through stability or strength), finite element modeling, macro and micro modeling, geometric considerations, and material heterogeneity.

Prerequisites: open to all graduate students with a particular interest in historic structures.

Learning objectives

At the completion of the course, the student will be able to:

- discuss and apply the fundamentals of conservation of heritage places in Canada and internationally for technical assessments;
- apply digital workflows for recording and modeling existing buildings;
- use simulation tools for structural and energy performance of existing buildings;
- apply and conduct research on construction materials, assemblies and building envelopes for improving rehabilitation purposes; and
- understand the role of monitoring systems can improve the maintenance and care of existing buildings.

Course structure

The course involves three hours of lectures and eventual activities related to the NSERC Create Heritage Engineering program that students enrolled in the program attend and other students are welcome to participate. The course includes fieldwork doing freehand sketching and surveying, as well as rapid assessment and thermal photography.

The following topics will be covered:

1. Fundamentals of studying existing buildings for their conservation and rehabilitation.
2. Digital workflows for recording and modeling existing buildings:
   a. Active sensors (eg. 3D scanning, Total Station)
   b. Passive sensors (eg. photogrammetry, thermal photography)
   c. Building Information Modeling with point clouds
   d. Digital Information Systems (eg. GIS and hybrids).
3. Building Sustainability Simulation.
4. Building Rehabilitation approaches.

Tentative class schedule

Date	Session	Title
Sept 6	L01	Introduction to learning outcomes and course structure
	L02	Recognizing Existing Buildings
	L03	Harnessing Digital Workflows for Conservation of Heritage Places
Sept 13	L04	Scientific Research Approach for Dissertation on Studying Buildings
	T01	Tutorial 1: Photogrammetry for Recording Historic Buildings
Sept 20		Alisha Seguin, Office of Research Ethics and Compliance, Ethics in Research
	L05	Building Digitalization Approach 2: Mario Santana
Sept 27	L06	Building Sustainability Simulation Approach 1: Sujan Shrestha
		Thesis showcase: Natalie Miller (Civil Engineer)
Oct 4	L07	Building Sustainability Simulation Approach 2
		Thesis showcase: Zeynep Ekim (Architecture)
		Hygrothermal Analysis of Historic Masonry Walls: Michael Gutland
Oct 11	L08	APT Workshop at CIMS – Also APT conference in Ottawa Starts

		Submission of Assignment 1 (5pm)
Oct 18	L09	Building Rehabilitation Approach 1
Oct 25		Reading week
Nov 1	L10	Building Performance Approach: Scott Bucking (Carleton University)
Nov 8	L11	Building Rehabilitation Approach 2: Brigitte Lemieux (WSP Canada) Student Presentations Assignment 2
Nov 15	L12	Building Rehabilitation Approach 3
Nov 22	L13	Course Wrap Up
Nov 29	L14	Building Rehabilitation Approach 4
Dec6	L15	Building Rehabilitation Approach 5
Dec 20		Submission of Assignment 3 (11:55pm)

Grading

Item	Weight of final grade
Course Compliance	20 %
Assignments	80 %
Total	**100 %**
+ extra Bonus Assignment (if submitted)	10 %

Final letter grades will be figured on the basis of these assignments.

Course compliance

Students are expected to arrive on time, attend <u>all</u> lectures and practicum, ask questions and provide feedback about assignments. Absences will generally be excused only for emergencies.

Technical Prerequisites

Students are expected to know the two-dimensional drawing features of Computer-Aided Design (CAD) application. For tutorials, visit http://www.cadtutor.net/, also the Ottawa Library provides accessibility to Lynda.com: https://biblioottawalibrary.ca/en/lynda here you can find CAD and other digital tools tutorials. Limited classroom instruction in the elements of CAD may be offered, depending on demand, but will not occur during course time.

AutoCAD 2015 (and Revit) through 2017 should be installed on student laptops prior to Week 2 of the CAD survey. Free copies of AutoCAD release are available for download by registering at the Autodesk Education Community (http://students.autodesk.com). AutoCAD and Revit are also available at the computer lab in event that you do not have a laptop computer.

For digital photography, each student is required to have:

- a camera with at least ten-megapixel resolution; and
- a tripod.

A departmental camera and tripod may also be available.

Assignments

Students are expected to submit assignments to CU Learn. An introductory page should be prepared to introduce your research interest, background and objectives for taking this course.

Assignment 1: Surveying and Modeling a historic structure assembly (20%)

The objective of this assignment is to develop a digital workflow to record, model and simulate an historic structure assembly. Students working in pairs will select a topic in Ottawa, record it using digital tools (eg. 3D Scanning, photogrammetry), model it using appropriate software (eg. Revit, AutoCAD) and conduct a simulation using specialized software to test its performance (eg. Energy, structural).

Students in the NSERC CREATE program can also select an historic structure assembly from their site of interest. At the submission deadline, students are expected to submit a written report and the digital files accompanying the assembly (eg. Model, Point cloud, AutoCAD file). The resulting model should also be uploaded into Sketch Fab (https://sketchfab.com).

Assignment 2: Seminar presentation (20%)

The objective of this assignment is to evaluate the capacity of student to produce and present (orally) a seminar about a scientific topic related to the course. Students working in pairs will select a topic related to the gaps identified in the NSERC CREATE Heritage Engineering Program and present an elaborated problem statement, a literature review and a proposal that is aimed at overcoming this gap.

A group of four students is expected to present for 20 minutes and to provide relevant handouts to other students. The presentation file (eg. PPT, PDF, google slides, or others) and handouts should be upload into CU Portfolio ahead of your presentation.

Assignment 3: Scientific Paper on Advanced Conservation (40%)

The objective of this individual assignment is to evaluate the capacity of students to produce a meaningful review of a scientific topic related to the course.

Students are expected to identify a scientific journal in their area of interest. Given that the course instructor is an editor of Emerald's Journal of Cultural Heritage Management and Sustainable Development, this publication is one possibility. More information can be found at http://www.emeraldinsight.com/loi/jchmsd.

Students are expected to download a paper review template from the journal, find related review papers published in that journal, select a topic, conduct a literature review and produce a review paper.

The manuscript draft (review) should be submitted into CU Portfolio, according to the template structure provided by the journal. The length should not exceed 3500 words with illustrations, tables and photographs.

Bonus Assignment (10%)

Students attending and submitting a report about the APT Conference session of papers in Ottawa will receive 10% bonus grades (4% for attending and 6% for submitting a 1000-word US Letter size report, illustrated with photographs).

Readings

Assigned readings (in order of relevance):

1. ICOMOS Charter – Principles for the Analysis, Conservation and Structural Restoration of Architectural Heritage (2003), https://iscarsah.files.wordpress.com/2014/11/iscarsah-principles-english.pdf (last accessed: Aug 30, 2016)

2. Letellier, R. Schmid, W. LeBlanc, F. 'Guiding Principles Recording, Documentation, and Information Management for the Conservation of Heritage Places' The Getty Conservation Institute, J. Paul Getty Trust (2007), http://www.getty.edu/conservation/publications_resources/pdf_publications/recordim.html (last accessed: Aug 22, 2016)

3. Eppich, E. Chabbi, A. ed. 'Illustrated Examples Recording, Documentation, and Information Management for the Conservation of Heritage Places' The Getty Conservation Institute, J. Paul Getty Trust (2007), http://www.getty.edu/conservation/publications_resources/pdf_publications/recordim.html (last accessed: Aug 22, 2016)

4. Canada Historic Places "Standards and Guidelines for the conservation of historic places in Canada", 2nd edition, Canada ISBN 978-1-100-15953-9, http://www.historicplaces.ca/en/pages/standards-normes/document.aspx (last accessed: Aug 22, 2016)

5. Historic England '3D Laser Scanning for Heritage: Advice and guidance to users on laser scanning in archaeology and architecture', (2011), https://historicengland.org.uk/images-books/publications/3d-laser-scanning-heritage2/ (last accessed: Aug 22, 2016)

6. The Getty Conservation Institute Conservation perspectives: Heritage Inventories, The GCI Newsletter (2013) http://www.getty.edu/conservation/publications_resources/newsletters/28_2/index.html (last accessed: Aug 22, 2016)

7. J. Hayes, S. Fai, S. Kretz, C. Ouimet, and P. White Digitally-Assisted Stone Carving of a Relief Sculpture for the Parliament Buildings National Historic Site of Canada, ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci., II-5/W3, 97-103, doi:10.5194/isprsannals-II-5-W3-97-2015, 2015 http://www.isprs-ann-photogramm-remote-sens-spatial-inf-sci.net/II-5/W3/97/2015/ (last accessed: Aug 22, 2016)

Journal Articles available through Carleton University Library (relevant to Assignment 3)

1. Dina D'Ayala Pierre Smars, **Architectural and Structural Modelling for the Conservation of Cathedrals**, Journal of Architectural Conservation, 2003, Vol 9/3 (2003), Pp.51-72

2. William Dupont, Hazem Rashed-Ali, Randall Manteufel, Thomas Thomson and Levi Sanciuc, **Energy Retrofit of Older Houses in Hot and Humid Climates**, APT Bulletin, Vol. 47, No. 1, SPECIAL ISSUE ON CLIMATE CHANGE AND

PRESERVATION TECHNOLOGY (2016), pp. 50-58Association for Preservation Technology

3. Christopher Young, **Understanding management in a World Heritage context: key current issues in Europe**, The Historic Environment: Policy & Practice, 7:2-3 (2016), Pp. 189-201.

4. Tiago Miguel Ferreira Alexandre A. Costa Aníbal Costa, **Analysis of the Out-Of-Plane Seismic Behavior of Unreinforced Masonry: A Literature Review**, International Journal of Architectural Heritage, Vol 9/8 (2015), Pp.949-972

5. Nunziante Squeglia Giuseppe Bentivoglio, **Role of Monitoring in Historical Building Restoration: The Case of Leaning Tower of Pisa**, International Journal of Architectural Heritage Vol 9/1 (2015), Pp.38-47.

6. F. Vegas C. Mileto V. Cristini, **Constructive features and preservation work of rammed earth architecture: the Islamic tower of Bofilla (Valencia)**, Journal of Architectural Conservation, Vol 20/1 (2014), Pp.28-42

7. d'Annibale, E. **Finalizing a low-cost photogrammetric workflow: from panoramic photos to Heritage 3D documentation and visualization**. International journal of heritage in the digital era Vol 3/1 (2014). Pp.33 - 50

8. David M. Barber Ross W. A. Dallas Jon P. Mills, **Laser Scanning for Architectural Conservation**, International Journal of Architectural Heritage , Vol 12/1 (2006), Pp.35-52.

9. Tesse D. Stek, **Drones over Mediterranean landscapes. The potential of small UAV's (drones) for site detection and heritage management in archaeological survey projects: A case study from Le Pianelle in the Tappino Valley, Molise (Italy)**, Journal of Cultural Heritage (2016)

10. Koenraad Van Balen, **The Nara Grid: An Evaluation Scheme Based on the Nara Document on Authenticity**, APT Bulletin, Vol. 39, No. 2/3 (2008), pp. 39-45, Association for Preservation Technology International (APT)

Conference Proceedings

1. Abate, D., Hermon, S., and Eliades, I.: **VIRTUAL AND PHYSICAL RECOMPOSITION OF FRAGMENTED ECCLESIASTICAL FRESCOES USING A PHOTOGRAMMETRIC APPROACH**, Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLI-B5, 153-160, doi:10.5194/isprs-archives-XLI-B5-153-2016, 2016, http://www.int-arch-photogramm-remote-sens-spatial-inf-sci.net/XLI-B5/153/2016/ (last accessed: Aug 31, 2016)

2. Barazzetti, L., Banfi, F., Brumana, R., Previtali, M., and Roncoroni, F.: **BIM FROM LASER SCANS… NOT JUST FOR BUILDINGS: NURBS-BASED PARAMETRIC MODELING OF A MEDIEVAL BRIDGE**, ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci., III-5, 51-56, doi:10.5194/isprs-annals-III-5-51-2016, 2016. http://www.isprs-ann-photogramm-remote-sens-spatial-inf-sci.net/III-5/51/2016/ (last accessed: Aug 31, 2016)

3. Bitelli, G., Castellazzi, G., D'Altri, A. M., De Miranda, S., Lambertini, A., and Selvaggi, I.: **AUTOMATED VOXEL MODEL FROM POINT CLOUDS FOR STRUCTURAL ANALYSIS OF CULTURAL HERITAGE**, Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLI-B5, 191-197, doi:10.5194/isprs-archives-XLI-B5-191-2016, 2016. http://www.int-arch-photogramm-remote-sens-spatial-inf-sci.net/XLI-B5/191/2016/ (last accessed: Aug 31, 2016)

4. Mezzino, D., Pei, W., Santana Quintero, M., and Reyes Rodriguez, R.: **Documenting Modern Mexican Architectural Heritage for Posterity: Barragan's Casa Cristo, in Guadalajara, Mexico**, ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci., II-5/W3, 199-206, doi:10.5194/isprsannals-II-5-W3-199-2015, 2015. http://www.isprs-ann-photogramm-remote-sens-spatial-inf-sci.net/II-5-W3/199/2015/ (last accessed: Aug 31, 2016)

Biographical sketch of instructor

Mario Santana-Quintero, is an associate professor on Architectural Conservation and Sustainability at department of Civil and Environmental Engineering Carleton University. He is also the Director of the NSERC Create program "Engineering Students Supporting Heritage and Sustainability (HERITAGEENGINEERING)" based at the Carleton immersive Media Studio Lab (CIMS). He has an architectural degree, holding a master in conservation of historic buildings and towns and a PhD in Engineering from the R. Lemaire International Centre for Conservation (University of Leuven, Belgium). He is also a guest professor at the Raymond Lemaire International Centre for Conservation (University of Leuven). These past years he has been teaching also at the Universidad Central de Venezuela, Universidad de Guadalajara (Mexico) and Universidad de Cuenca (Ecuador). In the past, he was a Professor at the University College St Lieven and lecturer at the University of Aachen RWTH and the Historic Preservation Programme at the University of Pennsylvania between 2006 and 2011. Along with his academic activities, he serves as ICOMOS Board member and he is the past president of the ICOMOS Scientific Committee on Heritage Documentation (CIPA). Furthermore, he has collaborated in several international projects in the field of heritage documentation for UNESCO, The Getty Conservation Institute, ICCROM, World Monuments Fund, UNDP, Welfare Association, and the Abu Dhabi Authority for Culture and Heritage.

Academic Accommodations

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website http://www2.carleton.ca/equity/accommodation/

Religious obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website http://www2.carleton.ca/equity/accommodation/

Students with disabilities requiring academic accommodations in this course must register with the Paul Menton Centre for Students with Disabilities (PMC) for a formal evaluation of disability-related needs. Documented disabilities could include but are not limited to mobility/physical impairments, specific Learning Disabilities (LD), psychiatric/psychological disabilities, sensory disabilities, Attention Deficit Hyperactivity Disorder (ADHD), and chronic medical conditions. Registered PMC students are required to contact the PMC, 613-520-6608, every term to ensure that I receive your Letter of Accommodation, no later than two weeks before the first assignment is due or the first in-class test/midterm requiring accommodations. If you only require accommodations for your formally scheduled exam(s) in this course, please submit your request for accommodations to PMC by the deadlines published on the PMC website: http://www2.carleton.ca/pmc/new-and-current-students/dates-and- deadlines/\

Absences

Anticipated and/or documented absences due to health reasons or important commitments should be brought to the attention of the instructor. Undocumented absences will result in a mark of zero assigned to the course component missed. For duly justified and documented absences please consult the instructor for adjustment of marks.

Documenting your absence. In case of illness you must consult a doctor within 24 hours of the onset of the conditions leading to your absence. Have your physician fill the form: http://www2.carleton.ca/health/doctors-notes/

If your absence is due to a personal emergency please document it in detail, as much as possible, including tickets, visas or passport entries, if travel is involved. You may also wish to include affidavits from coaches, witnesses, your mother, religious officials,

police reports, etc, as appropriate. If you know in advance of your absence please contact the instructor early with information on dates and nature of your absence.