

# History of American Building Technology

## ARH 5500

Spring 2016

Campbell Hall 108 MW 11-12.15

Ben Hays – PE, SE, LEED AP

bhays@virginia.edu

Office Hours M 12.30+ or by appt

### Description

This course examines the history of American building technology in the American context. Throughout this period, a wide range of materials and techniques have been used to erect the structures in which we live, work, and play. The materially diverse buildings that populate the University of Virginia will serve as case studies for investigating this technology, from commonplace building materials such as wood, masonry, steel, and concrete to less familiar materials such as structural tile and iron vaulting.

A familiarity with historic building technology is fundamental in today's design environment, where nearly half of all construction activity interacts with existing buildings. Additionally, the reuse of building fabric presents opportunities for sustainability that are not often realized. For historians and critics of architecture, an understanding of building technology is crucial in appreciating design decisions that result in the final form of the buildings.

### Course Methods

The course will meet twice weekly and will follow a lecture-workshop cycle. Each Monday, the lecture will provide an orientation to the historic period and construction technologies under investigation that week. Each Wednesday, the workshop will look at a specific building related to the week's lecture. The workshop will focus either on a set of historic drawings or comprise a field trip to a specific building on Grounds (or both!) Workshops will be discussion oriented and aim to give students "hands on" experience with reading drawings and analyzing actual buildings. Readings generally will be discussed during lecture; drawings and/or buildings generally will be looked at during workshops.

### Prerequisites

The course is open to upper level undergraduates as well as graduate students in Architecture, Architectural History, Civil Engineering, and related fields.

### Honor System

It is expected that students abide by the honor system.

## Learning Objectives

- Describe the development of building materials in the American context
- Read historic drawings and identify important building technologies and materials
- Look at existing buildings in the field and identify key building technologies and materials
- Write a building description that incorporates building technology into the architectural and historic narrative
- Participate in the construction of a scale model, historic wood or tile dome

## Evaluation

Class attendance and participation 15%

Regular class attendance at lectures, workshops, and final presentations is expected.

Technical reflections 15%

Technical reflections are a short, one-to-two page analysis that integrates the readings for the week with one set of building drawings from the semester. You will be responsible for handing in three such reflections throughout the semester. These can be turned in at any time, but early submissions are always appreciated.

*Note: Due to the dome construction workshop during weeks 8 and 9, many opportunities exist for substituting technical reflections with other assignments. Examples include creating working drawings for the tile and wood domes (which will be used to order and detail materials); prepping raw construction materials for the construction dates; etc. If you're interested, please contact me.*

Participation in the dome workshop 35%

In this iteration of the course, the dome construction workshop forms an integral part of the course. On two weekends following Spring break, two scale domes – one wood and one tile – will be constructed that replicate structures atop the UVa Rotunda. The participation grade involves attending the public lecture on Friday and participating in construction of the dome Friday and Saturday. This is in lieu of the regular midterm in past iterations of the course. After you have reviewed the **Course Schedule** below, please see me if you are unable to attend either dome construction workshop.

Final Project & Presentation 35%

The final project will consist of two parts: an in-class presentation (10 to 15 minutes in length) and an academic paper, 8-12 pages in length. Full requirements for the paper will be handed out in class by Week 4.

Historically, the final project has consisted of a historical and technical analysis of a building from UVa's Grounds using photographs, original building drawings, and analysis of the building itself in a manner similar to the National Park Service's *Historic Structure Report* (search Preservation Brief 43). I also am open to design-related projects that explore tight integration between a historic structure and a new addition. The focus of such a project would be on demonstrating a thorough understanding of the material fabric as well as the systems that would be impacted. Design-Research projects pairing a historian and architect are highly encouraged. Finally, a limited number of projects that document this year's dome construction workshops are also acceptable.

### Required Texts

Gordon, J.E. *Structures, or Why Things Don't Fall Down*. England: Da Capo Press. 2003.

Chapters from this book are assigned in the schedule below.

Articles and chapters from other sources are noted below and can be found on Collab.

### Recommended Texts

Addis, Bill. *3000 Years of Design, Engineering, and Construction*. Phaidon Press. 2007.

Friedman, Donald. *Historic Building Construction: Design, Materials, and Technology*. WW Norton: New York. 2010.

Wermiel, Sara. *The Fireproof Building: Technology and Public Safety in the Nineteenth-Century American City*. Johns Hopkins Press: Baltimore. 2000.

### Course Schedule

#### Week 1 Introduction

*W.Jan.20* *Lecture:* Introduction and Review of Syllabus

*Reading:* Reading one of the following for Mon Jan 25

Fitch, James. *American Building: The Environmental Forces That Shape It*. Oxford University Press. 1999, Chapter 8: "Skeleton and Skin: The Morphological Development of Structural Systems" pp. 221-256.

Peters, Tom. *Building the Nineteenth Century*. MIT Press: Cambridge. 1996, Chapter 2: "Structural Materials, Methods, and Systems: Prerequisites of Change" pp 35-78.

**Week 2            Methodology & Workshop Parameters**

- M.Jan.25*      *Lecture:*            Methods for Researching Construction History
- Reading:*            Read one of the following articles on balloon framing for Mon Feb 1:
- Sprague, Paul. "The Origins of Balloon Framing." *Journal of the Society of Architectural Historians*. Vol. 40, No. 4 (Dec 1981), pp. 311-319.
- Peterson, Fred. "Wooden Frame Farmhouses in the Midwest, 1830-1900: Origins of Balloon Frame Construction." *Perspectives in Vernacular Architecture*. Vol. 8, (2000), pp. 3-16.
- Additionally:*      Read one of the following articles on timber framing:
- Buchanan, Paul. "The Eighteenth-Century Frame Houses of Tidewater Virginia," *Building Early America*. Astragal Press. 1976, pp. 54-73.
- Graham, Willie. "Timber Framing" in *The Chesapeake House*. UNC Press: Chapel Hill. 2013, pp 206-238.
- W.Jan.27*      *Workshop:*            Intro to Reading Drawings & Site Visit to the A-School Fabrication Studio

**Week 3            Wood Structures: Timber and Balloon Framing**

- M.Feb.1*      *Lecture:*            Wood Structures
- Drawings:*            Study Pav I drawings in the HSR (pp 25-54) for Wed Feb 3
- Reading:*            Read the following chapters for Mon Feb 8:
- Gordon, J.E. *Structures, or Why Things Don't Fall Down*. England: Da Capo Press. 2003, Chapters 1 and 9.
- Additionally:*      Read one of the following:
- McKee, Harley. "Brick and Stone: Handicraft to Machine," *Building Early America*. Astragal Press. 1976, pp. 74-95.
- Wermiel, Sara. *The Fireproof Building: Technology and Public Safety in the Nineteenth-Century American City*. Johns Hopkins Press: Baltimore. 2000, Chapter 1: The Solid Masonry Fireproof Building, pp. 11-36.
- W.Feb.3*      *Workshop:*            Site Visit to Pavilion II; meet at Campbell Library "Bridge"

**Week 4            Masonry Structures: Stone and Brick Masonry**

M.Feb.8

*Lecture:*            Masonry Structures

*Project:*            Review "Project Requirements" and begin considering topics

*Reading:*            Read the following chapter for Mon Feb 15:

Gordon, J.E. *Structures, or Why Things Don't Fall Down*. England: Da Capo Press. 2003, Chapter 11

*Additionally:*      Read one of the following:

Wermiel, Sara. *The Fireproof Building: Technology and Public Safety in the Nineteenth-Century American City*. Johns Hopkins Press: Baltimore. 2000, Chapter 2: The Iron and Brick Fireproof Building, pp. 37-72.

Peterson, Charles. "Inventing the I-Beam: Richard Turner, Cooper & Hewitt and Others." *Bulletin of the Association for Preservation Technology*. Vol. 12, No. 4 (1980), pp. 3-28.

Lee, Antoinette. "Cast Iron In American Architecture: A Synoptic View." *The Technology of Historic American Buildings*. Association for Preservation Technology. Washington DC, 1983, pp. 97-116.

W.Feb.10

*Workshop:*        Visit to or from UVa Facilities Resource Center

**Week 5            Iron Structures: Cast and Wrought Iron**

M.Feb.15

*Lecture:*            Iron Structures

*Drawings:*        Study Brooks Hall and McDonald Brothers drawings for Wed Feb 17

*Reading:*            Read the following piece for Mon Feb 22:

Thompson, Steve. *A Developmental History of the University's Water Supply System*. July 1, 2015.

W.Feb.17

*Workshop:*        Drawings of Brooks Hall & the McDonald Brothers Rotunda

**Week 6 Early Water Systems**

*M.Feb.22* *Guest Lecture:* Early Water Systems at UVa

*Drawings:* Study MMW drawings of the Rotunda for Wed Feb 24

*Reading:* Read one of the following for Mon Feb 29:

Friedman, Donald. *Historical Building Construction: Design, Materials & Technology*. New York: WW Norton & Co. 2010, pp. 108-130, "Floor Systems."

Wermiel, Sara. *The Fireproof Building: Technology and Public Safety in the Nineteenth-Century American City*. Johns Hopkins Press: Baltimore. 2000, Chapter 3: Response to the Great Fires, pp. 73-103.

*W.Feb.24* *Workshop:* Site Visit to the Rotunda; meet at Campbell Library "Bridge"

**Week 7 Fireproof Structures**

*M.Feb.29* *Lecture:* Fireproof Structures

*Project:* Project Prospectus due Wed Mar 2

*Drawings:* Study MMW drawings of Old Cabell Hall for Wed Mar 2

*Reading:* Read one of the following for Mon Mar 14:

Ochsendorf, John. *Guastavino Vaulting: The Art of Structural Tile*. Princeton Architectural Press. 2010, pp. 150-167; 245: "Reasons For Success."

Collins, George. "The Transfer of Thin Masonry Vaulting from Spain to America." *Journal of the Society of Architectural Historians*. Vol. 27, No. 3 (Oct 1968), pp. 176-201.

*W.Mar.2* *Workshop:* MMW Drawings of Old Cabell Hall

**Spring Break!**

**Week 8            Dome Structures**

*M.Mar.14            Lecture:            Wood, Iron, and Tile Domes*

*Reading:            Read the following for Mon Mar 21:*

Harnsberger, Douglas. "An X-Ray Probe of Jefferson's Dome at Monticello." *Bulletin of the Association for Preservation Technology*, Vol. 13, No. 4 (1981), pp 2-8.

*W.Mar.16            Workshop:        NO CLASS – PREP FOR CONSTRUCTION OF TILE DOME*

*F.Mar.18            Public Lecture:   TBD*

*S.Mar.19            Construction:    Construction of a Tile Dome with Benjamin Ibarra Sevilla*

**Week 9            Construction Methodology and Construction Failures**

*M.Mar.21            Lecture:            Lessons from the 1890s: Old Cabell Hall and the Rotunda*

*Reading:            Read the following chapter for Mon Mar 28:*

Gordon, J.E. *Structures, or Why Things Don't Fall Down*. England: Da Capo Press. 2003, Chapter 11

*Additionally:      Read one of the following for Mon Mar 28:*

Wermiel, Sara. *The Fireproof Building: Technology and Public Safety in the Nineteenth-Century American City*. Johns Hopkins Press: Baltimore. 2000, Chapter 5: Triumph: The Fireproof Skyscraper, pp. 138-185.

Leslie, Tom. "Built Like Bridges: Iron, Steel, and Rivets in the Nineteenth Century Skyscraper." *Journal of the Society of Architectural Historians*, Vol. 69, No. 2 (June 2010), pp 234-261.

*W.Mar.23            Workshop:        NO CLASS – PREP FOR CONSTRUCTION OF WOOD DOME*

*F.Mar.25            Public Lecture:   TBD*

*S.Mar.26            Construction:    Construction of a Wood Dome with Doug Harnsberger*

**Week 10      Steel Structures**

*M.Mar.28*      *Lecture:*      Structural Steel and Vertical Construction

*Drawings:*      Study drawings of Memorial Gym for Wed Mar 30

*Reading:*      Read one of the following for Mon Apr 4:

Friedman, Donald. *Historical Building Construction: Design, Materials & Technology*. New York: WW Norton & Co. 2010, pp. 87-107, "Standardization of Steel Framing."

Addis, Bill. *Building: 3000 Years of Design, Engineering, and Construction*. Phaidon Press. 2007, pp. 387-405, "Building Higher...and Higher" and "Wind Bracing."

*W.Mar.30*      *Workshop:*      Site Visit to Memorial Gym (also perhaps the Amphitheater and OCH)

**Week 11      Vertical Transportation Systems**

*M.Apr.4*      *Guest Lecture:*      A History of Lift Systems

*Drawings:*      Study drawings of Observatory for Wed Apr 6

*Reading:*      Read one of the following for Mon Apr 11:

Gordon, J.E. *Structures, or Why Things Don't Fall Down*. England: Da Capo Press. 2003, Chapter 14.

Addis, Bill. *Building: 3000 Years of Design, Engineering, and Construction*. Phaidon Press. 2007, pp. 418-438, "The Reinforced Concrete Frame."

*W.Apr.6*      *Workshop:*      Site Visit to O-Hill Observatory and Alden House

**Week 12      Concrete Structures**

*M.Apr.11*      *Lecture:*      Reinforced Concrete and Cantilevered Construction

*Drawings:*      Study drawings of U-Hall and Campbell Hall for Wed Apr 13

*Reading:*      Read one of the following for Mon Apr 18:

Gordon, J.E. *Structures, or Why Things Don't Fall Down*. England: Da Capo Press. 2003, Chapter 16.



Addis, Bill. *Building: 3000 Years of Design, Engineering, and Construction*.  
Phaidon Press. 2007, pp. 597-608, "The Greening of Construction."

*W.Apr.13*      *Workshop:*      Drawings of U-Hall and Campbell Hall

**Week 13**      **Student Presentations**

*M.Apr.18*      *Presentations, Group A*

*W.Apr.20*      *Presentations, Group B*

**Week 14**      **Student Presentations**

*M.Apr.25*      *Presentations, Group C*

*W.Apr.27*      *Presentations, Group D*

**Week 15**      **Course Conclusion**

*M.May.2*      *Lecture:*      Construction History, Architectural History, and Architecture

**Finals Week**

*M.May.9*      *Final projects due (note: this date is tentative)*

**Below is a sample of UVa buildings with good drawings for final projects. Other buildings on and off grounds may be used; please check with me first.**

Scott Stadium, 1930; 1977; 2001 [poured in place and precast concrete]

Corner Building, 1912 [moving historic structures]

Pavilion I, original + 1997 collapse [failures and forensics]

U-Hall, 1960-65 [precast concrete; tension ring failure]

Alderman Library, 1936; 1967 [steel versus concrete]

Brown College, 1928 [masonry and wood]

Heat Plant, 1950 [continuous construction]

Madison Hall, 1961 [technology and tradition]

Old Med School + West Complex, 1920s+ [hospital construction]

Drama Building, 1970 [concrete frame]

Campbell Hall, 1960s [concrete waffle system]

Fayerweather Hall, 1920s; 2000s [masonry and steel]