

## Enclosures

### *selection, affinities & integration*

ARCH 732-001: Enclosures, Spring 2025

Wednesday 08:30 - 11:30

Fisher-Bennett Hall, Rm. 323 - **to be confirmed**

### Instructor

Charles Berman, RA, AIA

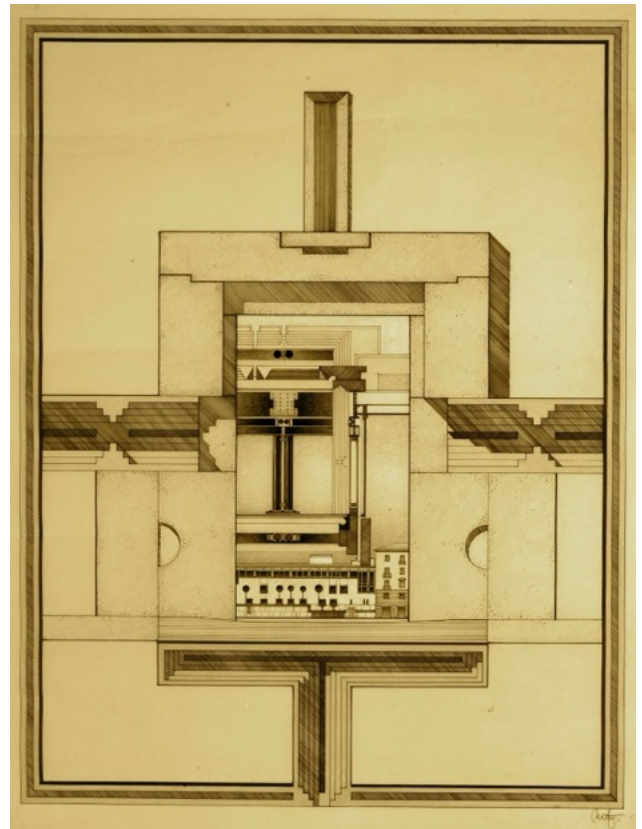
Associate Principal, Diller Scofidio + Renfro Architects

[bermanc@design.upenn.edu](mailto:bermanc@design.upenn.edu)

*"Details are much more than subordinate elements; they can be regarded as minimal units of signification in the architectural production of meanings."*

*The suggestion that the detail is the minimal unit of production is more fruitful because of the double-faced role of technology, which unifies the tangible and intangible of architecture."*

*"The Tell-the-Tale Detail" by Marco Frascari*



### Course Description

Details should be considered in the traditional sense, as assemblages of constituent elements. Not as a mere collection of parts, rather as an "assemblage", the act of assembling under a guiding principle; the relationship to a whole. Frascari defines the detail as the union of construction – having the dual role of ruling both the construction and construing of architecture. This obligation of the relationship of the parts to the whole and the whole to the parts is the essence of the revelatory detail in service of architecture.

This seminar seeks to establish a framework of understanding enclosures in this sense of the revelatory detail. We will seek to counterpoint the numerical (external) facts of what is accepted as facade design (criteria, codes, loads, forces and consumptions) with an understanding of the generative processes underlying these physical criteria. The aim of this seminar is to arm the student with a guided understanding of the materials and assemblies available to them to form enclosures. The underlying intent is twofold.

In a generative role as architects, the course intends not for an encyclopedic overview of the elements and calculative methodologies of envelope design. Rather we will endeavor to investigate concepts of enclosure through assemblage of elements, mediated by details, in the service of the architectural intentions of the student.

In an execution role as architects in practice, the investigation into methodologies of deployment and execution of enclosure, materials and assemblies is intended to arm the students to engage proactively in their future practices with the succession of consulting engineers, specialty facade consultants, manufacturers and facade contractors that they will encounter during the execution of their work.

## Course Objectives & Methods

*"Design is not making beauty, beauty emerges from selection, affinities, integration, love"*

*- Louis Kahn*

The nature of enclosures will be explored through an adaptation of Kahn's statement. We will take selection, affinities, and integration as a methodology of interrogating the materials and assemblies comprising the envelope. We will engage in an analysis and interrogation of materials, their attributes, their forms of assembly as well as the natures of their manufacture.

The vehicle for this interrogation will be the act of drawing and assembling. Case studies of materials, processes and applications will provide the basis understanding this interrogating and dissecting ability (in Frascari's sense of the word). To develop this interrogative skill the students will engage in generative detailing exercises to analyze and apply these decontextualized results to reveal their nature manifest in enclosure. This seminar of thirteen sessions will offer us the opportunity to explore materials and assemblies in depth. The seminar will employ live "redline" sessions of the student's detail studies to explore the issues together.



## Course Outline

*Semester begins Wednesday 1/15/25, **BUT** following Monday schedule that day. This seminar begins Wednesday 1/22/24*

### Week 1 1/22/24

#### 1. Enclosure & Influences

- Statement of Principles
  - Specialization Erodes
  - Calculations without Intention
  - Assemblage of Elements and Methodologies
- Enclosure - Assemblage of Elements and Methodologies
  - Assemblage, not systems
  - Elements gathered through detailing
  - The Power of Section
  - Simultaneity of Scales
  - Methodologies
    - Software is not a tool
    - Analytique
    - Sketch Assembly
- Influences - Criteria, Situations and Forces
  - Climate
  - Solar Orientation
  - Imposed Forces - gravity, wind, fire, sound
  - Elements - water, temperature, solar gain
- Seminar Structure & Rules

- Case Study:
  - Barclays Center, Brooklyn, NY - *FRONT* for SHoP Architects
- Assignment:
  - Analytique / Existing Building assigned

Week 2 1/29/24

## 2. From Wall to Enclosure

- The Obligations of the Envelope
- Transformation
  - The Facade Emerges
  - Apertures
  - Warm to Cold Facades
- Principles of Assembly
  - Transformation of Mass into Structure & Enclosure
    - Load Bearing
    - Non-load Bearing
  - Layers
    - Separation of Elements & Potentialities
    - Layers forming Enclosures
    - Performance Layers
  - Load Transfer
  - Hierarchy of Elements
  - Influences / Considerations

- Case Study:
  - CCTV / China Central Television Tower, Beijing - *OMA / Office for Metropolitan Architecture*
- Assignment:
  - none

Week 3 2/5/24

## 3. Opacity / Mass

- Stone
  - Material & Origins
  - Assembly
    - Fixity
    - Layers of Control
    - Joints & Openings
  - Code Considerations
  - Installation
- Masonry
  - Typologies & Manufacture
  - Processing
  - Assembly
    - Fixity
    - Layers of Control
    - Joints & Openings
  - Code Considerations
  - Installation
- Concrete
  - Typologies & Manufacture
  - Processing
  - Assembly
    - Fixity
    - Layers of Control
    - Joints & Openings
  - Code Considerations
  - Installation

- Case Studies:
  - The Broad Museum, Los Angeles - *DS+R / Diller Scofidio + Renfro Architects*
  - Casa da Musica, Porto - *OMA / Office for Metropolitan Architecture*
- Assignment:
  - Analytique / Existing Building due
  - Sketch Assembly No. 1 / Opacity assigned

Week 4 2/12/24

## 4. Opacity / Lightweight

- Metals
  - Material & Origins
  - Manufacture & Processing
  - Assembly
    - Fixity / Layers of Control / Joints & Openings
    - Thermal Breaks
  - Code Considerations
  - Installation
- Timber
  - Origins & Typologies
  - Manufacture & Processing
  - Assembly
    - Fixity / Layers of Control / Joints & Openings
  - Code Considerations
  - Installation
- Composites
  - Origins & Typologies
  - Manufacture & Processing
  - Assembly
    - Fixity / Layers of Control / Joints & Openings
  - Code Considerations
  - Installation

- Case Studies:
  - Granoff Center, Providence - *DS+R / Diller Scofidio + Renfro Architects*
  - Wylie Theater, Dallas - *OMA / Office for Metropolitan Architecture*
- Assignment:
  - Sketch Assembly No. 1 / Opacity due
  - Sketch Assembly No. 2 / Opacity assigned

Week 5

## Studio Travel Week - No Class

Week 6 2/26/24

## 5. Transparency / Glass

- Material & Origins
- Processing, Fabrication & Finishing
  - Forming - casting / blowing / pressing / drawing / float
  - Processing - surfacing / strengthening / lamination / coatings
  - Fabrication - cutting / bending / composites
    - Insulated Glass Units
- Dimensionality
  - Limiting Factors
  - Sourcing
- Assembly
  - Fixity
    - Support - dead load
    - Capture - lateral load
  - Assemblies
  - Load Transfer
  - Layers of Control
  - Joints
  - Openings
  - Code Considerations
  - Installation

- Case Studies:
  - Vakko Headquarters, Istanbul - *REX Architecture*
  - Beijing Books Building, Beijing - *OMA / Office for Metropolitan Architecture*
- Assignment:
  - Sketch Assembly No. 2 / Opacity due
  - Sketch Assembly No. 3 / Transparency assigned

Week 7 3/5/24

## 6. Transparency / Curtain Wall & Structural Glass

- Material & Origins
- Manufacturing
- Processing, Fabrication & Finishing
  - Extrusion
  - Machining & Cutting
  - Fastening & Welding
  - Dimensionality
- Assembly
  - Fixity
  - Capturing Glass
  - Joints
  - Typologies
    - Window
    - Window Wall
    - Curtain Wall
    - Structural Glazing
  - Load Transfer
  - Layers of Control
  - Joints
  - Openings
  - Code Considerations
  - Installation

- Case Studies:
  - 5 Manhattan West, New York - *REX Architecture*
  - 100 Eleventh Avenue, New York - *Jean Nouvel Architects*
- Assignment:
  - Sketch Assembly No. 3 / Transparency due
  - Sketch Assembly No. 4 / Transparency assigned

Week 8

## ***Spring Break - No Class***

Week 9 3/19/24

## 7. Transparency / Transluscents & Polymers

- Polymers
  - Typologies
    - Poly / PVC / PMMA / Acrylic
    - PTFE
    - ETFE
    - Polycarbonate
    - Composite Assemblies
  - Manufacturing
- Processing, Fabrication & Finishing
  - Casting / Extruding / Molding
  - Foaming / Pressing / Formed Sheets
  - Dimensionality
- Assembly
  - Fixity
    - Layers of Control
    - Joints & Openings
  - Code Considerations
  - Installation

- Case Studies:
  - The Shed, New York - *DS+R / Diller Scofidio + Renfro Architects*
  - Jane's Carousel, New York - *Jean Nouvel Architects*
- Assignment:
  - Sketch Assembly No. 4 / Transparency due
  - Sketch Assembly No. 5 / Transparency assigned

Week 10 3/26/24

## 8. Guest Lecture: Richard Green of Green Facades LLC

This will be a Zoom lecture as the guest is located in Seattle. Lecture start will be 10:00.

**TO BE CONFIRMED**

Week 11 4/2/24

## 9. Adaptive Enclosures

- Enclosure as Selective Filter - Passive
  - Performance Inherent in Materials
  - Performance Inherent in Configuration
- Reactions
  - Solar Gain
    - Energy
    - Solar Path
    - Daylighting
  - Thermal Gain
    - Energy & Thermal Transmittance
- Typologies
  - Fixed Shading
    - Structurally Integrated
    - External
  - Encapsulated Shading
  - Externalized Configurations
    - Deep / Double Skins
  - Hybrids

- Case Studies:
  - Hanwah Labs, Seoul - *BIG / Bjarke Ingalls Group*
  - Seattle Public Library, Seattle - *OMA / Office for Metropolitan Architecture*
  - YAS Island, Abu Dhabi - *FRONT for Asymptote Architects*
- Assignment:
  - Sketch Assembly No. 5 / Transparency due
  - Sketch Assembly No. 6 / Adaptive assigned

Week 12 4/9/24

## 10. Reactive Enclosures

- Enclosure as Selective Filter - Active
  - Performance Inherent in Materials
  - Performance Inherent in Configuration
- Reactions
  - Solar Gain
    - Energy
    - Solar Path
    - Daylighting
  - Thermal Gain
    - Energy & Thermal Transmittance
- Typologies
  - Kinetic Shading
    - External
    - Integrated / Encapsulated
    - Internal
  - Kinetic Apertures
    - Operable Walls
  - Actuation
- Harvesting
  - Solar Electric
  - Solar Thermal
  - Wind
  - Green & Bio-reactive
- Daylighting

- Case Studies:
  - The Shed, New York - *DS+R / Diller Scofidio + Renfro Architects*
  - Stabile Student Center / Columbia University, New York - *FRONT for Marble Fairbanks Architects*
  - CMA Tower, Riyadh - *FRONT for HOK Architects*
- Assignment:
  - Sketch Assembly No. 6 / Adaptive due
  - Sketch Assembly No. 7 / Reactive assigned
  - Analytique / Student's Project assigned

Week 13 4/16/24

## 11. Overhead Enclosures

- Unique Configurations - Span Determined
  - The Rules Still Apply
    - Load Transfer
    - Layers of Control
  - Hierarchy of Elements
- Span Influences Enclosure
  - Form Active
  - Vector Active
  - Section Active
  - Surface Active
  - Hybrid
- Assemblies
  - Opaque
    - Steep Slope
    - Low Slope
  - Transparent
    - Glass
    - PTFE Membrane
    - ETFE Cushion
    - Polymer Panels

- Case Studies:
  - Morgan Library, New York - *Renzo Piano Building Workshop*
  - Canadian Parliament West Block, Ottawa - *FRONT for ARCOP/FGM&A*
- Assignment:
  - Sketch Assembly No. 7 / Reactive due
  - Sketch Assembly No. 8 / Overhead assigned
  - Final Analytique assigned

Week 14 4/23/24

## 12. Performance & Execution

- Performance
  - Physical Criteria
  - Building Codes & Standards
    - IBC / International Building Code
    - Fire Performance
  - Energy Codes - ASHRAE
  - Sustainability Standards - LEED, BREEAM
- Process
  - Phases of the Work
  - Deliverables
    - Contract Drawings
    - Specifications
  - Bid / Tender Methods
    - Design-Assist / Design Build
  - Design Process
    - Consultants
- Execution
  - Design-Build Process
    - Samples & Trial Assemblies
    - VMU / Visual Mockup
    - PMU / Performance Mockup
    - Shop Drawings
    - Installation

- Case Studies:
  - Glass Museum, Toledo - *SAANA / Sejima and Nishizawa Architects*
  - Highline 23, New York - *Neil Denari Architects*
- Assignment:
  - Sketch Assembly No. 8 / Overhead due

Week 15 4/30/24

### 13. New Materials & Processes

- Sources of Innovation
  - Technology Transfer v. Inherent Improvement
- Materials
  - Masonry
    - Integrated Insulation Units / Recycled
  - Concrete
    - Autoclaved / Self-Healing / Cloth / Light Transmitting
    - Foamed / Admixtures
  - Composites
    - Bio-composites / Wood Plastics / EPS Cement
    - Aramid Fibers / GLARE
  - Insulation
    - Aerogel / Thermal Barrier Coatings /
  - Adhesives
    - UV Activated / Composite Bonding
- Configurations
  - Stressed Skin Panels / Vacuum Panels . UHWLTT
  - 3D Printed Materials
- Techniques
  - Software
    - Form-finding & Parametricism
    - Analysis
    - BIM
  - Building Physics
  - Rapid Prototyping
  - Generative Manufacturing

- Case Studies:
  - Lincoln Square Synagogue, New York -  
*FRONT for Cetra Ruddy Architects*
  - Carriage Road Passive House, Calgary -  
*FRONT*
- Assignment:
  - *none*

5/13/24

***Spring Term Ends***

5/13/24

**Final Assignment Due (by 18:00) - grades due to University 5/14 @ 12:00**



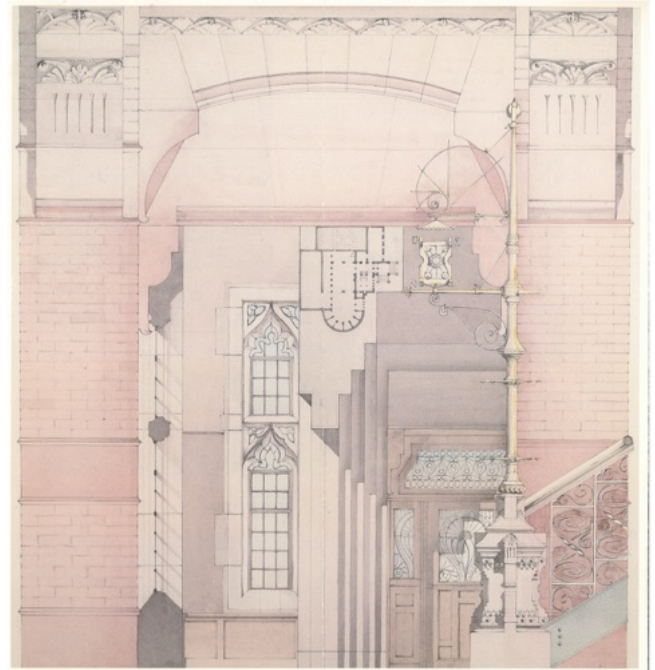
## Assignments

### Analytique / Existing Building

*"In the Beaux Arts tradition the understanding of the role of detail as a generator of the character of buildings determined that a very peculiar graphic means for the study of it, the analytique. In this graphic representation of a designed or surveyed building the details play the predominant role. They are composed in different scales in the attempt to single out the dialogue among the parts in the making of the text of the building. Sometimes the building as a whole is present in the drawing, and generally it is represented at a minuscule scale, and so it seems a detail among details."*

*The origin of the analytique and its role in the construing of architecture can be traced back to the technique of graphic representation and composition developed by Piranesi in his etchings surveying the Magnificenza of Roman architecture. These are a graphic interpretation, with a stronger Vichian bias, of Carlo Lodoli's understanding of the built environment as a sum of inadequate details to be substituted with more appropriate ones. Another form of the analytique, illustrating the architecture of Italy, can be found in the Italian lire notes today."*

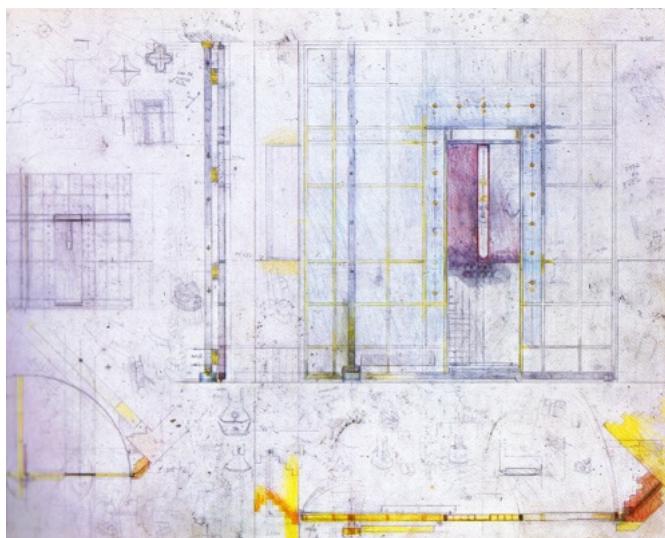
*"The Tell-the-Tale Detail" by Marco Frascari*



The student will develop an analytique of an existing building, with an emphasis on enclosure, from the selection provided by the Instructor. The analytique is no mere representation of a building; rather it presents a building through its facade details and it gives insight into the detail as generator. The analytique is intended to present multiple scales side by side in an overall composition.

The students are free to use any media (physical, digital or virtual) that they feel best suits their particular exploration in analytique. The final product is expected to be digital format.

### Sketch Assemblies



*"Details are much more than subordinate elements; they can be regarded as minimal units of signification in the architectural production of meanings."*

*Marco Frascari*

Each week the students will undertake a single sheet generative detailing exercise based on the topic of each seminar. The essential framework of enclosure development is the "PSE" or Plan / Section / Elevation. This combination of essential and simultaneous third angle projections as the point of departure for developing enclosure assemblies. This method stresses the simultaneity of scales on one sheet to support an exercise in generative assembling.

The intent is for the student to set forth a typical condition of base building structure (plan and section) as a point of departure and develop a sketch enclosure assembly based on an aspect of that particular seminar. The student should then develop a series of generative details at multiple, but related, scales to explore the topics discussed in the subject seminar. The use notes and other information, when warranted, is encouraged for the development of the ideas. Attention should be paid to developing an analytique methodology to explore how a simultaneity of scales informs the development of the enclosure in service of the student's architectural intentions.

These Sketches will be the subject of weekly live redline review sessions of selected Sketch Assemblies. The Instructor will project the sketches and digitally redline them to discuss salient issues graphically for the entire class.

### Analytique / Student's Project

The student is to produce a selected facade system prototype study of their current studio project in the form of an analytique. If the student does not have a current project see the alternative process below.

Select a facade, or facade assemblies, of your studio project that demonstrates a significant element of your design and this element should display a variety of materials, elements, assemblages and innovation. The study should bring emphasis to materials, detailing, and performance of your enclosure.

Draw a partial elevation, wall section and partial plan (at min. 1/8"=1'-0"), section and plan details (at min. 3"=1'-0") to describe your development of the enclosure assembly you have selected. The student is expected to develop this Study as an Analytique, as explored in the initial assignment. The focus should be on assemblies, assemblages and interrelations of facade elements related through scale. It is the intention for this study to be useful in the development of the student's current studio project. The instructor will be available for interim comments and reviews during the course of the semester. In this the class assignment and the studio project can benefit from increased depth of assembly and detail development.

If the student does not have a current studio project, the instructor will present a prototype form, structure and performance criteria as a basis for the Study. This can be assigned at the beginning of the seminar.

## Literature

There is no required textbook for the seminar. The following are reference materials to support the students development. Please note that some of these books are out of print or expensive, so I encourage you to avail yourself of the Architecture Library.

- Frascari, Marco. "The Tell the Tale Detail." **VIA 7: The Building of Architecture** Volume 7 1984: p. 23-37.
- Patterson, Mic. **Structural Glass Facades and Enclosures**. Hoboken, NJ: John Wiley & Sons, 2011.
- Kaltenback, Frank (ed.). **DETAIL Praxis: Translucent Materials**. Basel: Birkhauser, 2004.
- Nijssse, Rob. **Glass in Structures**. Basel: Birkhauser, 2003.
- Knaack, Klein & Bilow (ed.). **imagine 01: FACADES**. Rotterdam: 010 Publishers, 2008.
- Lovell, Jenny. **Building envelopes : an integrated approach**. New York: Princeton Architectural Press, 2010.
- Knaack, Ulrich. **Facades: principles of construction**. Basel: Birkhauser, 2007.
- Kristal, Marc. **Immaterial world : transparency in architecture**. New York: Monacelli Press, 2011.
- Murray, Scott. **Contemporary Curtain Wall Architecture**. New York: Princeton Architectural Press, 2009.
- Schittich, Christian(ed.). **In detail : building skins : concepts, layers, materials**. Basel : Birkhäuser, 2001.
- Schittich, Christian(ed.). **Glass Construction Manual**. Basel : Birkhäuser, 2003.
- Herzog, Thomas(ed.). **Facades Construction Manual**. Basel : Birkhäuser, 2017.
- Schittich, Christian(ed.). **Best of Detail: Glass**. Basel : Birkhäuser, 2014.

- Snyder, Frank. **Building Details**. New York: W.W. Norton, 2007.
- Watts, Andrew. **Modern Construction Envelopes**. Vienna: Ambra Verlag, 2013.
- Zahner, William. **Architectural Metals: A Guide to Selection, Specification, and Performance**. Hoboken, NJ: John Wiley & Sons, 1995.
- Zahner, William. **Architectural Metal Surfaces**. Hoboken, NJ: John Wiley & Sons, 2004.
- Zaera-Polo, Truby, and Koolhaas (ed.). **facade**. Venice: Marsilio, 2014.
- Boswell, Keith. **Exterior Building Envelopes**. Hoboken, NJ: John Wiley & Sons, 2013.
- Engel, Heino. **Structure Systems**. Berlin: Hatje Cantz, 2007.
- Fortemayer & Linn. **Kinetic Architecture: Designs for Active Envelopes**. New York: Images Publishing, 2014.

In addition to print media, the following online references may be of use.

#### Materials

- 4Specs - <https://4specs.com>
- ARCAT - <https://www.arcat.com>
- SWEETS - <https://sweets.construction.com>

#### Facade Systems

- Building Science Corporation - <https://www.buildingscience.com>
- Berkeley Lab - <https://buildings.lbl.gov>
- Glass On Web - <https://www.glassonweb.com>
- GPD - <https://gpd.fi>

#### Detailing

- The\_Donnies - Troy Donovan Instagram - [https://www.instagram.com/the\\_donnies/](https://www.instagram.com/the_donnies/)
- The Detail Library - <https://detail-library.co.uk>
- First in Architecture - <https://www.firstinarchitecture.co.uk>

### Course Meeting

The seminar will take place in thirteen sessions from January 22nd through April 30th. Meetings will be on Wednesday 8:30 am - 11:30 pm, Location: **Fisher-Bennett Hall, Room 323 - Classroom assignment TO BE CONFIRMED**

## Assessment Method

The seminar will be assessed on the performance of the student through the Assignments. The assessment is divided as follows:

Analytique / Existing Building	= 15% of total grade
Sketch Assemblies	= 6% each - (8) Sketches = 48%
Analytique / Student's Project	= 37% of total grade

The instructor will evaluate the student's submitted work and evaluate it as the summation of a process throughout the seminar. Letter grades are understood to mean the following. with + and - understood as their qualifiers.

A+	= 4.0	
A	= 4.0	Excellent
A-	= 3.7	
B+	= 3.3	
B	= 3.0	Good
B-	= 2.7	
C	= 2.0	Marginal
F	= 0.0	Fail
I	= 0.0	Incomplete*

*\* - A grade of "I" (incomplete) shall only be given in case of illness or family emergency as per PennDesign Academic Policies.*

Late work will be penalized by a full letter grade, except in the case of an excused absence as per University policy.

## Attendance

Students are expected to attend all classes for the entire scheduled meeting time and are responsible for completing assignments and for knowing the material covered in class. The Instructor will maintain a written record of student attendance for the semester. Students are allowed one absence without a final course grade reduction. After the allowed absence a student's final course grade will be reduced one-half level for each additional absence (e.g. after the second absence from a seminar the final course grade will be lowered from a B+ to a B, after the third absence from a B to B-, etc.). Absences due to illness will be excused in accordance with university policy.

## Academic Integrity Statement

Academic honesty is fundamental to our scholarly community. The PennBOOK contains the University Code of Academic Integrity, to which the School of Design strictly adheres. A confirmed violation of that Code in this course will result in a failing grade, and likely in other disciplinary measures. The UPenn Code of Academic Integrity is available online at: [http://www.upenn.edu/academicintegrity/ai\\_codeofacademicintegrity.html](http://www.upenn.edu/academicintegrity/ai_codeofacademicintegrity.html)

## Masking Policy

In alignment with the current University policy, masks are optional in classroom. However, should conditions change during the semester the Instructor may request that masks be worn during the seminar.