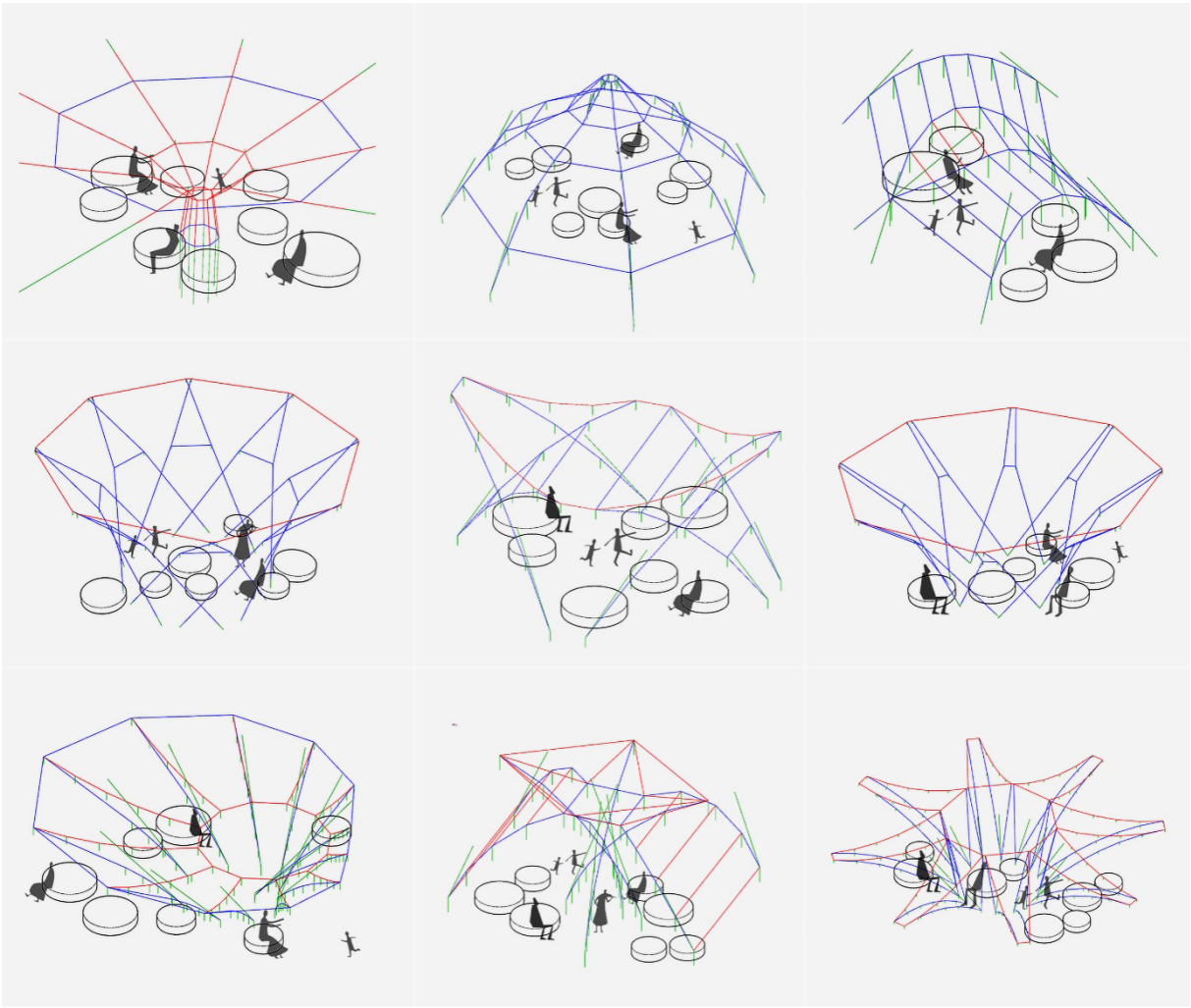

REUSE AS DESIGN

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ISSUE

"Nothing is created, nothing is lost, everything is transformed." − Antoine Lavoisier

This course challenges students to rethink structural design with a core focus on reuse. By combining fundamental principles with intricate architectural components, it emphasizes both aesthetics and functionality, promoting an integrated design approach. Students will learn to optimize structural designs, understand force transmission and balance, and translate principles into practical solutions. The course delves deeply into the concept of structural reuse, guiding students to design structures that can be disassembled and reassembled in new forms. To enhance this process, augmented reality (AR) tools are integrated to assist in the construction and reuse of structures.

DESCRIPTION

Historically, architectural design has transitioned from traditional methods to innovative approaches, incorporating materials science, structural engineering, and digital technology advances. This course situates itself within this context by addressing how principles of structural principle can be reinterpreted using contemporary tools and methods to create transformative and sustainable architectural solutions.

- Basic structural knowledge.
- Basic skills in Rhino and Grasshopper.
- An understanding of sustainability concepts in architecture.
- Experience with group work and collaborative projects.

The overall aims of the course are to:
- Encourage students to rethink and innovate in structural design.
- Integrate structural principles into architectural design.
- Explore both aesthetic and functional aspects of structures.
- Utilize digital design tools for structural form-finding and optimization.
- Translate abstract structural principles into practical, sustainable design solutions.
- Enable students to transform digital models into physical prototypes.
- Employ AR tools to enhance the construction process.
- Cultivate an integrated understanding of structure and architecture as interconnected elements.

This course complements other courses in the architectural programme by:
- Building on core courses in design studios and structural design.
- Providing advanced skills in digital tools and technology.
- Enhancing understanding of sustainable and circular architecture, tying in with environmental design and sustainability courses.
- Offering practical, hands-on experience through 3D printing and AR, which links to courses on construction methods and building materials.
- Promoting interdisciplinary collaboration and innovation, aligning with courses that emphasize design thinking and collaborative projects.

IMPACT AND SUSTAINABILITY

In this course, you will explore the diversity and innovation of structures, enhancing your understanding and practical skills in sustainable design and circular architecture.
You will delve into the following areas in this course:

- Integrated design methods for structure and architecture
- Sustainable development in architecture
- Designing and optimizing structural components
- Applications of AR in design and construction

01_Integration of Sustainable Design Principles
- Circular Construction: Students explore principles of circular construction, which emphasize designing structures that can be disassembled and reused. This approach minimizes waste and extends the lifecycle of building materials, aligning with sustainable practices.
- Material Efficiency: By designing structural components that optimize material use, students learn to create buildings that require fewer resources without compromising on strength or aesthetics. This efficiency is a critical aspect of sustainable construction.

02_Use of Advanced Technologies
- Digital Design and Analysis: Utilizing digital design software for structural analysis helps students to optimize their designs for both performance and material efficiency. This reduces the environmental impact by ensuring that structures are both resilient and resource-efficient.

03_Innovation in Construction Methods
- Disassemble Structures: Designing structures that can be easily disassembled and reassembled fosters a sustainable mindset. This method reduces the need for new materials and allows for adaptive reuse of components, supporting long-term sustainability.
- AR Tools: Using AR tools for construction planning and execution helps with representation and construction process.

COURSE SYLLABUS

TOPIC 1: FUNDAMENTALS AND APPLICABILITY OF GRAPHIC STATICS
- Understanding how to represent forces graphically using force polygons and vector diagrams.
- Analysing the relationships between different forces in a structure.

TOPIC 2: DIGITAL DESIGN SOFTWARE
- Software Tools Usage: Mastering the basic operations of digital design software such as Rhino and Grasshopper.
- Structural Simulation and Analysis: Learning how to simulate and optimize structures using software.

TOPIC 3: STRUCTURAL DESIGN AND OPTIMIZATION
- Methods of Structural Optimization: Learning how to improve the performance and aesthetic appeal of structures through design optimization.
- Design Scheme Evaluation: Mastering methods to evaluate and refine design schemes.

TOPIC 4: SUSTAINABLE DESIGN AND CIRCULAR ARCHITECTURE
- Principles of Circular Construction: Understanding the design methods for structures that can be disassembled and reassembled.

TOPIC 5: AUGMENTED REALITY (AR) FOR CONSTRUCTION
- AR Tools Usage: Learning how to use AR tools in the design and construction process.
- Precision Assembly: Utilizing AR technology to achieve rapid and precise assembly of structures.

METHODS

The course comprises four stages: foundational knowledge learning, design exploration, and structural construction.

In the first stage, students learn and understand the fundamentals of graphic statics, mastering essential concepts. They focus on the basics of force diagrams, equilibrium, and structural analysis through graphical methods. Additionally, they systematically study the basic principles and methods of structural principle using digital software simulations and practices. In the second stage, students work in groups to complete a pavilion design task. They conduct on-site investigations to explore and design structural units that can be disassembled and reassembled. They use 3D printing technology to create small-scale models to validate design feasibility. In the third stage, students collaboratively engage in the 1:1 construction of structural nodes, experiencing and comprehending the physical balance and stability of architectural structures from design to actual construction. They also learn to utilize AR tools to assist in the construction process.

WORKSHOP
An Augmented Reality workshop Organized in collaboration with PolyU, time and arrangement TBC.

FIELD TRIP
TBC

GUEST LECTURES
Input lecture regarding structural reuse (guest TBC)

EXHIBITION
All students' work will be exhibited at CUHK as well as in Shekou, Shenzhen (time and format TBC).

DELIVERABLES

01_Stage 1 (Individual): Mastering the Fundamentals
- Case Study Exercises: submit case studies and analyses related to graphic statics, including force diagrams, equilibrium, and structural analysis
- Digital Analogue and Design: Conduct static analysis of actual architectural structures using software, including load calculation, internal force analysis, and structural optimization.

02_Stage 2 (Group work): Design Exploration
- Site Survey Reports
- Design Drawings and Proposals: Including floor plans, elevations, sections, and site analysis diagrams. Demonstrating the reusability and transformation efficiency of the designs.
- 3D Models (1:20, 1:10)

03_Stage 3 (Group work): Structural Construction
- Structural Node Models (1:1, 1:2)
- Final Drawings and Construction Process Records
- Final Booklet: Documenting the design and construction process, including the use of AR models.

LEARNING OUTCOMES

1. An understanding of how to represent and analyse forces in structures.
2. An understanding of digital tools for design and structural analysis.
3. An understanding of methods to optimize structural design.
4. An understanding of sustainable design principles for reusable structures.
5. An understanding of technology's role in improving the construction process.
6. An understanding of the impact of local conditions on architecture
7. Able to work effectively in teams on design and research projects.
8. Able to adopt the taught methodology and skill sets to study architecture
9. Able to integrate structural concepts into architectural design.
10. Able to collaborate on investigation.

ASSESSMENT SCHEME

SPECIFIC ASSESSMENT

01_Review 01 (15%)
02_Review 02 (15%)
03_Final Review (50%)
04_Project Booklet (20%)

Total: 100%

COURSE FORMAT

1_Teaching Days

1. Students must attend for F2F teaching during these teaching hours.
   Teaching Day: Wednesday
2. Teaching Venue: WMY_502
3. Field trips, lectures, and other learning activities may be scheduled outside of teaching days.

2_Student Study Effort_3 credit course (Total: 140 hrs)

1. Class Contact: 39 hrs (Lecture –13hrs, Tutorial – 13hrs, Critique – 8 hrs, Field Trip –3 hrs)
2. Other Student Study Effort: 100 hrs (Studio / Self Study)

REQUIRED READINGS

Edward Allen, Waclaw Zalewski. *Form and Forces: Designing Efficient, Expressive Structures*. Hoboken: John Wiley & Sons, 2010.
Aurelio Muttoni. *The Art of Structures: Introduction to the Functioning of Structures in Architecture*, EPFL Press, 2011.
Corentin FIVET and Jan BRÜTTING, “Nothing Is Lost, Nothing Is Created, Everything Is Reused: Structural Design for a Circular Economy.” *The Structural Engineer* 98, no. 1, 2020, pp. 74-81.
Brütting, J., Desruelle, J., Senatore, G., & Fivet, C. Design of Truss Structures Through Reuse. *Structures*, 18, 2019, pp.128–137.
Stricker, Eva et al., eds. *Reuse in Construction : A Compendium of Circular Architecture*. Trans. by David Koralek, Ian Pepper, and Iain Reynolds. Zurich: Park Books, 2022.
Online source: *https://block.arch.ethz.ch/eq/drawing*

OTHER REFERENCES

Bjorn Normann Sandaker, *On Span and Space: Exploring Structures in Architecture*,1-18. London and New York: Routledge, 2008.
Eduard F. Sekler, “Structure, Construction, Tectonics.” In *Structure in Art and in Science*, edited by Gyorgy Kepes, 89-95. New York: George Braziller Inc., 1965.
Schwartz, Joseph. “Structural Theory and Structural Design.” In *Cooperation: The Engineer and the Architect*, edited by Aita Flury, 241-248. Berlin; Boston: Birkhäuser, 2012.
Bjørn N. Sandaker, Arne P. Eggen, Mark R. Cruvellier. *The Structural Basis of Architecture*, Routledge, 2011.
Cruvellier, Mark R., Luben. Dimcheff, and Bjorn N. Sandaker. *Model Perspectives: Structure, Architecture and Culture*, London: Taylor and Francis, 2017.

IMPORTANT NOTE TO STUDENTS

Expectations for Professional Conduct
The motto of The Chinese University of Hong Kong (CUHK) is "Through learning and temperance to virtue". This motto places equal emphasis on the intellectual and moral education of students. In addition to pursuing academic excellence, students of CUHK are expected to maintain and uphold the highest standard of integrity and honesty in their academic and personal lives, respect the rights of others and abide by the law. More information on Postgraduate studies can be found in the PG Student Handbook. https://www.gs.cuhk.edu.hk/

Attendance
Class attendance is required in all courses. For an excused absence, the instructor must be notified and presented with documentation of illness or personal matter. Please note: **Three (3)** or more unexcused absences may result in a failing grade for the course.

Academic Honesty
The Chinese University of Hong Kong places very high importance on honesty in academic work submitted by students and adopts a policy of zero tolerance on academic dishonesty

Attention is drawn to University policy and regulations on honesty in academic work, and to the disciplinary guidelines and procedures applicable to breaches of such policy and regulations. Details may be found at: http://www.cuhk.edu.hk/policy/academichonesty/.

With each assignment, students may be required to submit a statement that they are aware of these policies, regulations, guidelines and procedures.

Third-Party Assistance
All intellectual work essential to the design project must be completed by the student and cannot, under any circumstance, be outsourced to a third party (including, but not limited to a company, consultant, alumni, and/or friend).

In the design studio context, students may utilize external resources, such as printing services for presentation materials, and/or laser cutting and 3D printing services for prototyping purposes. Use of such third-party services constitutes non-intellectual work done by others. It is only permitted with prior written consent from the studio tutor and acknowledgment of such work done by the third party.

Assistance from other students or friends for aspects of project production also constitutes non-intellectual work done by others; this is allowed only if declared and acknowledged in a written statement attached to any such work that has received assistance.

Under all circumstances, students must declare all work done by others by completing the school's designated form before assessment. This form must include a detailed explanation of the third party's identity (name and relationship to the student), when and how they were utilized, and the specific tasks they performed in the project. The completed form, signed by the student, must be endorsed by the tutor and presented during the final review. The school will collect and retain this form for record-keeping purposes.

Failure to follow this code of conduct may be considered a case of academic dishonesty, to be reviewed by a disciplinary board, and possible failure of the course.

Artificial Intelligence
Unless approved by the Programme or School Director, any use of AI tools such as ChatGPT or image generation tools (Midjourney) etc. is strictly prohibited and may result in disciplinary action in accordance with university policy on academic honesty. Students may refer to the CUHK 'Use of Artificial Intelligence tools in Teaching, Learning and Assessments' – A Guide for Students.

Student Work
Submission of studio documentation must be complete and correctly formatted. Missing or incomplete submission of the documentation folder will result in the grade for the course being withheld. This will prevent registration for the following term or delay graduation. In addition, a grade deduction of *one letter grade* will be made.

Term 1: 2 September 2024 (Monday) – 30 November 2024 (Saturday)

WEEK 01		
04.09	**LECTURE**	Introduction of the course
WEEK 02		
11.09	**LECTURE**	Introduction of Graphic Statics
WEEK 03		
18.09	**NO CLASS**	The day following the Mid-Autumn Festival
WEEK 04		
25.09	**LECTURE & TUTORIAL**	Introduction of Graphic Statics and Digital Application; Installation and Basic Operation Exercises of Digital Design Software
WEEK 05		
02.10	**TUTORIAL**	Software Q&A Session; Task: Digital Tool Exercise, Assignment of Structural Form-Finding Results
WEEK 06		
09.10	**PRESENTATION**	Site Analysis Report and Initial Design Proposal
WEEK 07		
16.10	**LECTURE & TUTORIAL**	Discussion on Conceptual Design; Task: Creation of Digital Structural Models
WEEK 08		
23.10	**LECTURE & TUTORIAL**	Discussion on Conceptual Design; Task: Development of Digital Structural Models
WEEK 09		
30.10	**PRESENTATION**	Group Design Proposal, including Physical Models, Design Drawings, and Design Descriptions
WEEK 10		
06.11	**LECTURE & CONSTRUCTION**	Learning and Test AR-Assisted Methods
WEEK 11		
13.11	**LECTURE & CONSTRUCTION**	Finalising Design Proposal; Production and Fabrication of Structural Models
WEEK 12		
20.11	**FINAL PRESENTATION**	Presentation of the Final Design
WEEK 13		
27.11	**REVIEW & SUBMISSION**	Submission Due Final Booklet

Grade	Descriptor	Criteria	Points
A	Excellent	Comprehensively excellent performance on all aspects of the design intention, development, technical resolution and presentation. Achieving all learning outcomes with distinction.	4
A-	Very Good	Generally outstanding performance on the design intention, development, technical resolution and presentation. Achieving all learning outcomes with merit.	3.7
B+	Good	Substantial performance on the design intention, development, technical resolution and presentation. Achieving all learning outcomes satisfactorily.	3.3
B			3
B-			2.7
C+	Fair	Fair performance on the design intention, development, technical resolution and presentation. Achieving all learning outcomes at a passing standard.	2.3
C			2
C-			1.7
D+	Pass	Barely satisfactory performance on the design intention, development, technical resolution and presentation. Achieving all learning outcomes at a barely satisfactory standard.	1.3
D			1
F	Failure	Unsatisfactory performance on the design intention, development, technical resolution and presentation. Not achieving all learning outcomes.	0