*Proceedings of the IASS 2024 Symposium*
*Redefining the Art of Structural Design*
August 26-30, 2024, Zurich Switzerland
Philippe Block, Giulia Boller, Catherine DeWolf,
Jacqueline Pauli, Walter Kaufmann (eds.)

# Structural design pedagogy under the embodied perception: an equilibrium-based approach for architecture students

* Shuaizhong WANG

* The Chinese University of Hong Kong, School of Architecture
Rm. 201, Lee Shau Kee Architecture Building, School of Architecture,
The Chinese University of Hong Kong, Shatin, Hong Kong
shuaizhongwang@cuhk.edu.hk

## Abstract

Traditional architectural pedagogy primarily teaches structural design through engineering-based methodologies, formulae, and calculations. However, for architecture students, understanding structures' artistic and expressive aspects is equally important. This aspect transcends mere numerical analysis, necessitating a profound understanding of the interplay between form and forces—a component often overlooked or inadequately addressed within current pedagogical paradigms.

Inspired by the historical emphasis on perception within structural education, this paper addresses this lacuna by integrating recent findings from cognitive neuroscience into structural pedagogy. These findings elucidate the pivotal role of human embodied perception in comprehending architectural structures, informing an innovative educational approach that employs the human body as a metaphor and frame of reference for conceptual structural design.

This paper proposes a pedagogical approach that enables students to use equilibrium diagrams in graphic statics to establish a connection between bodily gestures and the design of structural equilibrium systems, taking into account both physical and psychological aspects. The suggested approach was executed in a course on structural design at the Chinese University of Hong Kong. Based on this case study, the paper elucidates the framework and significance of this pedagogical model.

**Keywords**: Structural education; Architectural education; Structural design; Embodied perception; Graphic statics; Equilibrium; Architecture students; Architecture and structure integration

## 1. Challenges of Structural Education

Structural design possesses significant artistic value and social contribution beyond merely supporting architecture. However, contemporary practice has largely overlooked its creativity and positive influence on architecture [1]. This stems from a fundamental flaw - the lack of conceptual unity between structural cognition and creativity, rooted in the divisive design and teaching approaches separating structural engineering from architecture [2].

Since the mid-19th century, the complexity of architectural projects has led to the separation of architecture and structural engineering. This division established load-bearing structures as an independent field, resulting in a design process where architecture precedes structural support [3]. Consequently, architects lost structural awareness, and structural engineers became passive due to their later involvement. Education reinforces this divide. Programs like Beaux-Arts emphasize aesthetics, treating architecture as an art form, while structural engineering focuses on technical analysis [4]. This siloed approach fosters the outdated belief that elegance is the domain of architects, with engineers merely ensuring functionality, thus stifling the creative potential of structural design.

The lack of conceptual awareness, interdisciplinary perspectives, and integrative abilities is pervasive in architectural structural design and education [5]. Numerous reports highlight deficiencies in structural design skills among engineering and architecture students, emphasizing the importance of conceptual synthesis early in the design process [6].

Architectural education often relegates structural considerations to a secondary role, diluting architects' structural consciousness and making it the sole responsibility of engineers [7]. This reduces structural teaching to a series of "structural types" for engineers to implement later, stifling innovation by confining structures to rigid templates or mere iterations of technique or style [8]. Technological advancements and new materials have further confined structural education within an engineering problem-solving paradigm, creating a gap between architects' structural comprehension and engineers' conceptual input.

As addressing complex societal needs becomes increasingly crucial for architecture, the traditional divisive practices between architects and structural engineers are inadequate. Cultivating professionals with integrative abilities is paramount. This article explores a new interdisciplinary structural teaching approach, and illustrates its experience and value through a case study on integrated structural and architectural pedagogy at the School of Architecture at The Chinese University of Hong Kong.

## 2. The Historical Endeavors in Structural Pedagogy

Historically, scholars like David P. Billington and Robert Le Ricolais pioneered integrating creativity into structural engineering curricula. Billington proposed a "discipline and play" model using historical case studies and physical models, though his approach remained engineer-centric, focusing on efficiency and elegance over architectural spatial and experiential aspects [9]. Le Ricolais used analogical teaching with physical models like soap films [10], which, while intuitive, confined students to passive structural optimization rather than encouraging exploration of architectural integration [11].

In contrast, the Austin pedagogy of the late 20th century, led by figures like Hoesli, Rowe, and Hejduk, emphasized structure, material, and space as central to architecture. This approach, drawing from cognitive science and Gestalt psychology, analyzed architectural spaces through visual perception [12]. However, it often prioritized abstract aesthetics over practical structural precision.

The rise of digital technologies has accelerated the exploration of complex structural forms through interactive tools and geometry-based analysis [13]. While these methods have made design and verification more efficient, they often remain performance-centric, risking detachment from the intuitive aspects of structural design [14].

Current structural pedagogy does not adequately meet architects' needs for integrated conceptual thinking. As architectural projects grow more complex, there is a pressing need for interdisciplinary education that cultivates integrated cognitive abilities. Integrating architectural and structural design thinking from the earliest conceptual stages remains a significant challenge.

This research proposes a new interdisciplinary framework for structural instruction. Combining cognitive science principles from the Austin pedagogy with Billington and Le Ricolais' intuitive models, and incorporating embodied cognition theory, it redefines structural design teaching. Techniques like graphic statics and model-making are integrated to make structural design an integral part of the architectural process from the conceptual stage.

## 3. Body in architectural and structural education

Austin pedagogical attempt to incorporate visual and cognitive science theories into the design paradigm offers valuable insights for integrating intuition and artistic dimensions into structural design education. The effectiveness of this approach stems from the central role of empathy (Einfühlung) - our ability to understand and resonate with external entities through bodily experiences of physical concepts like gravity, pressure, and structural equilibrium [15]. However, early 20th-century empathy theories lacked sufficient scientific grounding to explain how this mechanism operates fully.

The rapid development of modern brain imaging techniques like fMRI and EEG has enabled the field of cognitive neuroscience to explore previously better-unresolved issues in psychology and social sciences. A key milestone was the mid-1990s discovery of mirror neurons, emphasizing the crucial role embodied physical experience plays in how we perceive and make sense of the world around us [16]. The mirror neuron mechanism automatically retrieves memories of our past bodily experiences and emotional states when observing external stimuli, allowing us to directly and unconsciously re-activate our past related subjective experiences, facilitating interpretation and understanding of observed entities [17]. This finding elucidates the neural mechanism underlying our empathic responses to the built environment, indicating that traditional Western dualistic philosophical understandings of perception as mind-body separation are incomplete - perception comprises an integrated embodied experience[18].

This cognitive neuroscience revolution has fundamentally challenged architectural education’s guiding assumptions over the past 50 years or so. On the one hand, it demonstrates that human cognition is inherently embodied, making long-standing number and formula-driven architectural and structural teaching methods somewhat incongruent with the actual nature of how we think and process information. On the other hand, it provides solid scientific corroboration for the importance of intuitive design processes as emphasized by pioneers like Pier Luigi Nervi and others [19].

Calls for substantial changes to architectural education to align it with cognitive realities have become commonplace. Theorists have long advocated for embodied, multisensory, hands-on methods of interweaving insights across disciplines [19]. Their research indicates traditional priorities of form, function, and materials must be counterbalanced and integrated with the cognitive dimensions of perception, bodily experience, and intuition.

Participatory pedagogical methods directly engaging the body represent powerful teaching modalities. Research shows the crucial importance of embodied experiences for guiding design thinking and materials/forms exploration [20]. Findings underscore the continued relevance of practices like architectural drawing and physical modeling, as such embodied training directly impacts and shapes students’ imaginations [21]. Architectural structures and forms should be conceived as fundamentally embodied phenomena, not just abstract visualizations.

There is a rich historical lineage of incorporating embodied practices into design education, like Robinson’s advocacy for integrating an embodied, embedded, enactive cognition perspective into rethinking architectural pedagogy through immersive making and research at Aalborg University. The University of Venice even offers a master’s program dedicated entirely to Neuroarchitecture, uniting architectural design with neuroscientific study.

By quantifying cognitive principles governing bodily experience and perception interactions, neuroscience findings introduce a powerful conceptual lens for interpreting and teaching structural design at the fundamental level of human multisensory experience. This transforms perception into a pragmatic, embodied pedagogical medium. There are already notable examples of structural designers like Santiago Calatrava deriving inspiration from bodily analogies [22], or educators like Loren Whitehead at Iowa State basing their structural teaching methods on innate bodily awareness of forces and equilibrium [23]. This research aims to advance such embodied structural pedagogy systematically.

## 4. Graphic Statics as the Equilibrium Diagram

To further establish the synthetic association between the body and structures at the design level, this research employs Graphic Statics - a geometric tool for quantitative and qualitative structural equilibrium design/analysis. Unlike traditional finite element analysis, Graphic Statics visually delineates force flows and internal stress fields, offering an intuitive graphic operation method intertwined with equilibrium concepts [24]. Using a strut-and-tie model, it graphically represents force flows, illuminating structural logic during design by simplifying forces into compression and tension [25]. Its generative vector-based operations permit iterative form-finding adjustments driven by force flows. The abstraction, intuitiveness, and operability of graphic statics enable students to retain sufficient creative space while quantitatively and qualitatively designing and analyzing structures [26]. This fosters a design-oriented understanding of building internal forces through basic equilibrium principles, navigating architectural concepts with structural rationale via geometry.

Importantly, Graphic Statics can express not just structural equilibrium, but also the balance principles behind body gestures. Our body gestures are essentially equilibrium diagrams, where all imaginable poses represent certain equilibrium conditions. The associated muscle memories can then evoke corresponding emotional cognitions. Therefore, we can use Graphic Statics to represent forces and equilibrium states in body gestures through vector diagrams. This allows for unifying body gestures and structural systems under one diagrammatic language [27] (Figure 1).

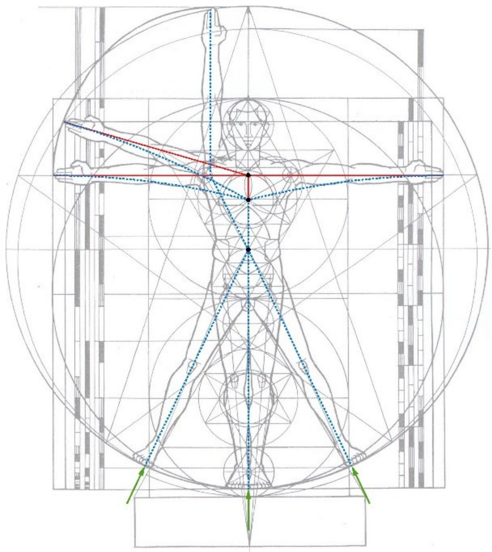


Figure 1: Graphic statics can express forces not only in structures but also in the human body [27].

The proposed pedagogical methodology synthesizes Graphic Statics and cognitive neuroscience principles of embodied equilibrium. Graphic Statics' form diagrams capture physical equilibrium, while "bodily diagrams" informed by neuroscience address psychological equilibrium facets. These dual approaches amalgamate under an integrated Graphic Statics-governed paradigm.

Furthermore, Graphic Statics' diagrammatic and abstract nature combines well with sketching. This allows for rapidly explaining observed equilibrium principles between elements conceptually, benefiting the integration of embodied experiences into the design process. It enables intuitive expression, rapid communication, and intuitive definition of structural forms during brainstorming phases [28].

## 5. An Embodied Structural Pedagogy

Centered on embodiment, the author conducted a teaching experiment at the Chinese University of Hong Kong. This course attempts to combine the teaching experiences of predecessors in structural design with new knowledge from neuroscience, exploring new modes of teaching structures. The main stages of the course are (1) theoretical introduction; (2) making and mimicking (3) case studies and applications. The 13-week course allocates four weeks to stage 1, 4 weeks to stage 2, and 5 weeks to stage 3, with 16 students (14 masters and two undergraduates) participating in groups of 3-4 for stages 2 and 3.

The initial phase immerses students in the theoretical underpinnings and operational methods of graphic statics, and gains their embodied understanding through interactive construction and bodily exercise. In the subsequent phase, students employ the imparted methodology to dissect renowned architectural cases, discerning their interplay between architectural expression and structural equilibrium, and how the structural system influences bodily movement. The final phase challenges students to design an embodied experiential spatial concept for a designated site and materialize it structurally.

Inspired by embodied cognition research in cognitive neuroscience, the teaching philosophy divides the conceptual design of structures into two aspects: physical equilibrium and psychological equilibrium [27]. Students are required to simultaneously observe, analyze, and construct the physical and psychological equilibrium models of structures. For example, if stacked objects can stand, it is considered technically in physical balance. However, in this course, students must also consider the psychological balance brought by these objects artistically: how we read and understand this balance in an embodied way. Moreover, besides the classic methods of hand-drawing, bodily experiences, and model-making, the course also includes graphic statics as a diagrammatic tool for structures to facilitate the interaction and transformation between the body and structural concepts.

### 5.1. Stage 1: theoretical introduction

The first stage involved a theoretical introduction, primarily revolving around the fundamental knowledge of graphic statics and the introduction of embodied theory, as well as their application in structural design. The theoretical portion was mainly conducted in the form of lectures.

Since the students at CUHK already had a specific knowledge base in graphic statics, the course primarily focused on introducing more perception-related structural design and analysis methods through particular case studies of graphic statics. For instance, the impact of structural misalignment on perception in the Bordeaux House, and the reinforcement of design concepts through structural design. In addition to in-class explanations, graphic statics teaching was supplemented with in-class exercises for deeper understanding.

For the embodied theory part, the course mainly explained the historical analogy between the body and structures, the inspiration of bodily equilibrium for structural design, and the theory of embodied cognition from a neuroscientific perspective. Three relevant theoretical papers were assigned as out-of-class readings, followed by in-class group discussions. Paper 1 showcased a case study that integrated the body into structural teaching [23]. Paper 2 introduced a method that combined body gestures with structural diagrams using graphic statics methods [27]. Paper 3 presented a compilation of structural designs driven by architectural intentions, providing design references [29].

### 5.2. Stage 2: making and mimicking

The second part of the course was the construction and experiential phase. Students were encouraged to build small-scale structural equilibrium prototypes using everyday objects, physically simulate the equilibrium principles involved, and use graphic statics to analyze the relationship between the two.

Unlike typical structure courses where model-making is result-oriented, students first create digital models and then physically construct them for verification or re-expression. This course promoted a “trial-and-error” structural construction process. Without a predetermined design, the construction process required rapid and unconscious bodily participation. This encouraged direct bodily engagement in constructing the structural equilibrium system, interacting with it and directly feeling the forces needed. Through repeated explorations of reasonable component combinations, connections, and balancing methods, as well as visually attractive structural expressions, students found the balance between physics and perception (Figure 2). This direct interactive prototyping will serve as an instrumental approach to grasping the embodied significance of structural equilibrium, transforming model-making from a re-expressive tool into a means for generating, operating, verifying, or communicating structural designs.

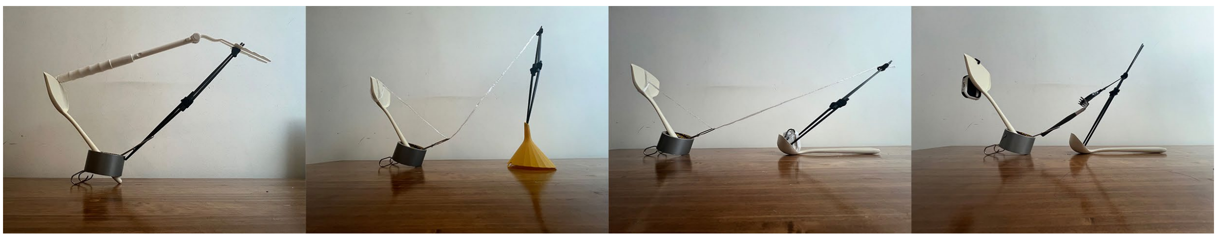
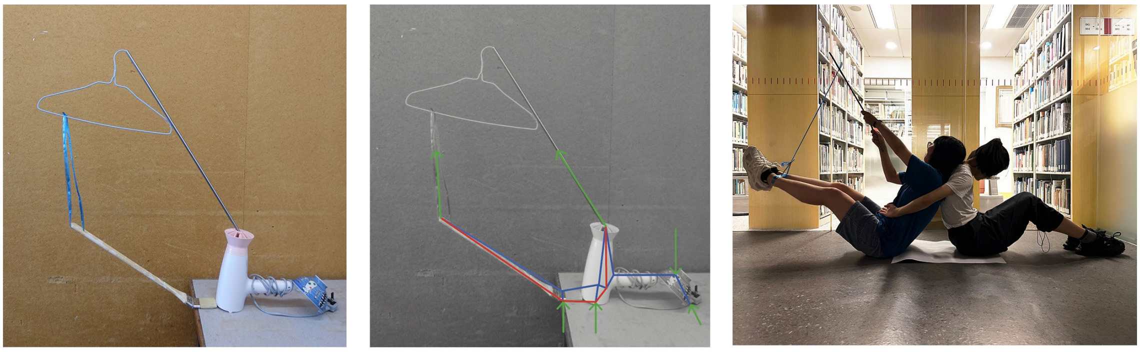


Figure 2: Students constructed and deformed structural equilibrium systems based on trial and error.

Afterward, students physically simulated the equilibrium systems of the small structural devices in groups, feeling the forces and equilibrium principles involved. Through this iterative process, students directly experienced and verified the structural equilibrium systems with their bodies, tested different combinations, understood the differences between equilibrium states, and directly experienced emotional resonance at the bodily level. By feeling the forces in different body gestures like pushing, pulling, and gripping, students could preliminarily identify critical points, weaknesses, high stresses, or even imbalances in the structural system, and then optimize and adjust the original system based on their bodily experiences, using the body and experiences as "form-finding" tools.



(a) (b) (c)

Figure 3: Students' exploration of structural equilibrium around the "cantilever" in the second phase and the different body simulations developed.

For example, a group of students experimented with a series of equilibrium systems derived from "cantilevers" and continuously changed the weight and position of the cantilever to understand the state of forces between objects and the underlying equilibrium principles (Figure 3-a). Graphic statics were further used to understand the force states behind the chosen systems (Figure 3-b). Students then physically simulated how forces in the members changed at different positions and angles, directly feeling the structural strength, force locations, and weaknesses (Figures 3-c) and understanding the relationship between form and force in structural design. This associated embodied sensations with the equilibrium vocabulary of the devices, establishing a deeper connection between bodily sensations and the potential spatial sensations of structures.

Since these objects were highly industrialized products, their structural force flows were often quite complex and not easily simplified or studied. The primary challenge students encountered was how to simplify the relationship between the structure and the external environment, thereby extracting the complex equilibrium logic within the structure as much as possible for subsequent simulation and analysis.

### 5.3. Stage 3: case studies and applications

After designing and analyzing at the small installation scale, students proceeded to case studies for one week and large-scale design for four weeks in the third part. To establish connections between embodied cognition and real architectural spaces, students first attempted to analyze famous architectural cases using the learned methods, discerning the interplay between architectural expression and structural equilibrium through graphic statics and its embodied expressions. The final challenge was to design a conceptual scheme that combined structure, perception, and space for a self-selected designated site.

In the case study, a group of students analyzed the Viewing Platform Conn. They first collected, read, and analyzed the background, site, and design concept of the building. Through small-scale structural equilibrium models, they aimed to understand the underlying structural principles. Additionally, they attempted to use body simulations and graphic statics to analyze the equilibrium systems and conditions, further enhancing their comprehension and interpretation of the structural principles employed in the case (Figure 4).

Figure 4: Students translate the structural equilibrium logic of the Viewing Platform Conn into small equilibrium devices and bodily feel the underlying forces.

During the case study process, the students simplified the complex structural systems and broke them into smaller subsystems. By examining the equilibrium principles within each subsystem and the spatial equilibrium formed by the three-dimensional combination of subsystems, they analyzed how the relationships between structural components could influence embodied perception. Furthermore, they explored how these structural strategies affect spatial experience, visual guidance, movement within the space, and the relationship between these strategies and architectural concepts (Figure 5).

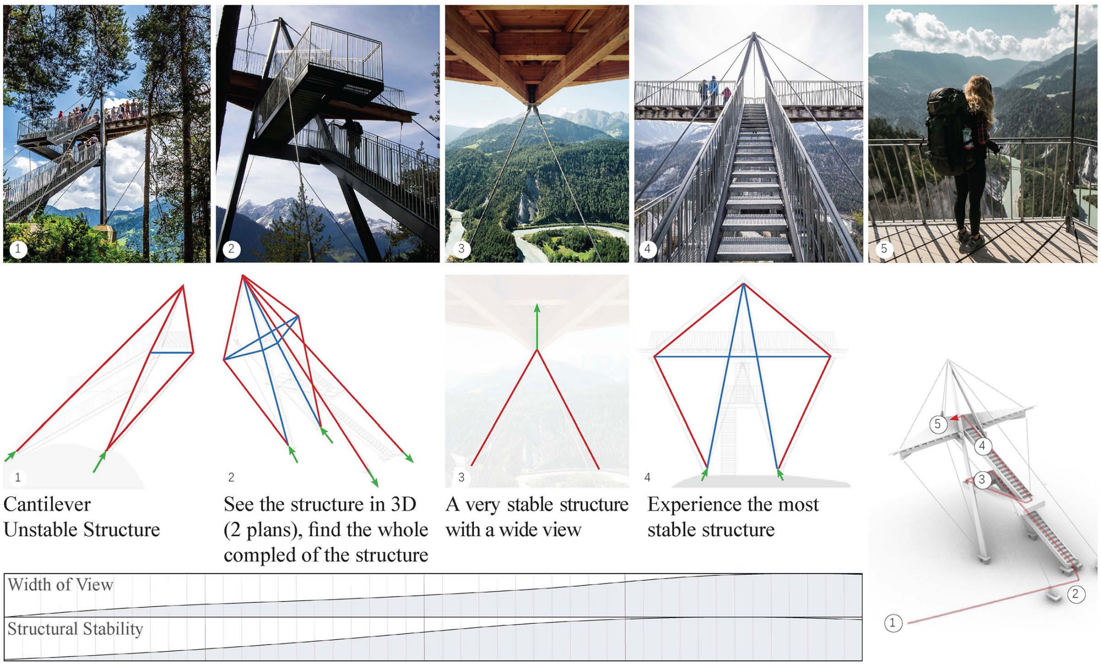



Figure 5: Students split the structural equilibrium system in Viewing Platform Conn into a series of subsystems, and interpreted the continuum of experiences from each perspective in an embodied aspect.

In the large-scale architectural design part, students seek to combine their experience in small-scale modeling, bodily experience, and case studies with graphic statics as a tool to design a structure-oriented architectural space on a self-chosen site.

One group chose a hillside along the elephant migration route in the Xishuangbanna Wild Elephant Valley Reserve in Yunnan Province. The building aimed to provide researchers with maximum observation vistas of the elephants without impacting their activities and natural environment, while also offering private living and office spaces (Figure 6).

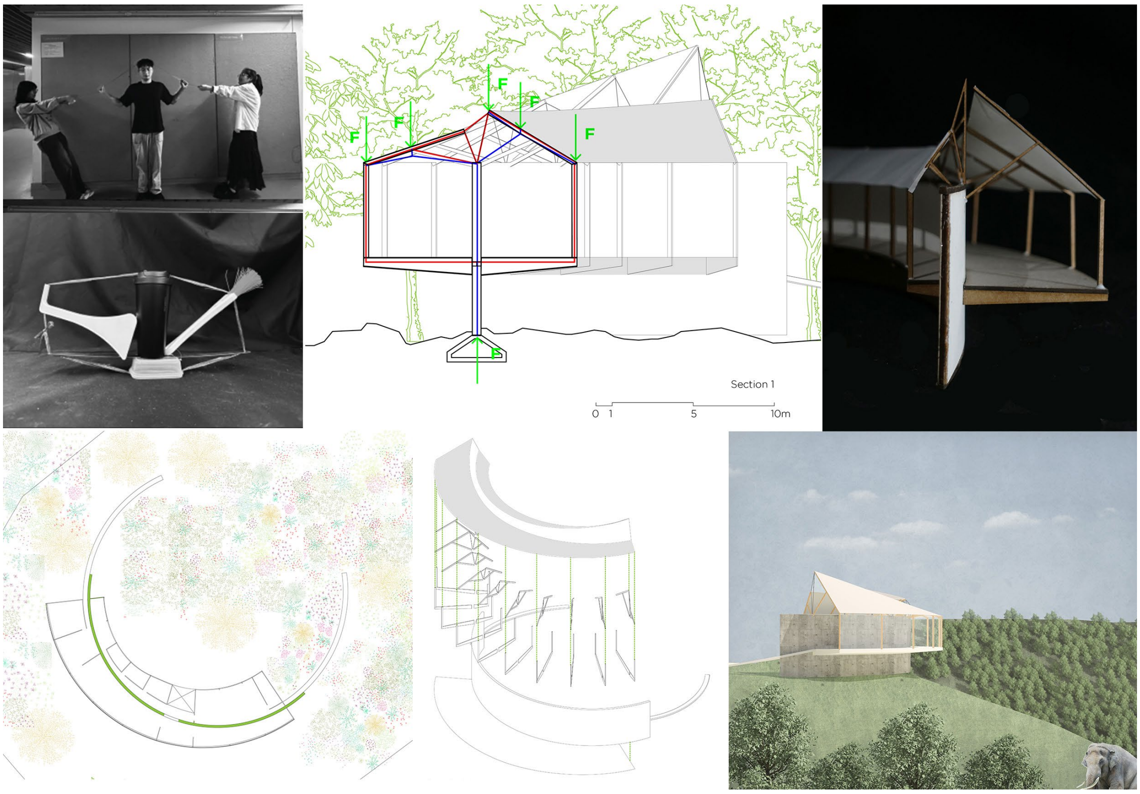



Figure 6: Elephant Observatory designed by students based on design concepts combining model making, body simulation and graphic hydrostatics.

To meet the design needs, students elevated the main space off the ground using a wall that is arched in plan, maximizing observation vistas with the outer curved surface while providing relatively private spaces with the inner surface. Using this as a spatial prototype, they experimented with various cantilevering principles extending from the central wall, and conducted bodily simulations to feel the changes in internal forces and potential structural challenges.

They then translated these embodied experiences into a complex roof design. Through graphic statics analysis, they divided the structure into compression and tension members to minimize obstructions at the central opening for daylighting. They also considered how the structure would guide forces from the cantilevered sides to the central wall and ground under external loads. By conducting a sequence of model testing and bodily simulation, they consistently improved the final design, successfully integrating environment, views, privacy, light, and structure to define the space.

After the courses, students completed questionnaires. Their feedback indicated that nearly everyone felt the trial-and-error construction, embodied experiences, and diagrammatic expressions of graphic statics significantly improved the clarity of structural logic and creativity in structural design. They believed this teaching mode allowed them to move beyond traditional structural types, deeply integrating architectural intent and structural systems into spatial designs. Students widely reflected that this perception- and intuition-driven structural design approach significantly boosted their confidence in innovating during the design process, transcending traditional structural knowledge limitations. All external reviewers highly praised the students' work, considering it far beyond the level of ordinary structural courses.

## 6. Conclusion and Outlook

This embodied structural teaching strategy provides a simple way for students to engage with their existing body knowledge. This approach converts the examination of structural concepts into a qualitative, game-like activity, incorporating various aspects into the design of architectural structural concepts.

Introducing the human body emphasizes the significance of model-making in structural education, broadening its function as a creative and practical design instrument. This empowers students to articulate their structural thinking with greater confidence and initiative rather than simply solving problems passively.

By incorporating graphic statics as a means of communication, students can combine abstract concepts with structural forms, enabling them to express their ideas effectively. This pursuit, which focuses on the body and aims to achieve both technical and artistic equilibrium, encourages collaboration across different disciplines and promotes an understanding of intricate societal requirements.

Although the proposed teaching method does not encompass all aspects of structures, it still necessitates integration with other courses to instruct them effectively. Nevertheless, the suggested pedagogy for embodied structural design serves as an initial framework that encourages an investigative approach. This approach frees architectural design and education from theoretical discussions, reconnects it with the human aspect, and indicates potential avenues for progress in structural building design and teaching methods.

## Acknowledgements

Many thanks to the CUHK students who participated in the course for their active participation and excellent design results.

## References

[1] A. W. Charleson, *Structure as architecture: a source book for architects and structural engineers*. Oxford: Elsevier, 2005.

[2] A. Flury, *Cooperation the engineer and the architect*. Basel: Birkhäuser, 2012.

[3] A. Saint, "Architect and Engineer: A Study in Construction History," *Construction History*, vol. 21, pp. 21–30, Jan. 2005.

[4] D. P. Billington and M. E. Moreyra Garlock, "Structural Art and the Example of Félix Candela," *Journal of Structural Engineering*, vol. 136, no. 4, pp. 339–342, Mar. 2010.

[5] M. Vrontissi, "The Physical Model as Means of Projective Inquiry in Structural Studies - The Paradigm of Architectural Education," Zürich, 2018.

[6] R. Dermody, D. Oakley, and M. S. Uihlein, "A survey of structures education in north american schools of architecture.," in *Structures and architecture : beyond their limits*, Paulo J.S. Cru, Ed., Boca Raton: CRC Press, 2016, pp. 942–949.

[7] H. Engel, *Tragsysteme = Structure systems*, 2. Aufl. Ostfildern-Ruit: Hatje, 1999.

[8] R. M. Felder and L. K. Silverman, "Learning and Teaching Styles In Engineering Education," *Engineering Education*, no. 78, pp. 674–681, 1988.

[9] D. P. Billington, "Discipline and Play. The art of engineering. Interview with B.Cole," *Humanities*, vol. 26, no. 2, p. 6, 2005.

[10] R. Motro, "Robert Le Ricolais (1894–1977) 'Father of Spatial Structures,'" *International Journal of Space Structures*, vol. 22, no. 4, pp. 233–238, Dec. 2007.

[11] Gass Siegfried, *Experimente—experiments*, vol. 25. Stuttgart : Institut für Leichte Flächentragwerke, 1990.

[12] M. Angélil, *Inchoate an experiment in architectural education*. Zürich: Swiss Federal Institute of Technology Faculty of Architecture, 2003.

[13] A. Menges, "Material computation higher integration in mophogenetic design," in *AD*, A. Menges, Ed., Bognor Regis: Wiley, 2012.

[14] S. Wang, T. Kotnik, and J. Schwartz, "Redefining Structural Art: A Neuroaesthetics Perspective on the Art of Structural Design," *Architecture, Structures and Construction 2022 2:1*, vol. 2, no. 1, pp. 3–16, Mar. 2022.

[15] H. Francis. Mallgrave, *Architecture and embodiment : the implications of the new sciences and humanities for design*. Abingdon, Oxon: Routledge, 2013.

[16] G. Rizzolatti, L. Fogassi, and V. Gallese, "Mirrors in the mind," *Scientific American*, vol. 295, no. 5. Scientific American Inc., pp. 54–61, 2006.

[17] V. Gallese, "Embodied simulation: From neurons to phenomenal experience," *Phenomenology and the Cognitive Sciences 2005 4:1*, vol. 4, no. 1, pp. 23–48, Jan. 2005.

[18] A. Newen, L. de Bruin, and S. Gallagher, *The Oxford handbook of 4E Cognition*, First edition. in The Oxford handbooks. Oxford, United Kingdom: Oxford University Press, 2018.

[19] S. Robinson, J. Pallasmaa, and T. D. Albright, *Mind in architecture : neuroscience, embodiment, and the future of design*. Cambridge, Massachusetts ; The MIT Press, 2015.

[20] C. Groth, "Design- and Craft thinking analysed as Embodied Cognition," *FormAkademisk*, vol. 9, no. 1, Jun. 2016.

[21] L. P. Kirsch, K. Dawson, and E. S. Cross, "Dance experience sculpts aesthetic perception and related brain circuits," *Ann N Y Acad Sci*, vol. 1337, no. 1, pp. 130–139, Mar. 2015.

[22] S. Calatrava, *Santiago Calatrava - drawing, building, reflecting*. London: Thames & Hudson, 2018.

[23] R. Whitehead, "Supporting Students Structurally: Engaging Architectural Students in Structurally Oriented Haptic Learning Exercises," in *Architecture Conference Proceedings and Presentations*, 2013.

[24] A. Muttoni, *Design of concrete structures with stress fields*. Basel [etc: Birkhäuser, 1997.

[25] A. Muttoni, *The art of structure: introduction to the functioning of structures in architecture*. in EPFL Press Series. Lausanne: EPFL Press, 2011.

[26] T. Kotnik and P. D'Acunto, "Operative Diagramatology: Structural Folding for Architectural Design," in *Proceedings of the Design Modelling Symposium, Berlin, Germany, 28 September–2 October*, 2013, pp. 193–203.

[27] S. Wang, T. Kotnik, J. Schwartz, and T. Cao, "Equilibrium as the common ground: Introducing embodied perception into structural design with graphic statics," *Frontiers of Architectural Research*, vol. 11, no. 3, pp. 574–589, Jun. 2022.

[28] S. Wang, F. Bertagna, P. O. Ohlbrock, and D. Tanadini, "The Canopy: A Lightweight Spatial Installation Informed by Graphic Statics," *Buildings 2022, Vol. 12, Page 1009*, vol. 12, no. 7, p. 1009, Jul. 2022.

[29] B. N. Sandaker, *The structural basis of architecture*, Third edition. London: Routledge, 2019.

*Proceedings of the IASS 2024 Symposium*
*Redefining the Art of Structural Design*
August 26-30, 2024, Zurich Switzerland
Philippe Block, Giulia Boller, Catherine De Wolf,
Jacqueline Pauli, Walter Kaufmann (eds.)

# Copyright Declaration

Before publication of your paper in the Proceedings of the IASS Annual Symposium 2024, the Editors and the IASS Secretariat must receive a signed Copyright Declaration. The completed and signed declaration may be uploaded to the EasyChair submission platform or sent as an e-mail attachment to the symposium secretariat (papers@iass2024.org). A scan into a .pdf file of the signed declaration is acceptable in lieu of the signed original. In the case of a contribution by multiple authors, either the corresponding author or an author who has the authority to represent all the other authors should provide his or her address, phone and E-mail and sign the declaration.

Paper Title: Structural design pedagogy under the embodied perception: an equilibrium-based approach for architecture students

Author(s): Shuaizhong Wang

Affiliation(s): The Chinese University of Hong Kong, School of Architecture

Address: Rm. 201, Lee Shau Kee Architecture Building, School of Architecture,
The Chinese University of Hong Kong, Shatin, Hong Kong

Phone: +85255781352
E-mail: shuaizhongwang@cuhk.edu.hk

Printed name: Shuaizhong Wang | Signature: Wang Shuaizhong

Location: Hong Kong | Date: 01.07.2024