ARCASIA 44th COUNCIL MEETING

Adoption of AI by Architects in Their Practices

Prof. Dr. Ying Liu

2025/01/15

中国建筑学会 The Architectural Society of China

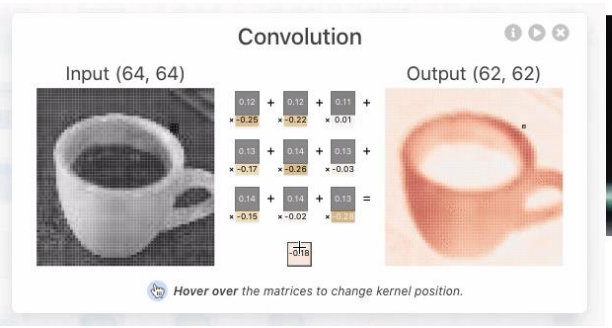
中国建筑学会计算性设计专业委员会 Committee of Computational Design-ASC

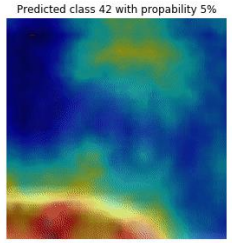
CONTENTS

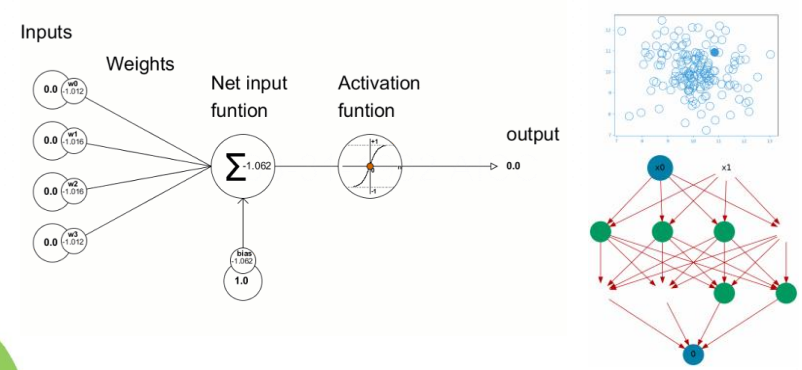
1 Developments of AI-SUPPORTED design and construction

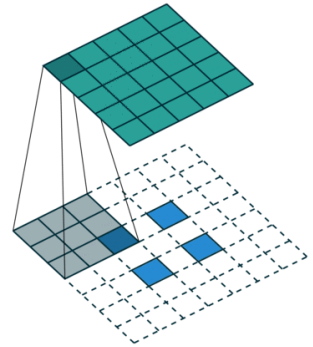
1.1 Developments of AI Technologies

In the wave of Industry 4.0, algorithms, big data, and computing power are developing rapidly. Emerging technologies such as AI, big data, and cloud computing have opened up a new era of human-machine collaboration, bringing new development opportunities to the traditional construction industry.









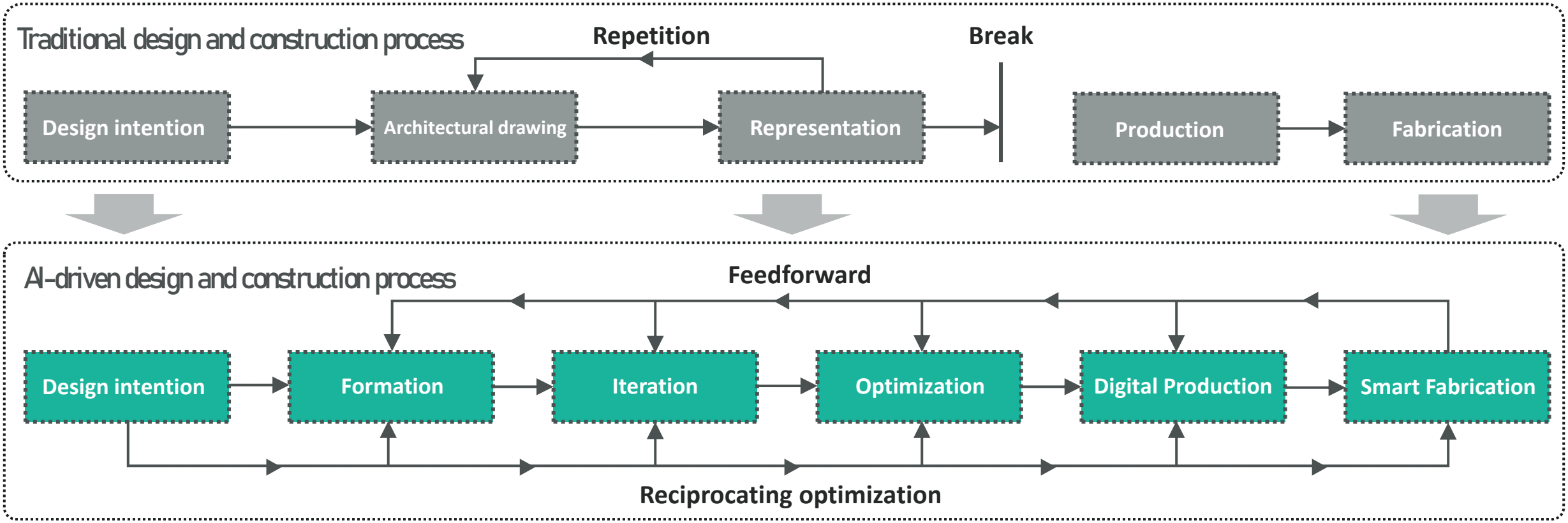
Algorithms and Architecture

Computing Power

Big Data

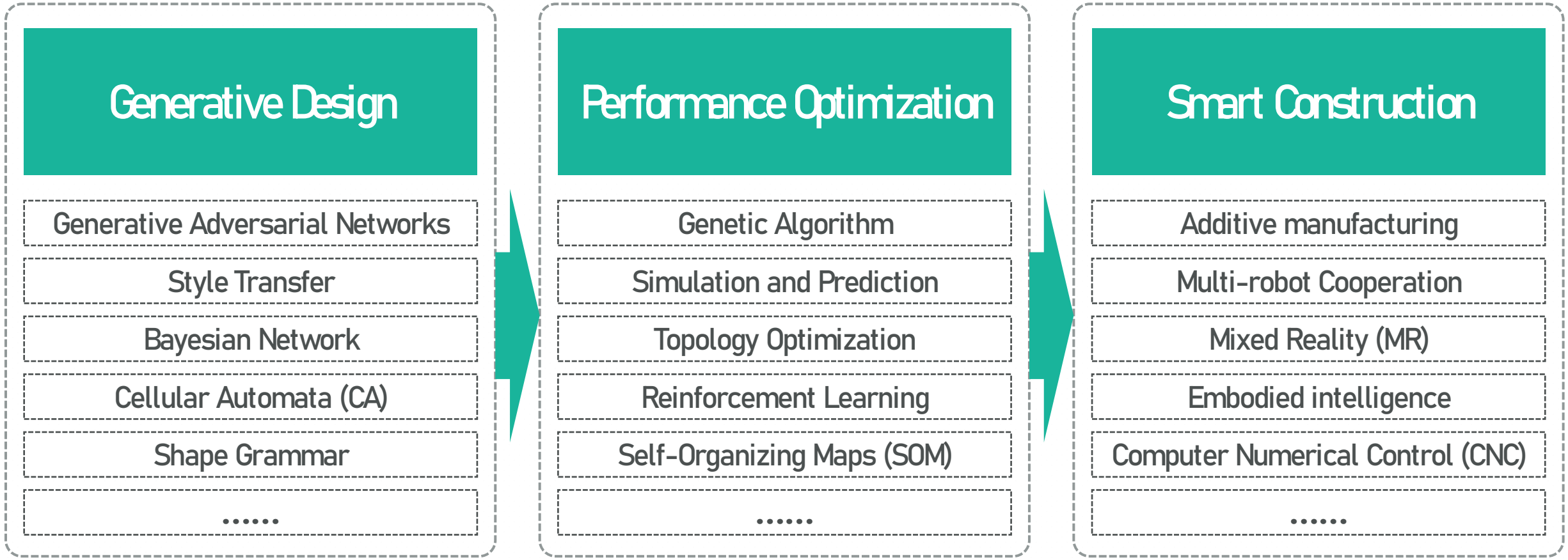
1.2 Architecture Workflow Revolution in AI Era

Under the influence of artificial intelligence technology, the traditional design process is gradually transforming into an integrated process of intelligent design, production, and construction centered on automatic shaping, iterative design, performance optimization, CNC production, and lean construction.



1.3 Keywords of AI-SUPPORTED building design and construction in China

In the architecture practice in China, generative design, performance optimization, and smart construction are the three most rapidly developing fields, related methods and technical systems enable Chinese architects to carry out AI assisted architectural design and construction practices.

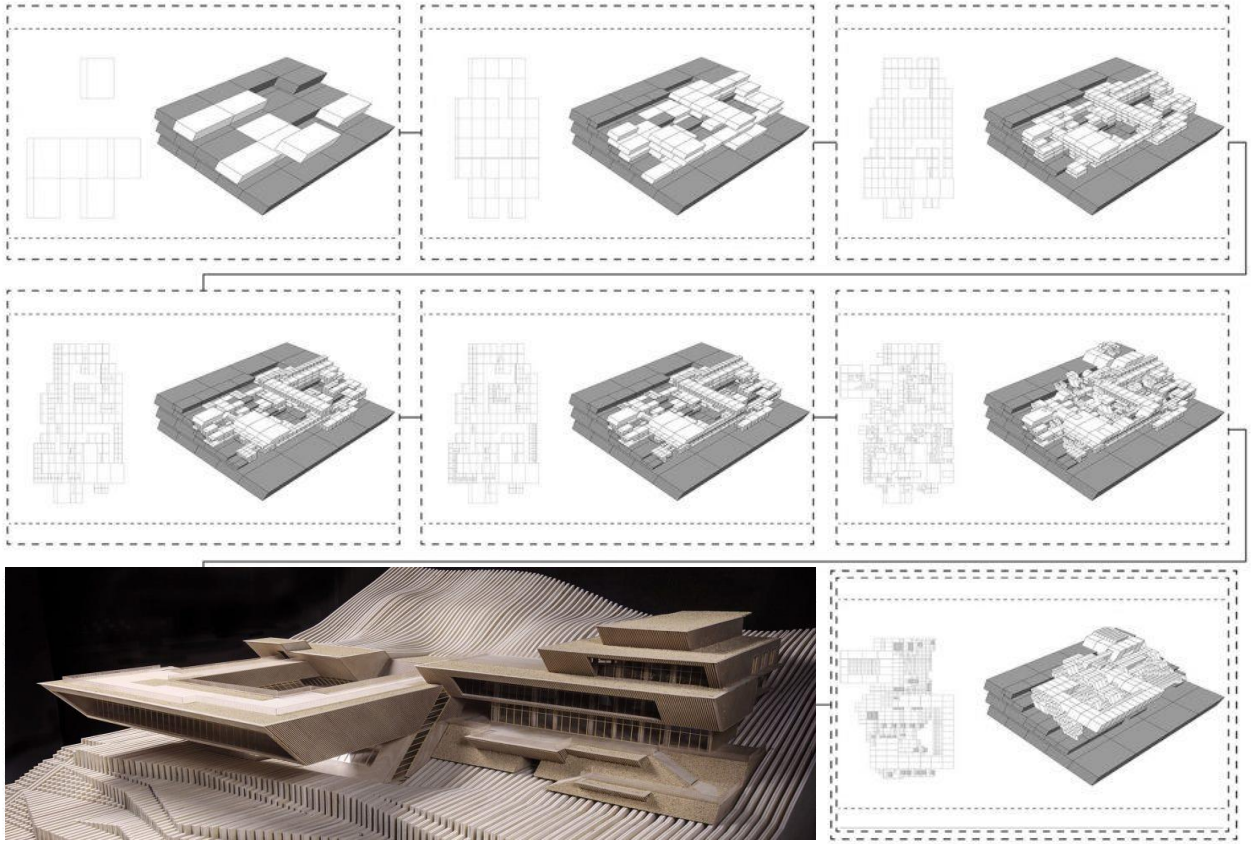


2 Adoption of AI for Generative Design

2 Adoption of AI for Generative Design

Public Transportation Center, Qiandao Lake, Zhejiang – Algorithm Generation Based on Mountain Geometry

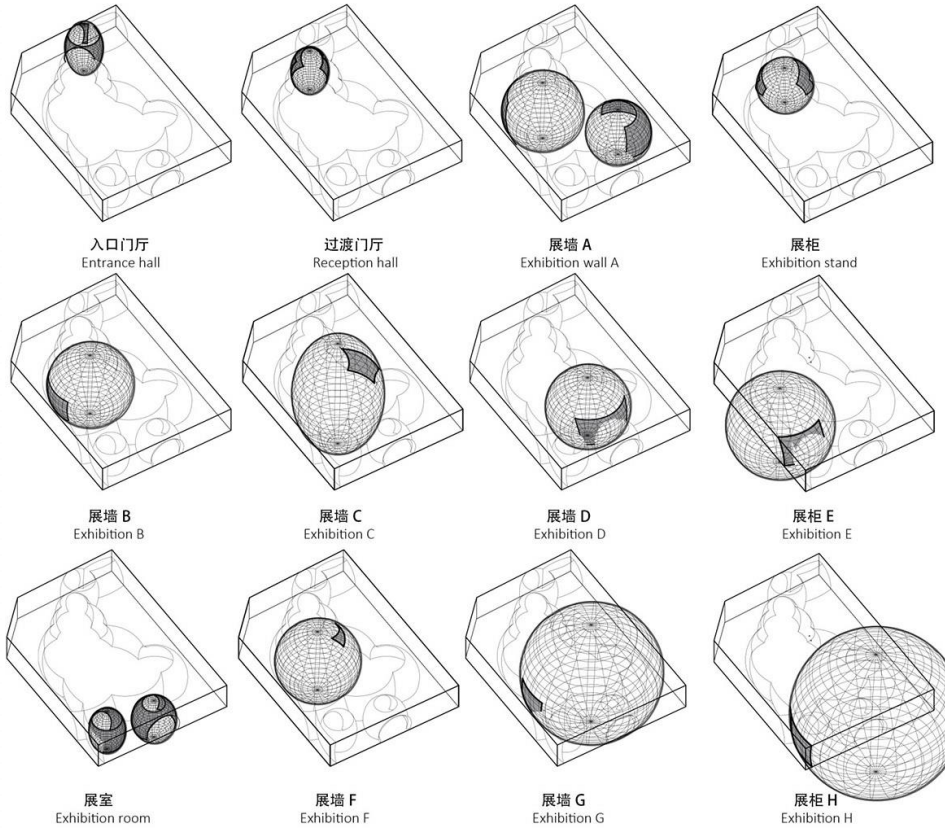
The project draws inspiration from mountain morphology to determine the basic units, and uses algorithms to summarize the geometric logic of mountains, then predicting future shape changes by semantic association. Through temporal deduction, continuous fractals, iterations, juxtaposition, and subtraction, the form gradually grows out and scattered fragments shape a new landscape, hiding but not dissolving in the mountains.

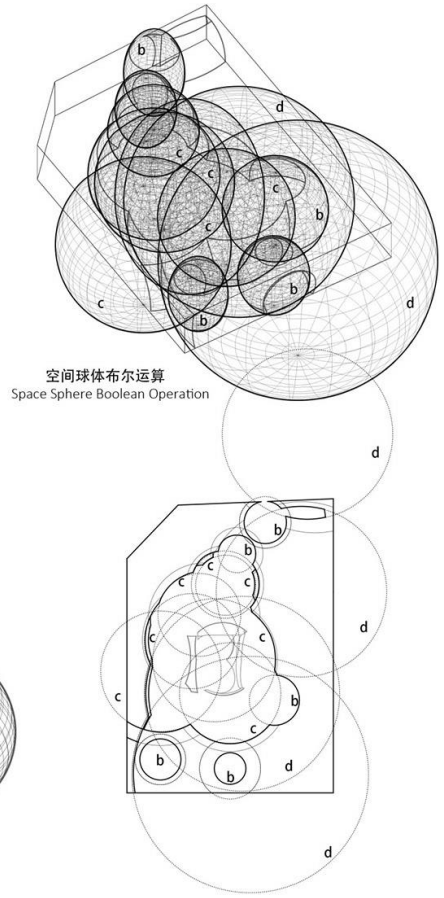


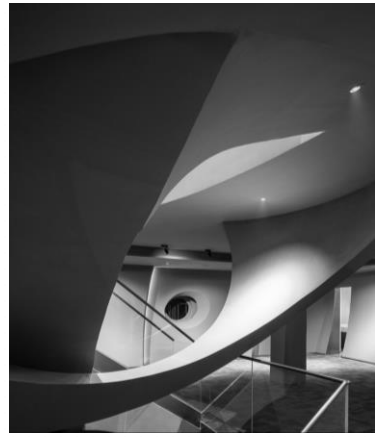
2 Adoption of AI for Generative Design

Shanghai Jade Museum – Spherical Cutting Space Generation

The project reshapes and unifies the entire display space through the cutting of the sphere. Spheres of different sizes and proportions, cutting and blending methods, and spatial combinations make the entire space rich and varied. The internal spaces are divided into different scales of halls, alleys, gardens, corridors, etc., and also interconnected through holes, valleys, peaks, and lakes for visual connectivity.



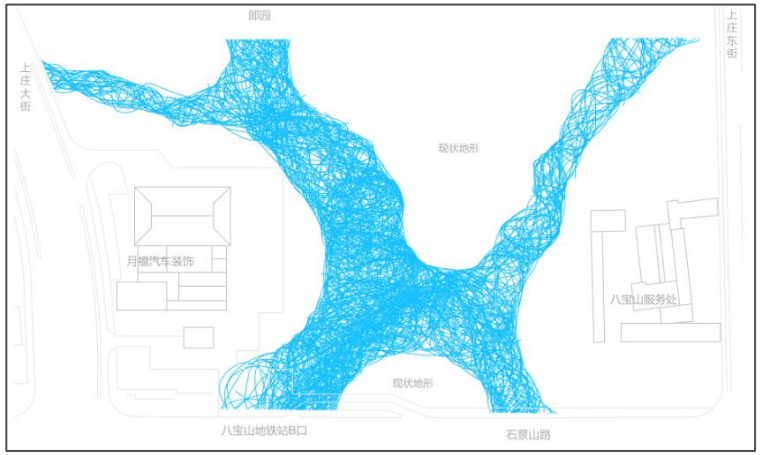




2 Adoption of AI for Generative Design

Shaanxi, Xi'an – Cultural and Art Park

Simulation driven pedestrian system generation

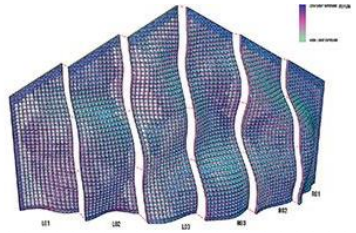


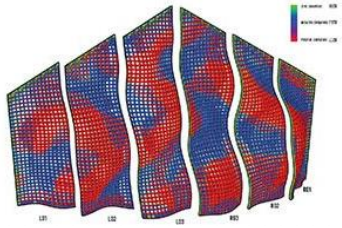
Guangdong Guangzhou – Middle School

RL driven generation of group morphology

Beijing – Residential Renovation

CFD simulation driven facade generation



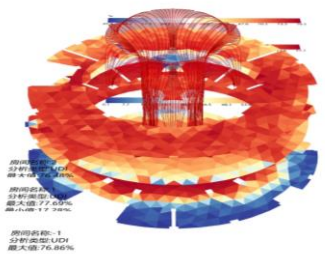


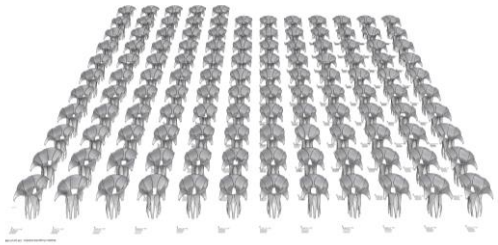
3 Adoption of AI for Performance Optimization

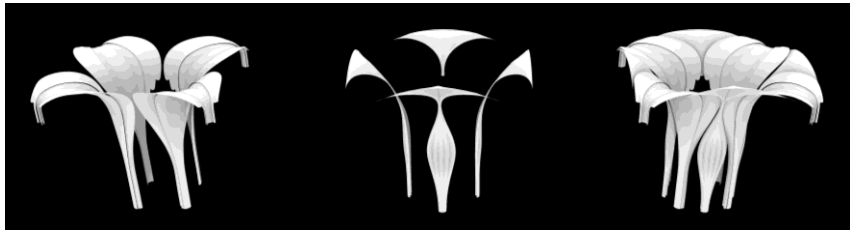
3 Adoption of AI for Performance Optimization

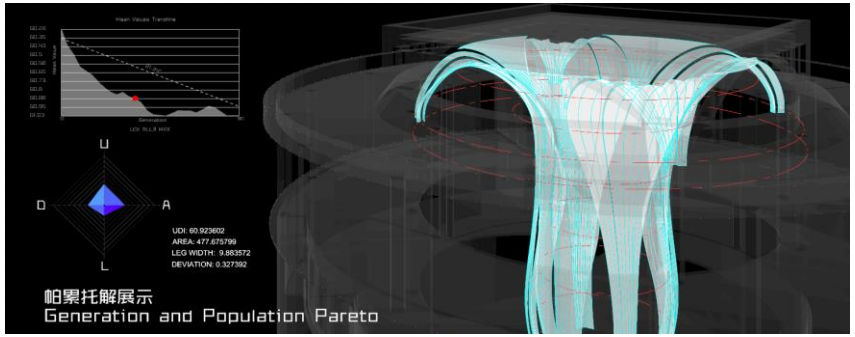
Radio and Television Station, Harbin, Heilongjiang - Traffic Core Optimization Design Driven by Lighting Environment

Multi-objective optimization techniques are used to optimize the form of the traffic core, obtaining the spatial curvature form that maximizes the indoor lighting performance and visual comfort. 125 sets of Pareto solutions were obtained through iterative operations based on genetic algorithms, and the optimal solution was determined based on lighting performance and aesthetics.





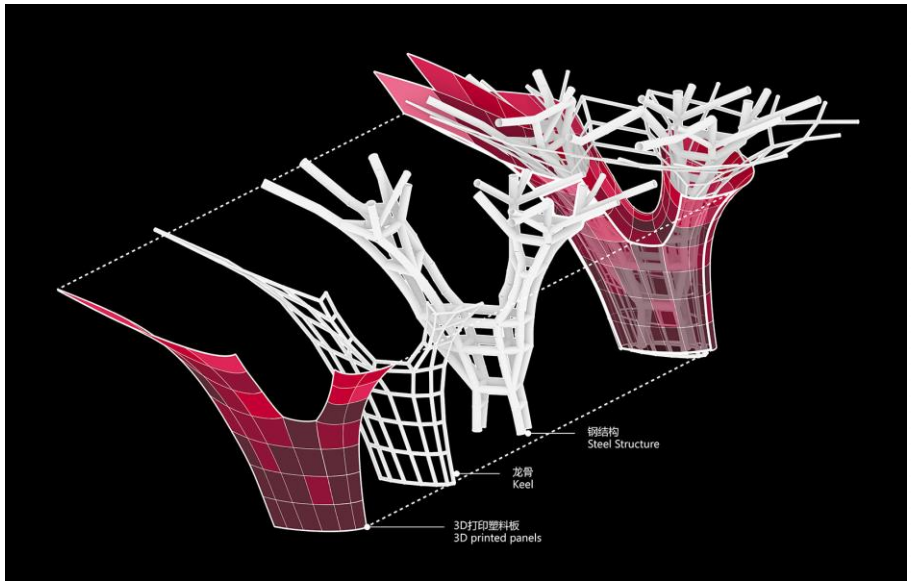


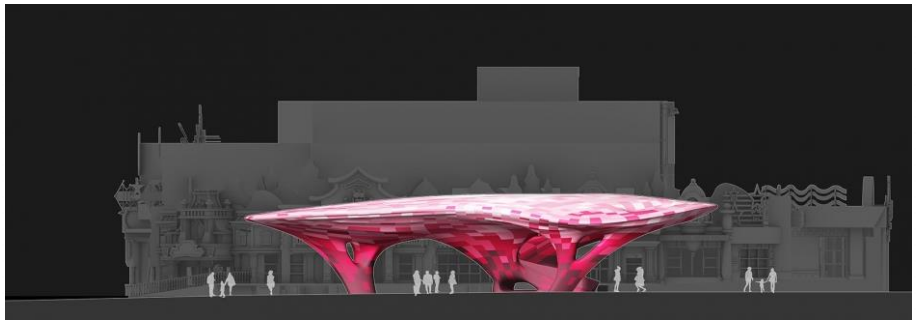


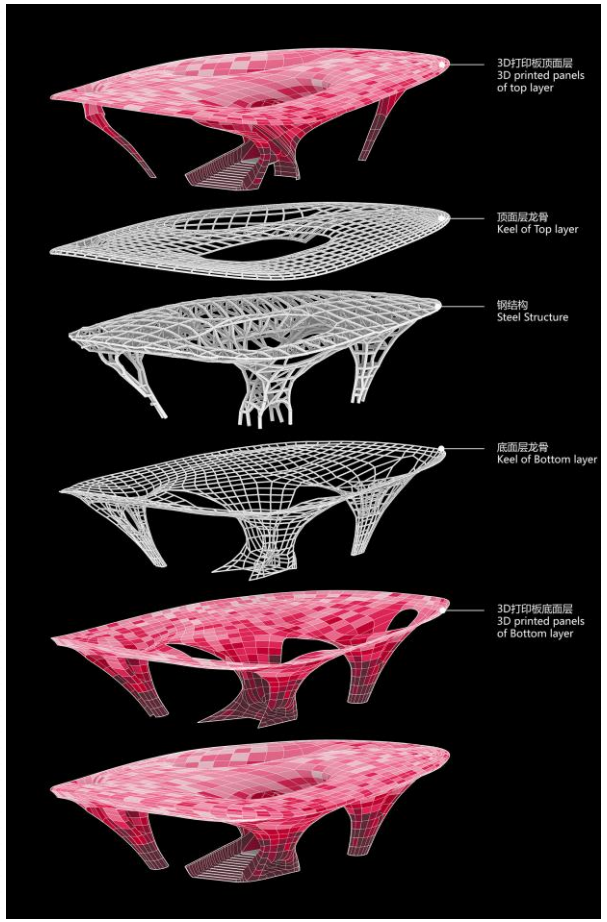
3 Adoption of AI for Performance Optimization

Entrance of Theme Park, Nanjing, Jiangsu – Structure Optimization Design Driven by Geometric Expansion

The main entrance scheme is a multidimensional topological geometry floating on the site, and the supplementary surface is generated in four steps: boundary input, surface skeletonization, skeleton subdivision, and mesh division. Position of support points is optimized by structure simulation, visual accessibility and mechanical stability are considered to develop a multi-point supporting system. The surface geometric mesh is generated based on the topological mesh.



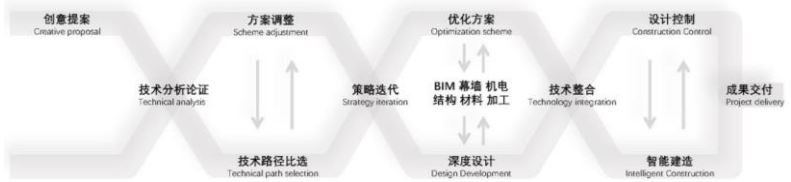


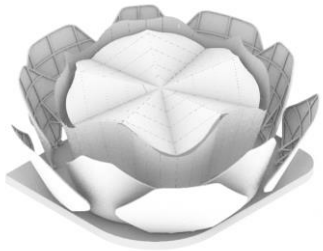


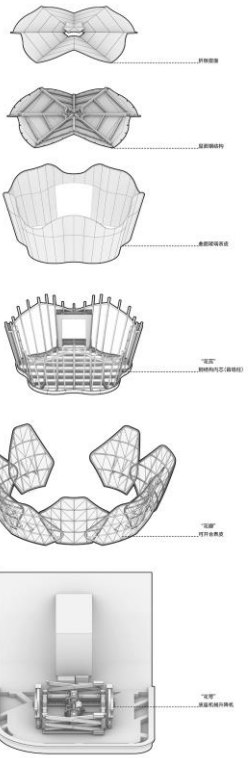
3 Adoption of AI for Performance Optimization

Changsha, Hunan – Xiangjiang Eye

Optimization of Variable Steel Structure

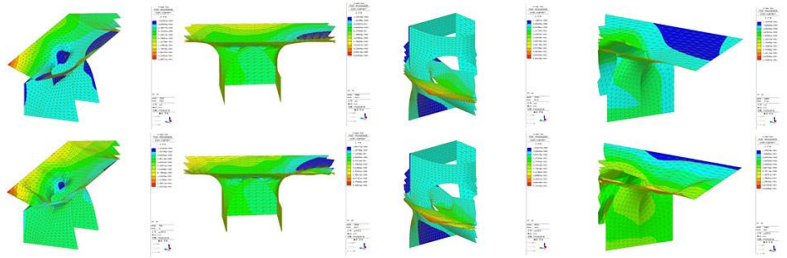


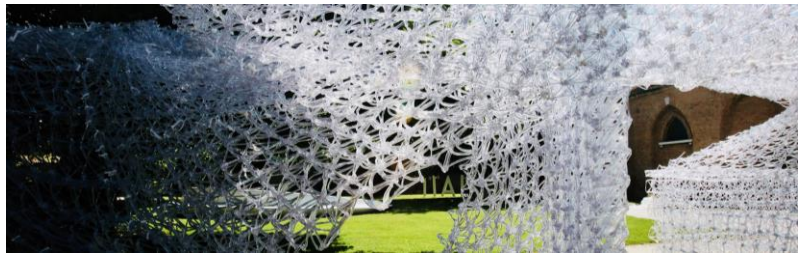




Venice Biennial – Cloud Pavilion

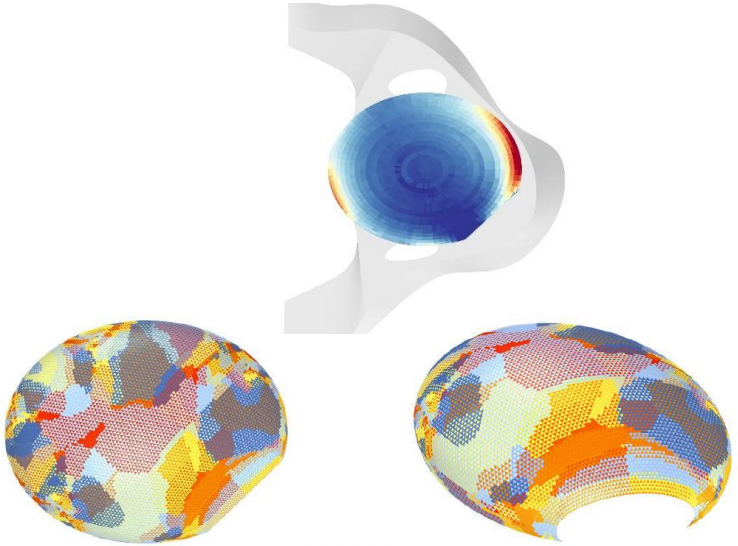
Optimization of 3D printing construction form





Xingping, Shaanxi – Sports Stadium

Optimization of Roof Form by Wind Environment



4 Adoption of AI for Smart Construction

4 Adoption of AI for Smart Construction

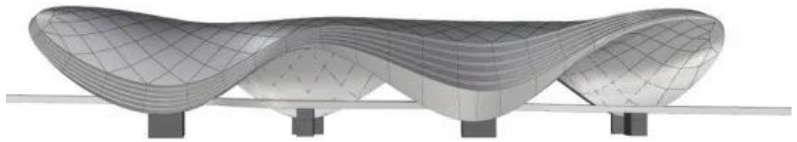
Wujiazhuang Residence in Hebei Province – 3D Printed Concrete

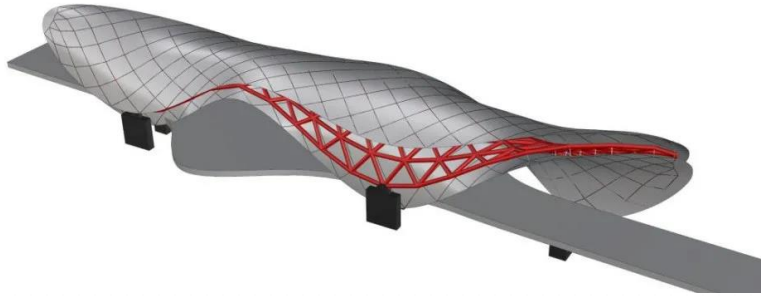
Integrate design system based on structural pipeline and robot self-control system The exterior walls are integrated with woven textures and structural walls, and insulation materials are poured into the center to form an integrated system that combines decoration, structure, and insulation.

4 Adoption of AI for Smart Construction

Park Covered Bridge, Nanjing, Jiangsu Province – Non standard Curved CNC Machining and Construction

The building form is generated based on digital chain, and the GRC skin element data corresponding to each structural grid is accurately calculated, so that the non-standard surface shape can be perfectly reproduced and the error is minimized. It is processed by CNC equipment such as robotic arms and laser cutting and assembled on site.





4 Adoption of AI for Smart Construction

Yixing, Jiangsu – City Renewal

3D printing adjustable textures

Shanghai – Rest Pavilion

Machine woven carbon fiber

Community Center – Dayi, Sichuan

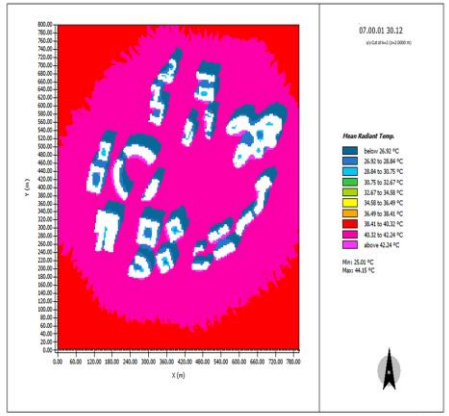
3D printing flexible partition wall

5 Multi-scale Integrated Applications

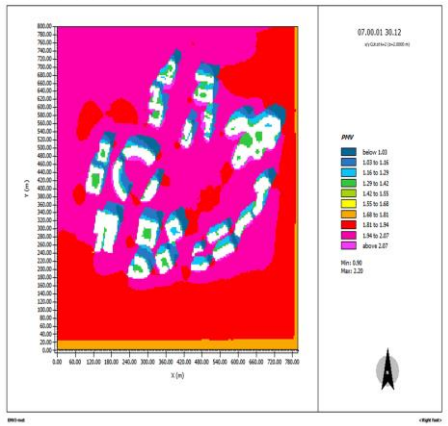
5.1 Integrated Application —— Western Science City in Chongqing

Scale of Building Complex – Optimization Design of Building Complex Layout Driven by Outdoor Wind and Heat Environment

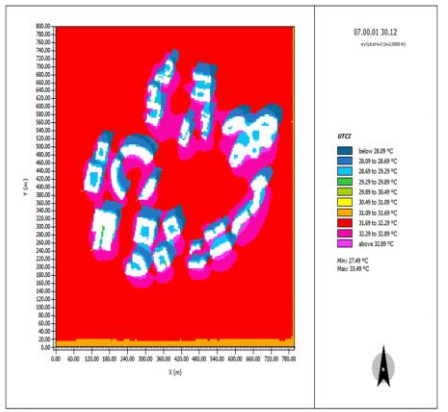
GANs are used to construct performance prediction models for site wind environment, outdoor thermal comfort, etc. By integrating performance prediction models and design decision support models, a balanced improvement of green performance goals in wind and heat environments is achieved.



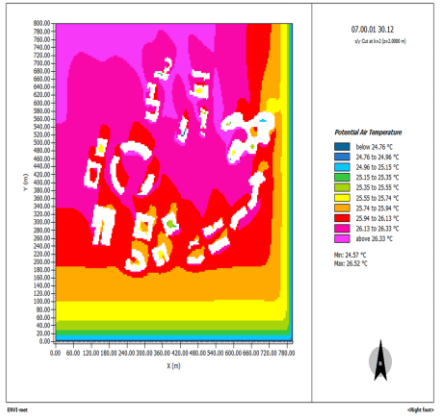
Mean Radiant Temperature



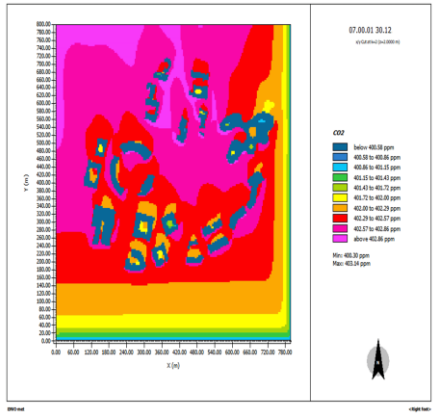
Outdoor PMV value



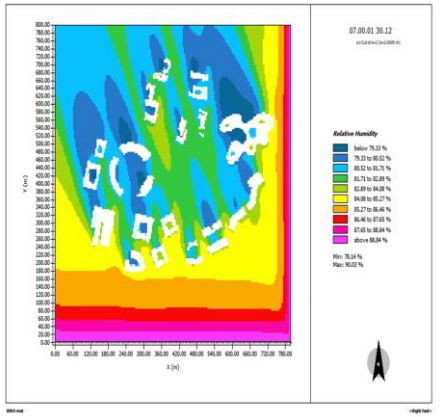
Outdoor UTCI value



Potential outdoor temperature



Distribution of CO2 concentration

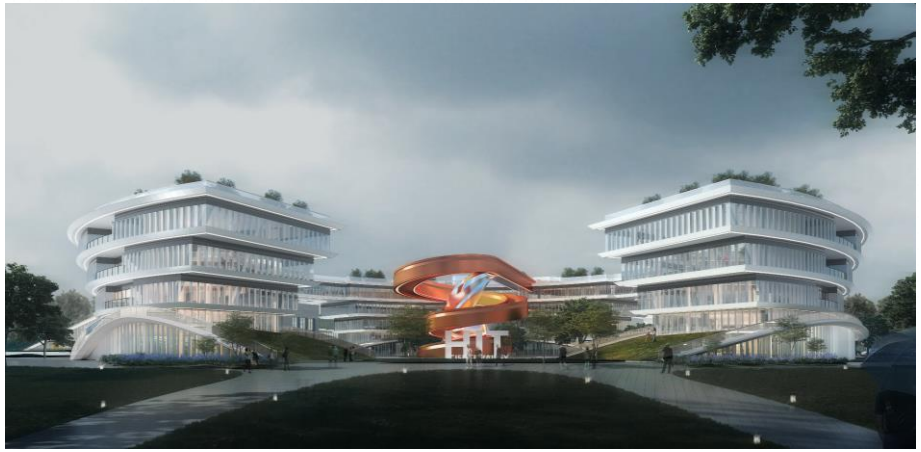


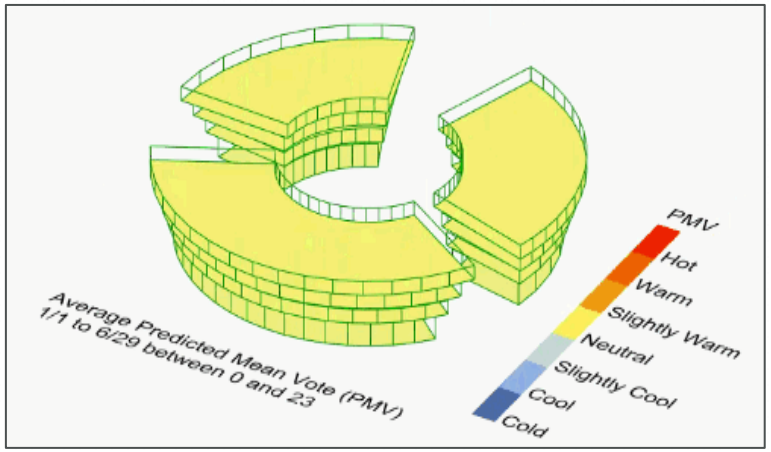
Distribution of relative humidity

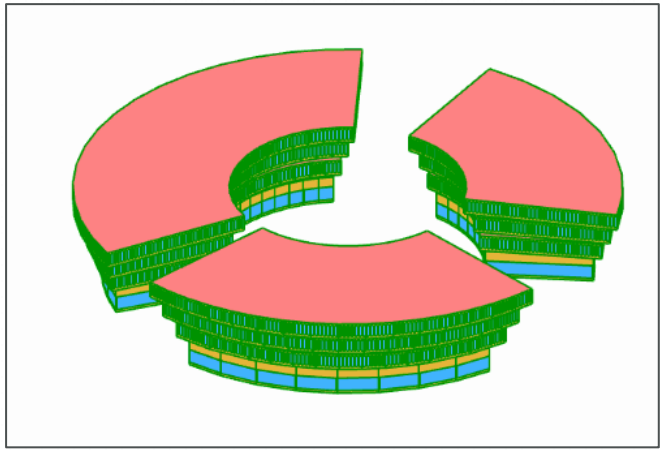
5.1 Integrated Application —— Western Science City in Chongqing

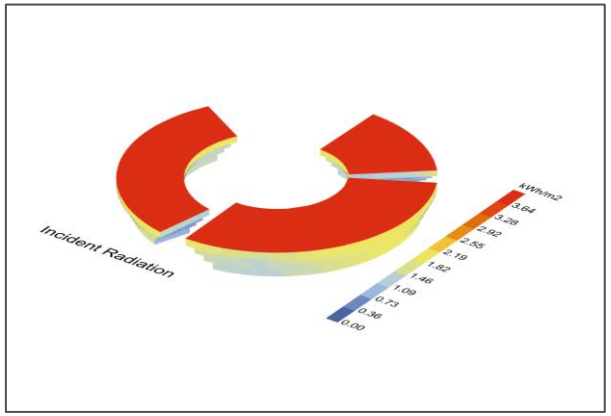
Individual Building Scale - Indoor Thermal Comfort and Photovoltaic Potential Driven Building Form Optimization Design

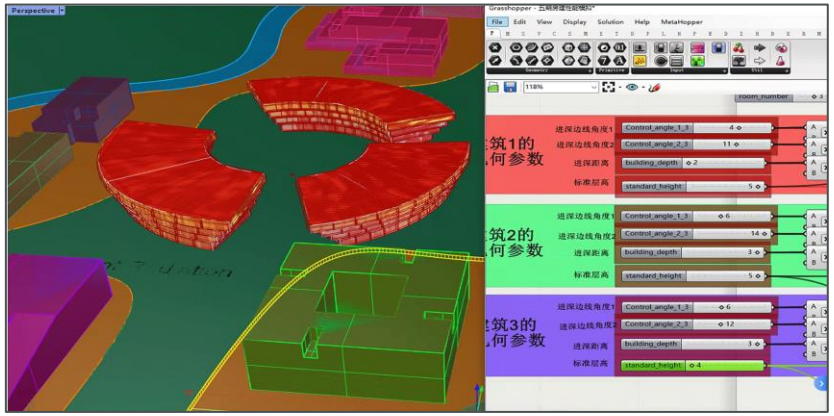
In the design of key individual buildings, the optimal solution of the building complex is transferred as a constraint parameter to the individual buildings to ensure the coordination with the surrounding environment. The optimization goals include indoor thermal comfort, lighting comfort, and photovoltaic potential. The design parameters include building orientation, room depth ratio, and sunshade form. Multi-objective optimizations are made to improve the overall building performance.







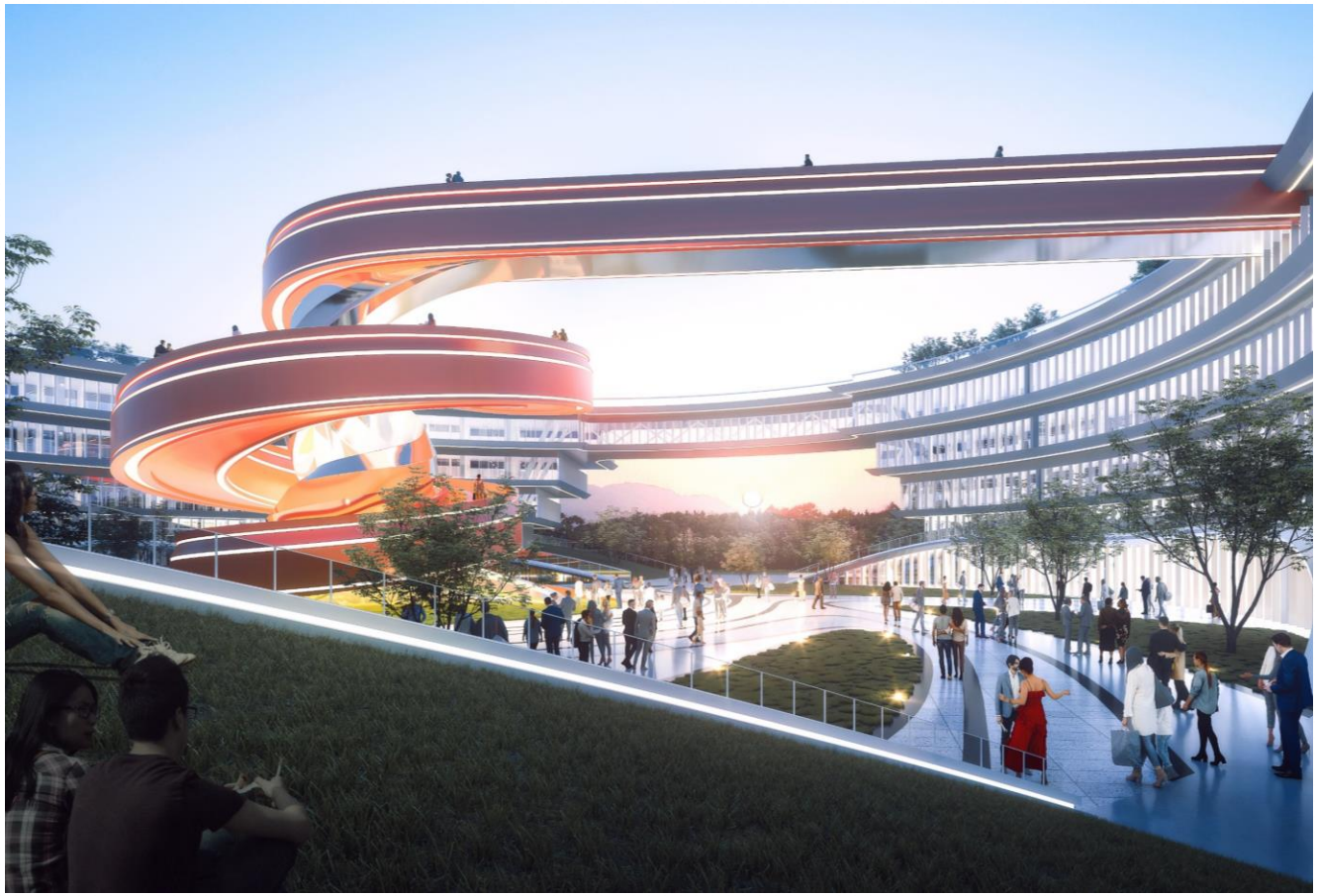


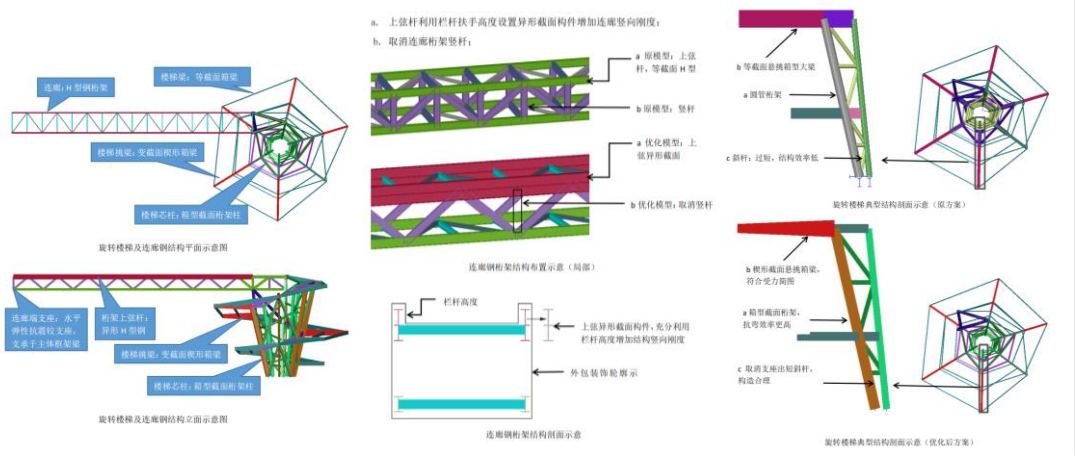


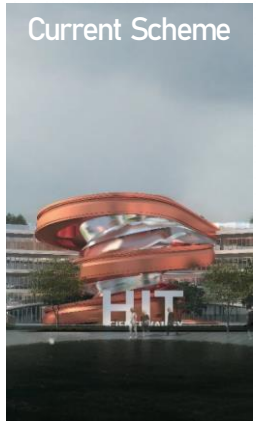
5.1 Integrated Application —— Western Science City in Chongqing

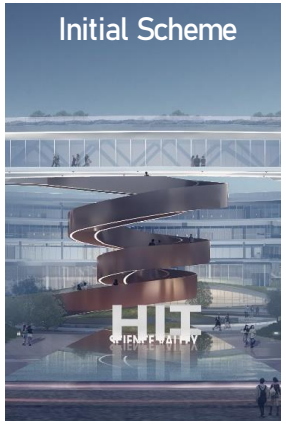
Building Node Scale - Material saving and Cost driven Optimization Design of Rotary Stair Node Form

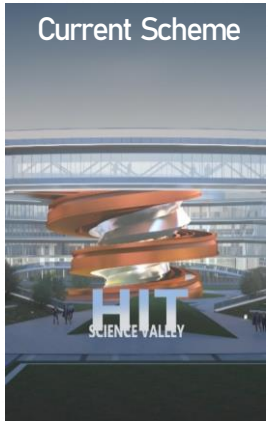
In the design of important nodes, the optimization design of outdoor spiral staircase form takes the full life cycle cost and material consumption as the objectives, and the form, surface material, and construction methods as the design parameters. The optimized plan reduces the steel consumption of the structure by 600 tons, saves more than 1000 square meters of surface aluminum plate, significantly reduces carbon and material consumption, and lowers construction costs.







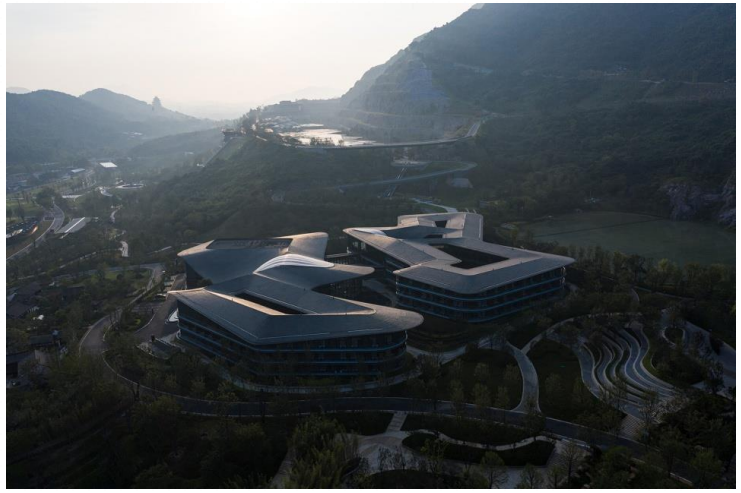


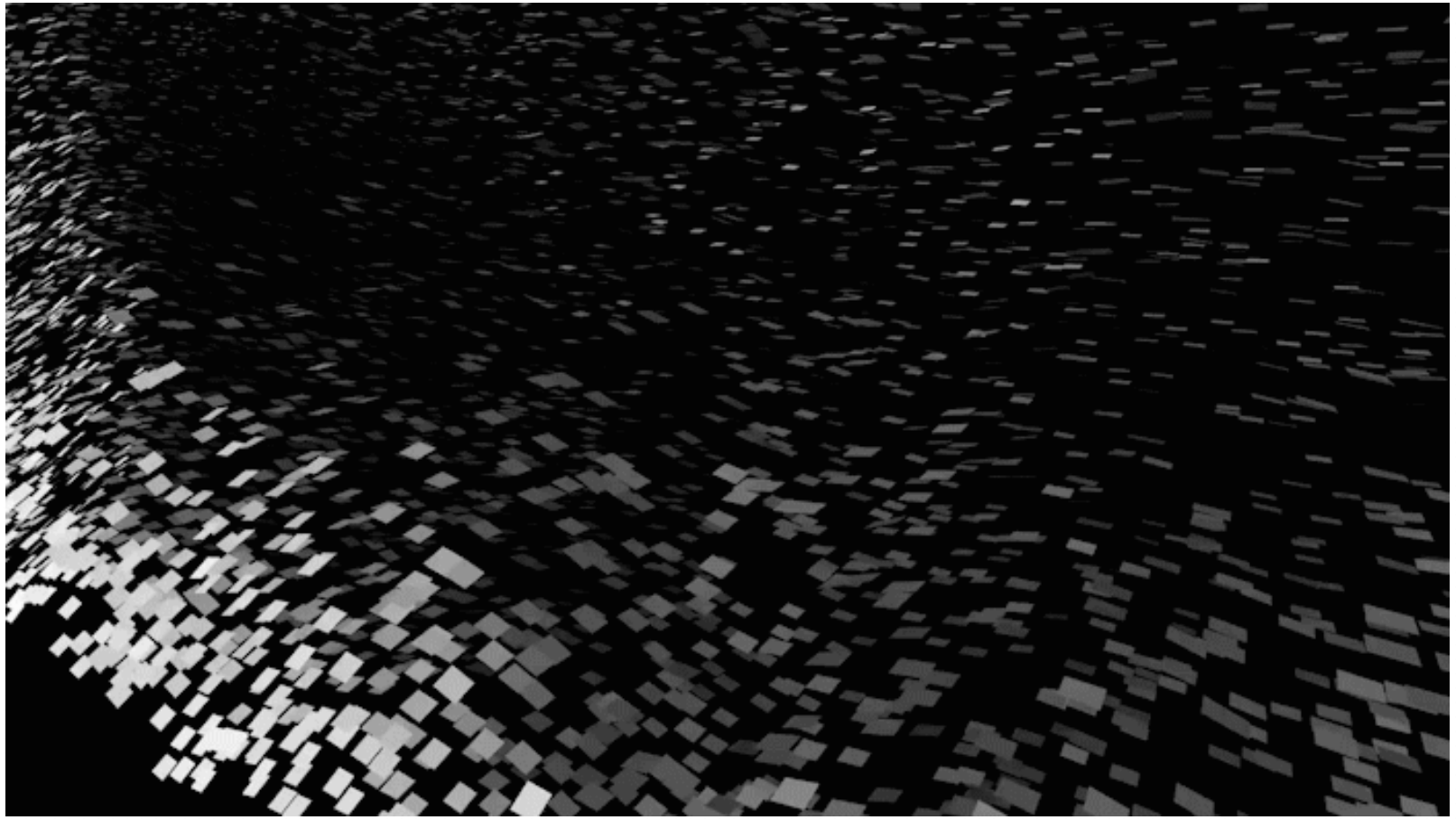


5.2 Integrated Application —— Resort Hotel in Nanjing

Single Building Scale - Particle Swarm Algorithm Driven Architectural Form Generation Design

The project introduces GIS visualization technology based on the current situation of the site, and analyzes and interprets the relationship between cliffs, pond scenery, and site trends in the site. The motion trajectory is obtained through particle swarm intelligence algorithm. Cluster particles generate geometric paths strongly correlated with the texture, geometric relationships that conform to the form of hotels hidden in the environment and integrate into the landscape.

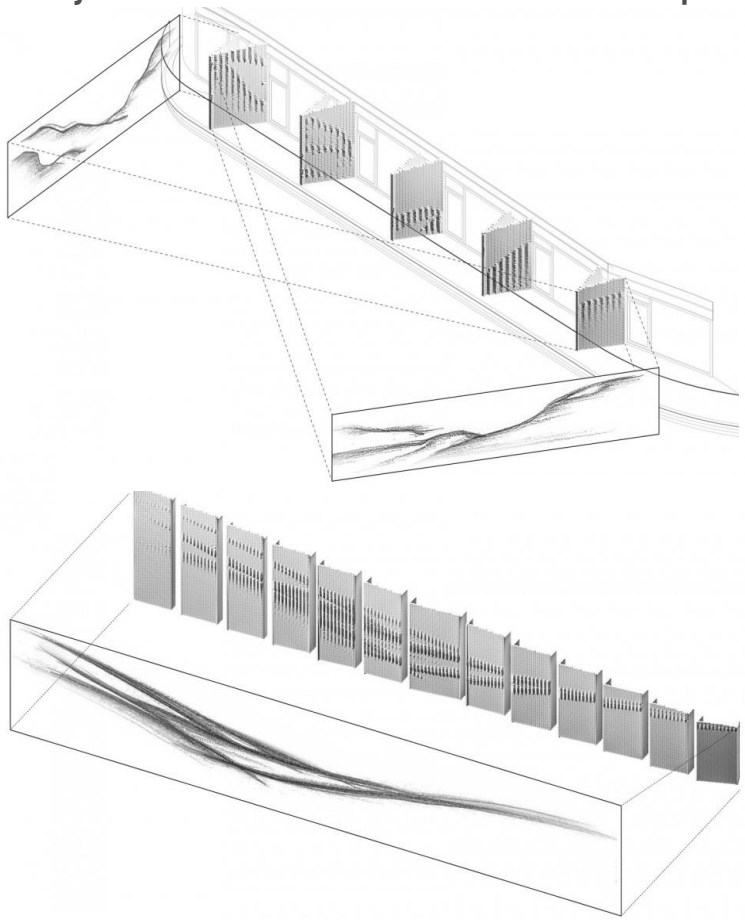


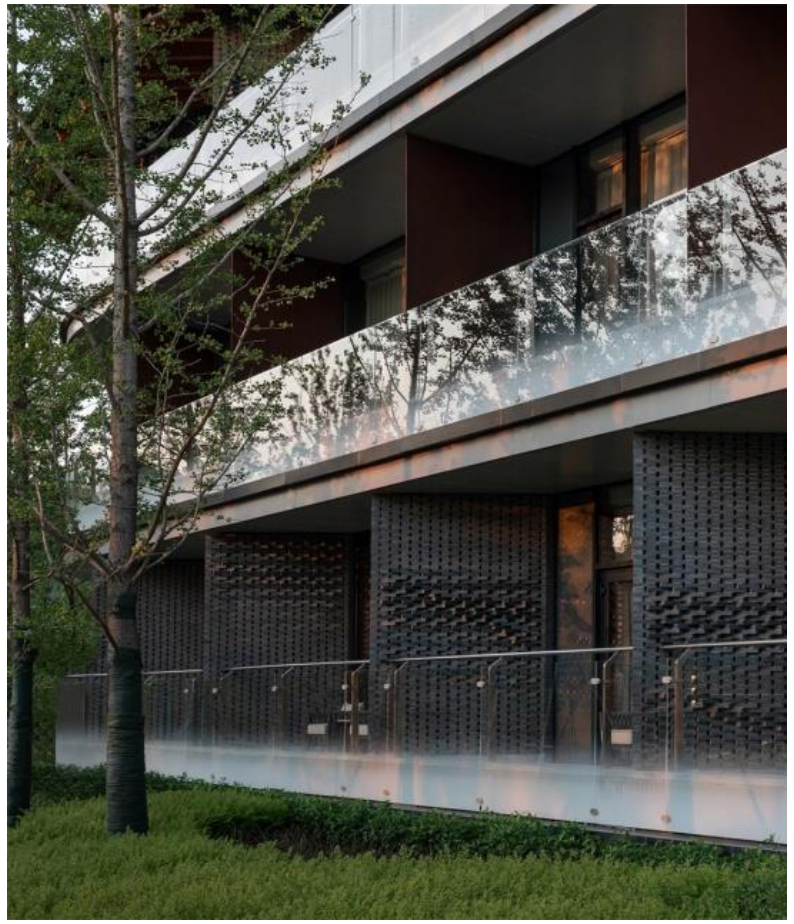


5.2 Integrated Application —— Resort Hotel in Nanjing

Scale of Enclosure Structure - Robot Brick Wall based on Style Transfer and Image Interference

By using image interference to control the rotation angle of the bricks, the concave and convex light and shadow, as well as the unevenness of the joints, are used to abstractly reshape the image information through digital geometry, reproducing the dual picture of nature and itinerary. Image translation utilizes GAN to transfer the style and structure of over 500 local landscape images, and iteratively generates a digital landscape painting that matches the cliff on the site.

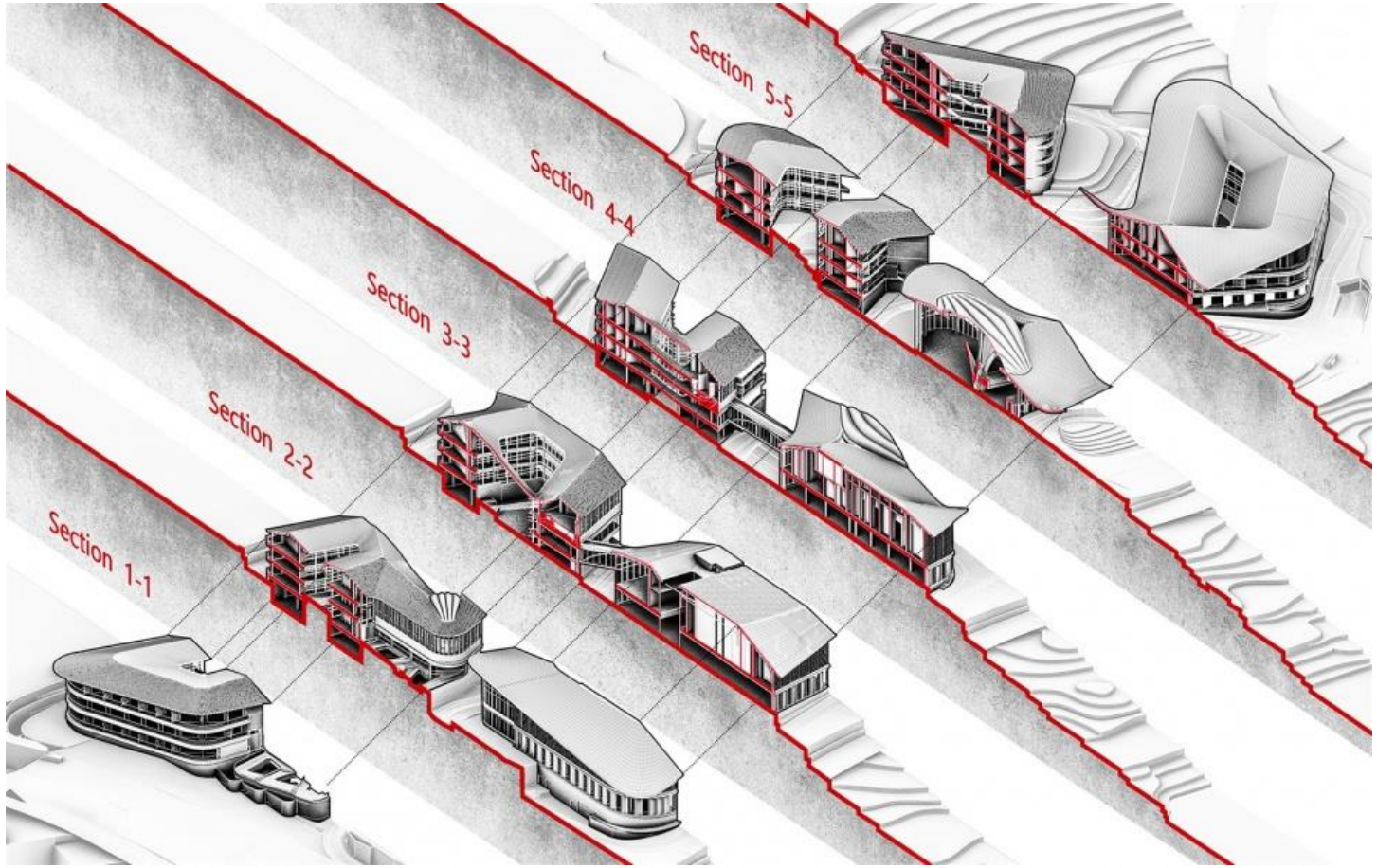




5.2 Integrated Application —— Resort Hotel in Nanjing

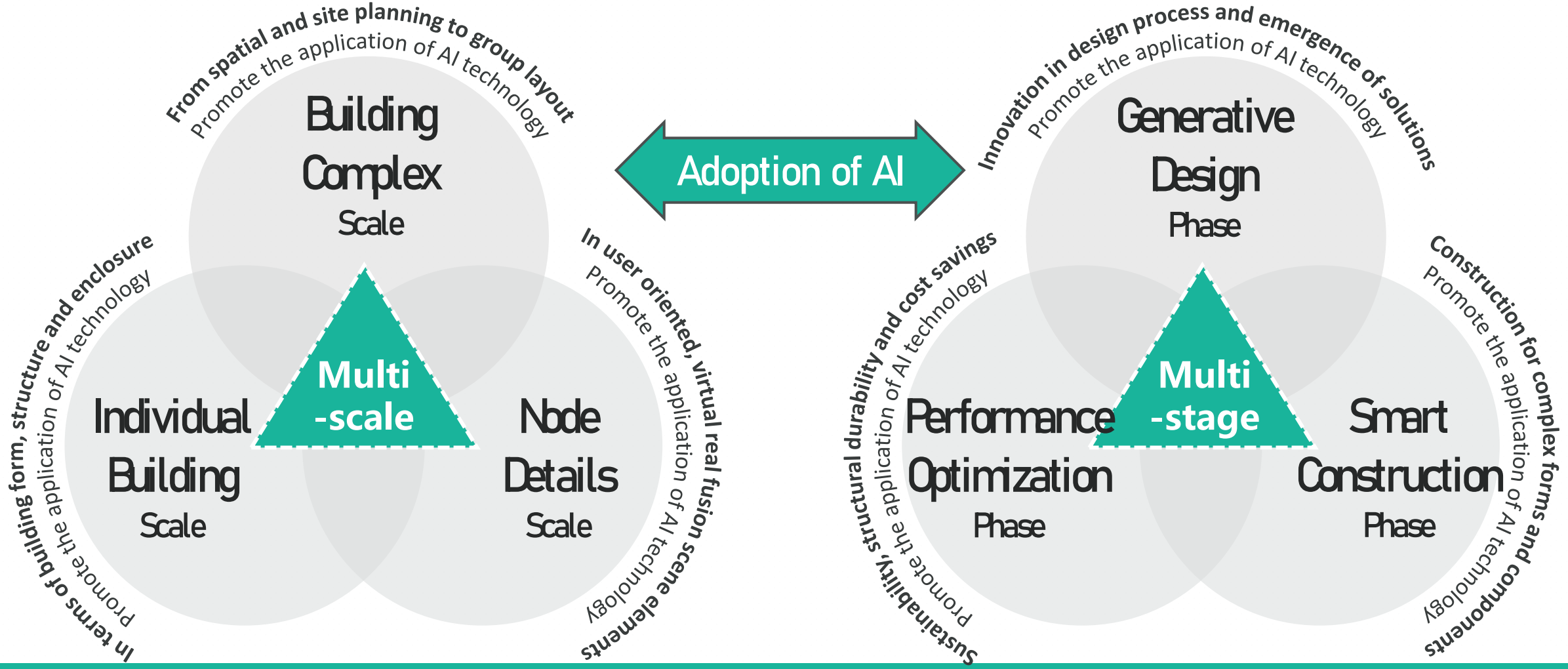
Building Node Scale - Integrated Beam Column Structure Based on Topology Optimization and Dynamic Simulation

The beam column integrated structure located in the hotel lobby has achieved a hyperbolic roof space of nearly 2000 m^2 through the coupling calculation of structural mechanics and form. Using a quarter topology configuration and Kangaroo dynamics simulation, the force and shape finding objective of the overall roof is optimized.



5.3 Conclusion and Prospects

As architects continue to explore the application of AI technology, the improvements of efficiency and effectiveness by advanced algorithms to the practice is highly appreciated. In the future, the multi-scale integrated application and multi-stage interconnected application of AI technology will help create a green, healthy, and intelligent living environment.



Thanks!

中国建筑学会计算性设计专业委员会
Committee of Computational Design-ASC