HS 2022

Structural Design

D-BAUG - MIBS

Prof. Dr. Joseph Schwartz · Prof. Dr. Philippe Block
Federico Bertagna · Davide Tanadini · Dr. Ole Ohlbrock

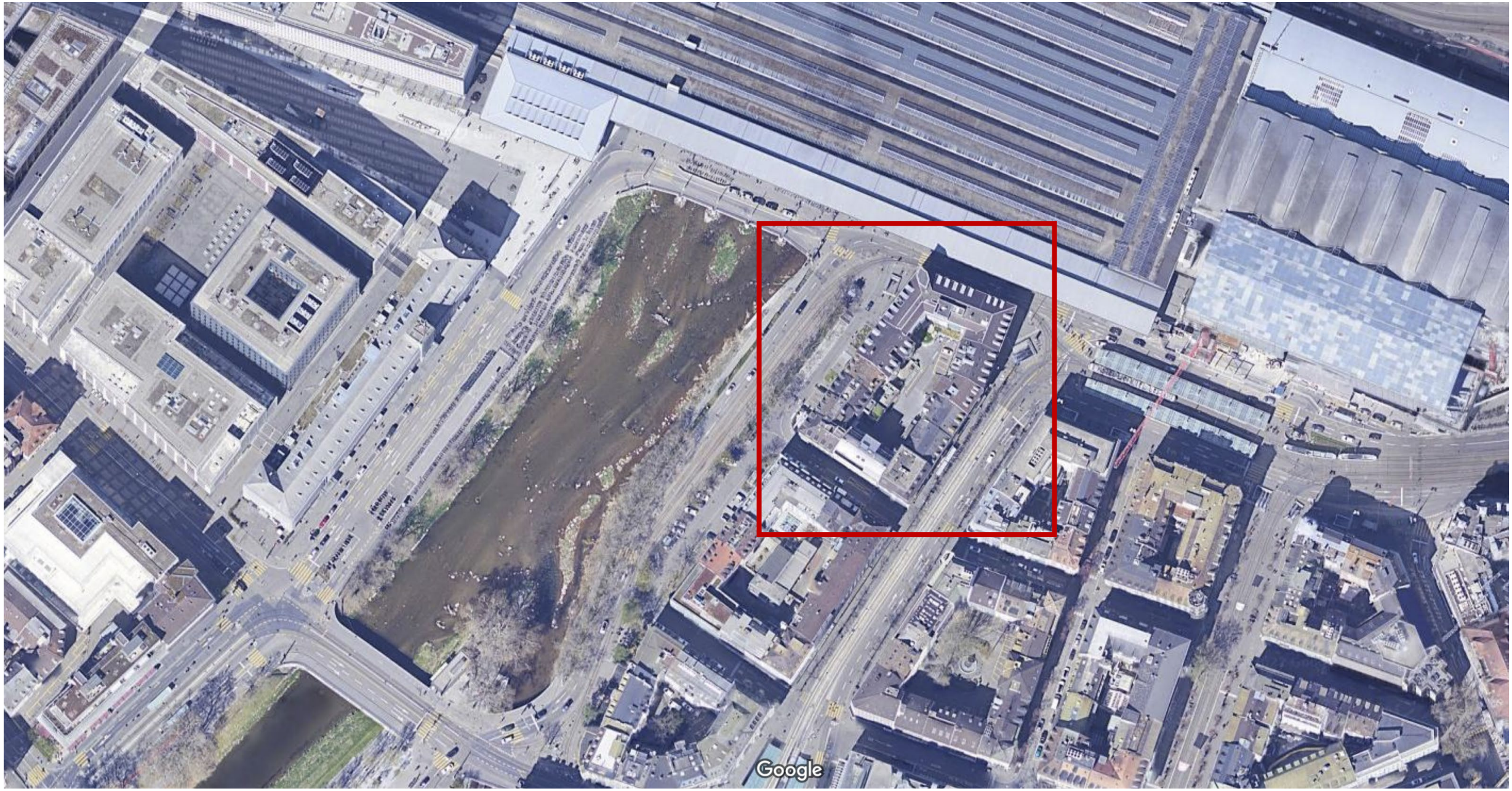
		Lecture	Exercise session / Task	Submission (Friday 23:59)
Week 1	22.9.	Introduction		
Week 2	29.9.		Basics of graphic statics	
Week 3	06.10.		*Task 0*	
Week 4	13.10.	Theory of Plasticity		Submission of Task 0
Week 5	20.10.		Strut-and-tie models	
Week 6	27.10.		*Design exercise (Task 1)*	
Week 7	03.11.		*Design exercise (Task 1)*	
Week 8	**10.11.**		**Midterm review**	Submission of Task 1
Week 9	17.11.	Stress fields		
Week 10	24.11.		From STM to stress fields	
Week 11	01.12.			
Week 12	08.12.		*Design exercise (Task 2)*	
Week 13	15.12.			Submission of Task 2
Week 14	**22.12.**		**Final review**	

Course overview

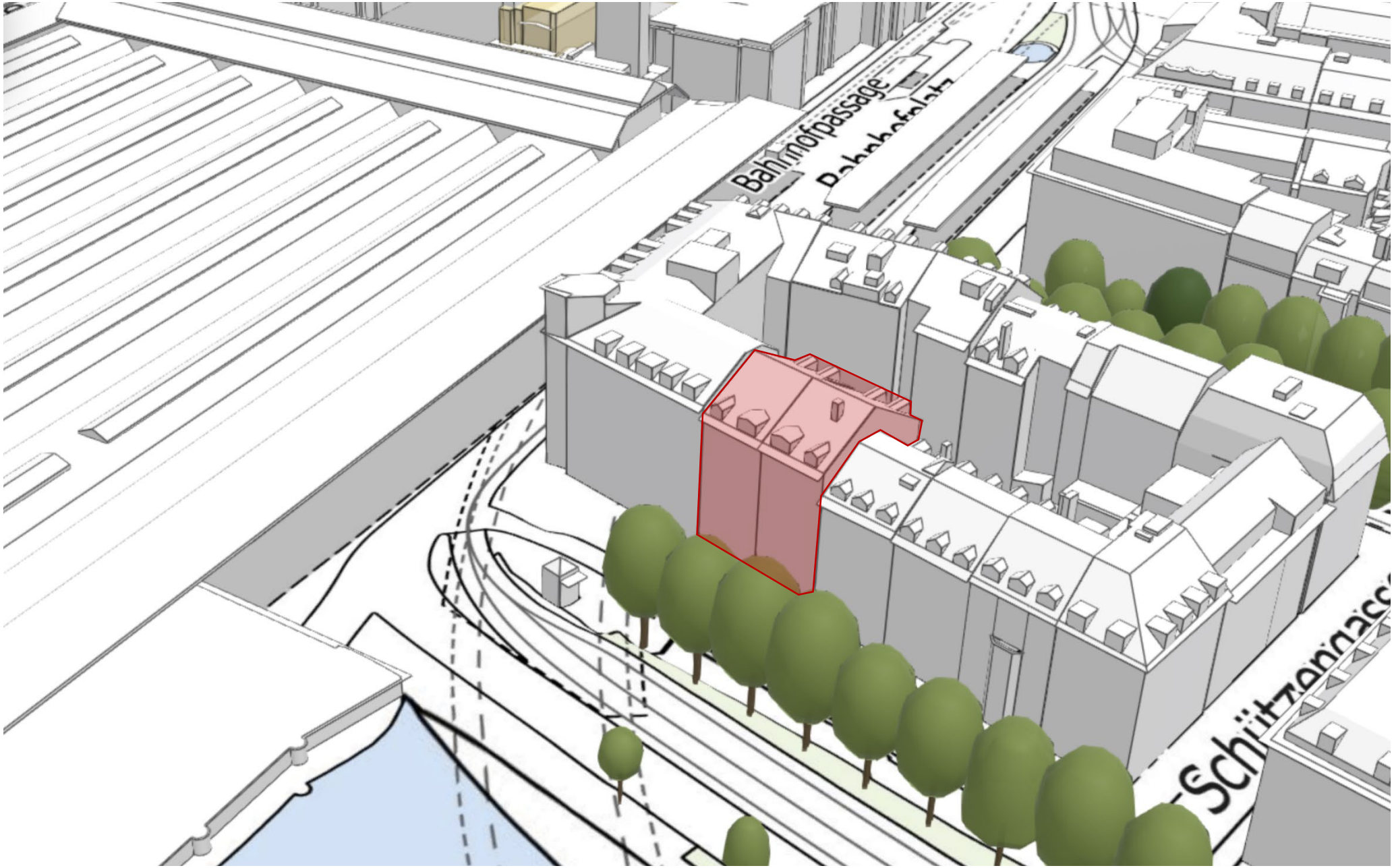
© Pezo von Ellrichshausen

DESIGN TASK

The scope of the design task is to investigate the relationship between architectural space and load-bearing structures by developing a **design proposal for a new multistory office building in Zurich**.

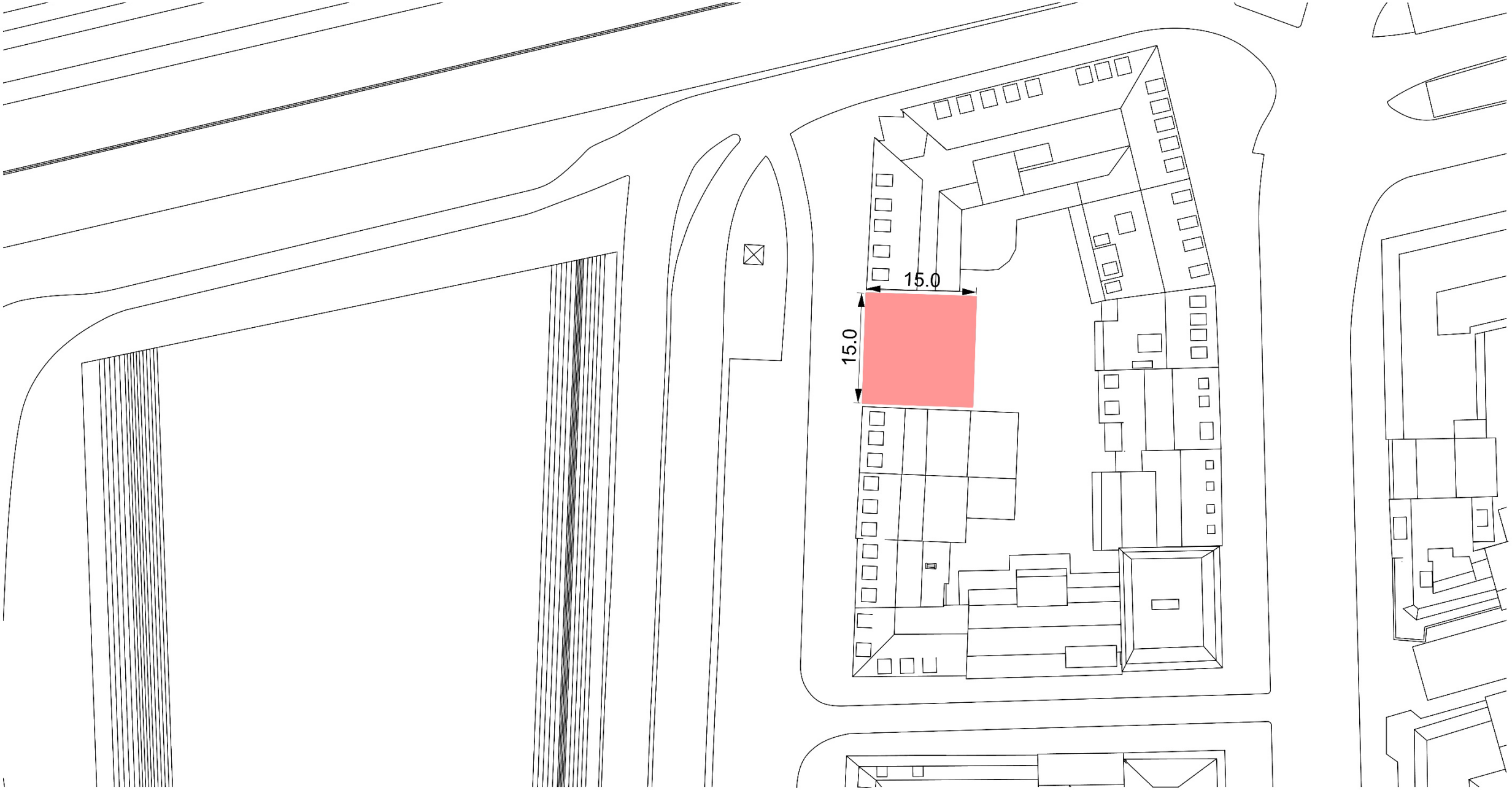


Site

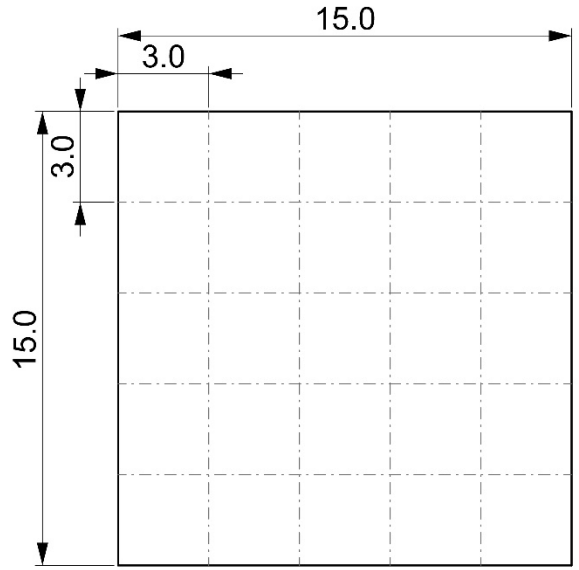


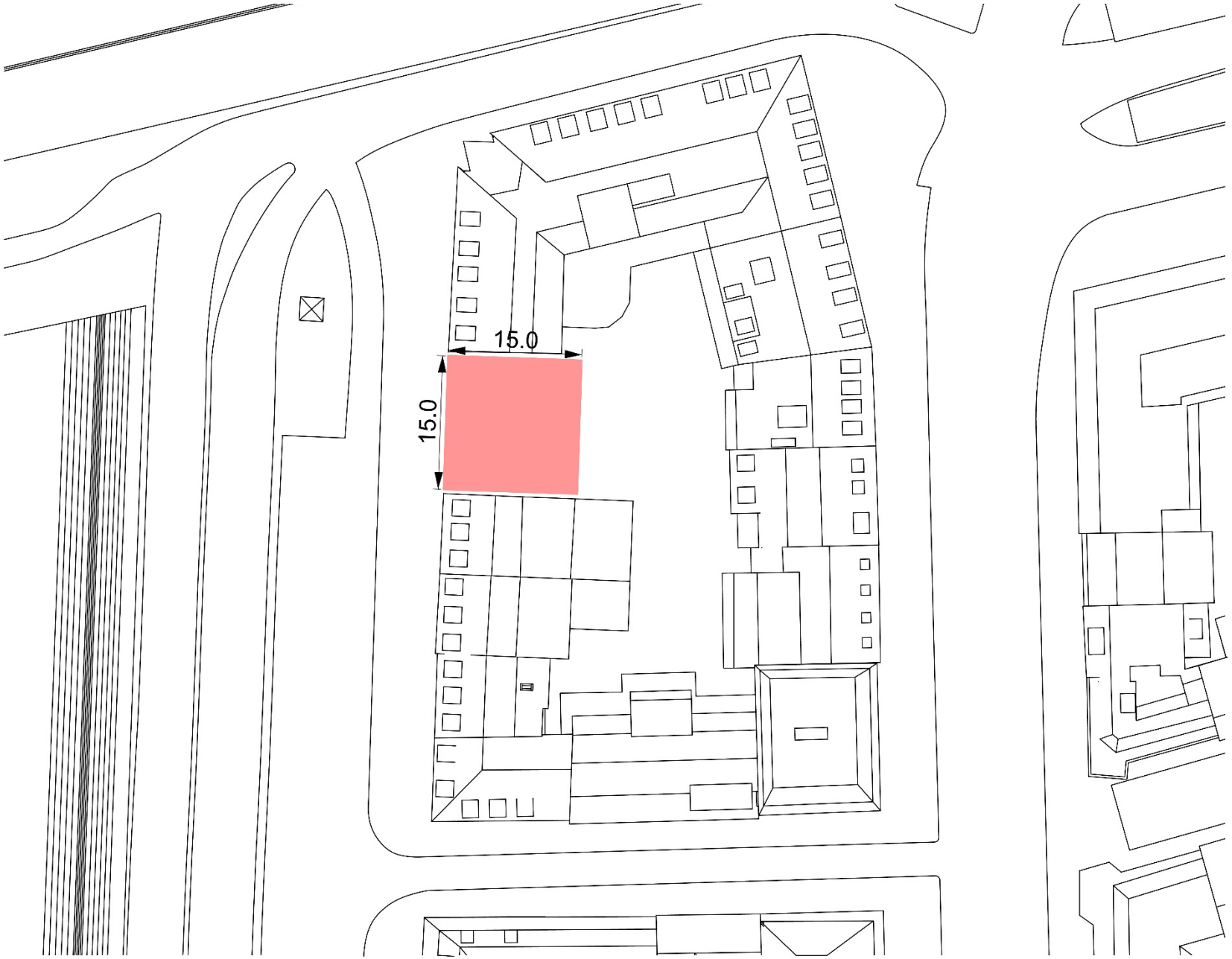
Site

Site



Site





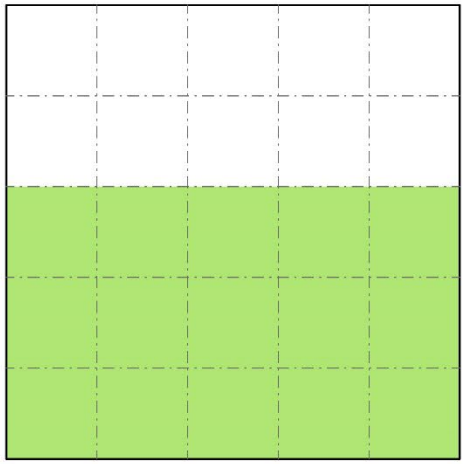
Site

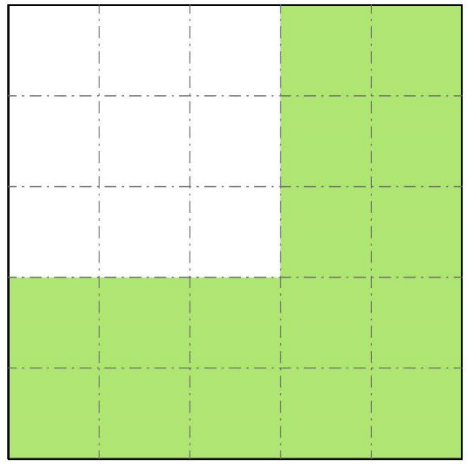
Site area: 15.0x15.0 m

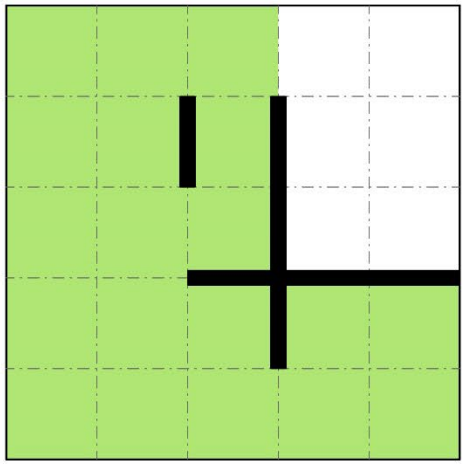
Program: office building

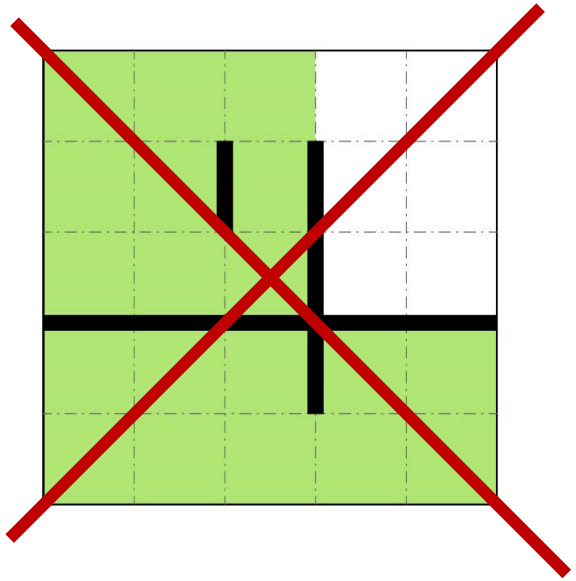
Required spaces:

- Lobby/hall (*15-20 cells*)









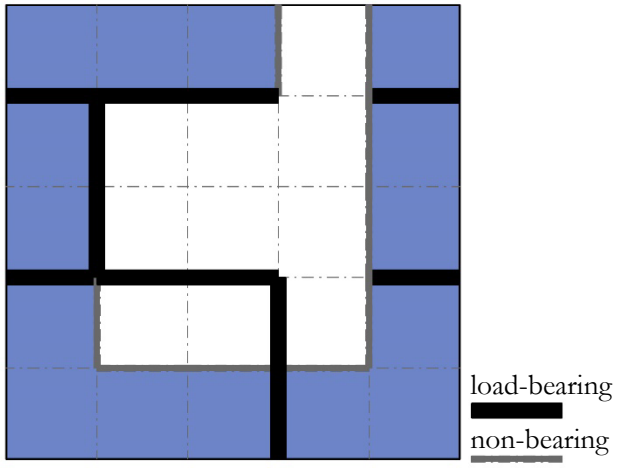
Lobby/hall

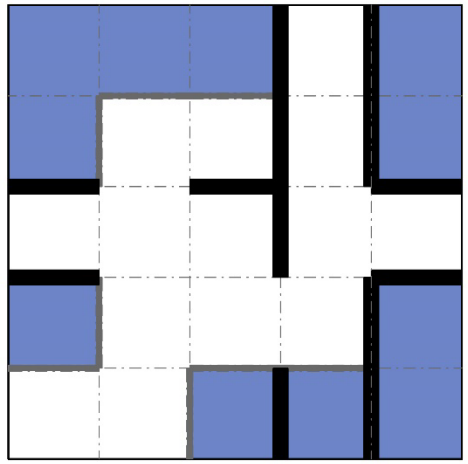
Site area: 15.0x15.0 m

Program: office building

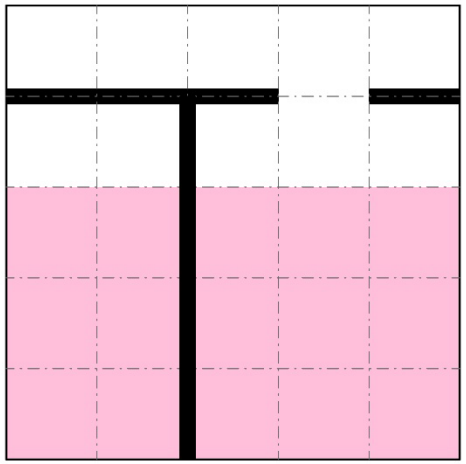
Required spaces:

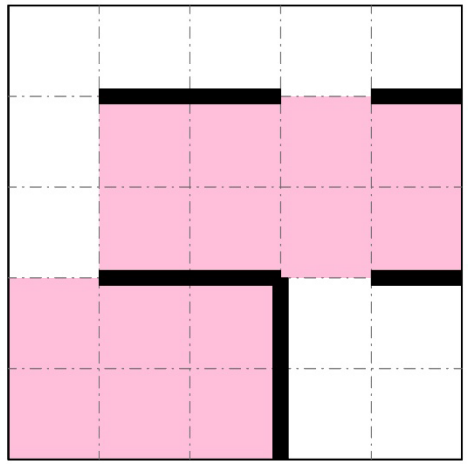
- Lobby/hall (*15-20 cells*)
- 8-12 individual offices (*1-2 cells each*)
- 2 open space offices (*6-10 cells each*)





Individual offices





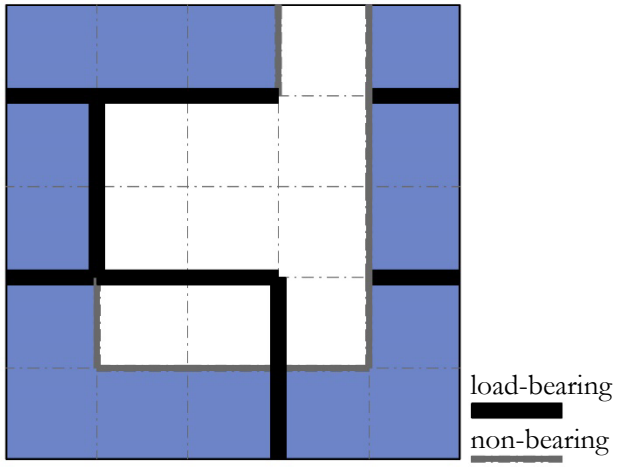
Open space offices/meeting room/cafeteria

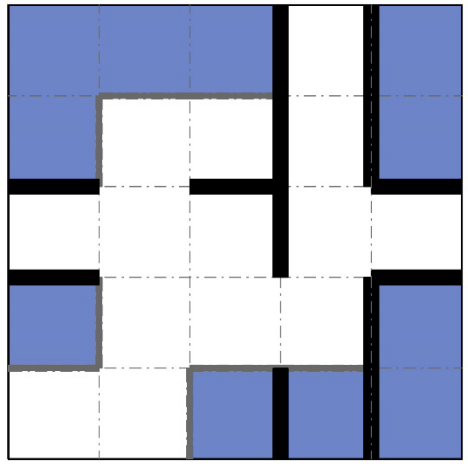
Site area: 15.0x15.0 m

Program: office building

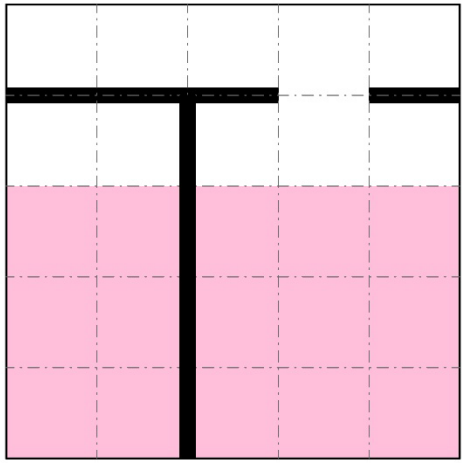
Required spaces:

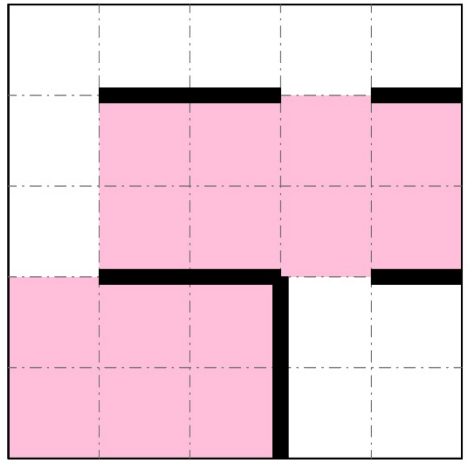
- Lobby/hall (*15-20 cells*)
- 8-12 individual offices (*1-2 cells each*)
- 2 open space offices (*6-10 cells each*)
- Meeting room (*6-10 cells*)
- Cafeteria (*6-10 cells*)





Individual offices





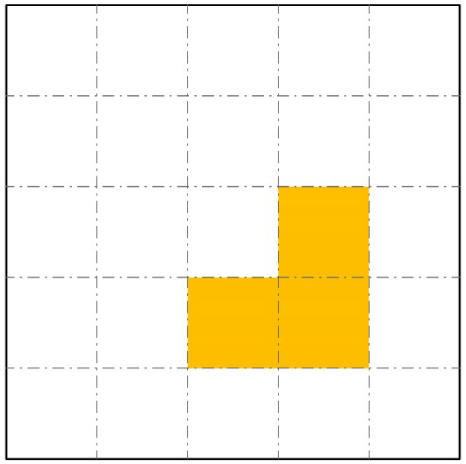
Open space offices/meeting room/cafeteria

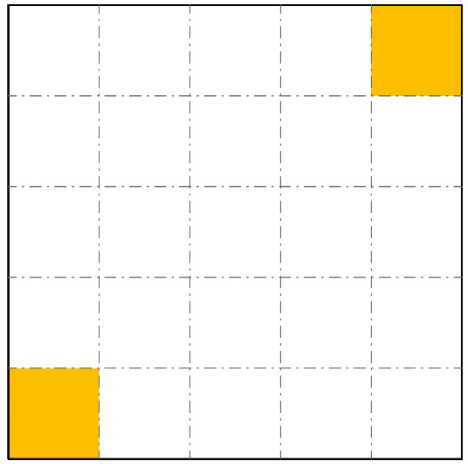
Site area: 15.0x15.0 m

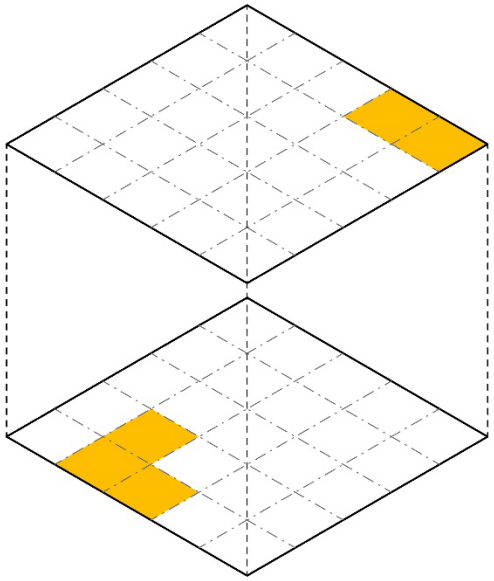
Program: office building

Required spaces:

- Lobby/hall (*15-20 cells*)
- 8-12 individual offices (*1-2 cells each*)
- 2 open space offices (*6-10 cells each*)
- Meeting room (*6-10 cells*)
- Cafeteria (*6-10 cells*)
- Staircases/lift (2-3 cells)







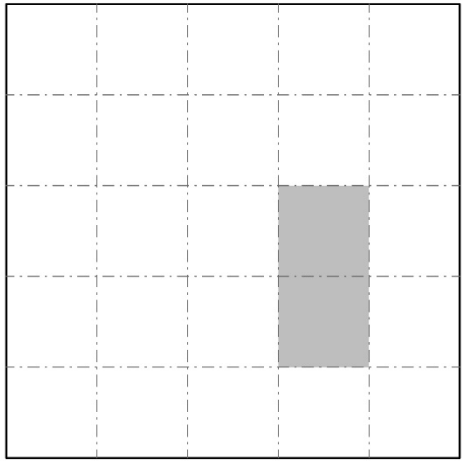
Staircases/lift

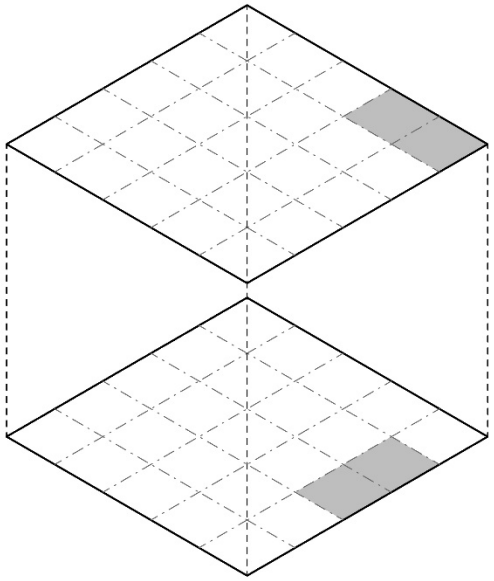
Site area: 15.0x15.0 m

Program: office building

Required spaces:

- Lobby/hall (*15-20 cells*)
- 8-12 individual offices (*1-2 cells each*)
- 2 open space offices (*6-10 cells each*)
- Meeting room (*6-10 cells*)
- Cafeteria (*6-10 cells*)
- Staircases/lift (2-3 cells)
- Restrooms (2 cells)





Restrooms

Site area: 15.0x15.0 m

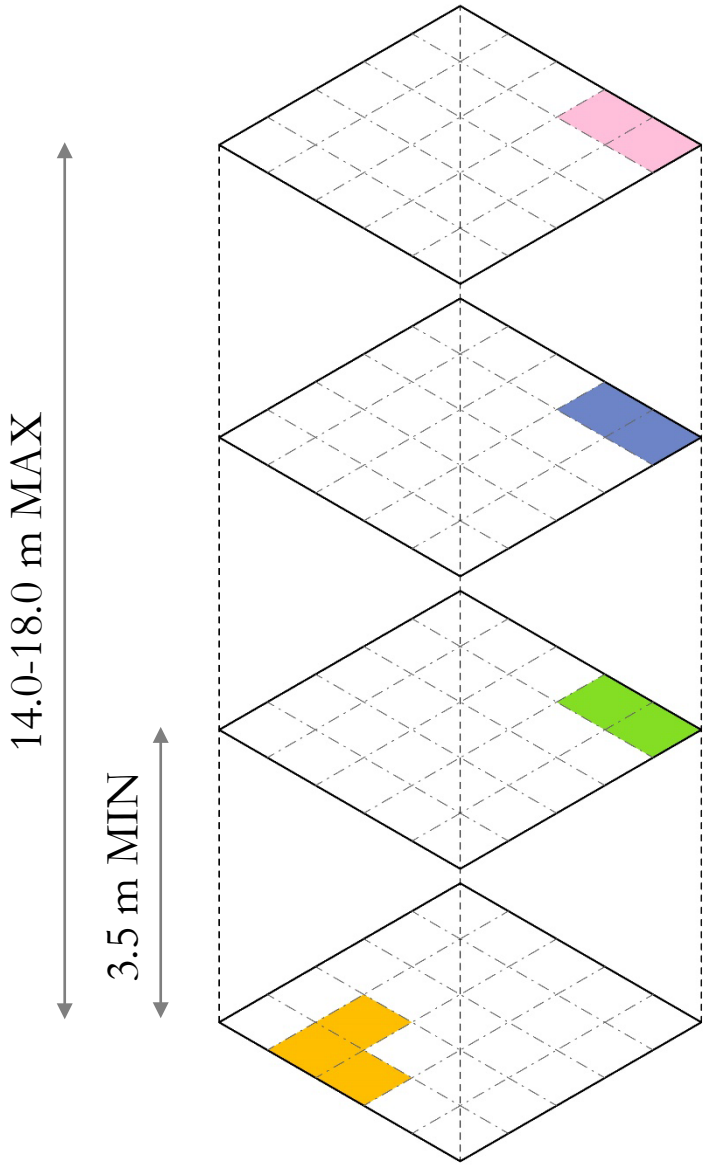
Program: office building

Required spaces:

- Lobby/hall (*15-20 cells*)
- 8-12 individual offices (*1-2 cells each*)
- 2 open space offices (*6-10 cells each*)
- Meeting room (*6-10 cells*)
- Cafeteria (*6-10 cells*)
- Staircases/lift (2-3 cells)
- Restrooms (2 cells)

Design constraints:

- The building must be structurally independent from the neighboring buildings
- Max building height = 14.0-18.0 m
- Minimum floor height = 3.5 m



Floor height

Site area: 15.0x15.0 m

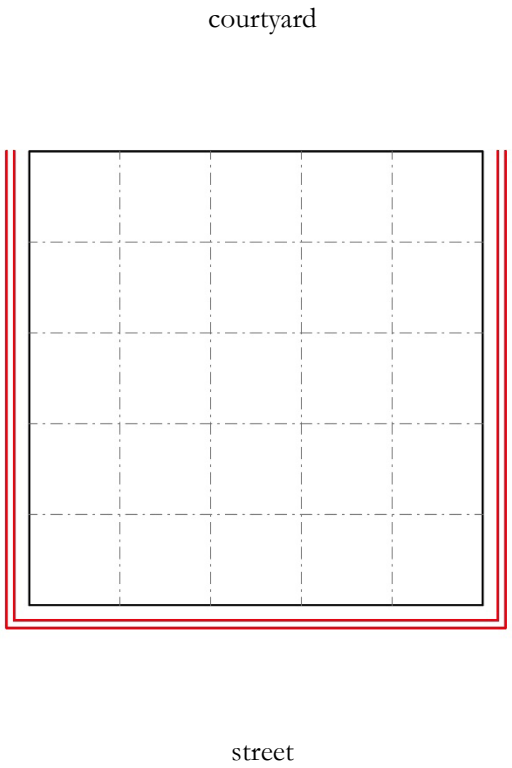
Program: office building

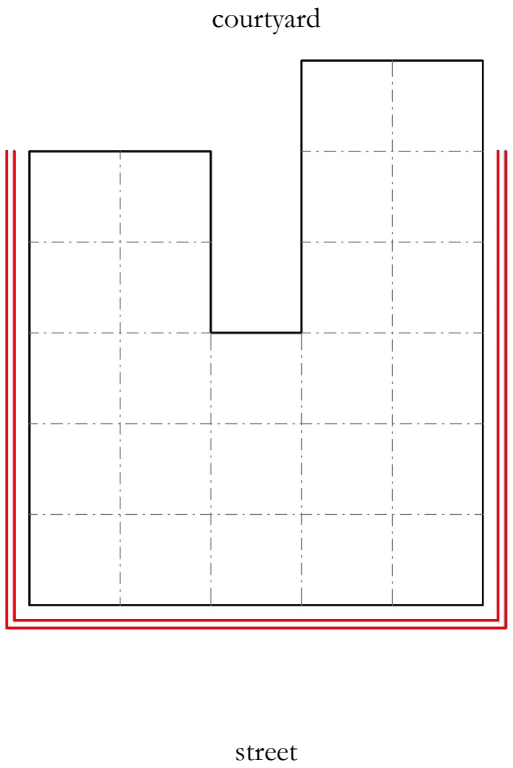
Required spaces:

- Lobby/hall (*15-20 cells*)
- 8-12 individual offices (*1-2 cells each*)
- 2 open space offices (*6-10 cells each*)
- Meeting room (*6-10 cells*)
- Cafeteria (*6-10 cells*)
- Staircases/lift (2-3 cells)
- Restrooms (2 cells)

Design constraints:

- The building must be structurally independent from the neighboring buildings
- Max building height = 14.0-18.0 m
- Minimum floor height = 3.5 m
- The building cannot extend towards the street, but can extend towards the courtyard





Building boundary

Site area: 15.0x15.0 m

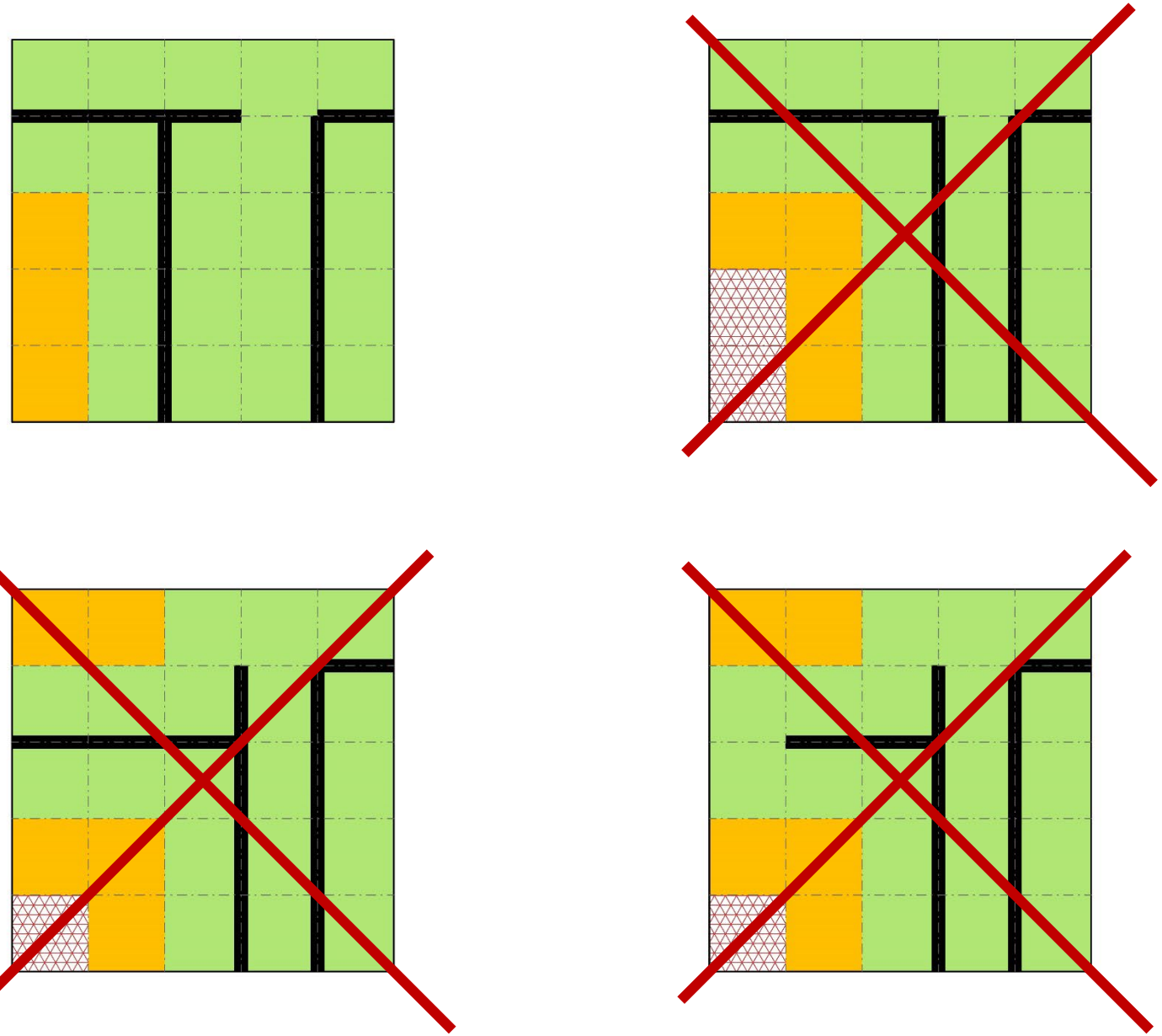
Program: office building

Required spaces:

- Lobby/hall (*15-20 cells*)
- 8-12 individual offices (*1-2 cells each*)
- 2 open space offices (*6-10 cells each*)
- Meeting room (*6-10 cells*)
- Cafeteria (*6-10 cells*)
- Staircases/lift (2-3 cells)
- Restrooms (2 cells)

Design constraints:

- The building must be structurally independent from the neighboring buildings
- Max building height = 14.0-18.0 m
- Minimum floor height = 3.5 m
- The building cannot extend towards the street, but can extend towards the courtyard
- The maximum admissible distance between a node and the closest wall is 2 cells



Cantilevering elements

Site area: 15.0x15.0 m

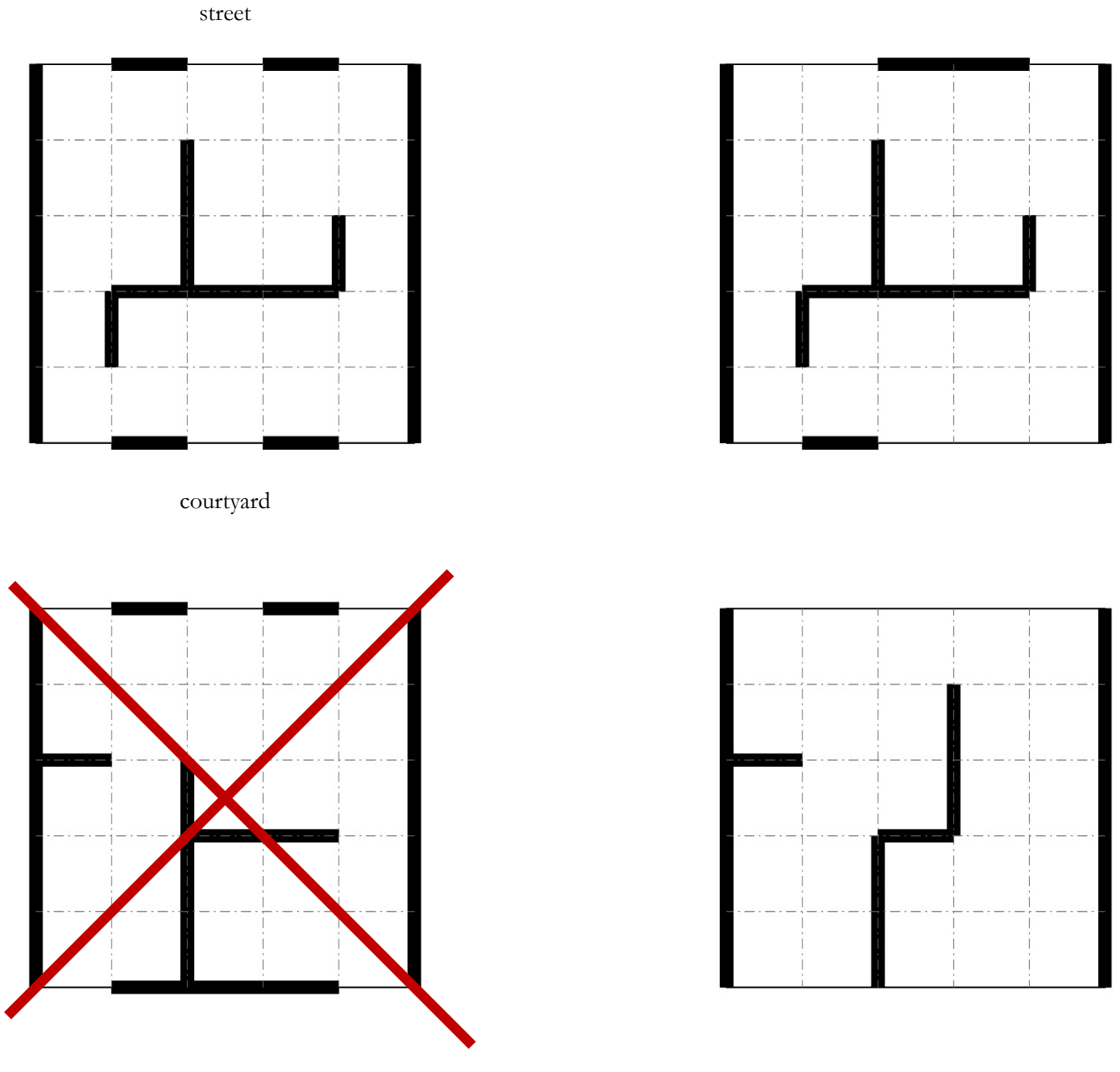
Program: office building

Required spaces:

- Lobby/hall (*15-20 cells*)
- 8-12 individual offices (*1-2 cells each*)
- 2 open space offices (*6-10 cells each*)
- Meeting room (*6-10 cells*)
- Cafeteria (*6-10 cells*)
- Staircases/lift (2-3 cells)
- Restrooms (2 cells)

Design constraints:

- The building must be structurally independent from the neighboring buildings
- Max building height = 14.0-18.0 m
- Minimum floor height = 3.5 m
- The building cannot extend towards the street, but can extend towards the courtyard
- The maximum admissible distance between a node and the closest wall is 2 cells
- The building envelope must have at least 3 cells open towards the street and the courtyard



Building envelope

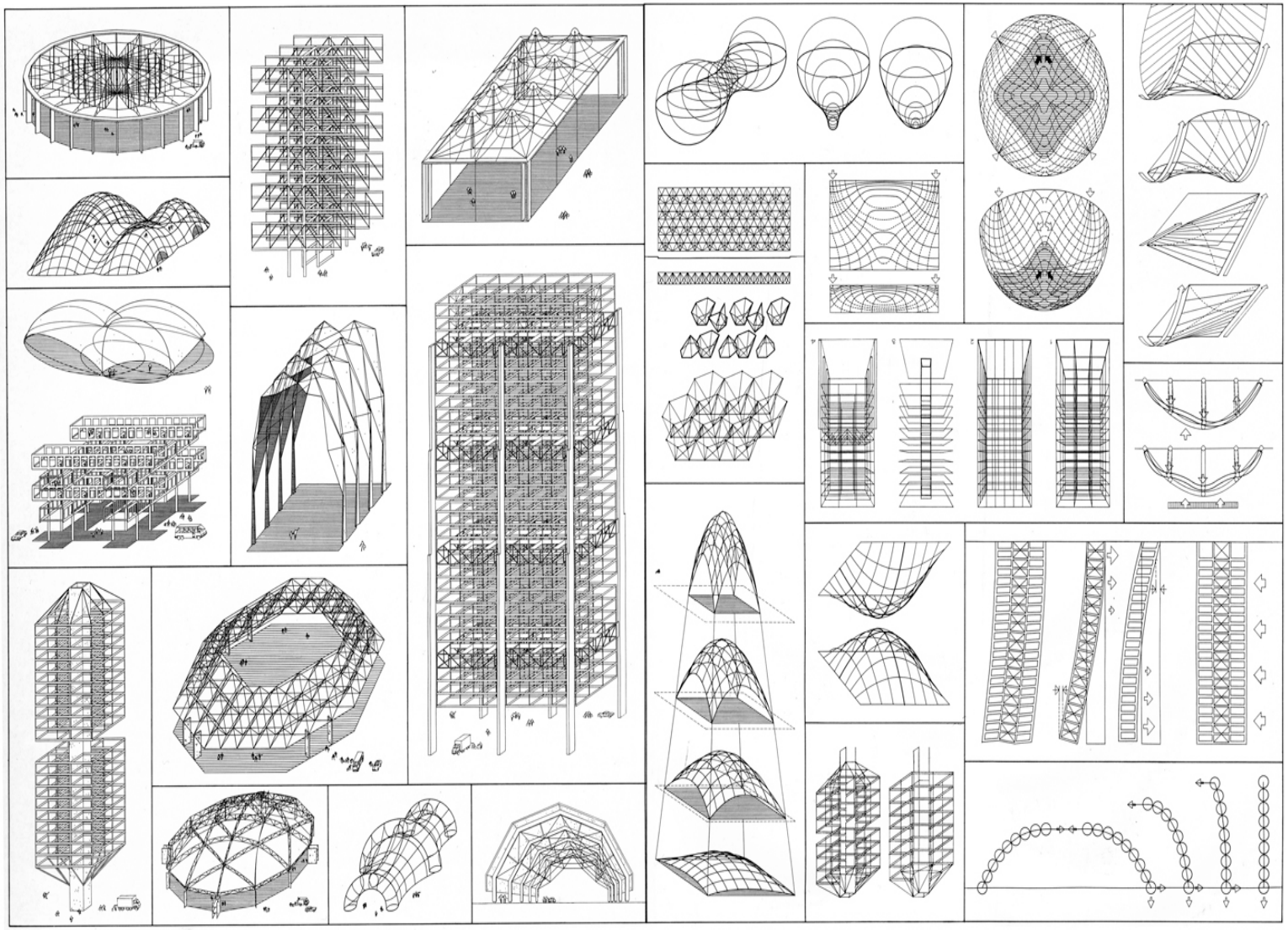
"There is certainly ***no rule or recipe*** *leading to good form, but there are means towards it. The engineer, if he is interested, can contribute to it with* ***variety*** *and lightness. We must evoke the structural engineer's interest in this most inspiring part of his profession."*

Jörg Schlaich

"One way is to design structures by making imaginative use of the existing bodies of engineering knowledge and relatively ***tried-and-tested*** *structural solutions".*

"But many designers believe that the best way to achieve good buildings is to go back to ***first principles*** *and create designs by a* ***combination*** *of inspiration and logic"*

Bill Addis



Classification of Structures, Heino Engel

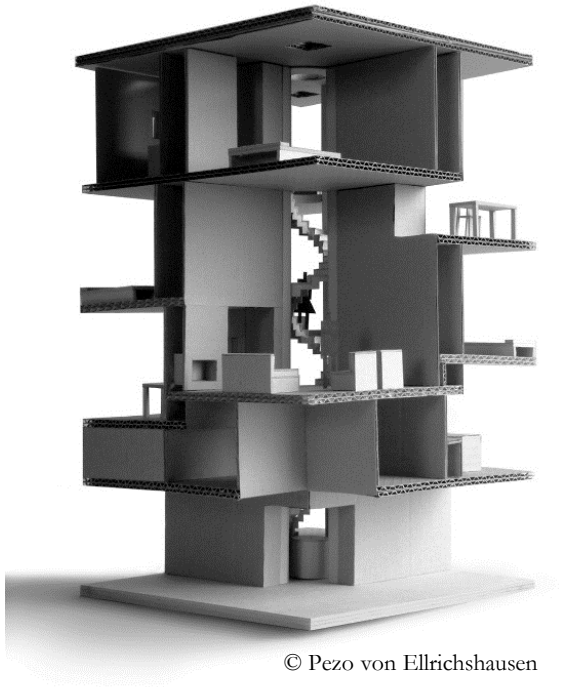
Zollverein Essen, Sanaa

Ottoplatz Chur, Jüngling Hagmann mit Conzett Bronzini Partner

EMPA Nest Zürich, Gramazio & Kohler mit Dr. Schwartz Consulting

H1 Zwhatt Regensdorf, Boltshauser

Central core(s)

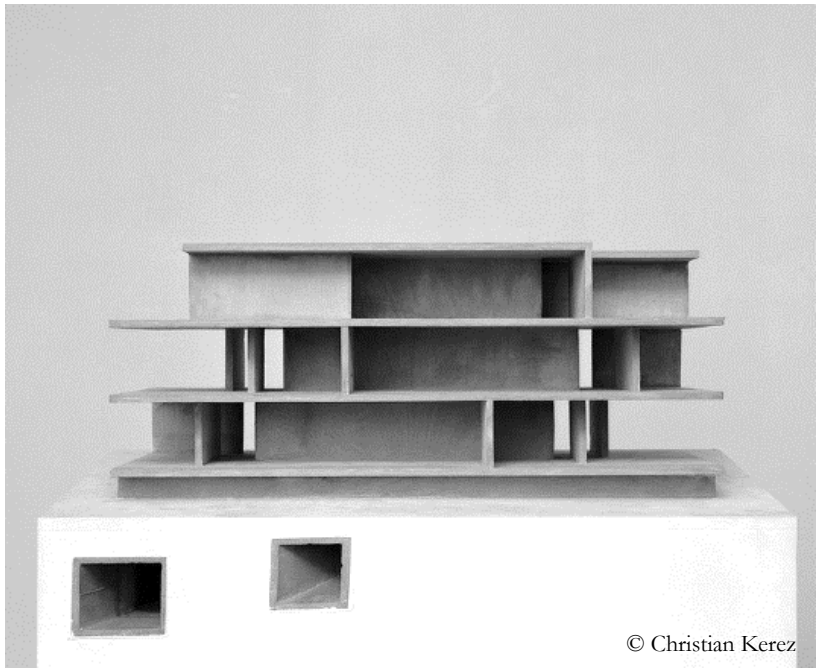


© Pezo von Ellrichshausen

Outer ring

© Cristina Jiménez Molano

Diffuse structure



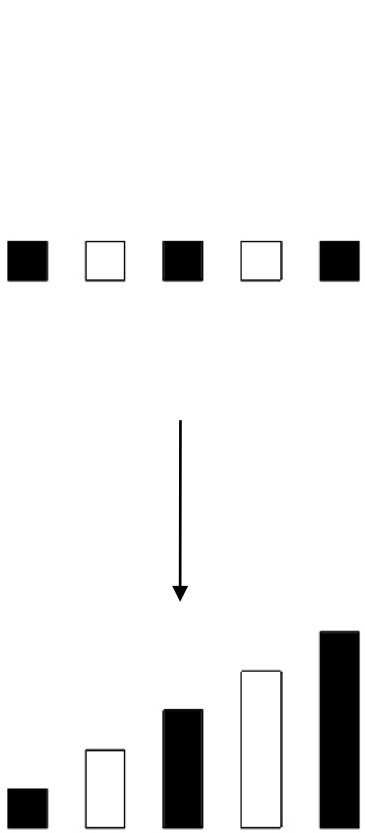
© Christian Kerez

"One way is to design structures by making imaginative use of the existing bodies of engineering knowledge and relatively ***tried-and-tested*** *structural solutions".*

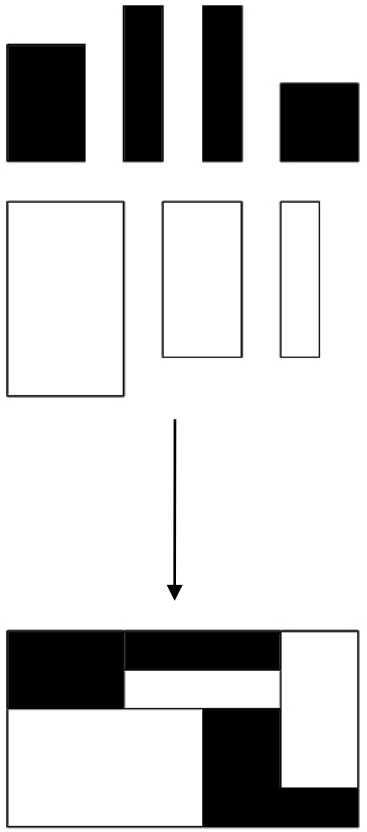
"But many designers believe that the best way to achieve good buildings is to go back to ***first principles*** *and create designs by a* ***combination*** *of inspiration and logic"*

Bill Addis

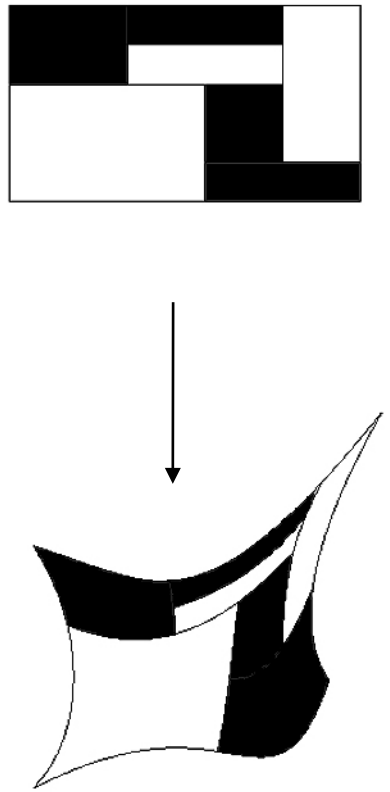
Concept of Variation and Combination



Parametric Variation



Combinatorial Variation



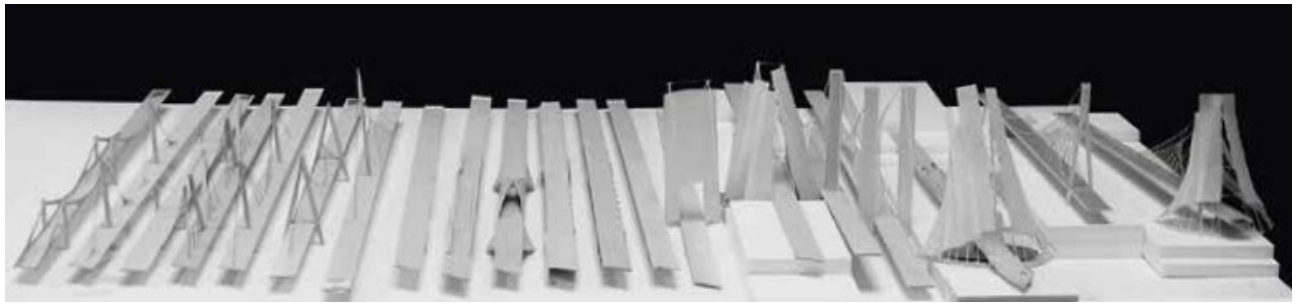
Geometric Variation

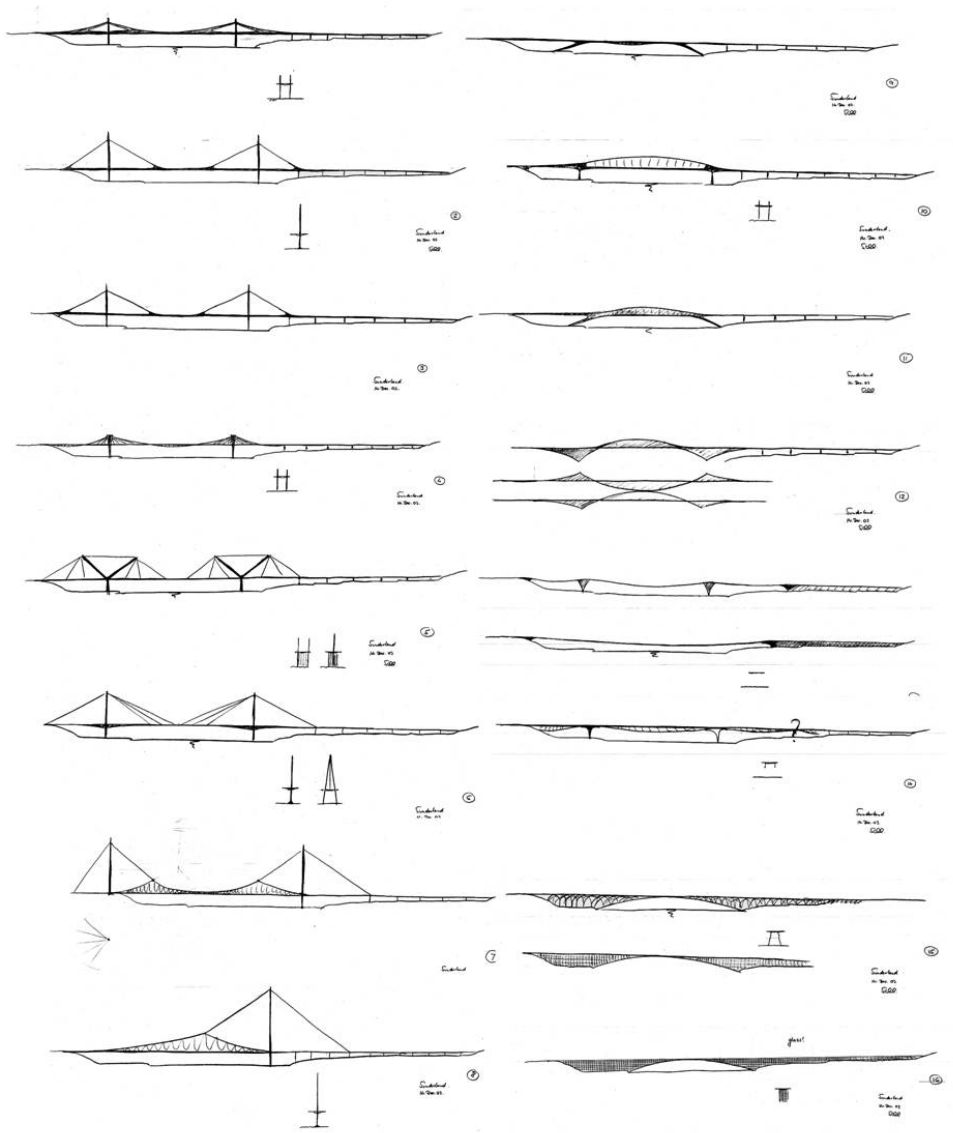
Variation

lat. *variare* „to alter/ to modify“

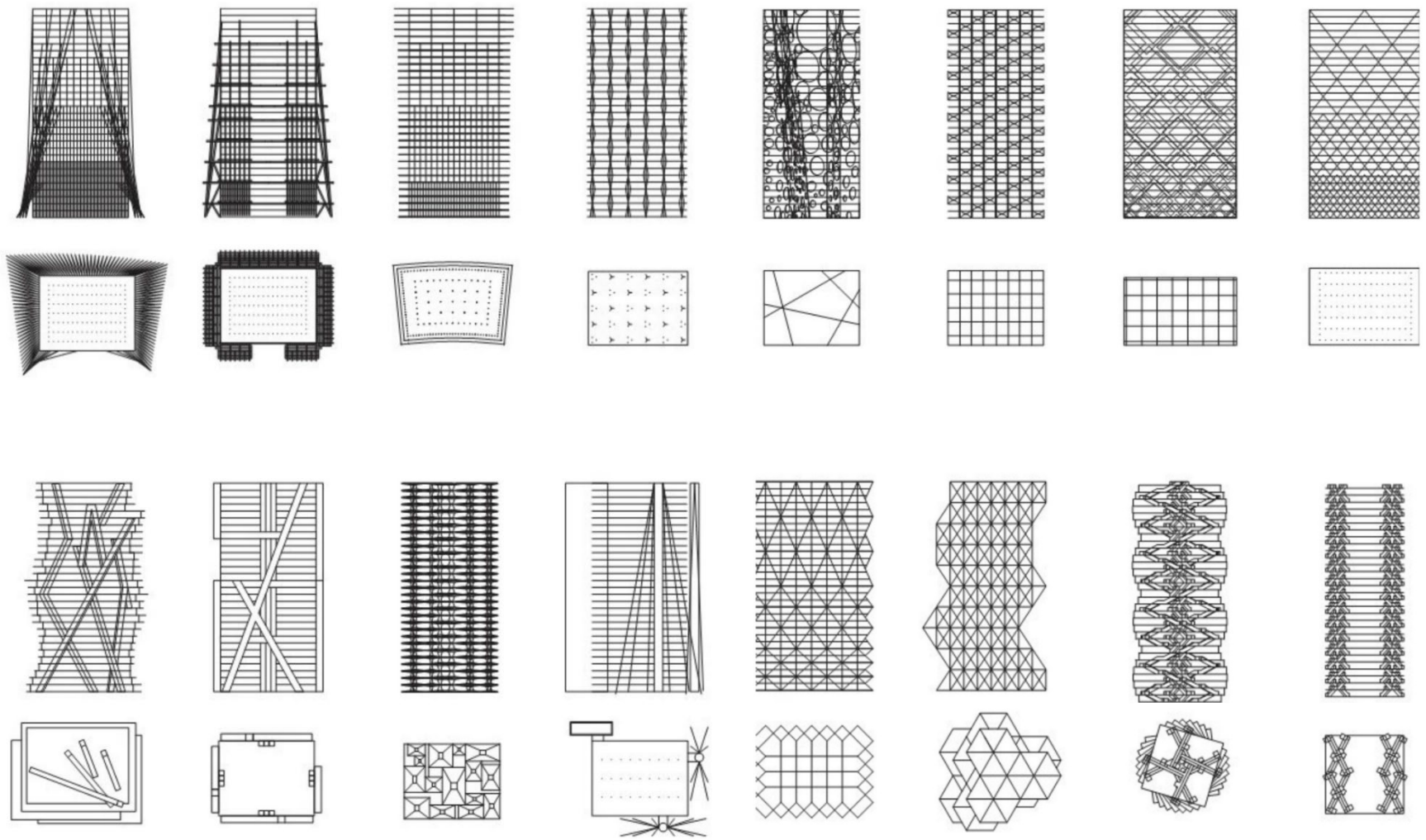
variation as a design method
is about the controlled modification of properties

variation is closely related to replication,
the unchanged repetition

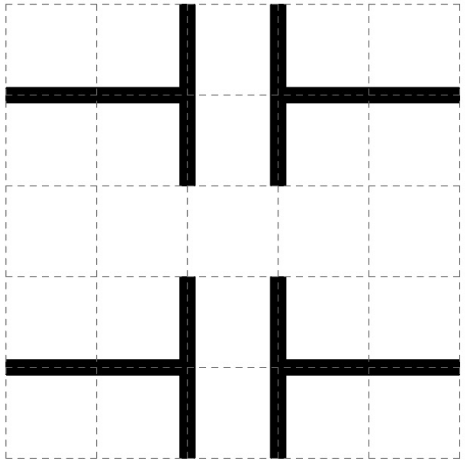




Design Session with Frank O Gehry & Jörg and Mike Schlaich

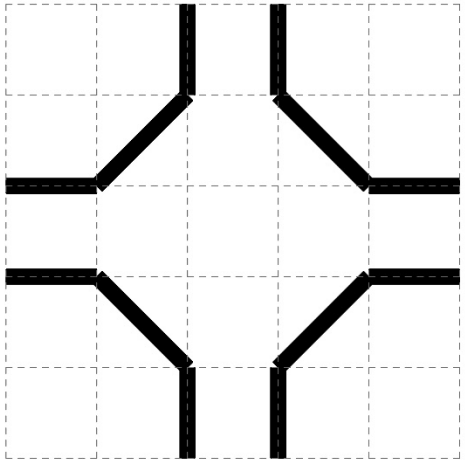


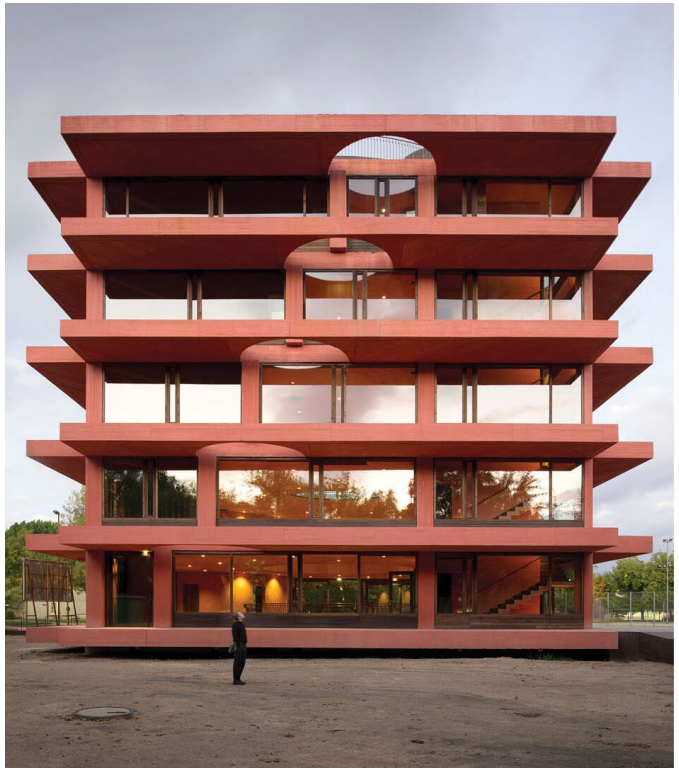
High-Rise in Zhengzhou. Architect: Christian Kerez, Structural Engineer: Joseph Schwartz. Zhengzhou, 2012-13

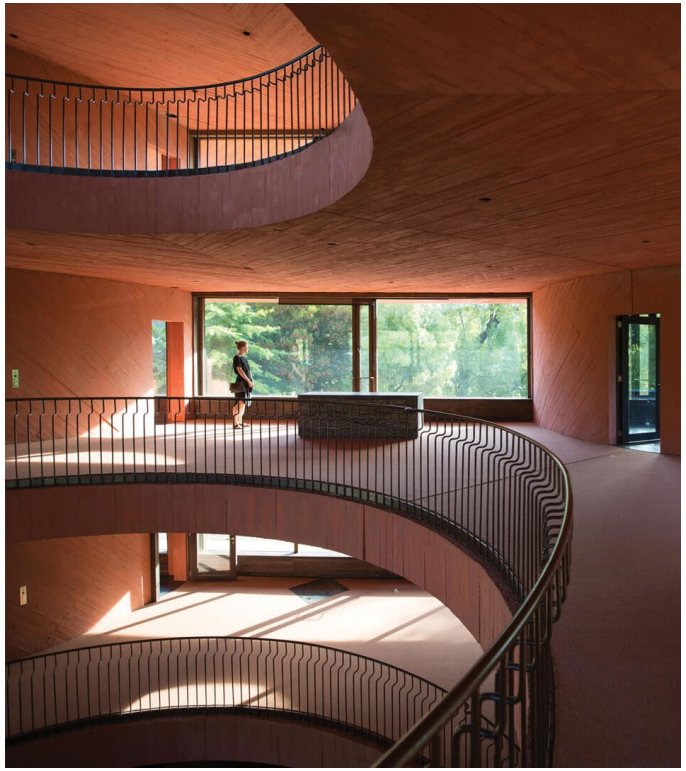


Leutschenbach School, Christian Kerez and Joseph Schwartz

Symmetry

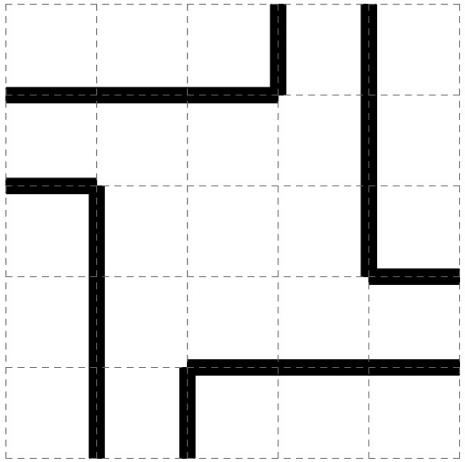


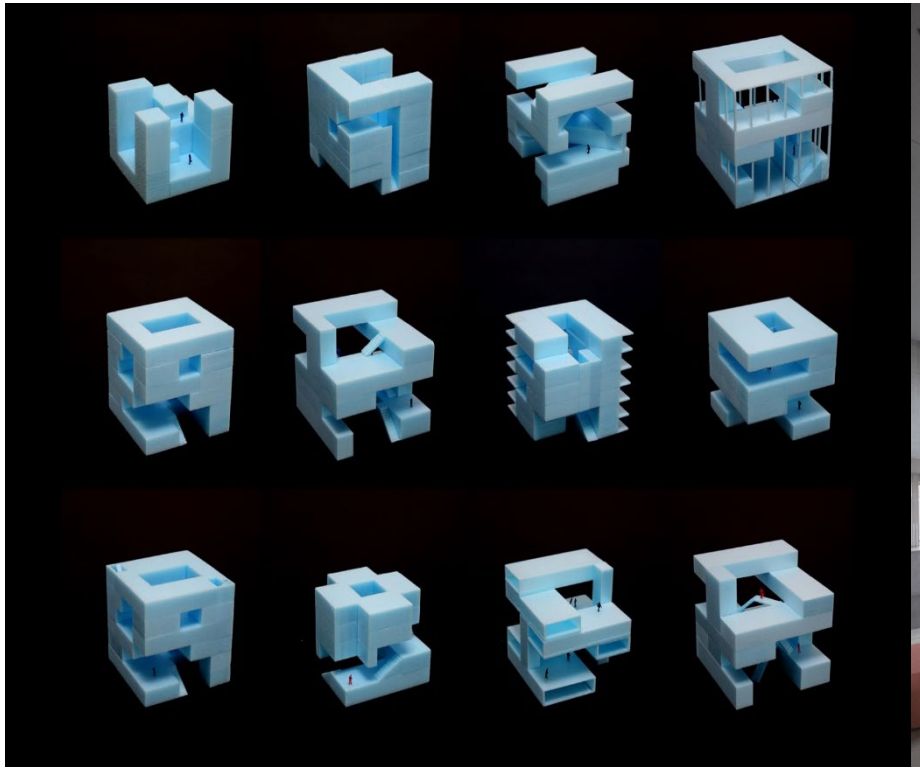


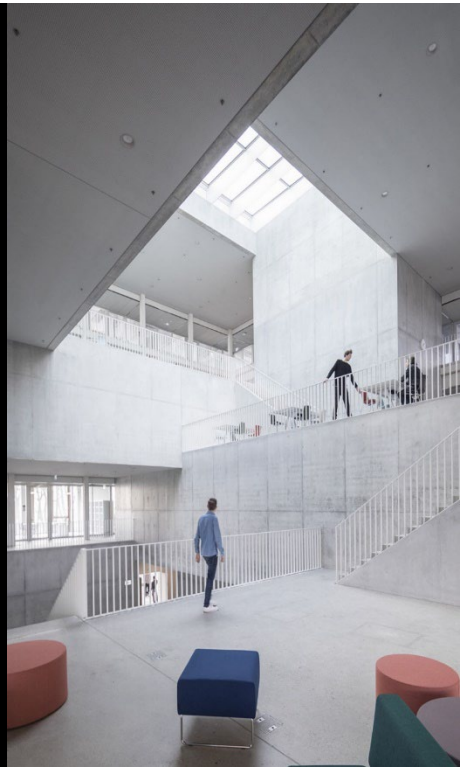


INES Center, Pezo von Ellrichshausen

Radial

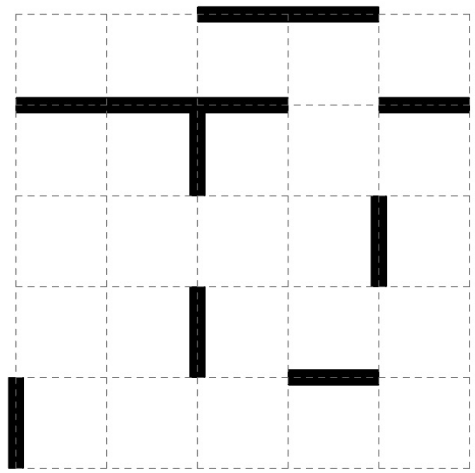


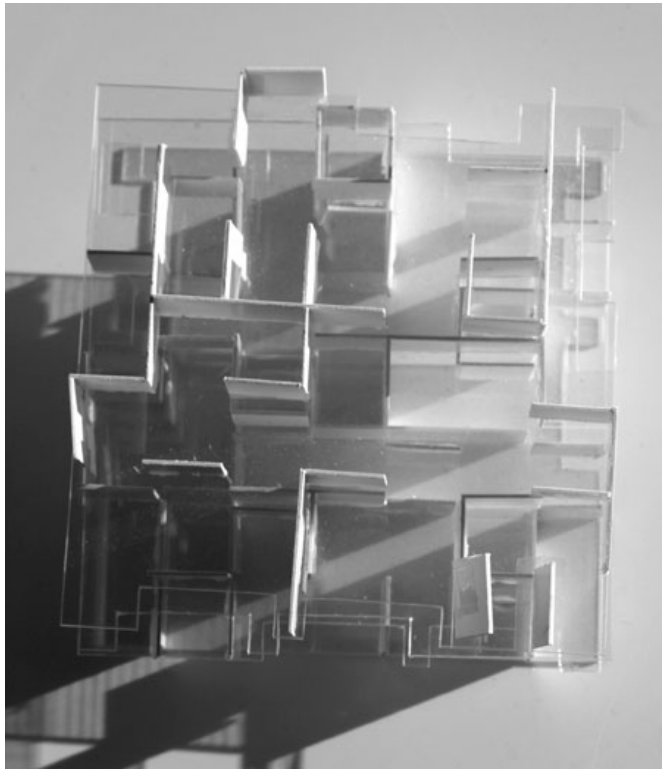


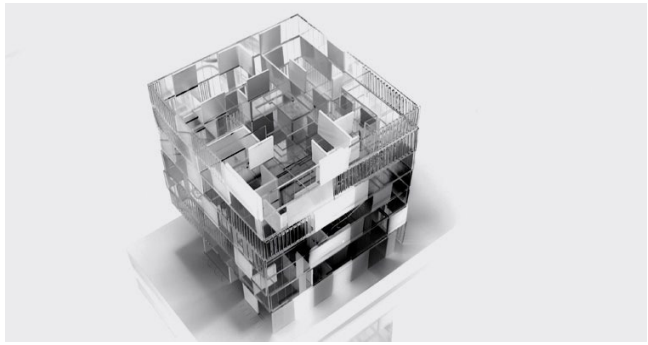


International Sports Sciences Institute Lausanne, Karamuk Kuo

Polar



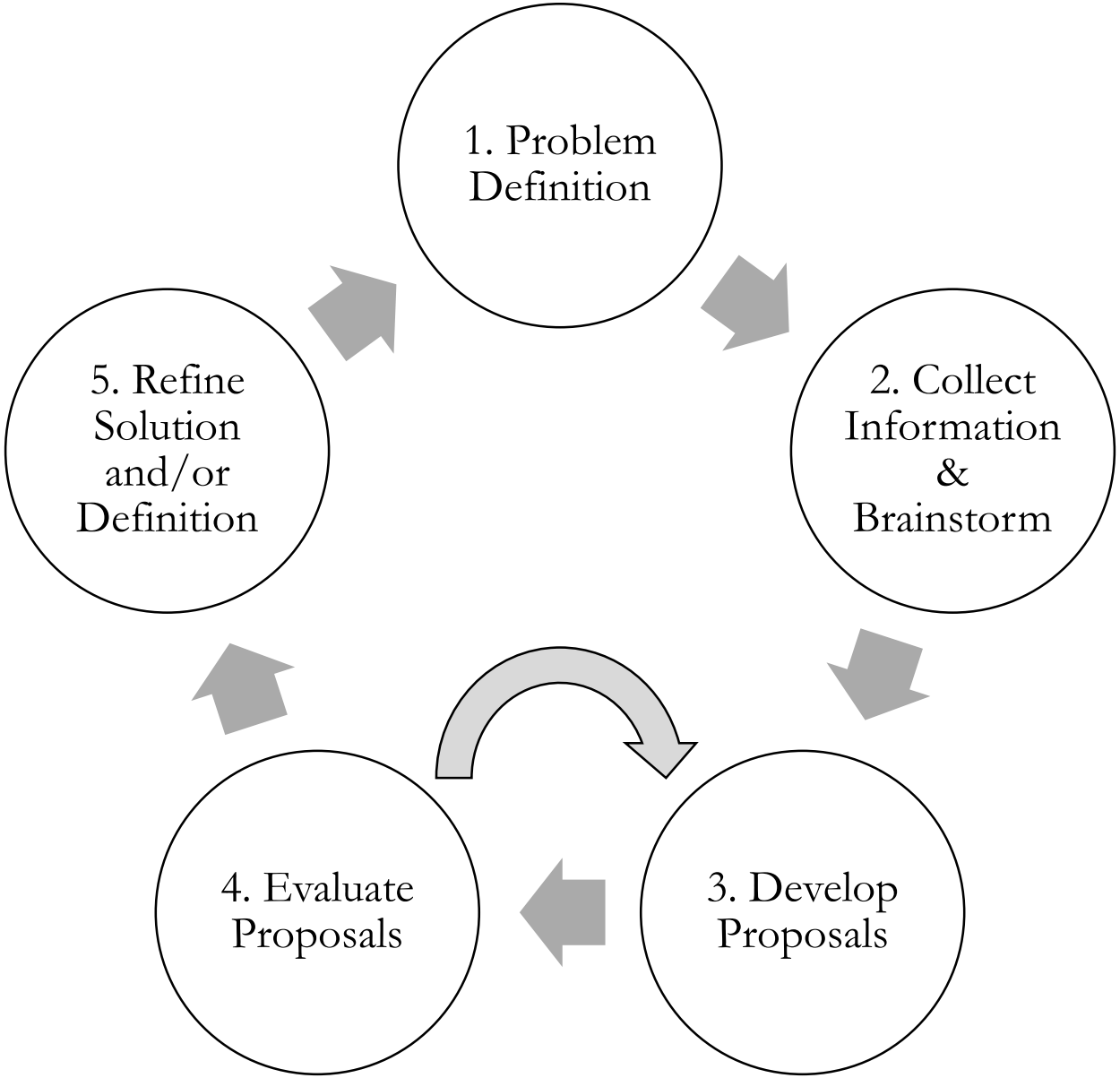




Stuttgart University Voxel, Lava Architects

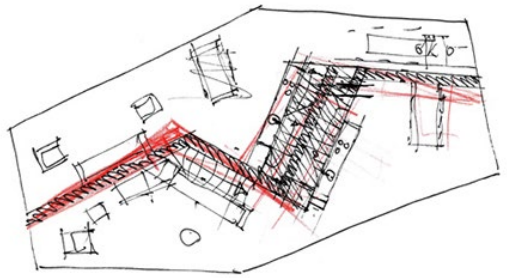
“Informed Chaos”

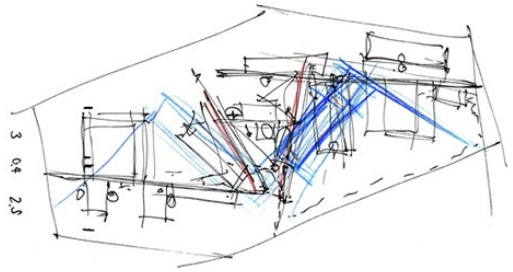
Concept of Iteration

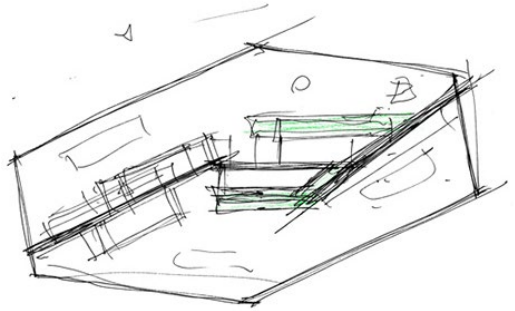


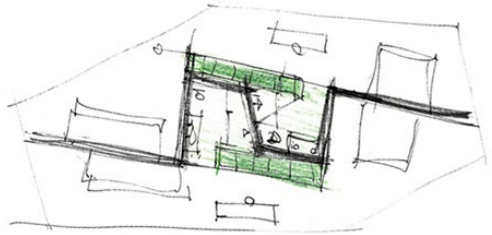
"My hand is the extension of the thinking process - the creative process"

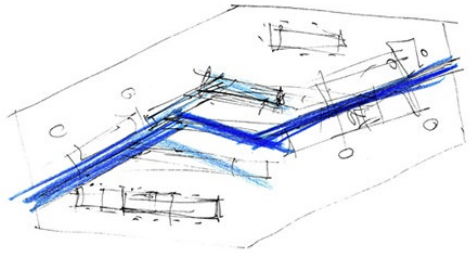
Tadao Ando

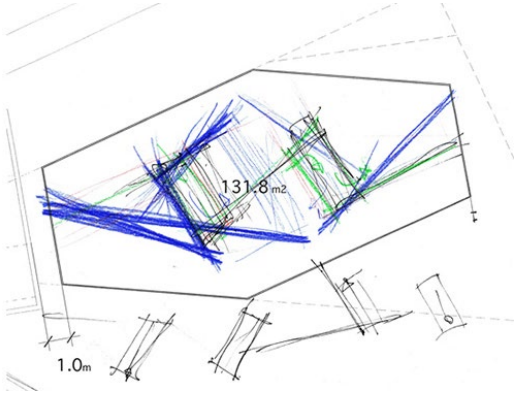








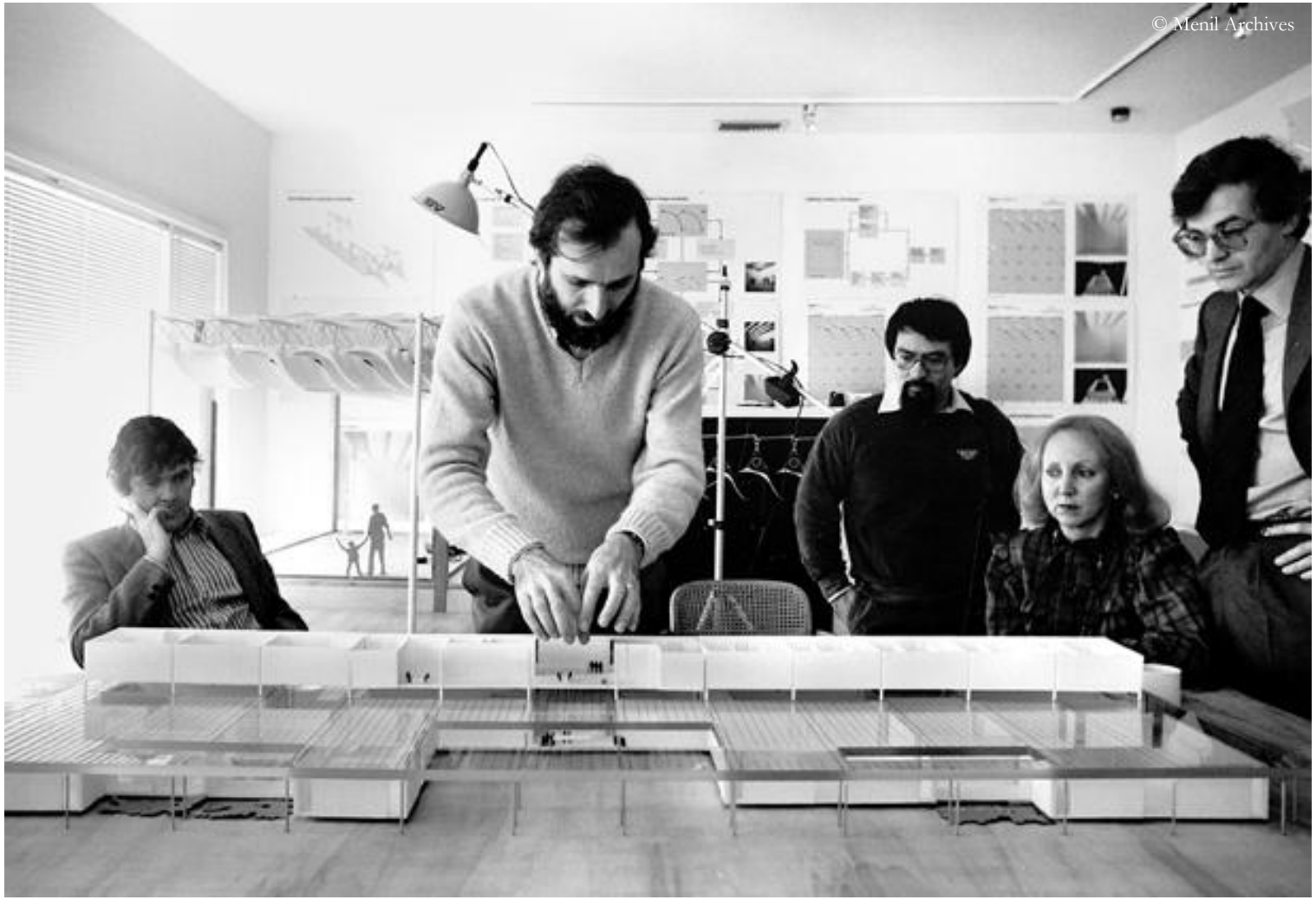




House with One Wall. Architect: Christian Kerez, Structural Engineer: Joseph Schwartz. Zurich, 2007

Possible (non-structural) evaluation criteria

- constraints from brief
- relationship with site (courtyard vs street, view out, daylight…)
- relationship within inner space
- circulation within the building
- flexibility of floorplan
- …



Design session with Peter Rice (left) and Renzo Piano (middle)