FS2010 Lecture 5 - 7

Simulation

L5: An Attempt Of An Overview

Design, Engineering, Architecture • Science

L6: Simulation and Design

Digital Chain • Monte Rosa • Future Cities Project

L7: Computation and Complexity

Simulation of Complex Systems

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FS2010 Lecture 7

Simulation: Exercise 2

One Image and short description of architectural or urban design simulation from your perspective

To be handed in per e-mail until April 12, 2010 to

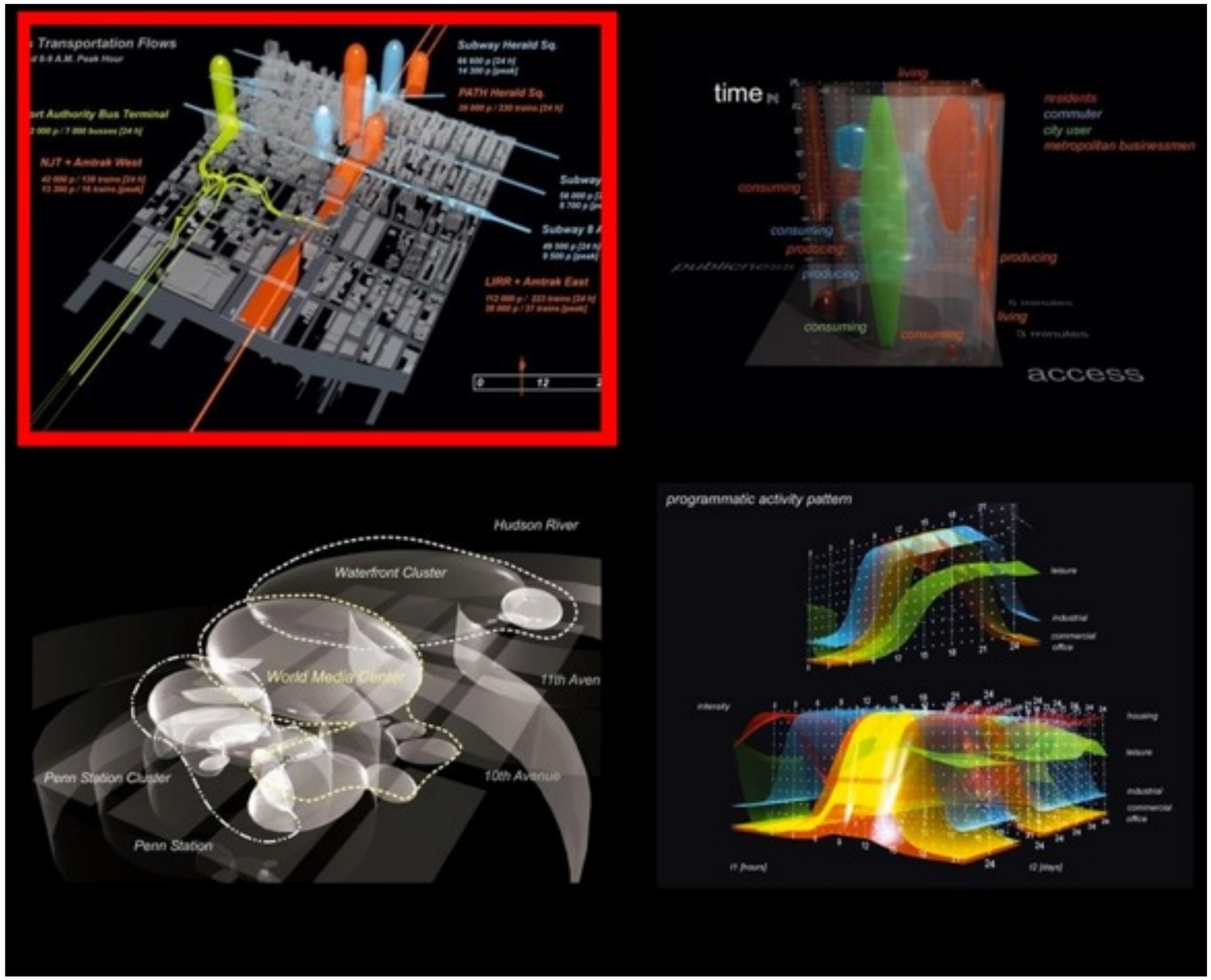
coleman@arch.ethz.ch

Format: Powerpoint or Keynote

iA
Chair for Information Architecture

Student assignment 2 | FS2010

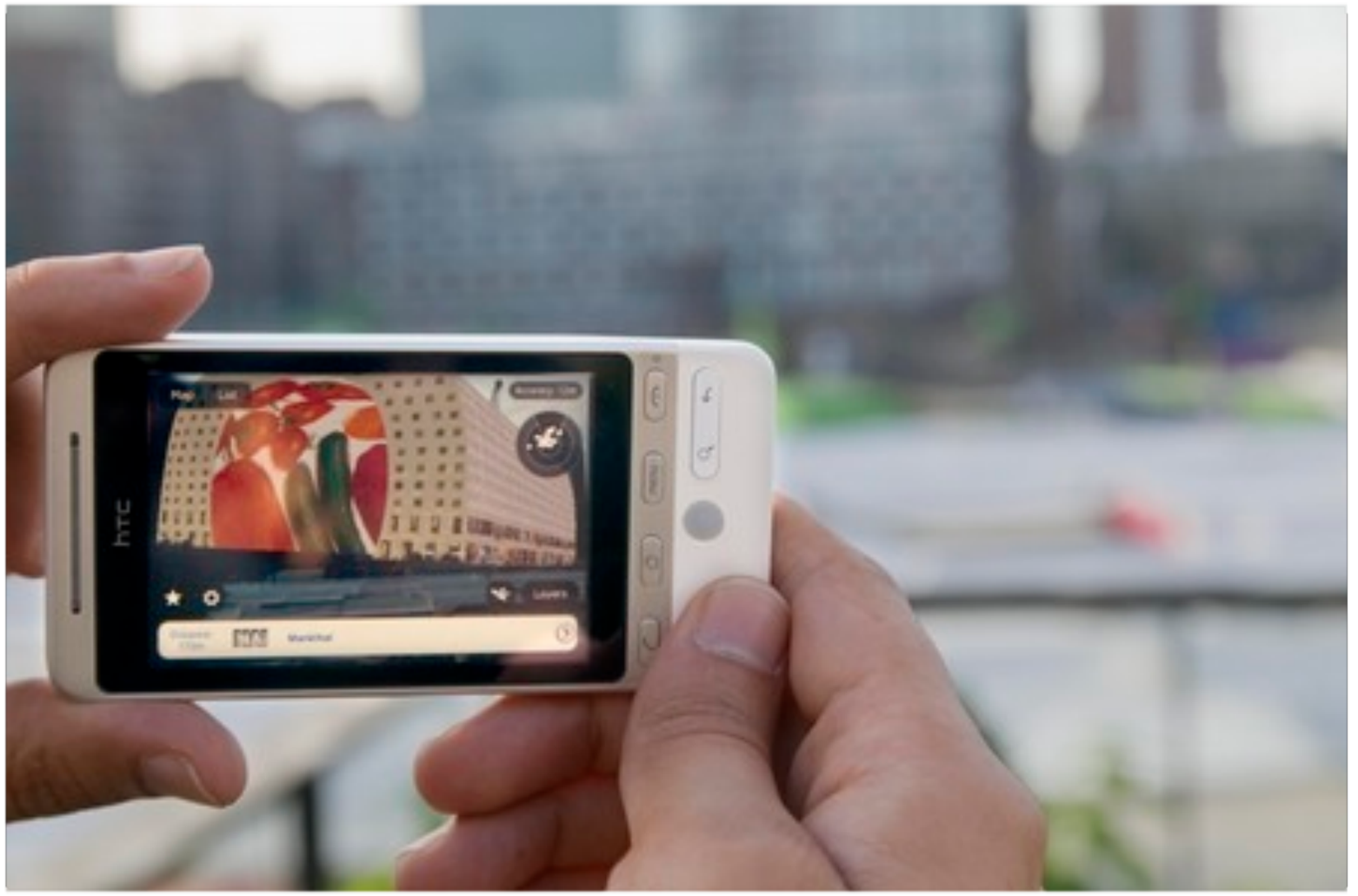
Aiste Plentaite



The Image is an urban proposal of UN STUDIO for West Manhattan (competition entry IFCAA year 1999). In this image the 3D model of Manhattan is constructed which is a basis for diagrams and simulation of different flows. Generated diagrams visualize the existing user flows related to program, time and location. The diagrams map the performance of Manhattan in order to extract parameters for the development of the site.

Student assignment 2 | FS2010

Roderick Trompert



SARA urban augmented reality application in Layar
The world's first building to appear in three dimensions on the smartphone via augmented reality is the eye-catching Market Hall which is currently under construction in Rotterdam 's Blaak area. The Market Hall was designed by architects MVRDV and is being built by Provast. With SARA, an urban augmented reality application, you can see and experience the built environment of the past, present and future, via Layar Browser. The NAI (Netherlands Architecture Institute) has set itself an incredible challenge: to make the Netherlands the first country in the world to have its entire architecture viewable on smartphones thanks to augmented reality

Student assignment 2 | FS2010

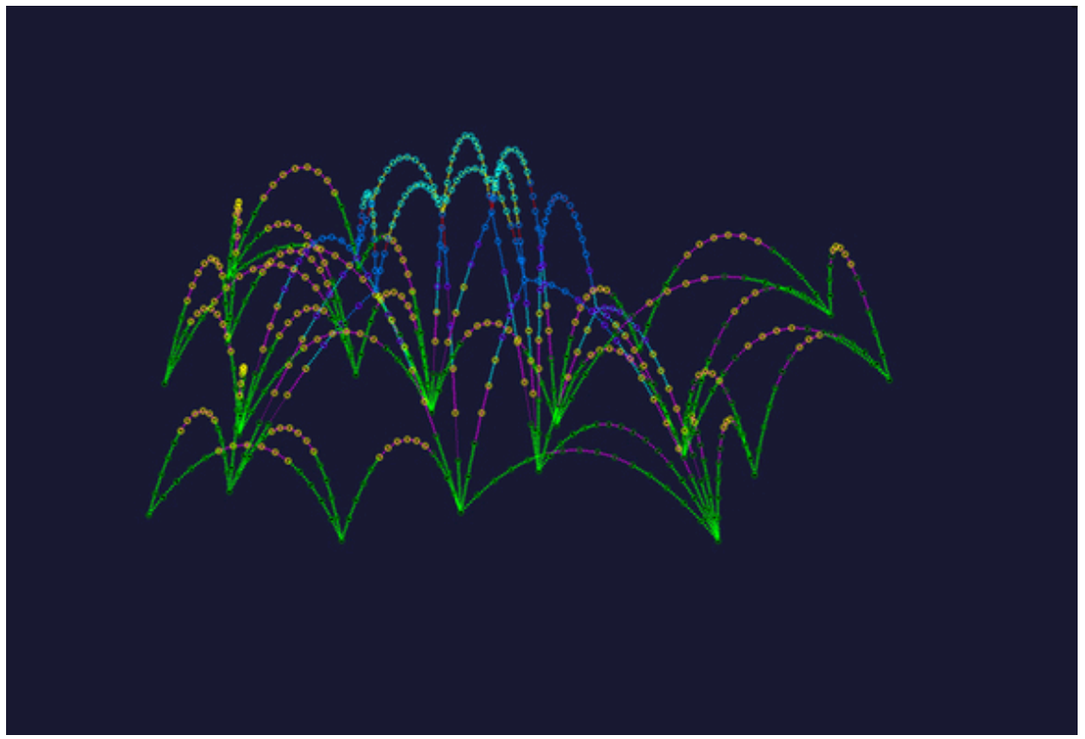
Severin Neukom

Acrobat 3D Commercial Architecture Walkthrough

Student assignment 2 | FS2010

Matthew Huber

Gaudi Chain Model



MOS Catenary Software

Gaudi used analog simulation tools. All digital models are the translation of real physical forces into abstract rule sets. In digital simulation, theorization becomes increasingly important as abstract further disconnects the outcome from intuitive understandings of real phenomenon. Though, digitalization offers unrivaled capacities for modeling complexity.

Student assignment 2 | FS2010

Jingzhi XU

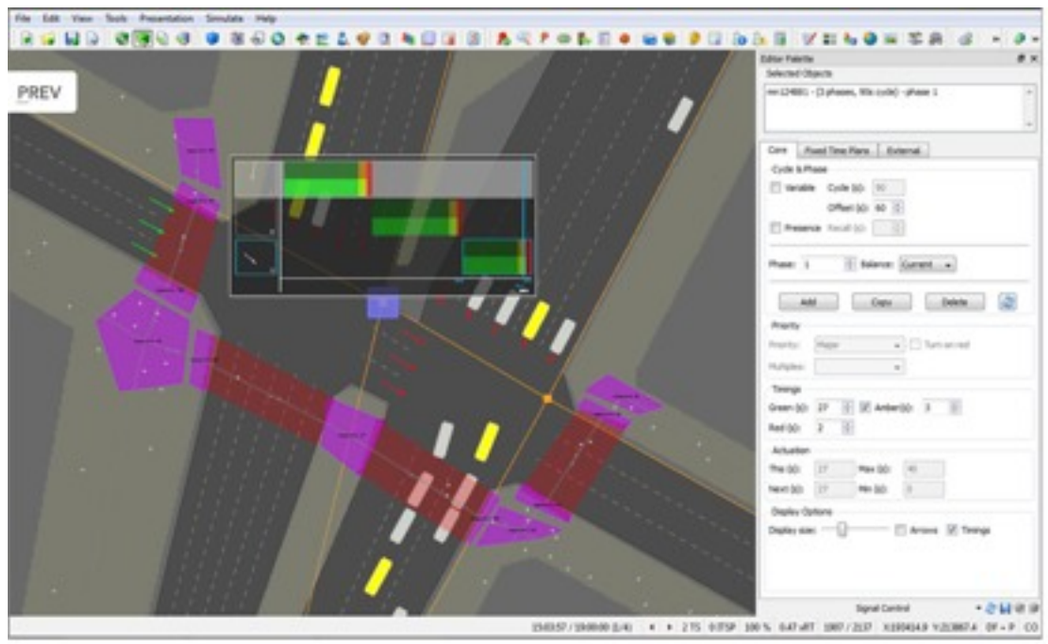
Mode Gakuen Cocoon Tower stands as a symbol of innovation and exception in educational design. The 50 level building contains 3 different schools: Tokyo Mode Gakuen (fashion), HAL Tokyo (IT and digital contents) and Shuto Iko (medical treatments and care). The building's innovative shape and cutting edge façade embodies Kenzo Tange's unique "Cocoon" concept, which not only use the cocoon shape, but the inter-frame structure has also absorbed many advantages of cocoon.

Student assignment 2 | FS2010

Nicolas Schwab

Pedestrian Presentation Graphics
Image 1 of 2

CLOSE



Walk / Dont Walk blocking regions connected to signal phases
Image 2 of 2

CLOSE

Jingzhi Xu

"Quadstone Paramics provides a realistic representation of the “friction” to traffic flow caused by pedestrians. The pedestrian modelling system allows users to obtain a realistic model of pedestrian flow. The pedestrians are free space agents; simulated people who can move freely within the study area defined by the user."
This could be used in Urban city planning for instance.

Source: http://www.paramics-online.com/pedestrian-modeling.php

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Michèle Skarpetowski

Dieses Bild zeigt ein Rendering eines tollen Gefährts in der Stadt.

Student assignment 2 | FS2010

F. Cihan Kuyucu

Urban Design Simulation

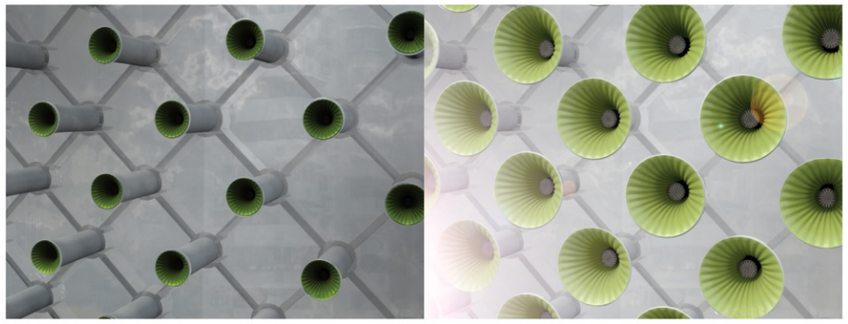
Student assignment 2 | FS2010

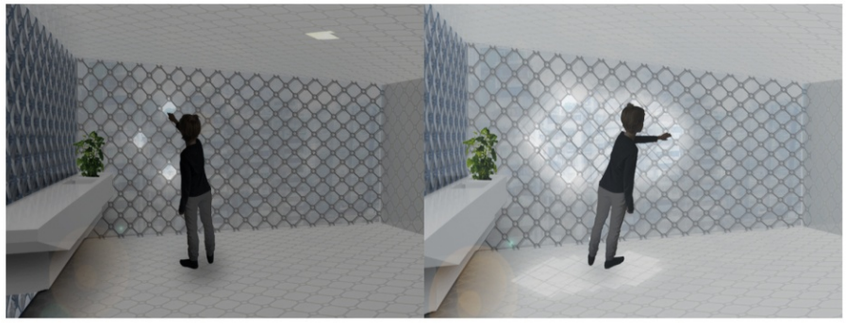
Lukas Hüsser

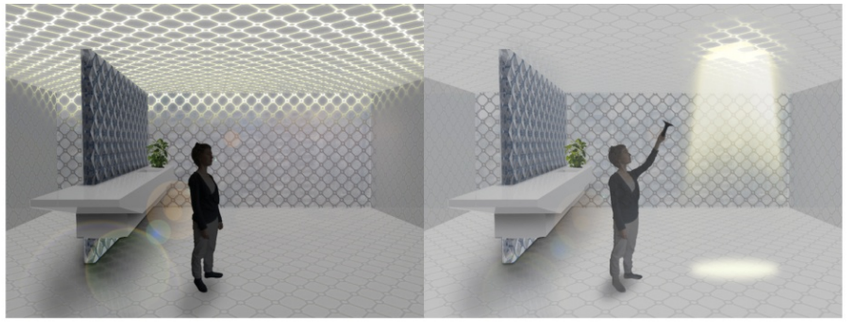
What if we dramatically reduce the car traffic? In Copenhagen they have a 200% luxury tax on new cars and very little parking spots. They are serious about putting the human traffic completely on the bicycle.
It would be very interesting to simulate a city where everyone moves with public transport and bikes. Where would be new car-free zones, new smaller roads, more public street space? Where would people life/ move to, if no one has a car? How would it affect health cost, street costs and maintaining, pollution? The traffic defines a city. What is its future?

Student assignment 2 | FS2010

Elvan Dajko







Off the grid: Sustainable Habitat 2020

The whole project is based on the brief to develop sustainable housing for urban megalopolis in China in 2020.
A membrane creates a strong link between the exterior and interior of the habitat and used as a transporter collecting and channeling the elements of air water and light - from the outside feeding into the inside space.
Even though is not the best example of simulation (probably a result of rendering or Photoshop), I found it an important example to underline the importance of simulation as probably the only mean to devepol such ambitious and expensive projects.

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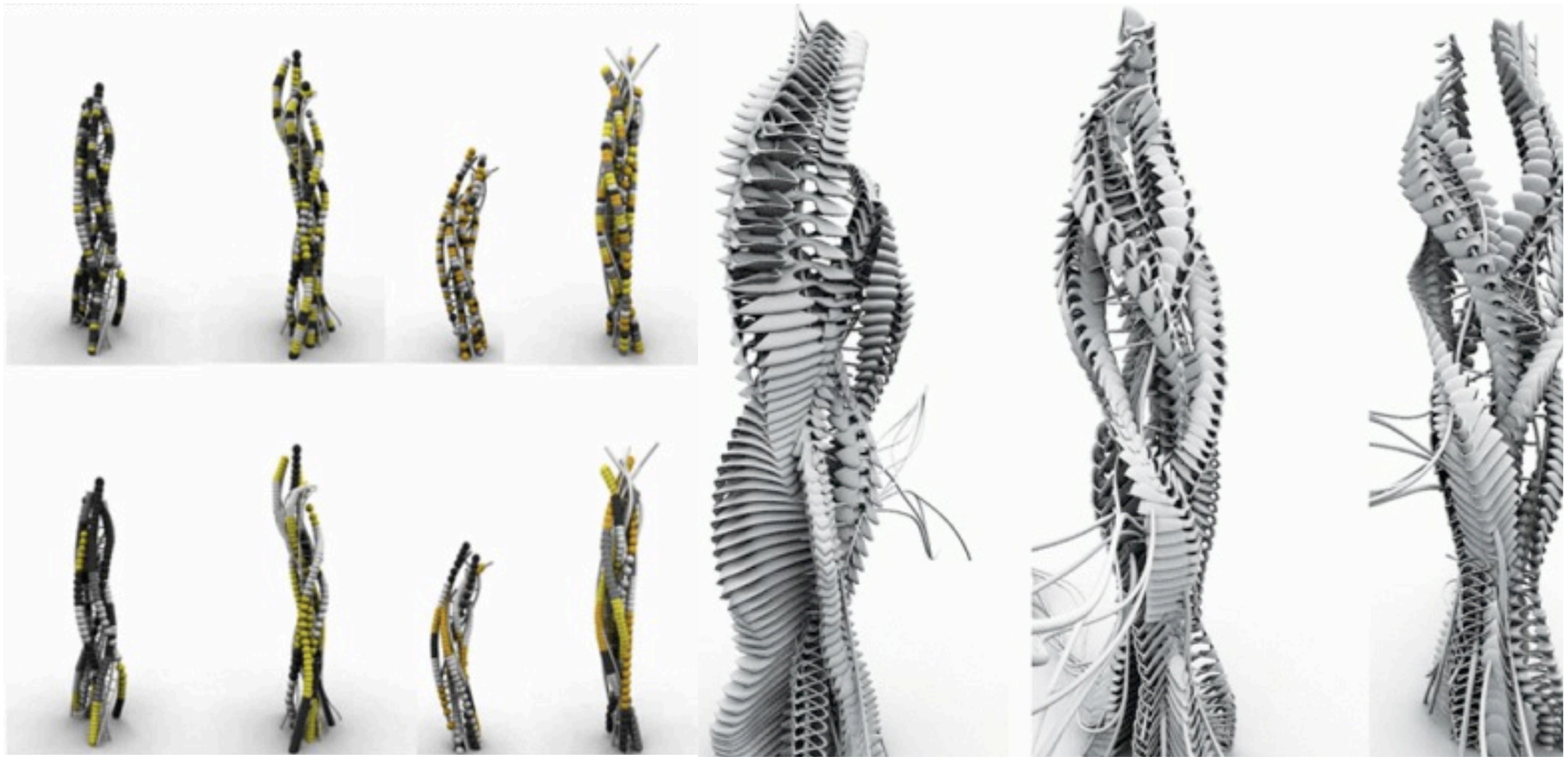
Celi Andrade Diana



This building is a representative structure according to changing programs. The tower shifts or twists when different activities are happening, giving the possibility to have a basic structure and form but with the simulation of the potentialities of spaces that it can provide, new buildings are instantly created according to their necessities. The project was modeled by for a competition of a housing proposal in East London, and the initial structure resembles the back bones. Borrowing rules and functions, the project is an investigation of parametric development adapting to different urban needs.

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Nathalie Bodarwé

Truman Show: architectural simulation through "movie decor" aiming to represent the real life situation of a human beeing

Second life (1): the virtual univers, metaverse, aiming to represent a network of virtual people and virtual activities:

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Suzanne Coleman

light simulation

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Simulation

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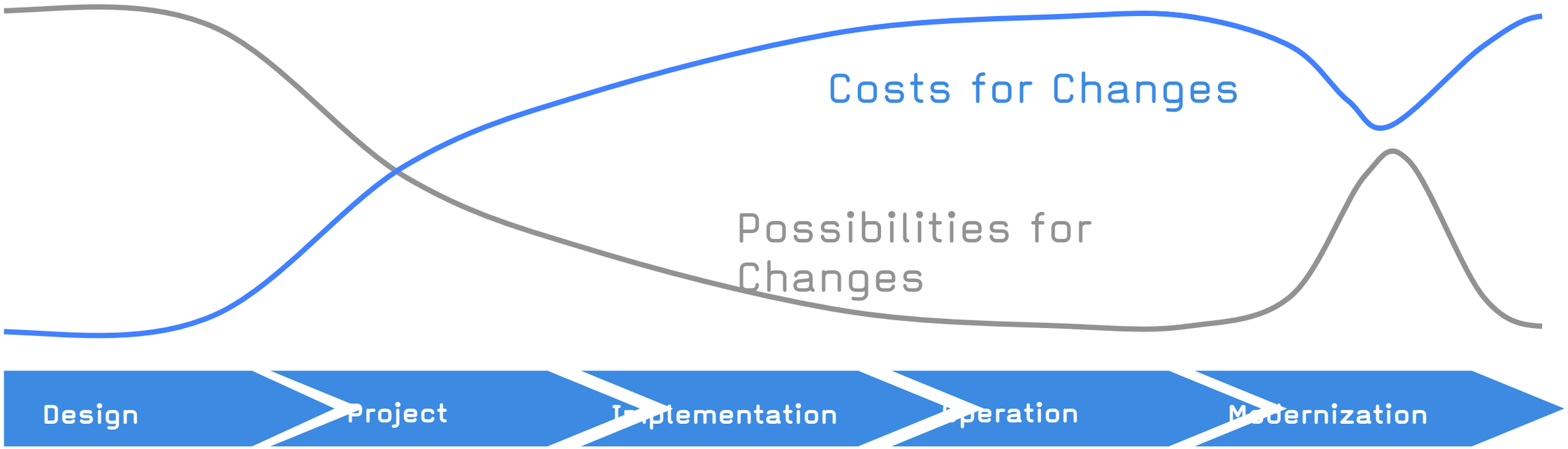
Glacier retreat simulation

Simulation: Climate Change

New Monte Rosa Hut, Switzerland, Andrea Deplazes
In May 2009 construction has started on one of the world's largest and highest altitude building sites.

Simulation

Simulation within the lifecycle of a building



Potential capicities of simulation

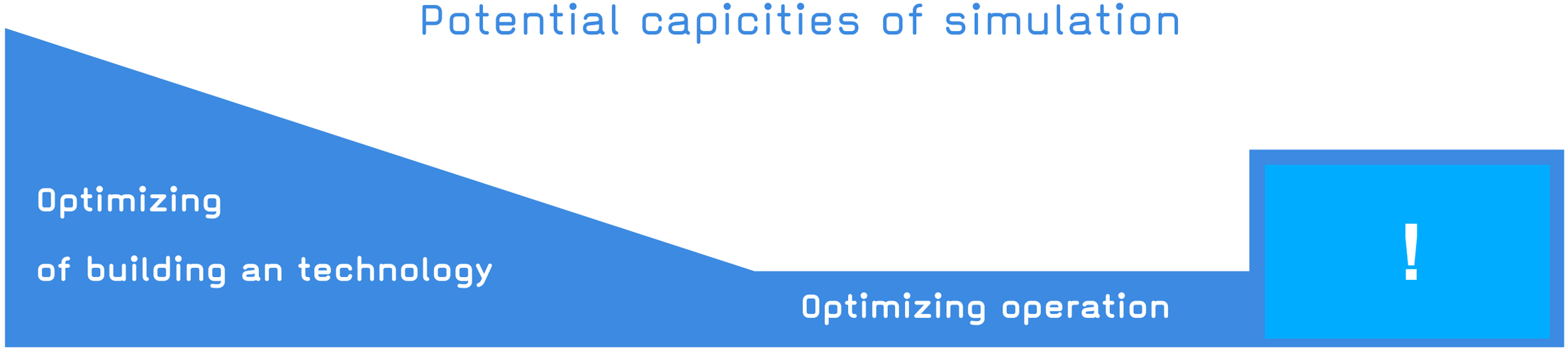
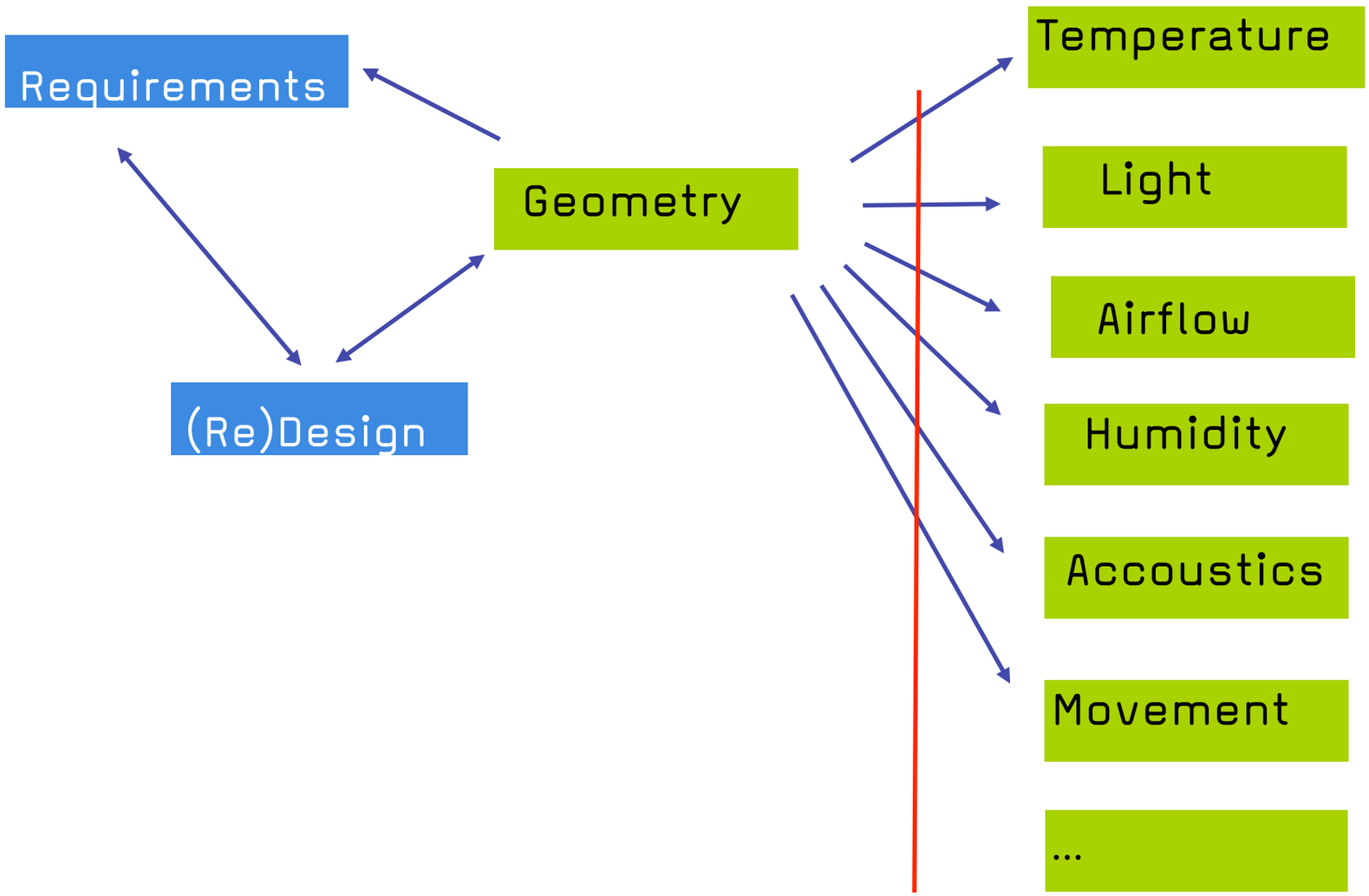


Diagram from HTA Luzern

Simulation

Today‘s simulation tools are used by experts and detached from the design process



There is no integrated approach for architects

Feedbacks are difficult to implement.

The right effort must meet the right time, the right geometry and the right instruments for insights.

Simulation

Cost for simulation tasks

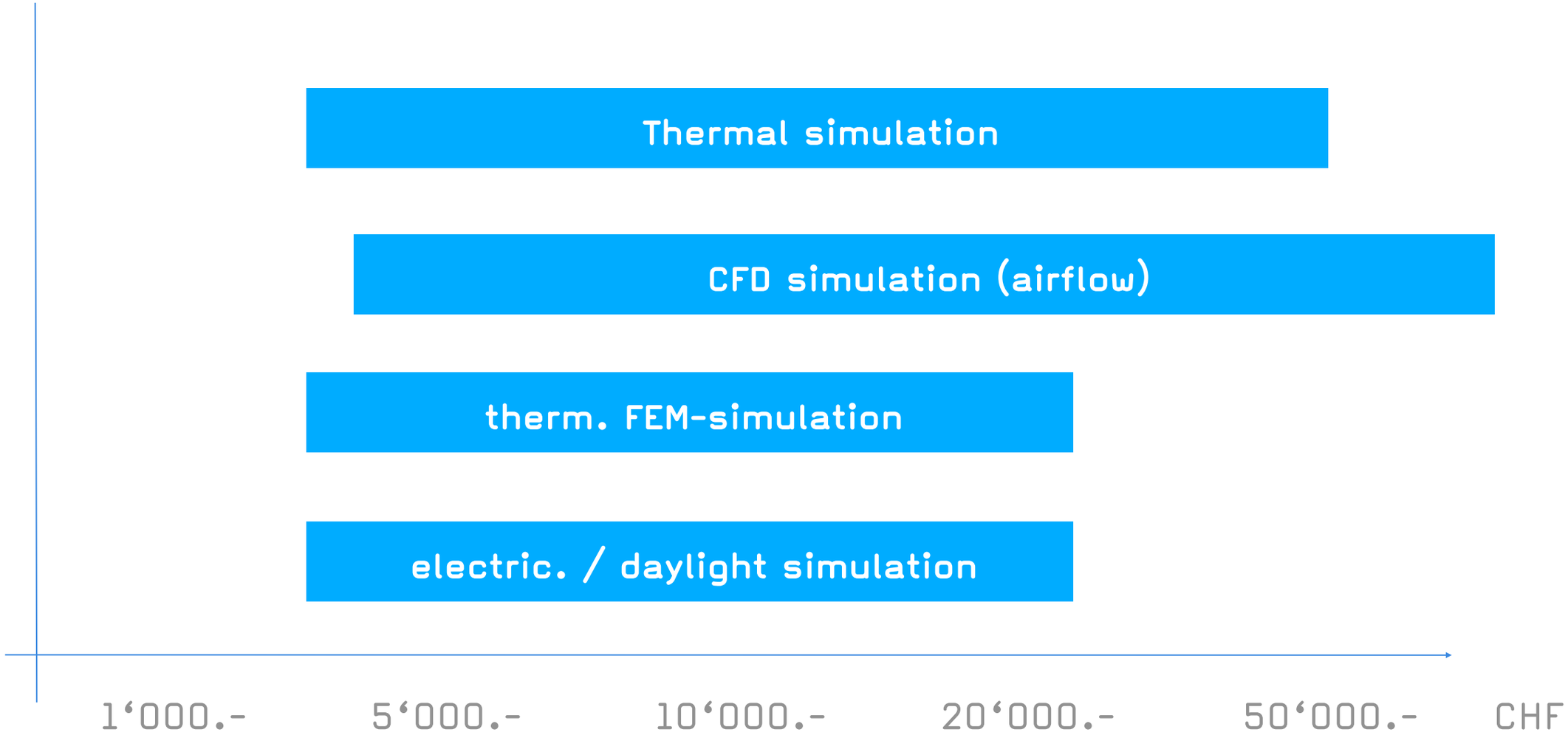
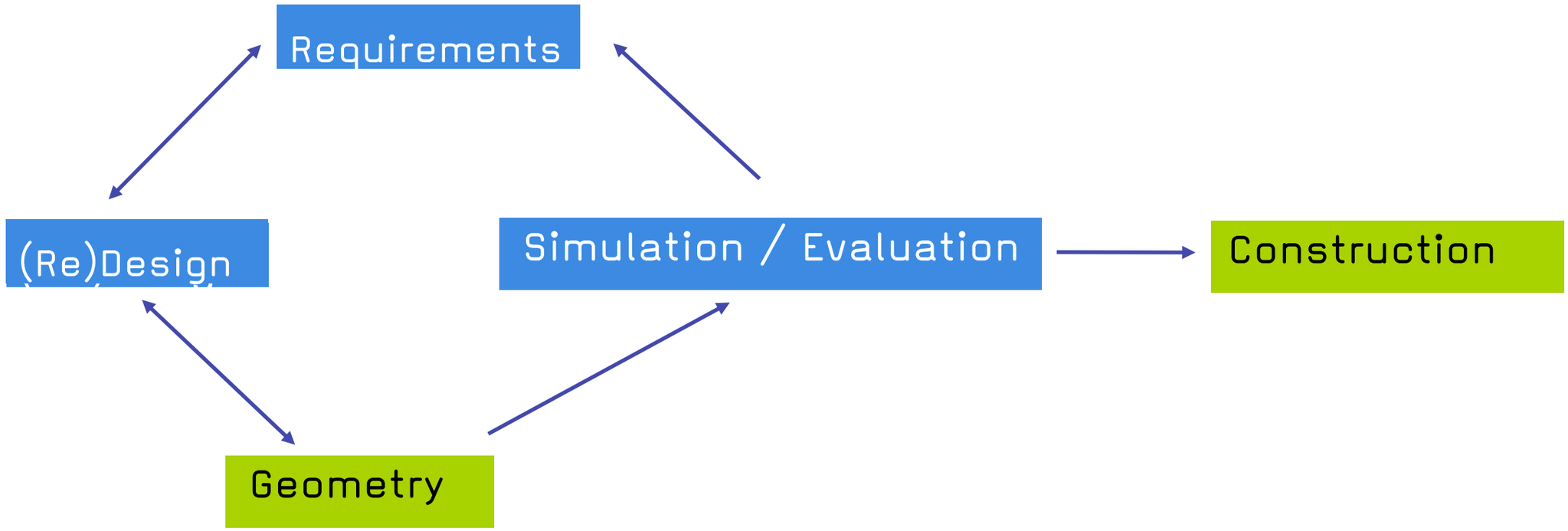


Diagram from HTA Luzern

Simulation

Next step: One integrated design and evaluation solution.



(Building design lifecycle)

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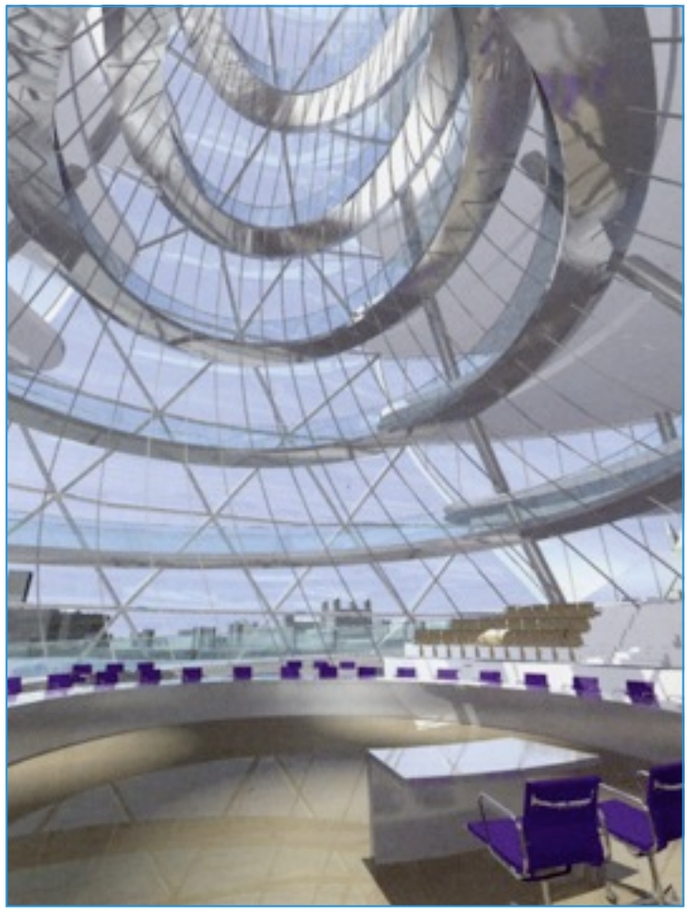
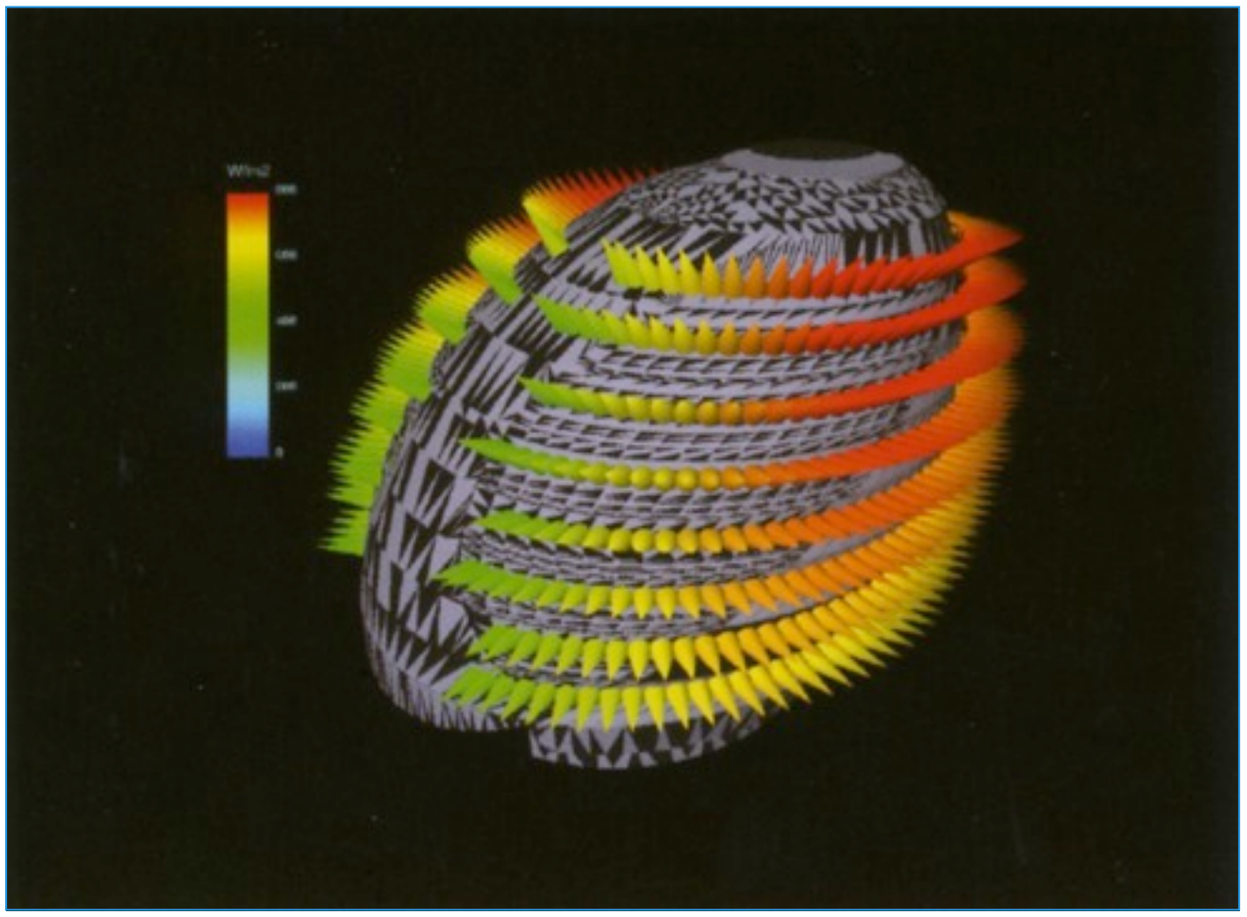
Simulation

Simulating Light





- to assure quality of life
- to utilize principles of thermodynamics

City Hall: Foster & Partner, London UK, 1998 - 2002

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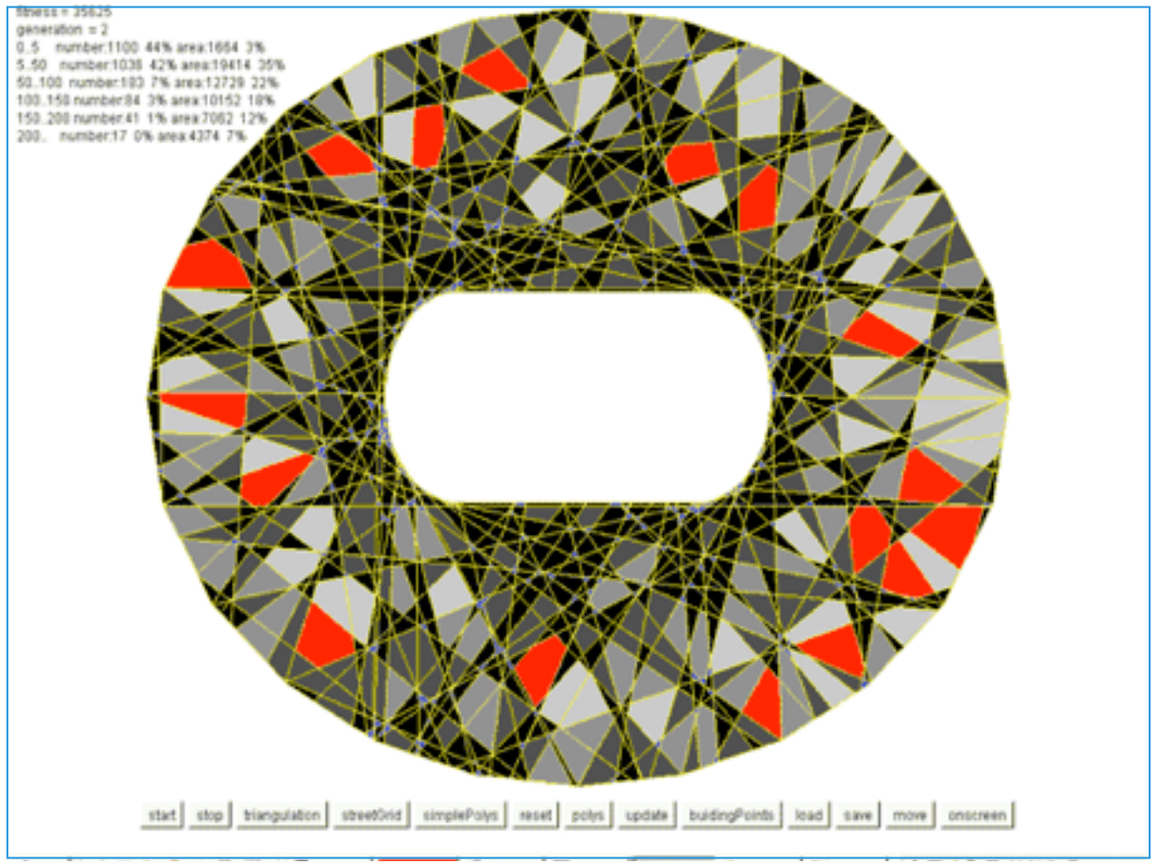
Simulation

Simulating Structure



- to push expressive designs ahead
- to guarantee safety

Peking Stadion: Herzog & Meuron / CAAD.ETHZ

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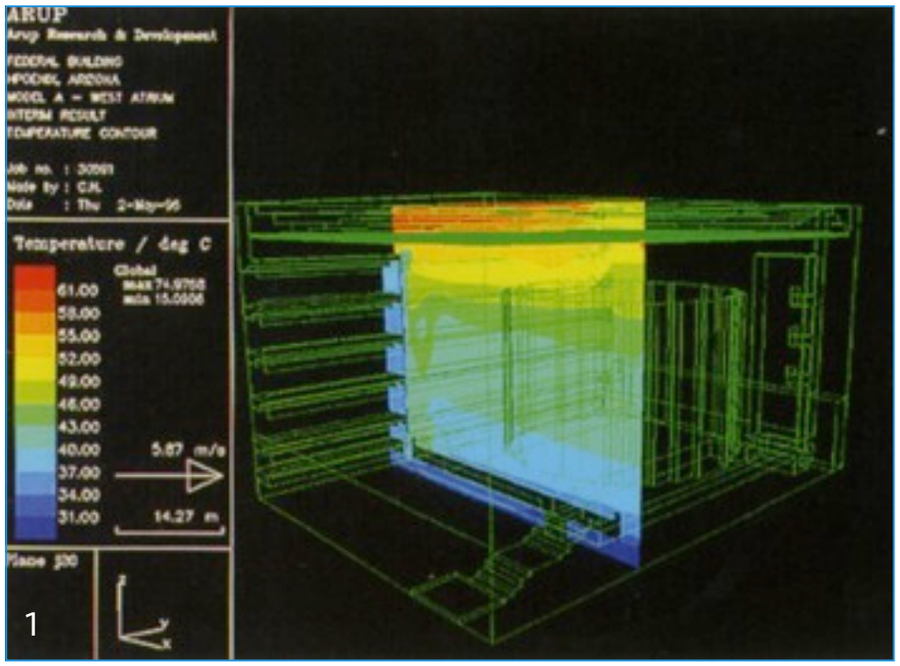
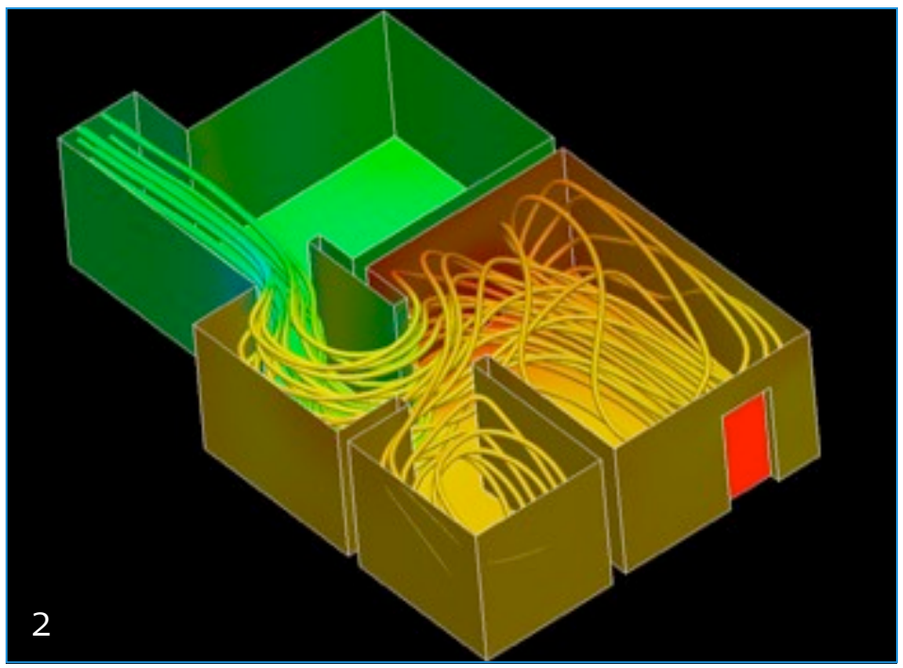
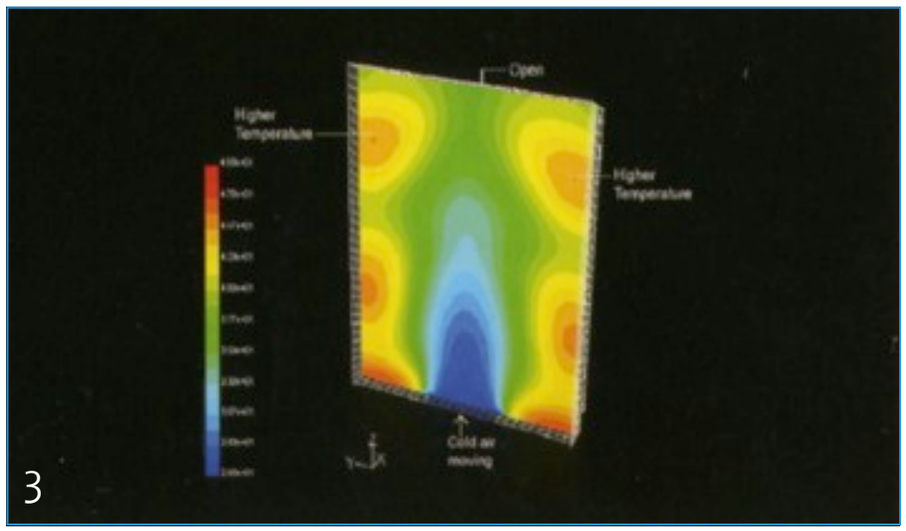
Simulation

Simulating Temperature







1. Federal Courthouse: Meier &Partners, Phoenix USA, 1995 - 1998
2. Simulation of appartment heat & air circulation by Ninsight.at
3. Thermoanalysis of facade-piece of New York Police Station

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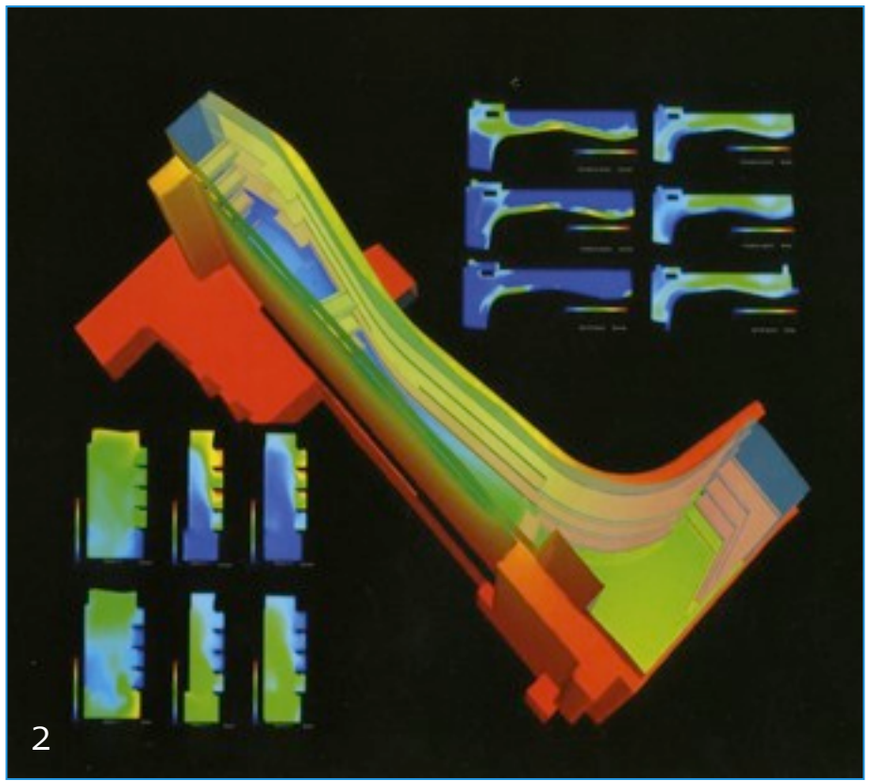
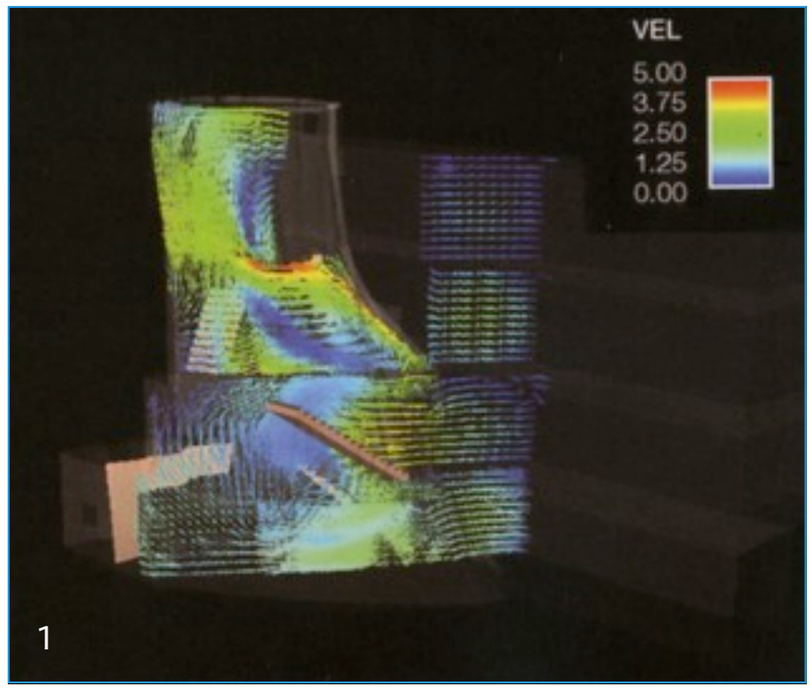
Simulation

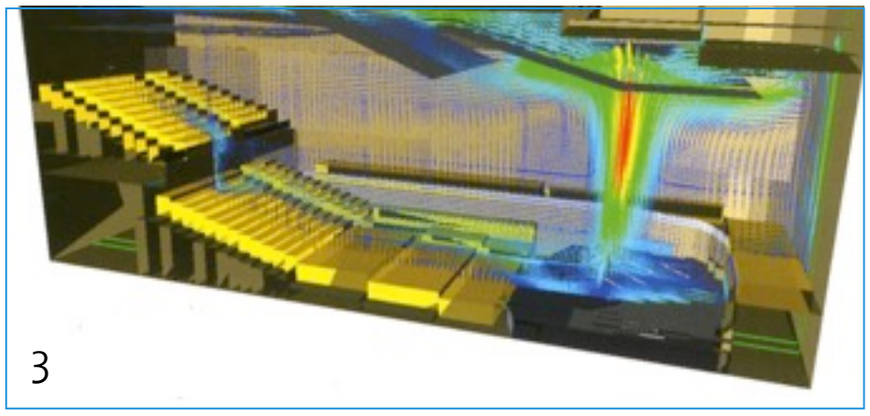
Simulating Airflow inside buildings


1


2



1


3

1. Simmons Hall: Steven Holl, Cambridge USA, 1999 - 2002
2. Biomedical Research Building:Polshek Architects, Michigan USA, 2001
3. Experimental Media & performing arts Center: Grimshaw, Troy USA, 2003.

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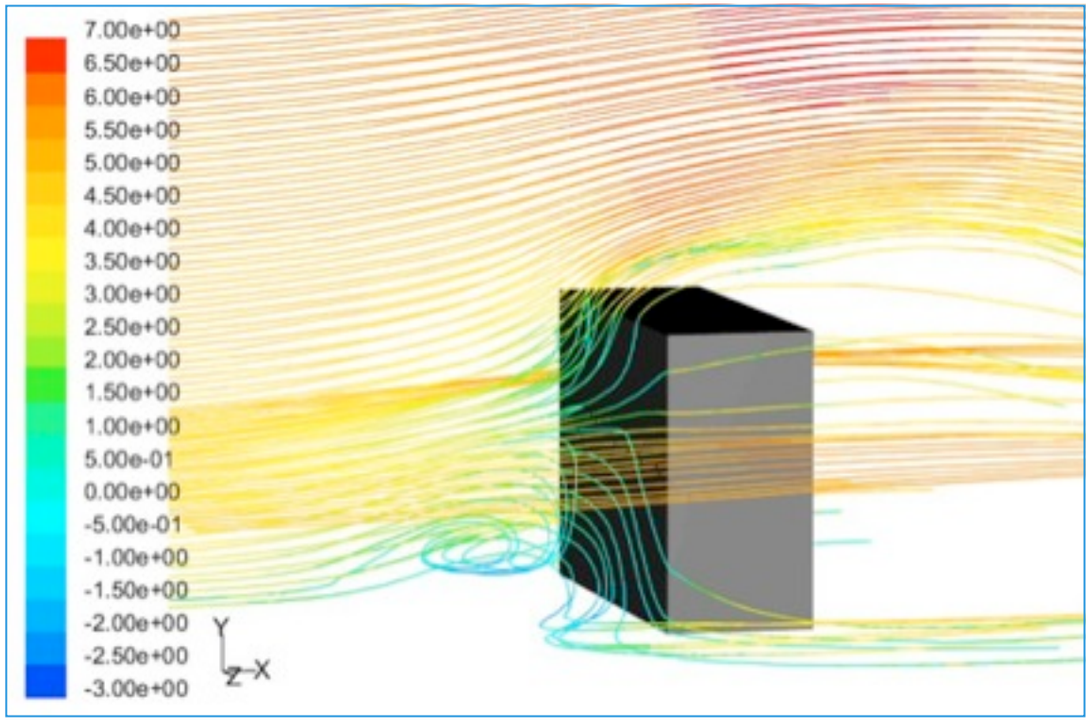
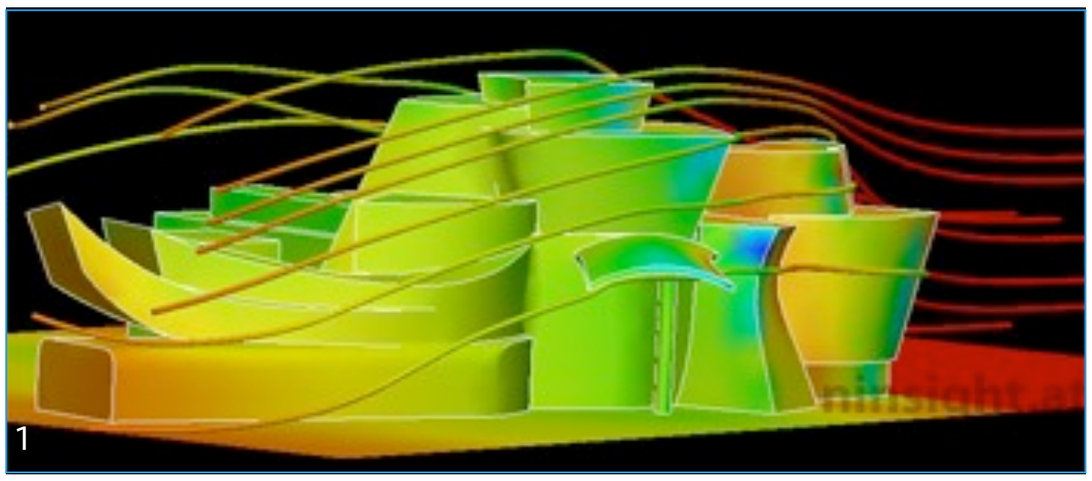
Simulation

Simulating airflow outside of buildings





1. Guggenheim Museum : Ninsight.at
2. Concept with integrated wind power. ZED: Future Systems, UK, 1995

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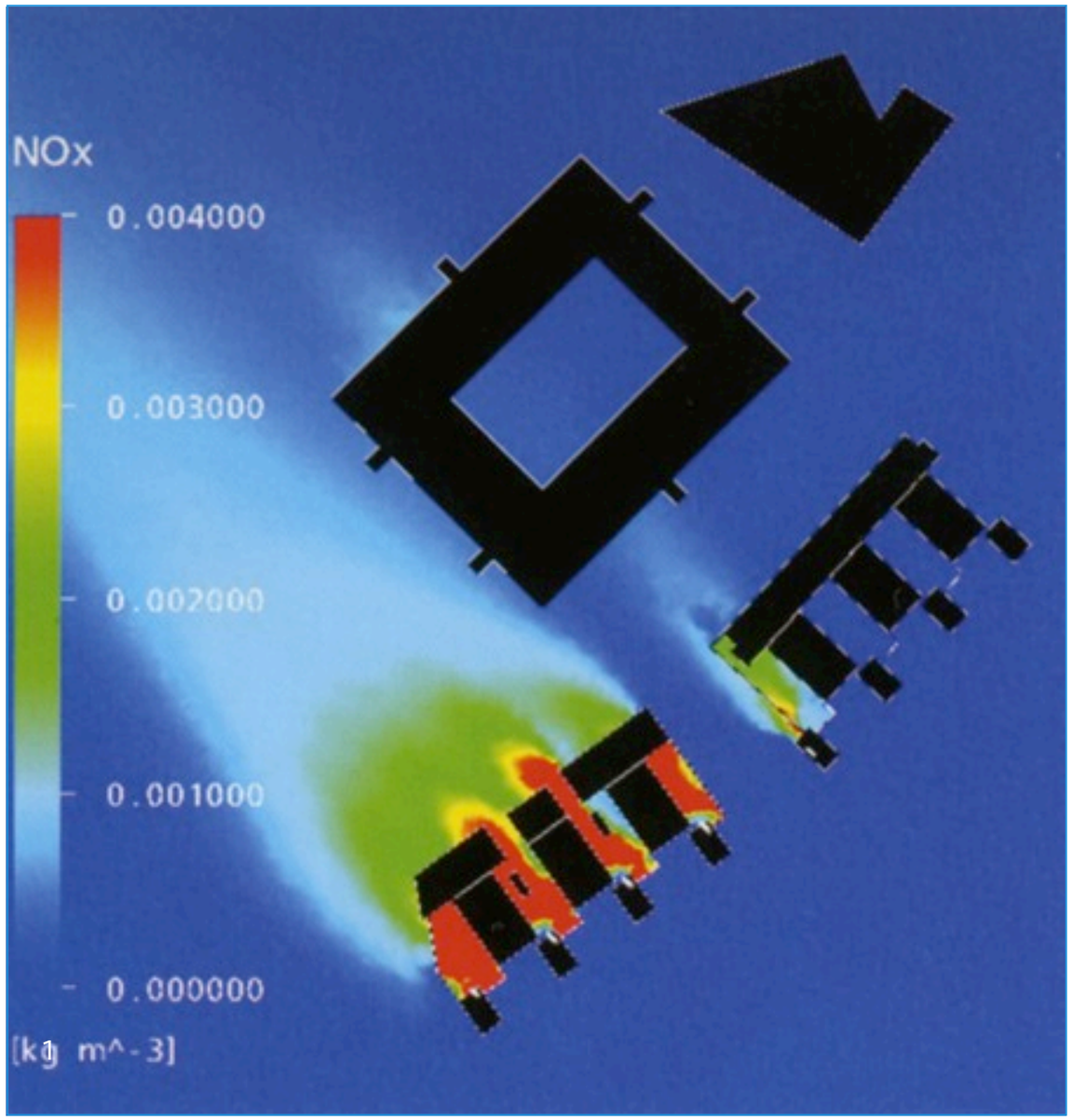
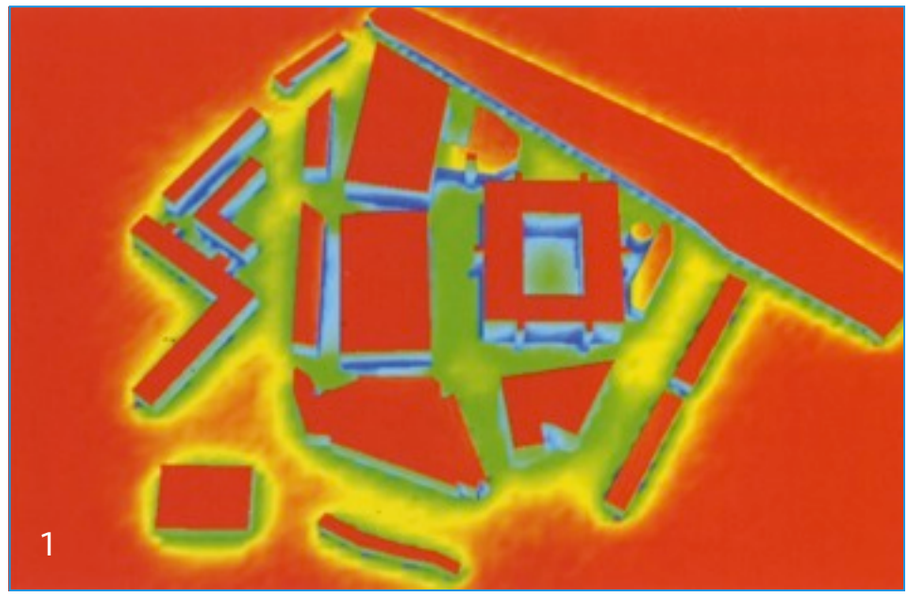
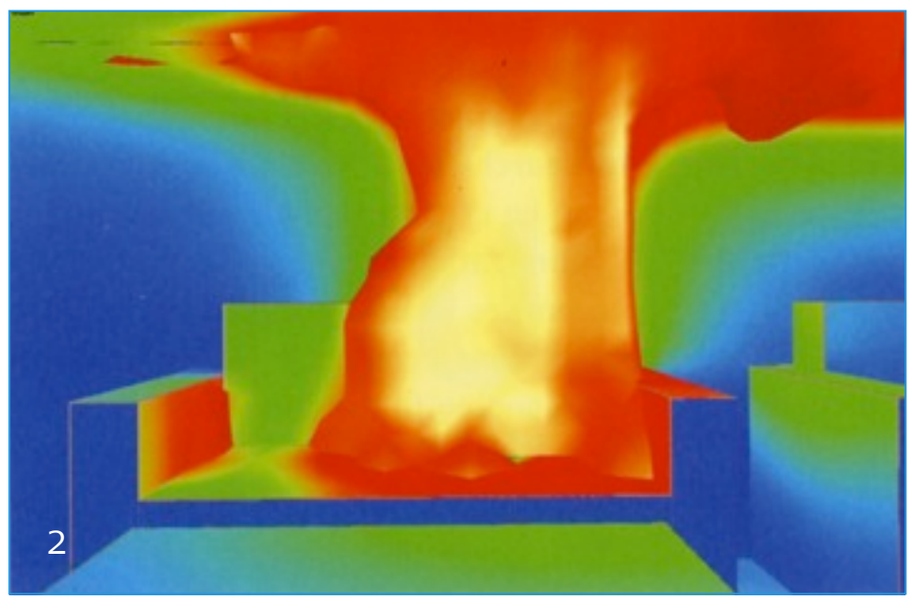
Simulation

Simulating Dust, Smoke, Pollution, Fire







1. BBC White City: Allies & Morrison , London UK, 2002
2. Smokeview from tool Fire Dynamics Simulator

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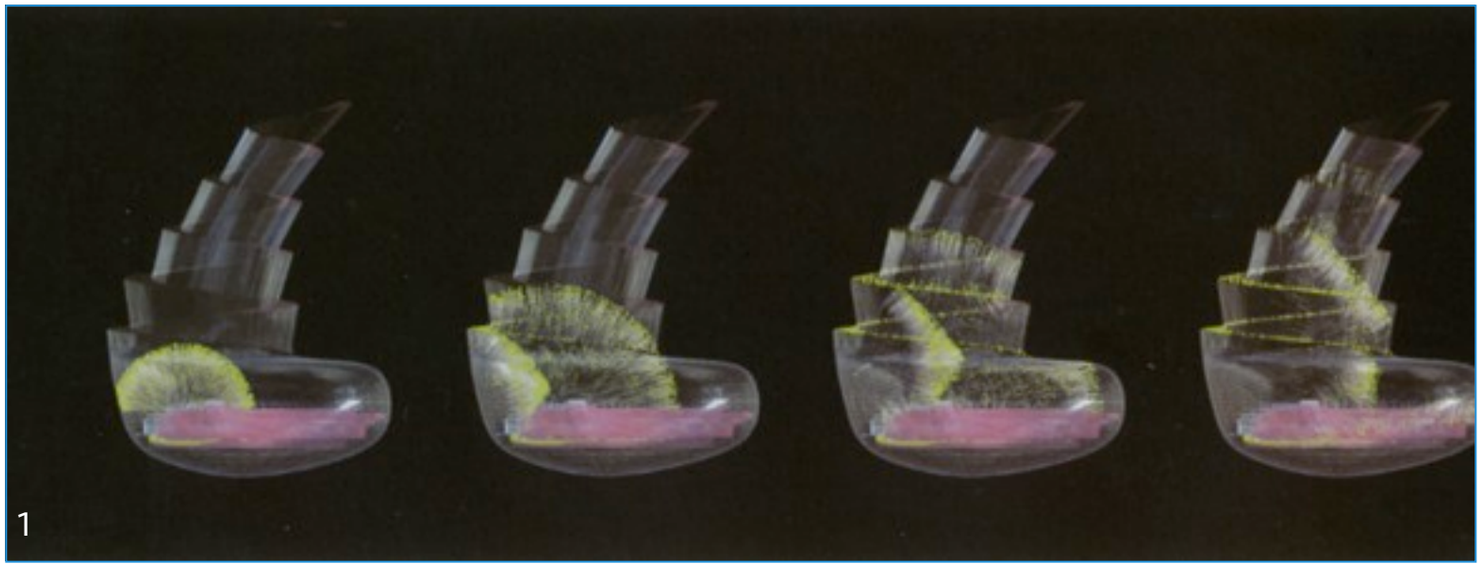
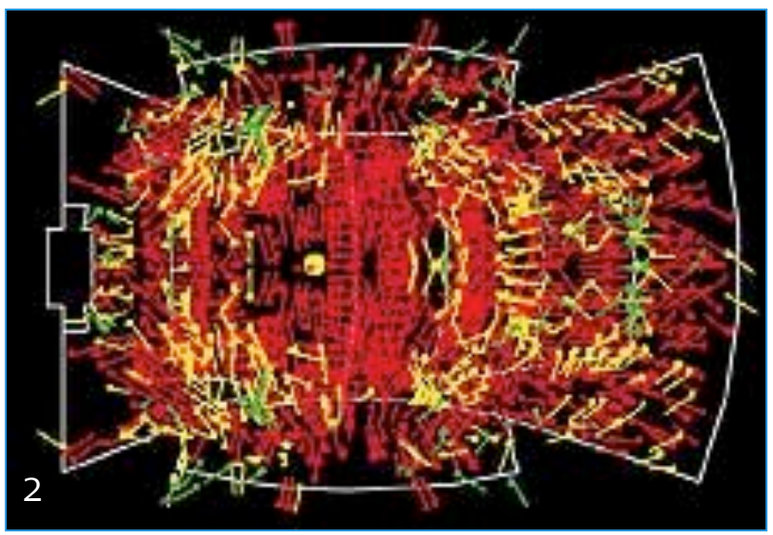
Simulation

Simulating Acoustics



1

2



2

1. Greater London Assembly: N. Foster, UK, 1999 - 2001
2. Disney Concert Hall: F.O.Gehry, USA, 1987 - 2003

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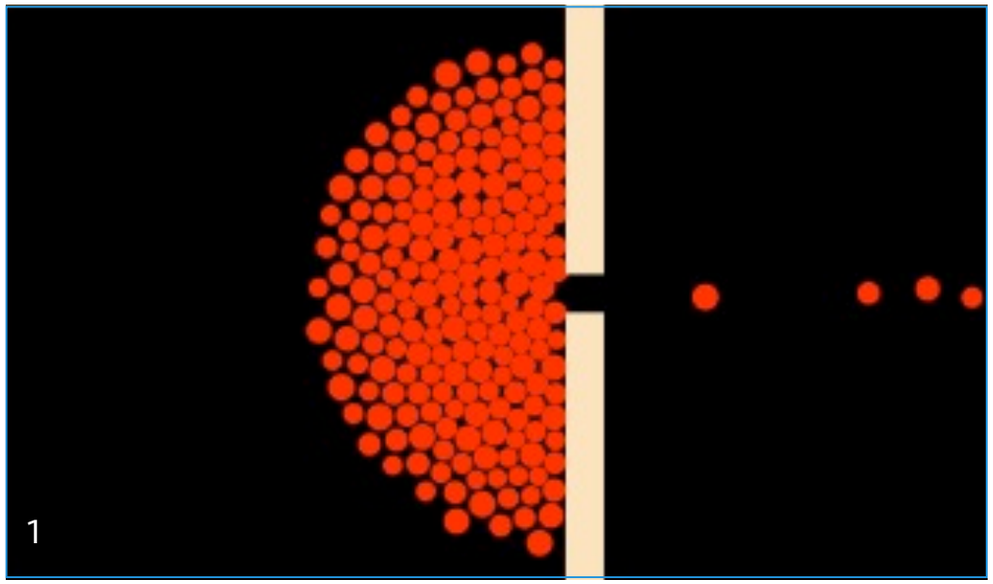
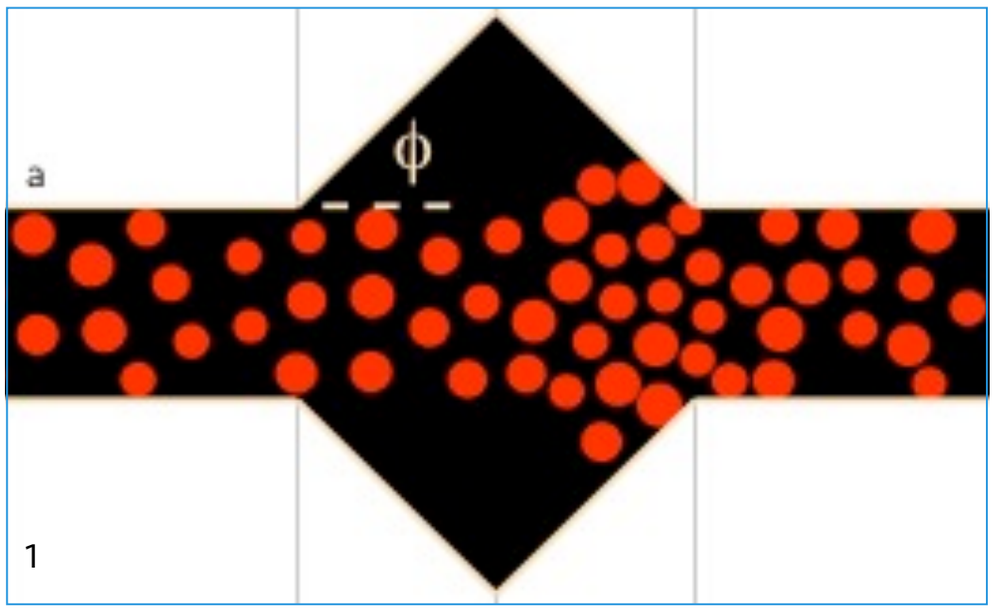
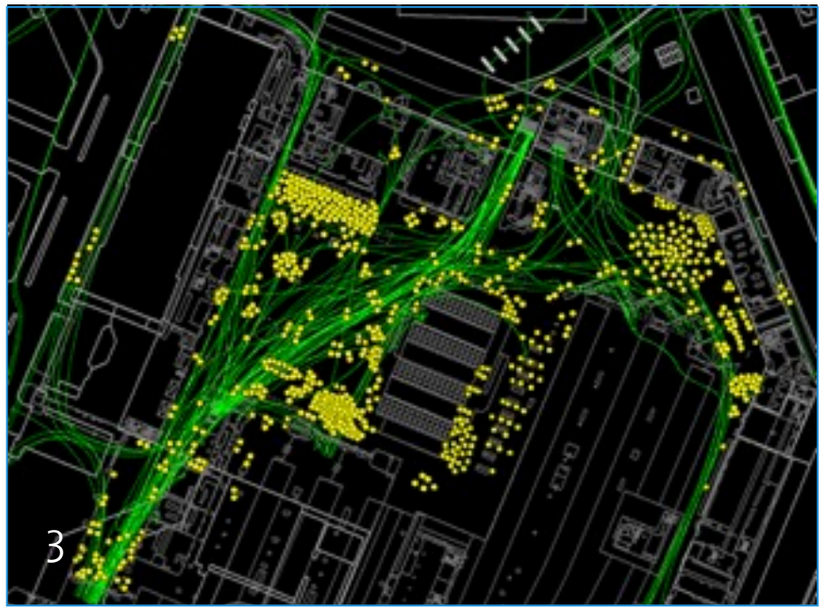
Simulation

Simulating Crowds







1. Escape Simulation: A.Helbling, University Duisburg, 2000
2. Arsenal Stadium - Crowd flow simulation: HOK Sport, London UK, 2001
3. Analysis of Wayfinding: Space Syntax, ongoing

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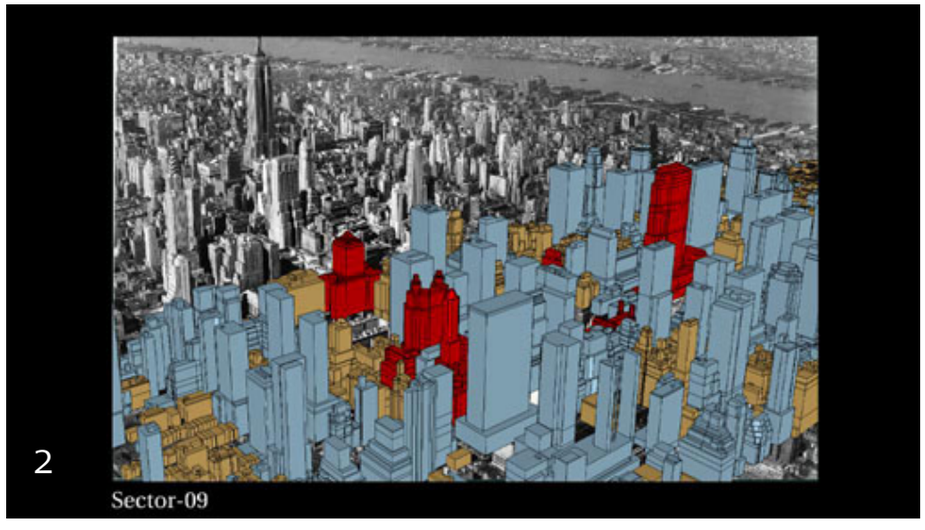
Simulation

Simulating Cities


1


2


1



2

1 CityEngine, P.Müller, Computer Vision Laboratory, ETH Zürich
2 CityBot for movie King Kong, Chris White, Universal Studios (from CGarchitect.com, 24.10.2006)

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Simulation

Applications in city planning

A. Ulmer, J. Halatsch, A. Kunze, P.Müller, L. Van Gool, “Procedural Design of Urban Open Spaces”, eCAADe 2007

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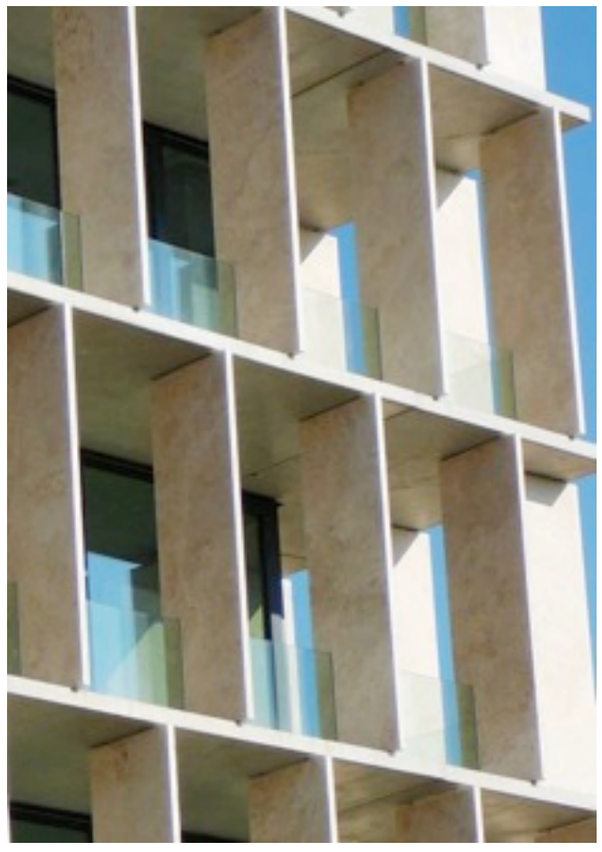
Simulation

Information Science Lab, HIT, ETH Zürich



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(prov. Minergie Zertifikat ZH-800)

Lauber IWISA

plant baut erneuert

Master plan Energy Supply

- **Strategy**

Supply → Distribution → Consumption

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Master plan Energy Supply

- **Strategy**

Supply → Distribution → Consumption

Energy supply
CO_2-reduced
by utilising renewable energy sources

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Master plan Energy Supply

- **Strategy**

Supply → Distribution → Consumption

Energy supply
CO_2-reduced
by utilising renewable energy sources

Minimising
energy consumption

Lauber IWISA
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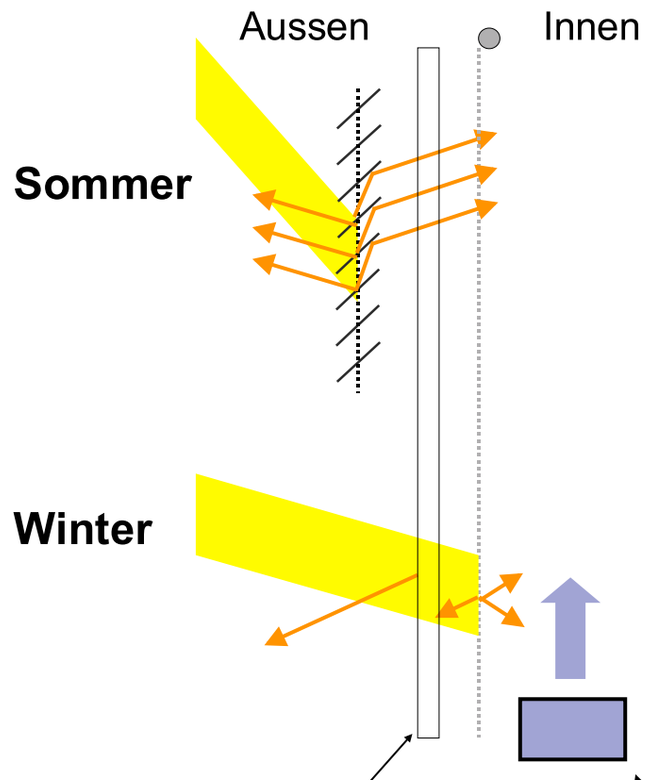
Implementation (1. Task)

- **Minimising energy consumption**



Outdoor:
Weather variable

Indoor:
variable user requirements (utilisation)

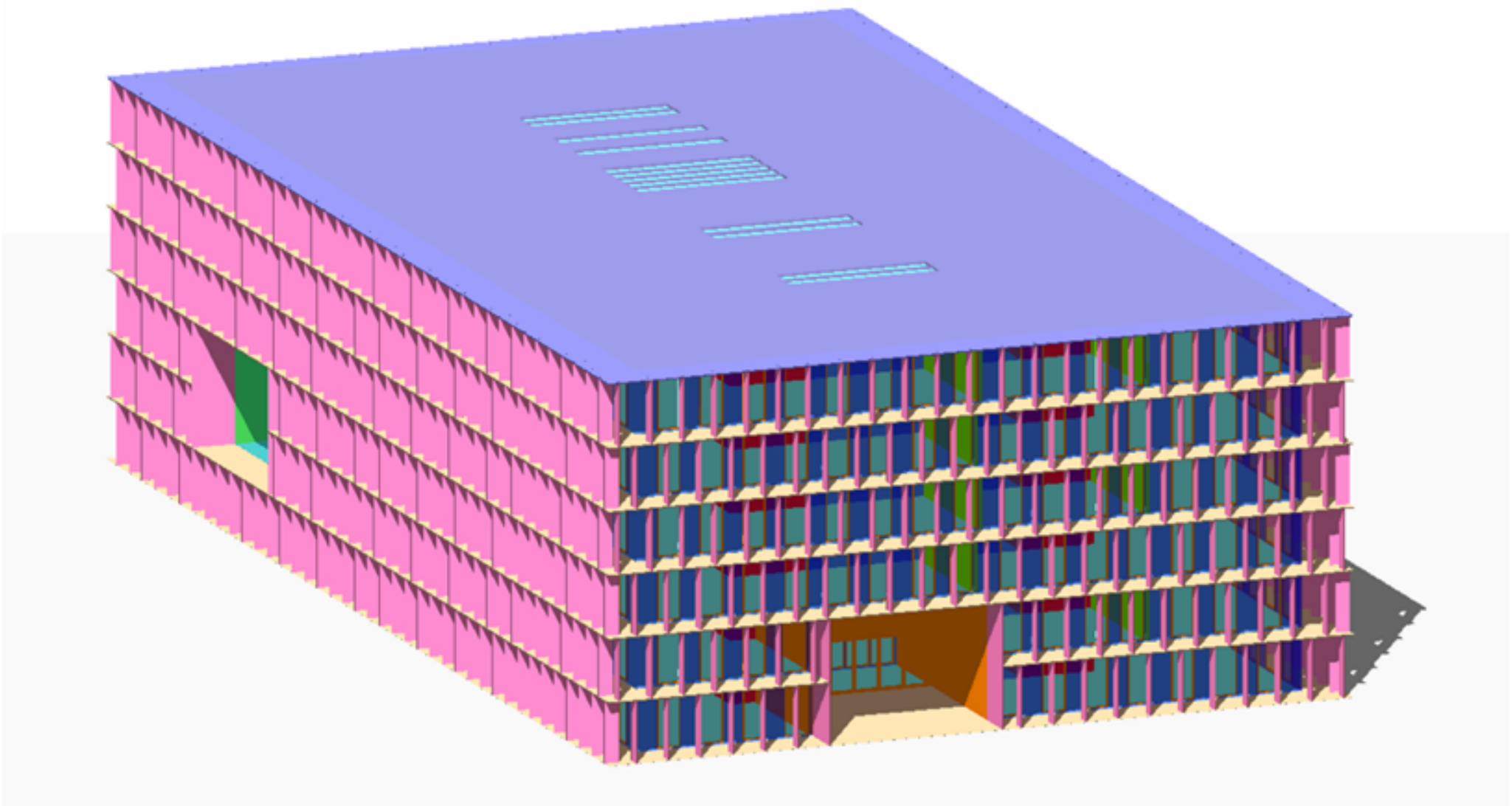
Minimising energy demand
by developing an effective façade

The desired indoor climate is regulated by the façade as far as possible ‘the rest’ must be supported by the technique

Lauber IWISA
plant baut erneuert

Minimising Energy Demand, HIT

- Digitalisation of the Building

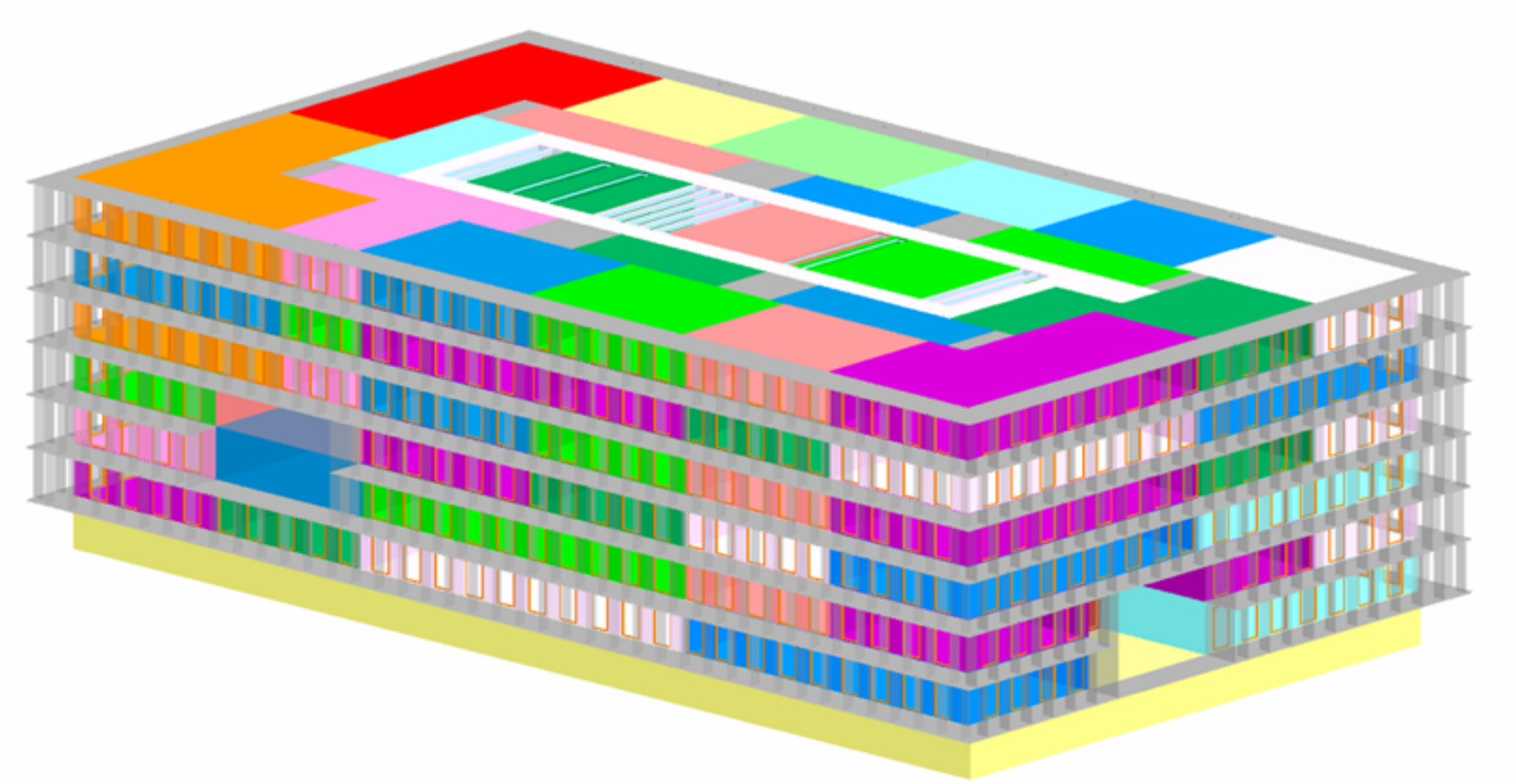


Lauber IWISA

plant baut erneuert

Minimising Energy Demand, HIT

- **Digitalisation of the Building: > 160 Zonen**

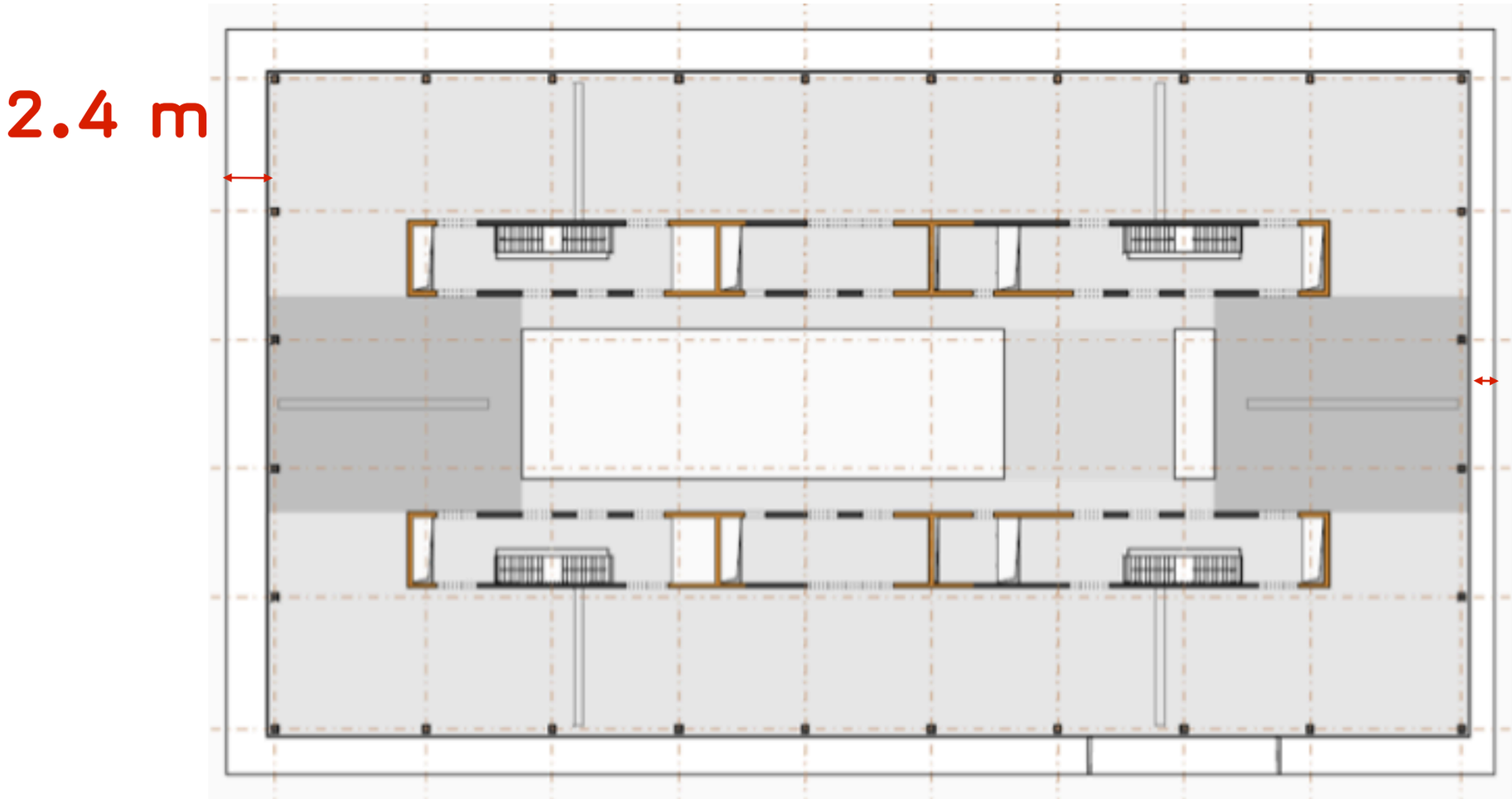


Lauber IWISA

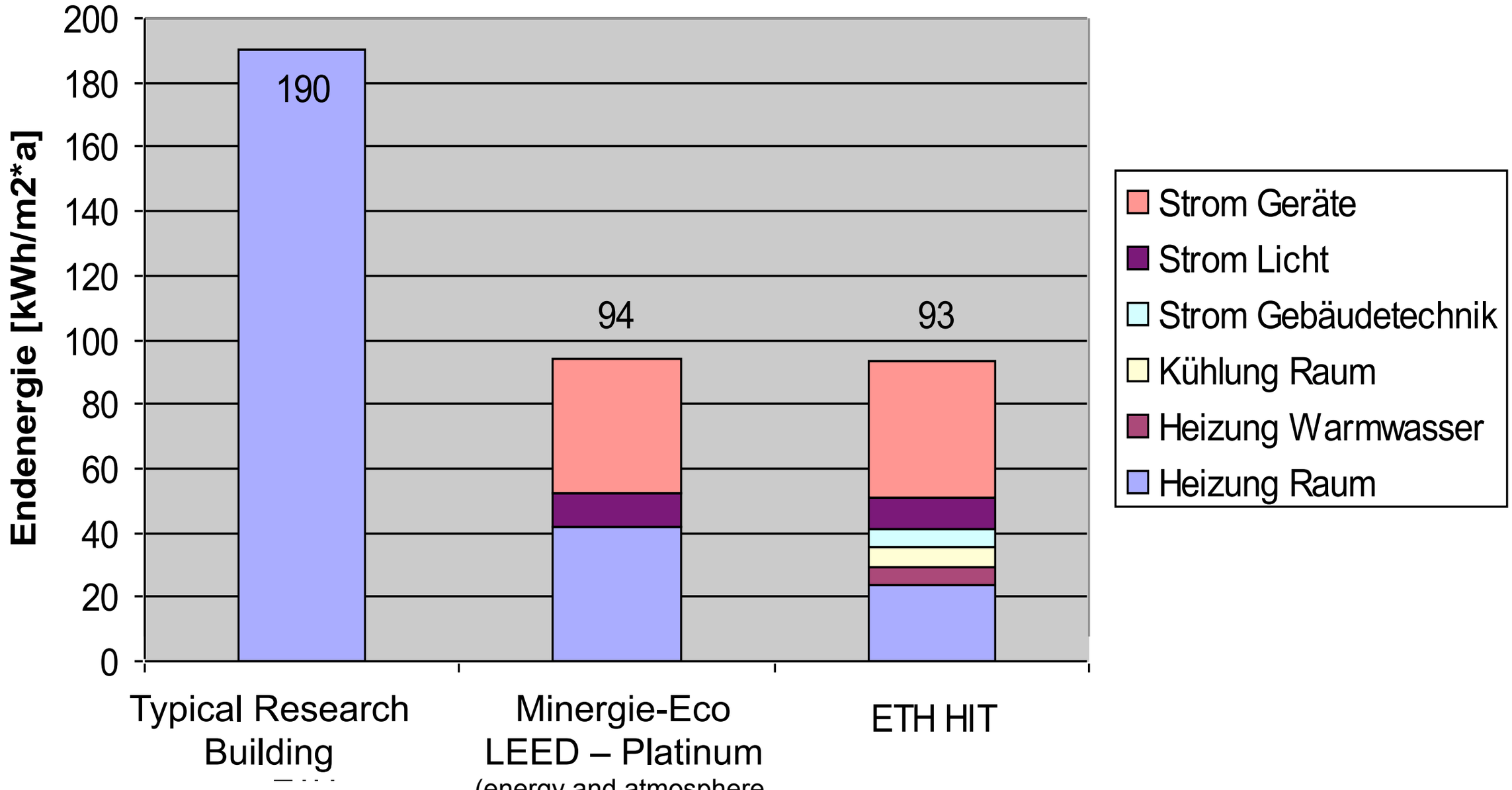
plant baut erneuert

Minimising Energy Demand, HIT

- Variable balcony depth



Minimising Energy Demand, HIT



Lauber IWISA
plant baut erneuert

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Simulation Platform 2009

People • Water • Material • Energy • Capital • Space • Information

Value Lab, ETH Science City, Zurich

Conclusions - Simulation 3

- What? Simulation is a method next to theory and experiment in science, next to theory and design in architecture. It helps to predict form and behavior of complex systems, such as Architecture and Cities

- How? Simulation can start with imagination, design, and model building. Increasingly, computational methods help to generate desired and realistic future scenarios

- Why? Simulation should occur in the early design phase and in the early building management phase to reduce costs and to increase sutainability of Architecture

➡ Simulation is one of the most powerful methods to increase design quality and sustainability both locally and globally

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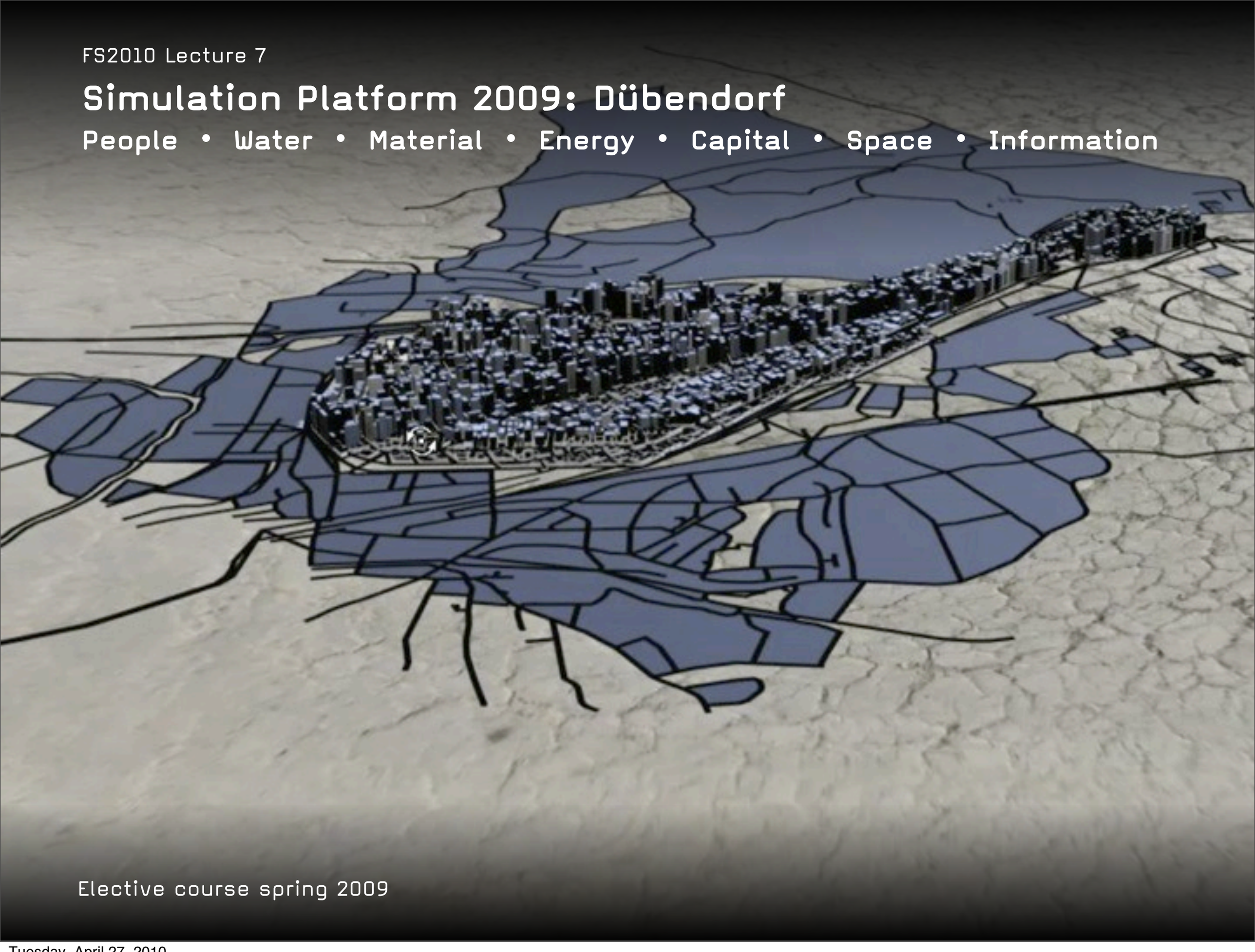
Simulation Platform 2009: Dübendorf

People • Water • Material • Energy • Capital • Space • Information



Elective course spring 2009

FS2010 Lecture 7

Preview

L8 | 26.04.2010 New Methods in Architectural and Urban Design

Jan Halatsch

Chair for Information Architecture | HS2010

Elective Course Information Architecture

New Methods in Urban Simulation - Grammar-based modelling of urban scenarios

Jan Halatsch

April 26, 2010

iA
Chair for Information Architecture

Overview

New methods in urban simulation

Course ‘Vertiefungsfach (6ECTS)’ in fall 2010:
063-1357-09 NEW METHODS IN URBAN SIMULATION

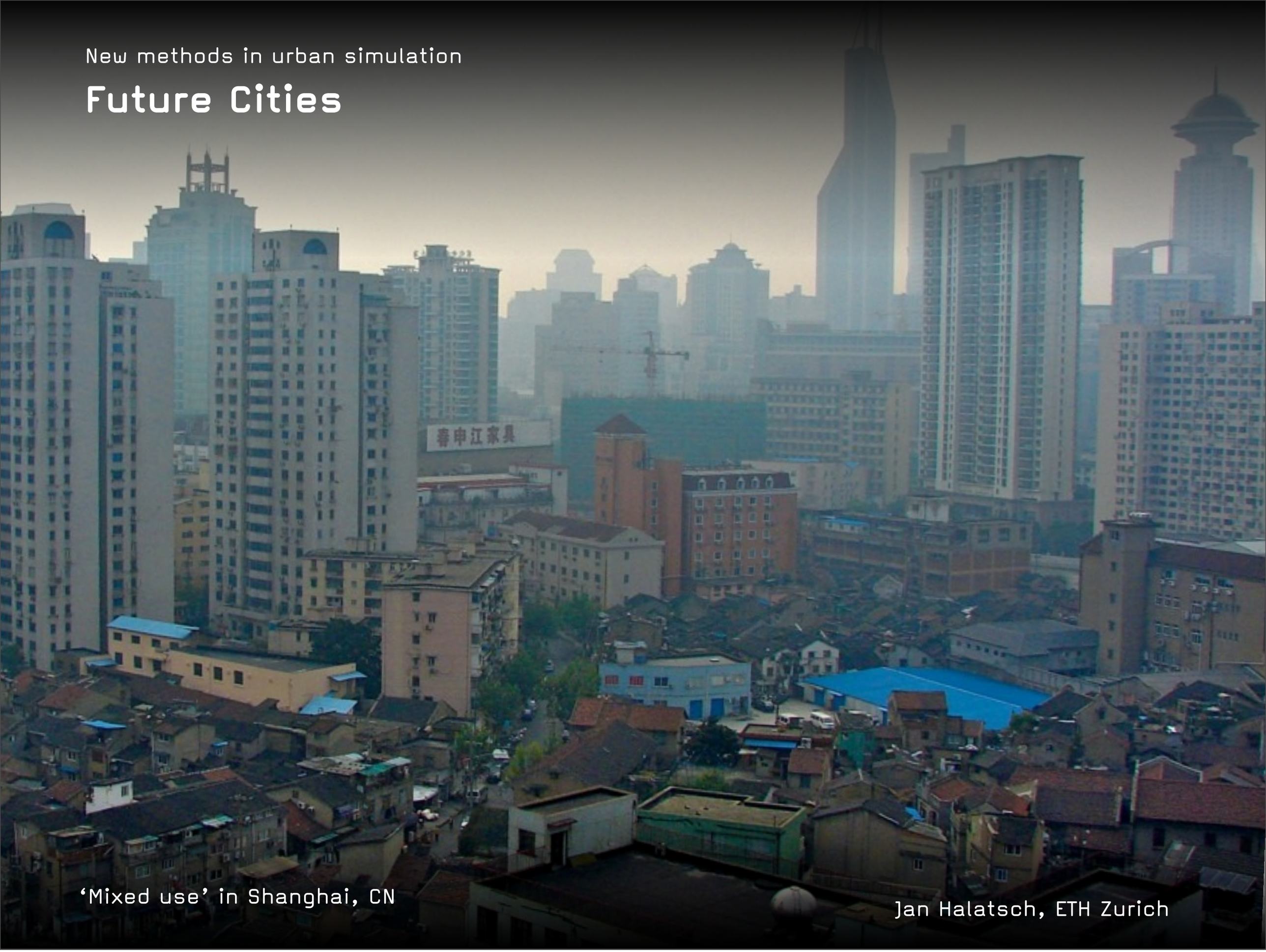
New methods in urban simulation

Overview

Future Cities

New methods in urban simulation

Future Cities



‘Mixed use’ in Shanghai, CN

Jan Halatsch, ETH Zurich

New methods in urban simulation

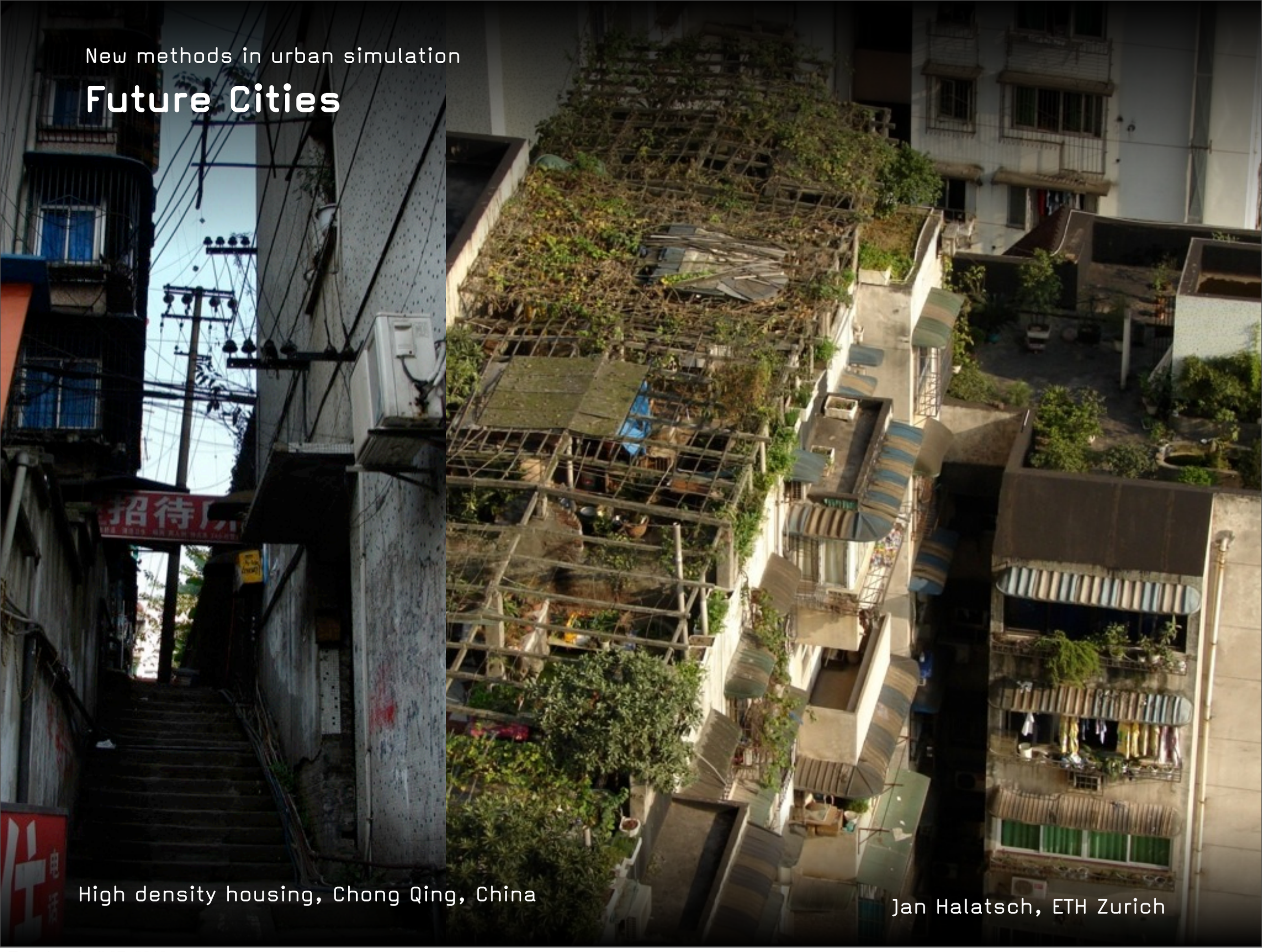
Future Cities

High density housing, Chong Qing, China

Jan Halatsch, ETH Zurich

New methods in urban simulation

Future Cities



High density housing, Chong Qing, China

Jan Halatsch, ETH Zurich

New methods in urban simulation

Future Cities

New methods in urban simulation

Future Cities

Quest for a prosperous future city

a) maintaining & restructuring cities in the ‘old worlds’

b) developing & erecting cities in the ‘new worlds’

New methods in urban simulation

Future Cities

Silk City

Civic Arts, London

New methods in urban simulation

Future Cities

Quest for sustainable criteria

a) **environmental**
(e.g. microclimate, CO_2 neutral)

b) **social / cultural**
(e.g. access, vernacular schemes)

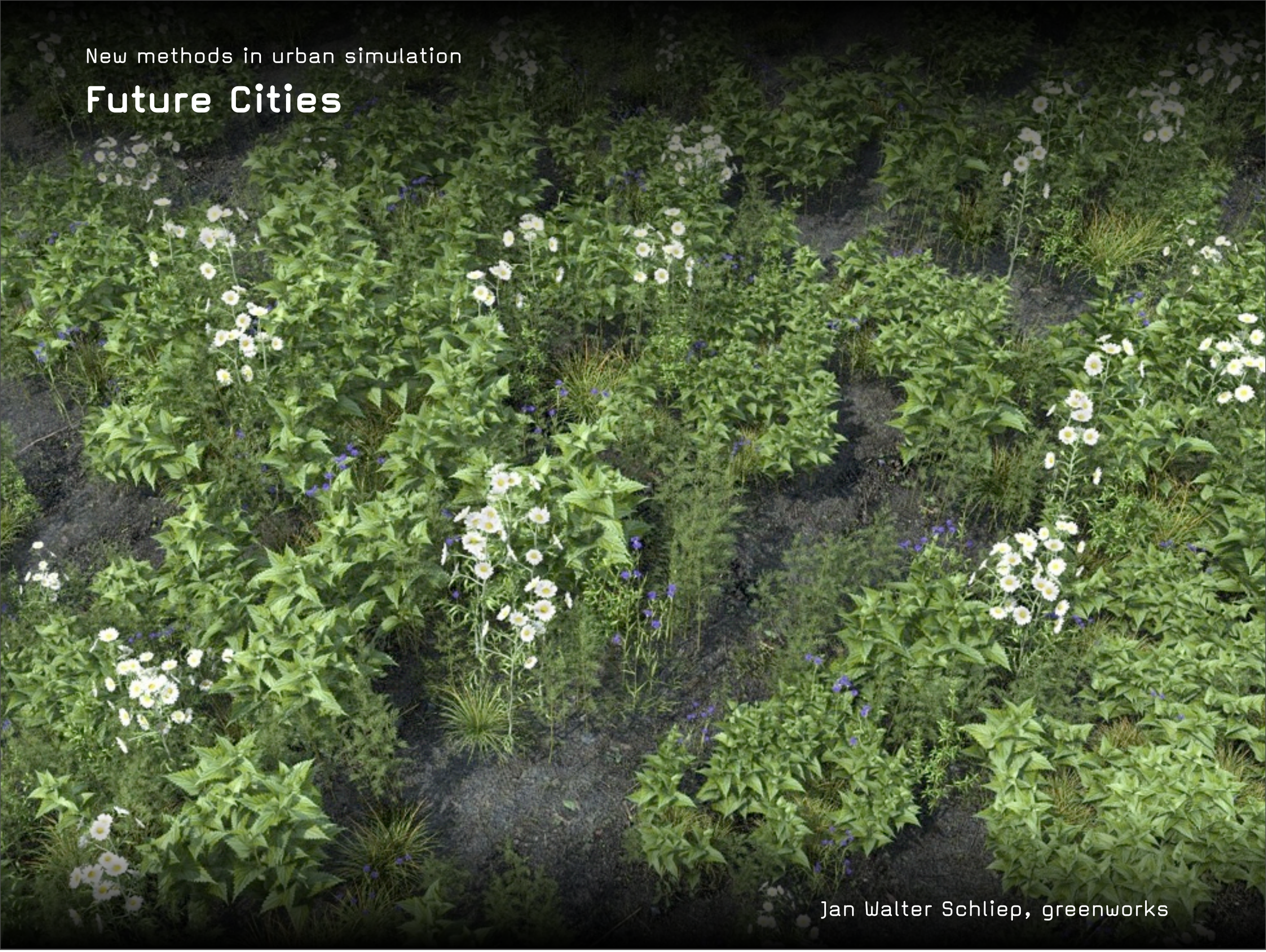
c) **economic** (e.g. growth, urban mining)

Silk City

Civic Arts, London

New methods in urban simulation

Future Cities



Jan Walter Schliep, greenworks

New methods in urban simulation

Future Cities

A city is sensitive and complex:

“A city is not a tree ...”, Christopher Alexander

- It is an eco system.

Jan Walter Schliep, greenworks

Overview

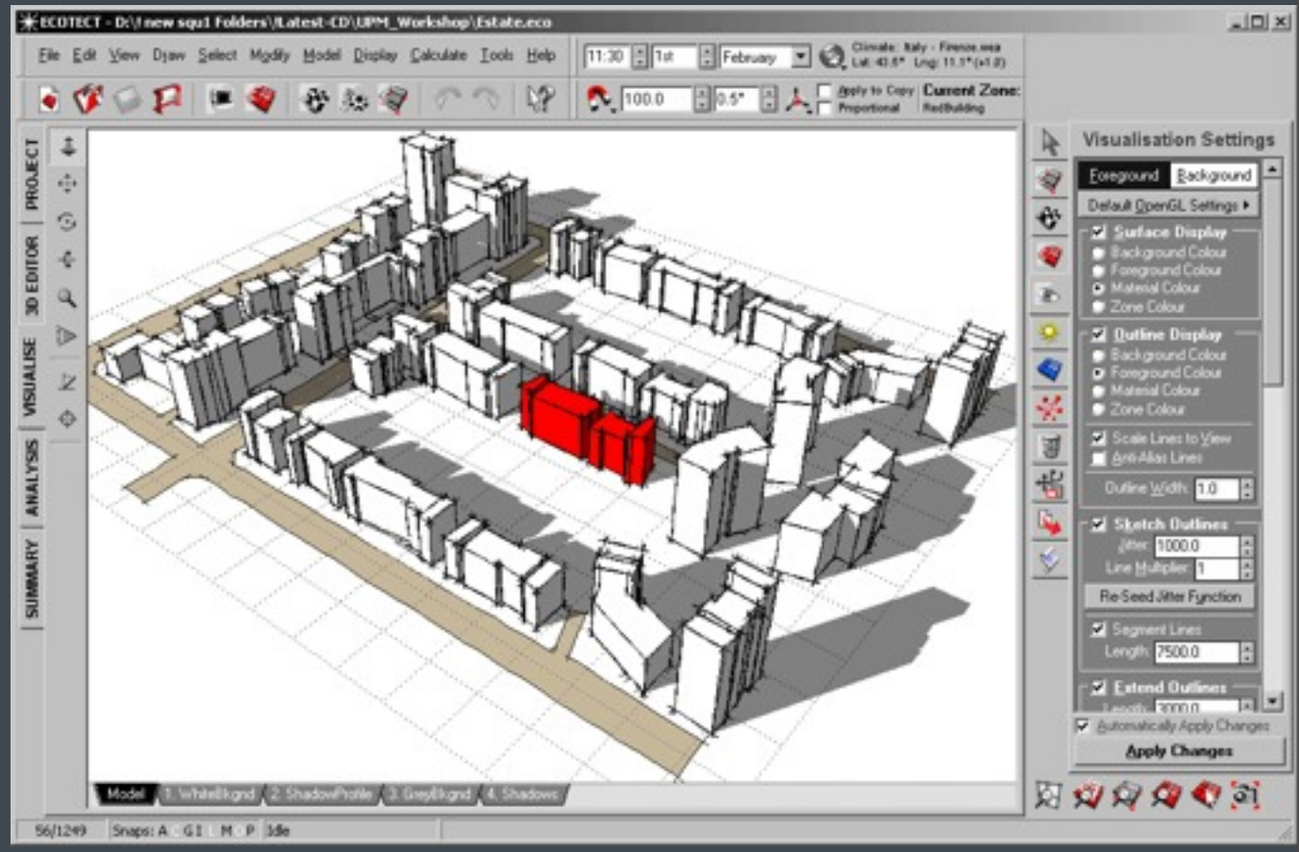
Design

Process

Design Process

Evidence based design:

- Evidence base by planners for design schemes
- Application to urban blueprint plan and verification



Autodesk Ecotect

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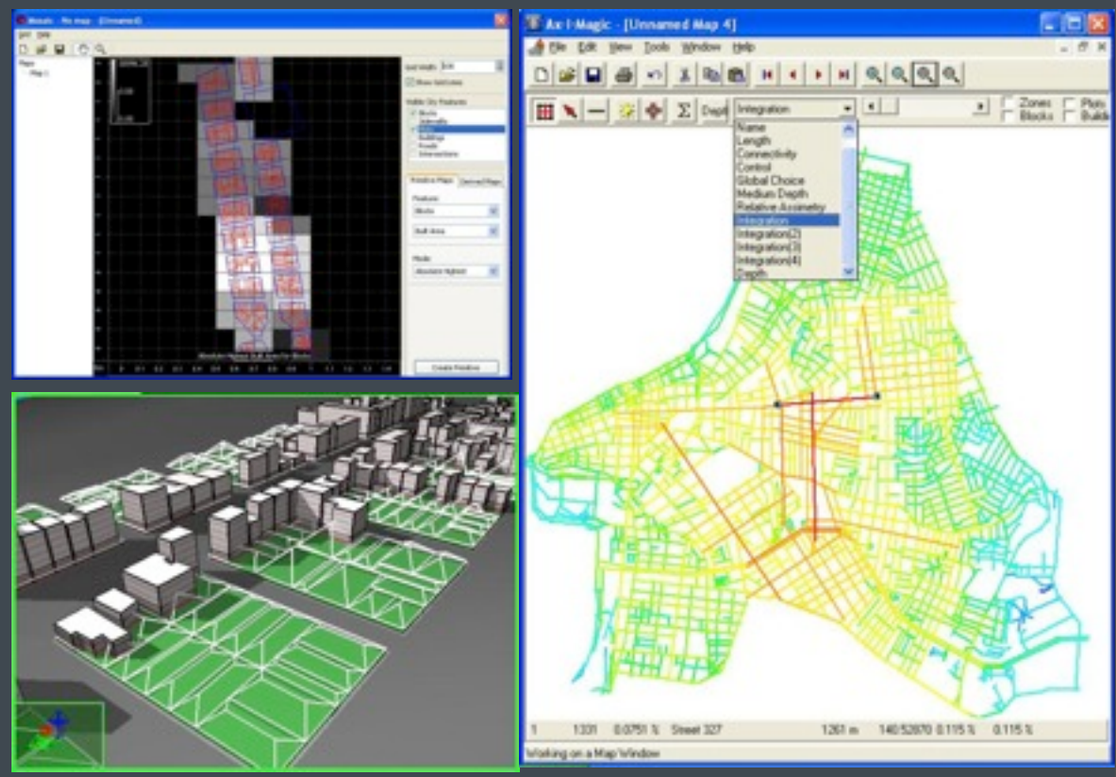
Design Process

Performative urban design

- Analytical survey of planning area by experts
- Survey criteria serve as performance indicators



CityZoom, Benamy Turkenicz

Design Process

Participative design

- interactive workshops for proposal evaluation
- design goal communication
- design benchmark validation
- design guidelines

New Methods in Urban Simulation

Design Process

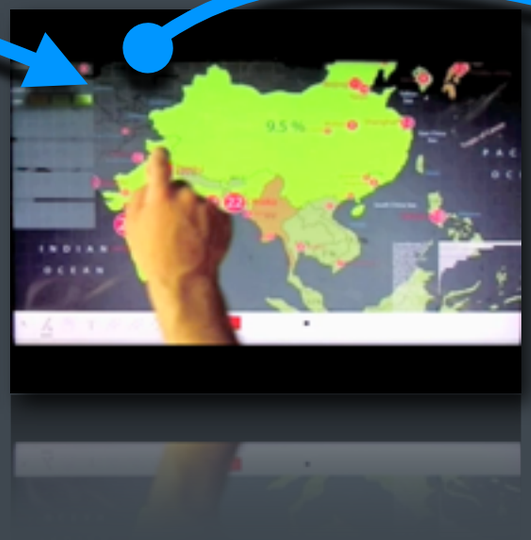
Urban Design Synthesis

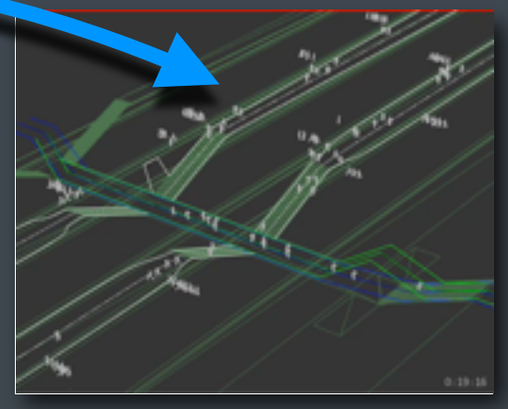
Participative

Evidence

Performance

Evaluation





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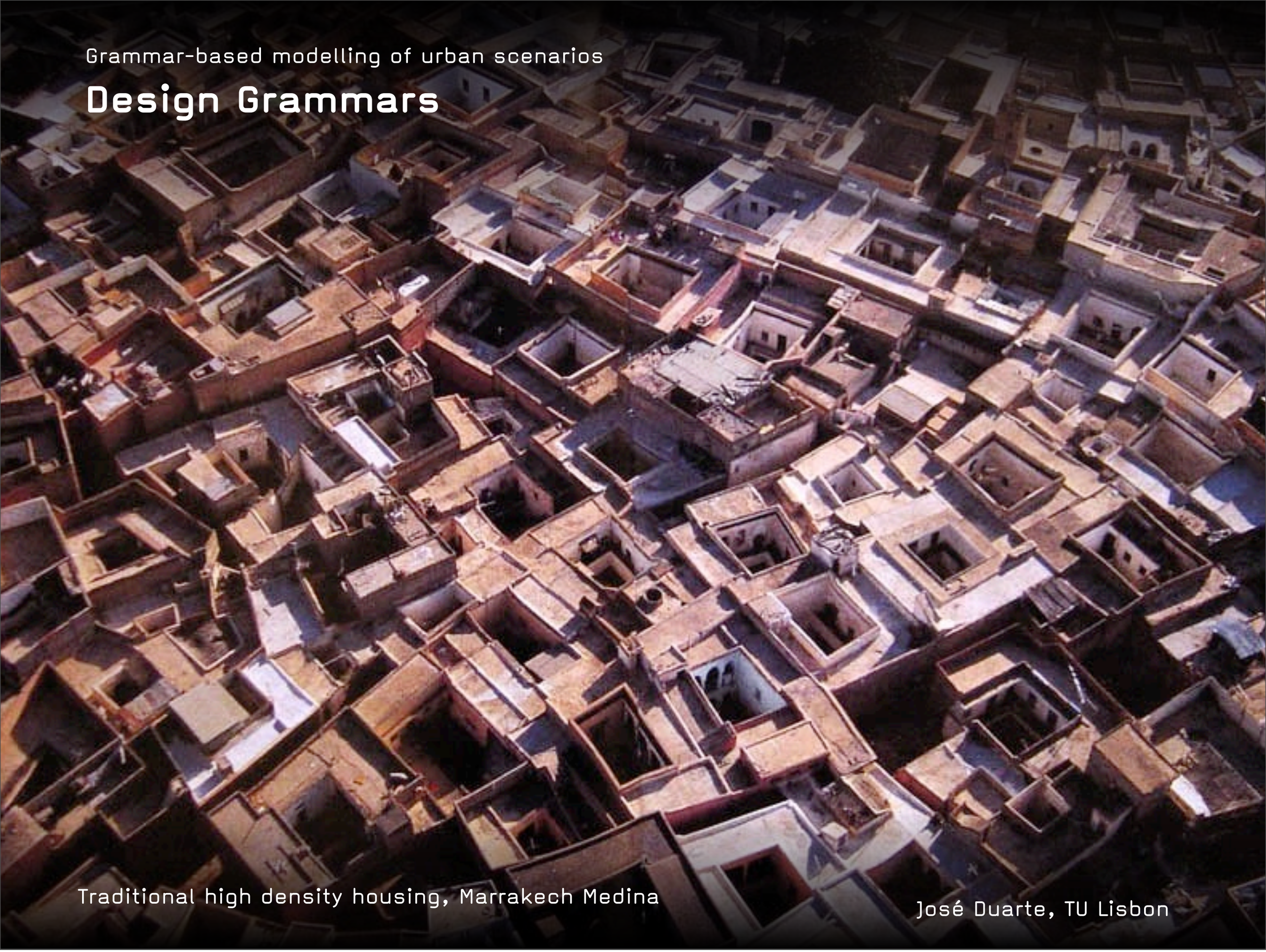
Overview

Design Grammars

Grammar-based modelling of urban scenarios

Design Grammars



Traditional high density housing, Marrakech Medina

José Duarte, TU Lisbon

Grammar-based modelling of urban scenarios

Design Grammars

Concept of grammars

Grammars in general are used to describe and to alter 'strings' in a defined manner. The results are sequences of symbols that can represent e.g. human language, compiled code ready for the interpretation by an interpreter (computer science), production of architectural shapes and their layout (shape grammars).

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Design Grammars

Concept of grammars

Due to their nature grammars can be easily adapted to store:

a) spatial configuration (geometry, network dependencies)

b) meta data (population density, value, topology)

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Design Grammars

Concept of grammars

In computer science a formal grammar consists of:

- Set of start symbols / nonterminal symbols: N
- *Set of alphabet / terminal symbols: Σ (disjoint from N)*
- *Set of production rules for transforming strings: P*
- *Language, resulting set of all strings: L*

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Design Grammars

Concept of grammars

Generation of a string

- Begins with a single *start symbol (e.g. S)*
- *Then successive application of the rules in P*

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Design Grammars

Concept of grammars

Example 1

Start symbol / Nonterminal symbol: $N = \{ S \}$

Alphabet / Terminal symbols: $\Sigma = \{a, b\}$

Rules: $P = \{ Rule\ 1, Rule\ 2 \}$

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Design Grammars

Concept of grammars

Example 1

Rule 1: $S \dashrightarrow aSb$

Rule 2: $S \dashrightarrow ba$

Possible production:

$S \dashrightarrow_1 aSb \dashrightarrow_1 a\mathbf{aSb}b \dashrightarrow_2 aa\mathbf{ba}bb.$

Resulting set of all strings (language):

$L(G) = \{ba, abab, aababb, aaababbb, ...\}$

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Design Grammars

Concept of grammars

Example 2

Possible productions:

S -->

$2:\ abc$

S -->

$1:\ aBSc$ -->

$2:\ aBabcc$ -->

$3:\ aaBbcc$ -->

$4:\ aabbcc$

Rule 1. S --> $aBSc$

Rule 2. S --> abc

Rule 3. Ba --> aB

Rule 4. Bb --> bb

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Design Grammars

Concept of grammars

Example 2

Resulting set of all strings (language):

$L(G) = \{a^n b^n c^n \mid n \geq 1\}$

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Design Grammars

Concept of grammars

CityEngine's CGA Shape

G= { P, C, T, V, ω}

Start symbol / Axiom: $\omega = \{ Lot, Street, \ldots \}$

Alphabet: $V = \{ variables, inbuilt\ functions, P \}$

Rules: $P = \{ \mathbf{C}, \mathbf{T}, \mathbf{V}, \boldsymbol{\omega} \}$

Constants: $C = \{NIL, .\}$

Terminals: $T = \{I, C\}$

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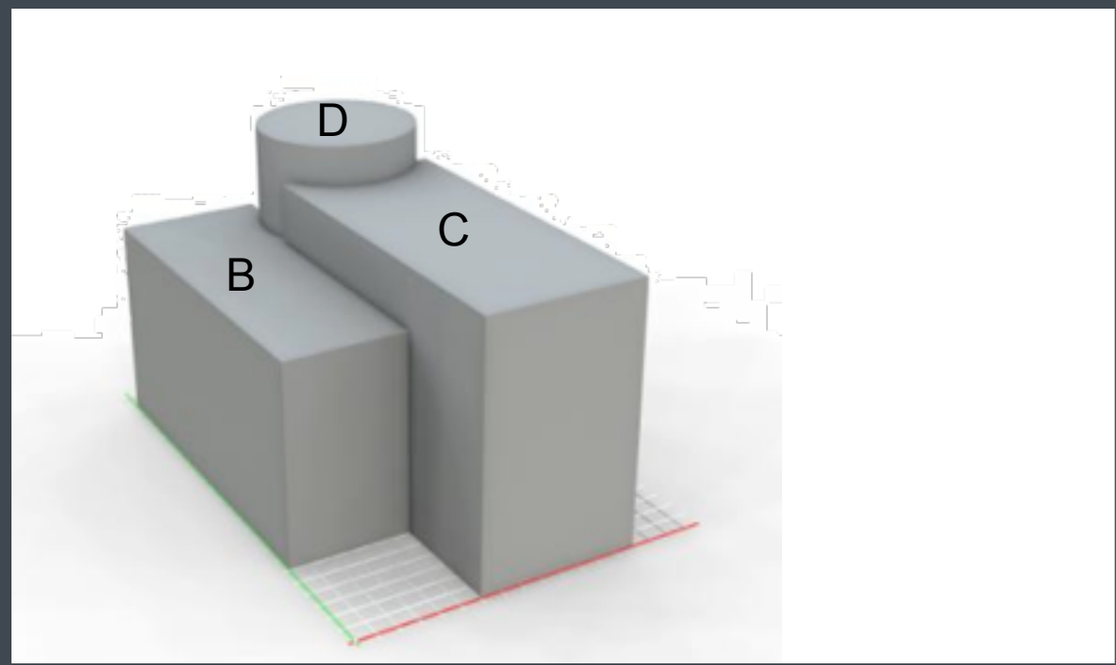
Design Grammars

CGA Shape: Operations

- Geometry Insertion: i(objId)
- Transformations: $t(t_x,t_y,t_z)$, $s(s_x,s_y,s_z)$, $r(r_x,r_y,r_z)$
- Branching: [...]

-Simple example:

A ⇢ **[** **t**(0,0,6) **s**(8,10,18) B **]**
t(6,0,0) **s**(7,13,18) C
t(0,0,16) **s**(8,15,8) **i**(cylinder) D



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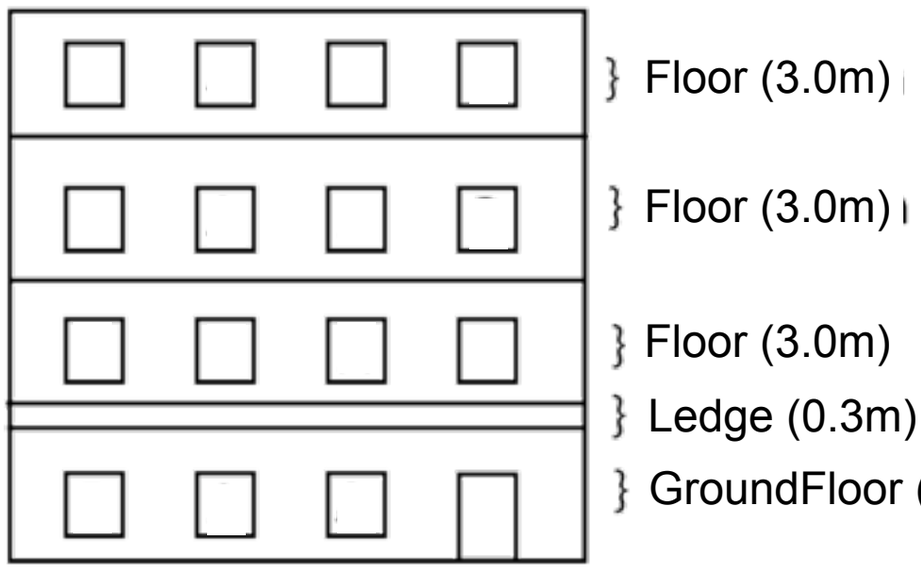
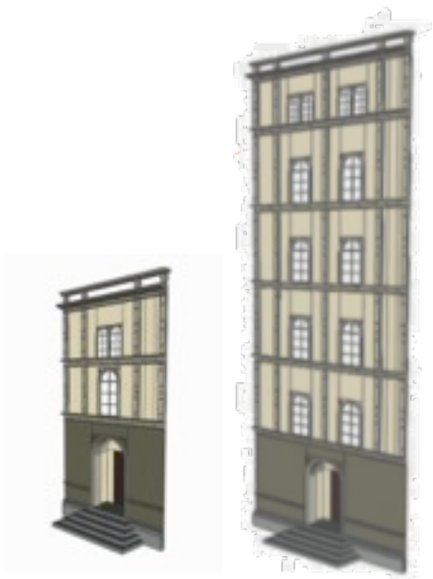
Design Grammars

CGA Shape: Operations

Example:

Facade ⇢
split(y){ 3.5: GroundFloor | 0.3: Ledge | { 3: Floor }* }





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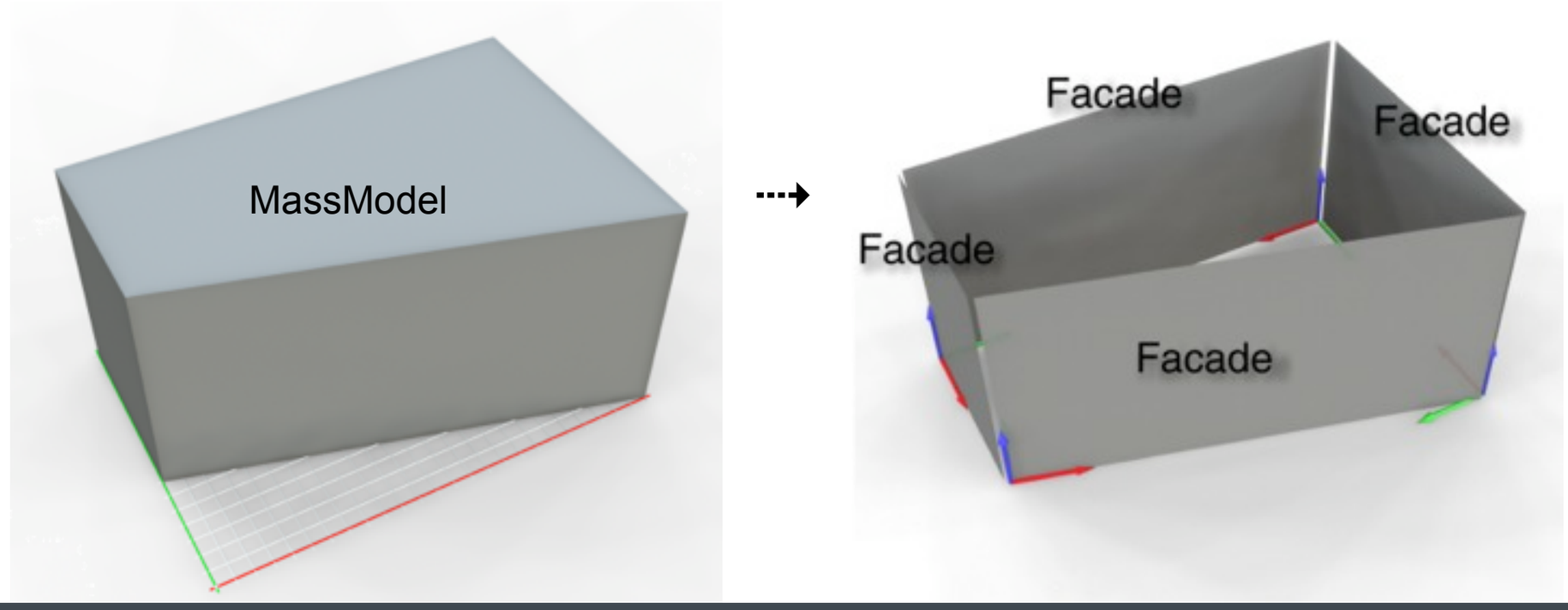
Design Grammars

CGA Shape: Operations

Example:

MassModel ⇢ **comp**(f){ side: Facade }



Overview

Design Patterns

Grammar-based modelling of urban scenarios

Design Patterns

Digital Prototyping, high density housing, Marrakech Medina

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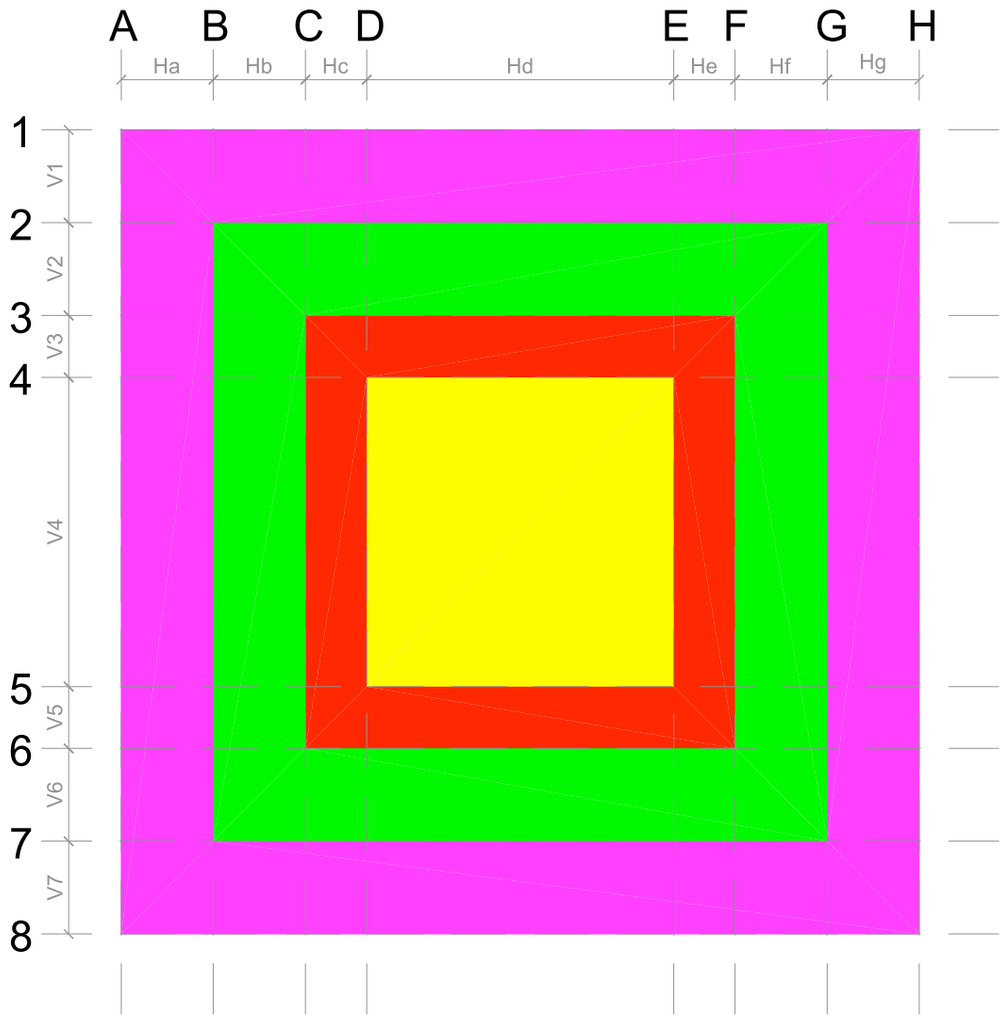
Grammar-based modelling of urban scenarios

Design Patterns

Generic Building Block Pattern



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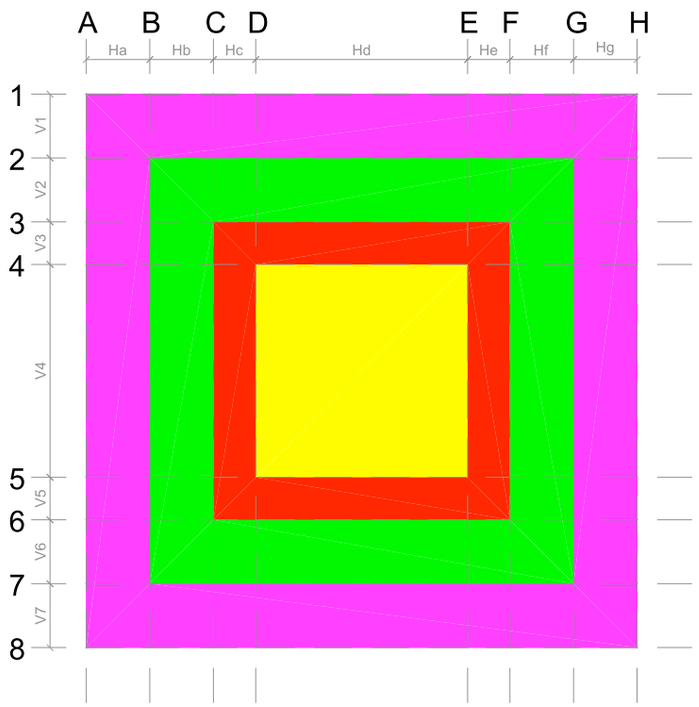
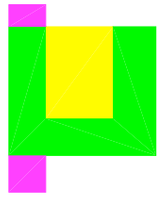
Grammar-based modelling of urban scenarios

Design Patterns

Generic Building and specialization





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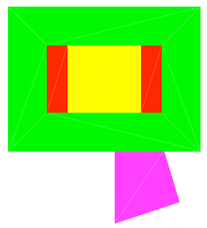

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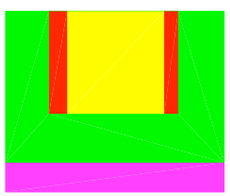

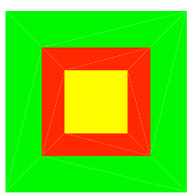

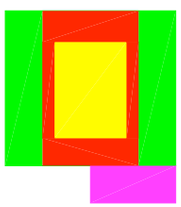

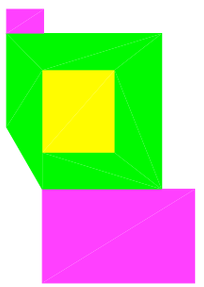

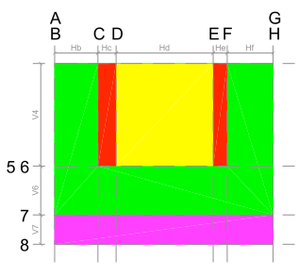

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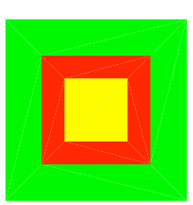

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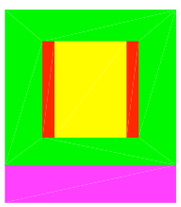

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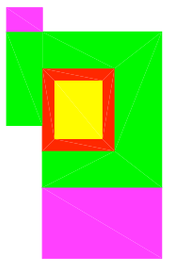

Dar Hanane

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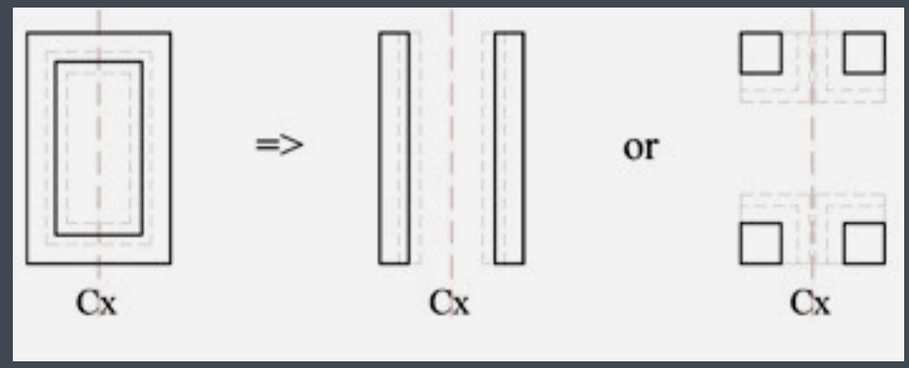
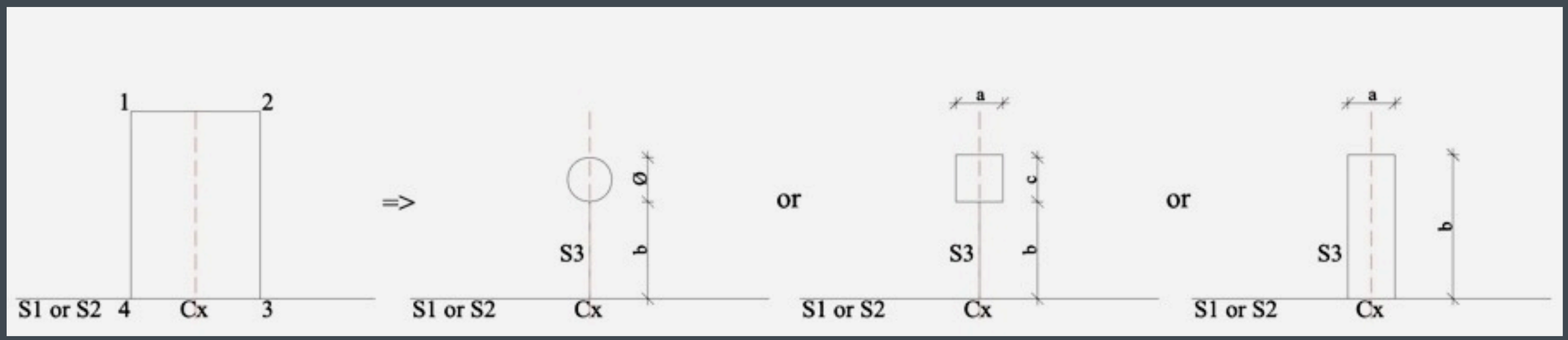
Design Patterns

Pattern Examples

Block types: closed, linear and punctual



Block access: in continuity, cul-de-sac, courtyard, ring access



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Grammar-based modelling of urban scenarios

Design Patterns

Digital Medina

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Grammar-based modelling of urban scenarios

Design Patterns

Grammar Implementation CGA

- Simple encoding of building patterns and facades
- Split Grammar
- Context sensitive conditions

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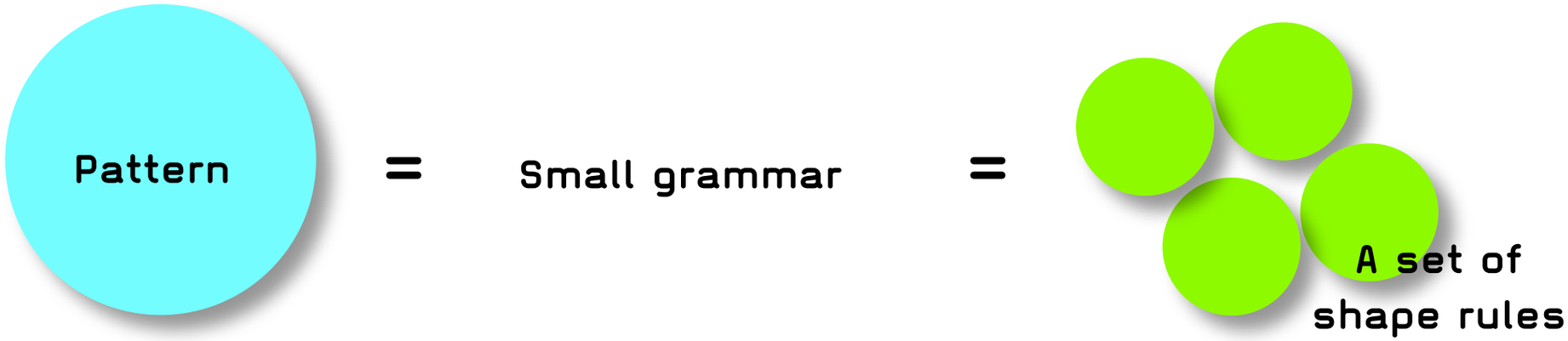
Design Patterns

Pattern Modelling

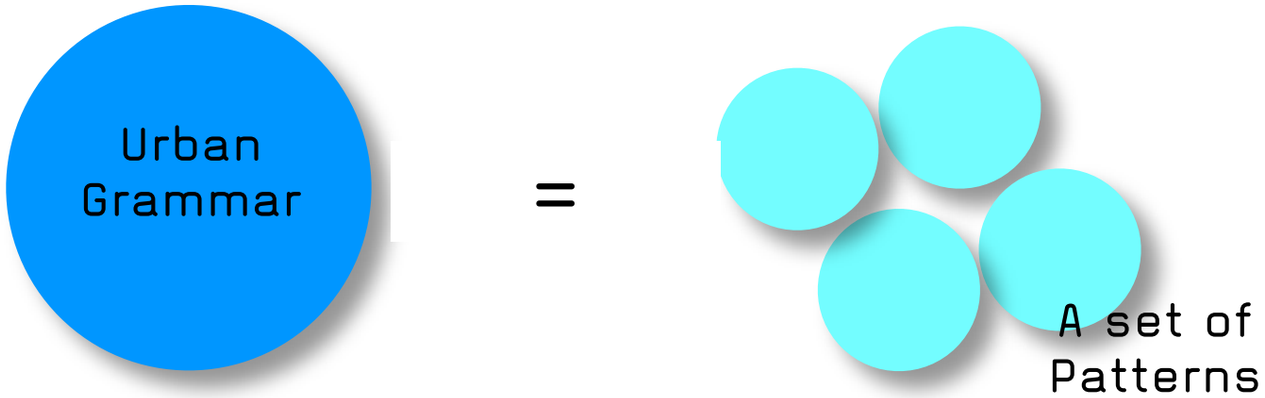


A pattern is a small grammar defined to produce results that satisfy the pattern's description.

Grammar-based modelling of urban scenarios

Design Patterns

Pattern Modelling



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José Beirão, TU Delft

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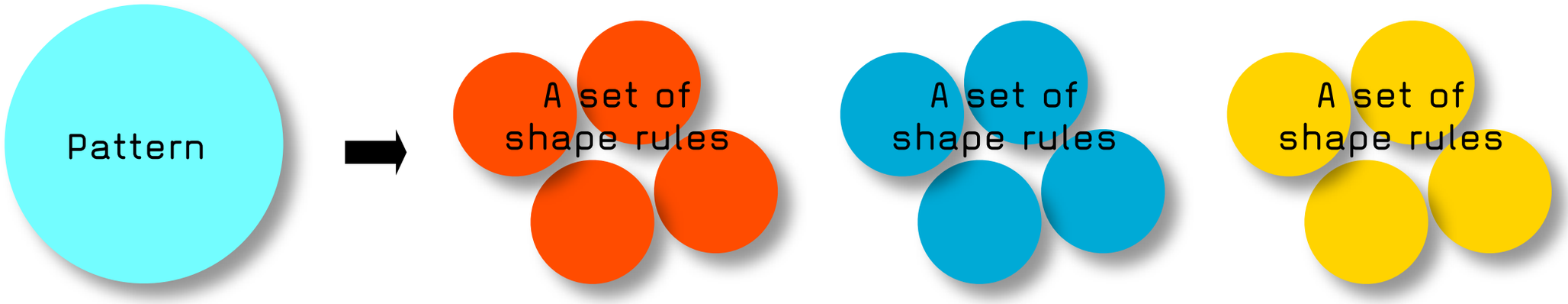
Design Patterns

Pattern Modelling



Each designer may have a different set of shape rules for interpreting a certain pattern.

Grammar-based modelling of urban scenarios

Design Patterns

Scale classification

City Region	Grammar Scope
Zoning (Usage mix, Open Space)	— **Vegetation Patterns**
Street graph generation (major, minor streets)	— **Street Patterns** (Avenues, Highways)
District & Block Derivation	
Open Space	— **Vegetation Patterns**
Lots, footprints	— **Lot Opening**
Building derivation	— **Patterns of 3D Masses** — **Facade Patterns**

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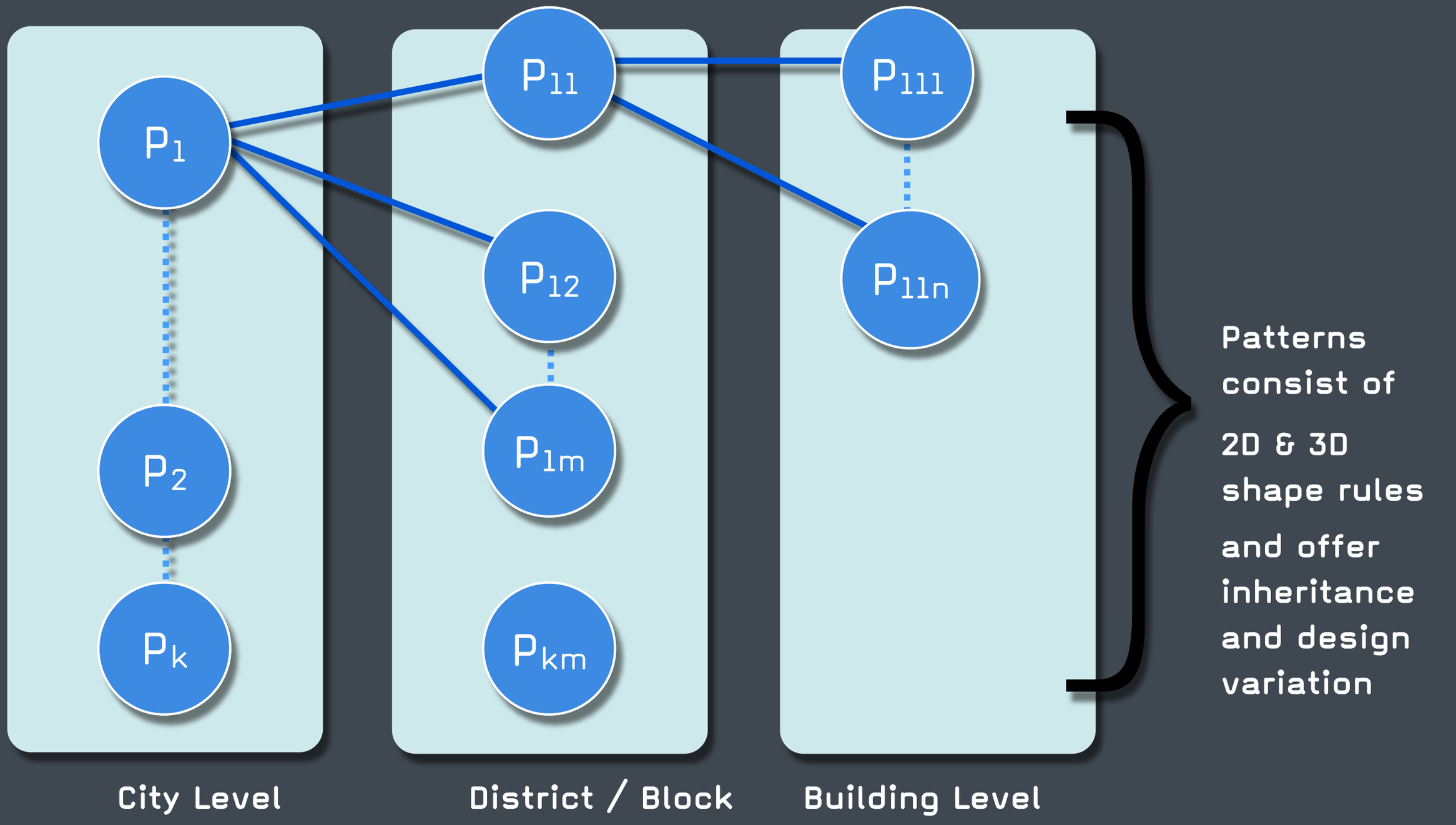
Design Patterns

Pattern inheritance and distribution



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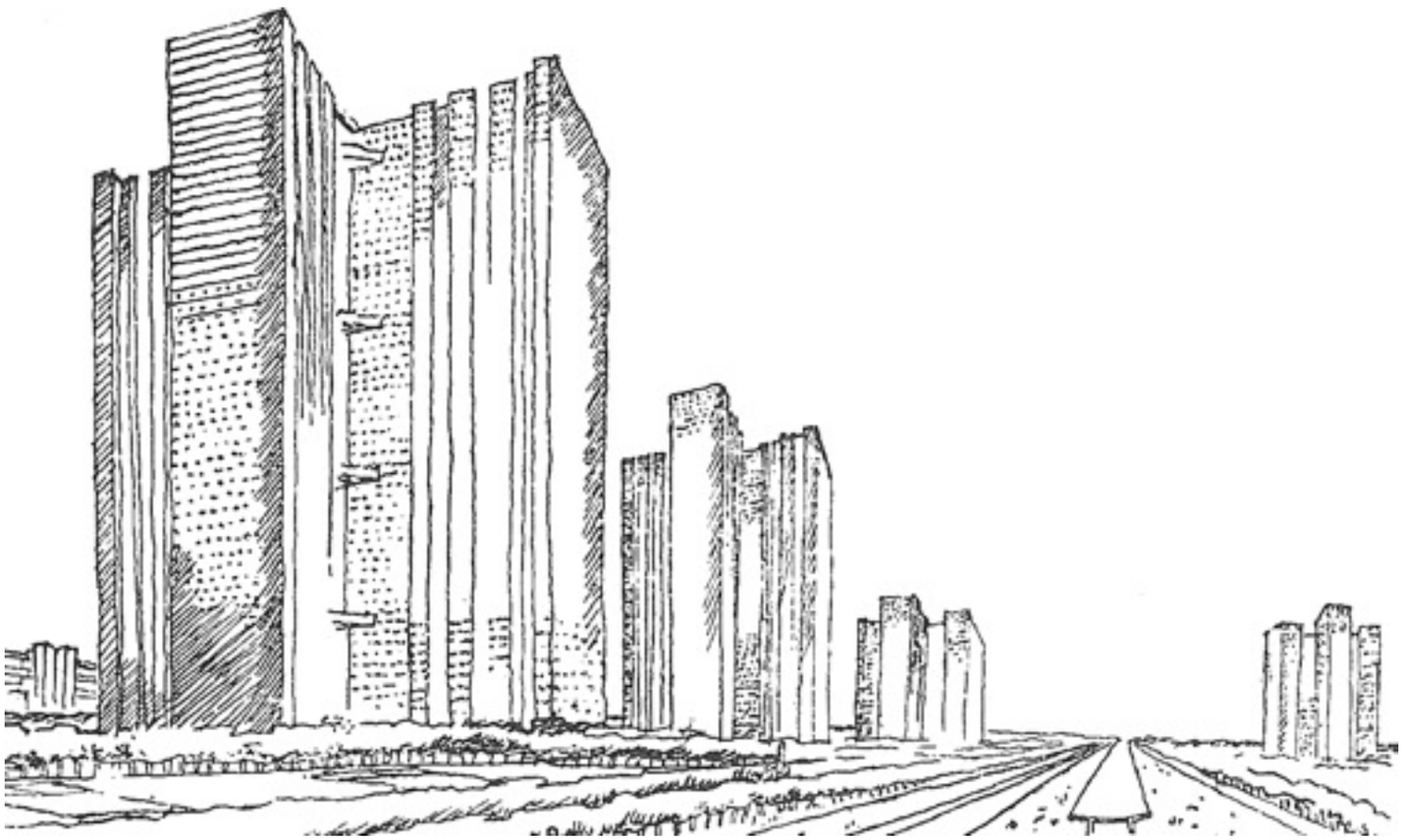
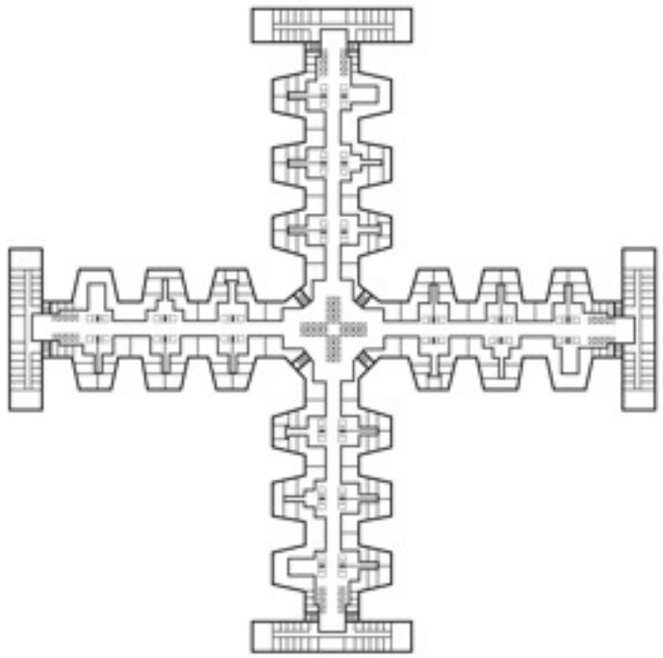
Design Patterns

Example: Parameterized Patterns





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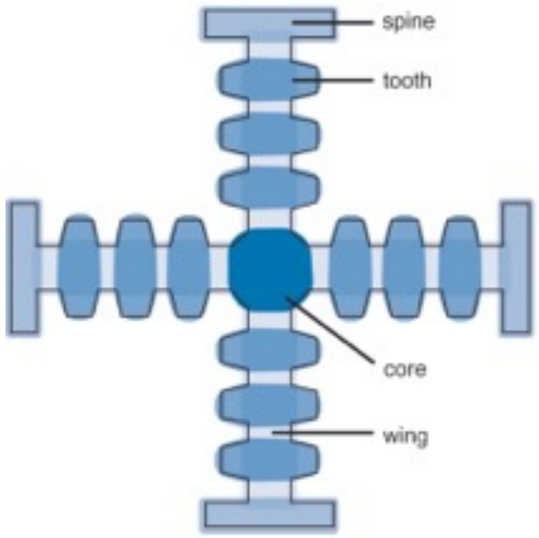
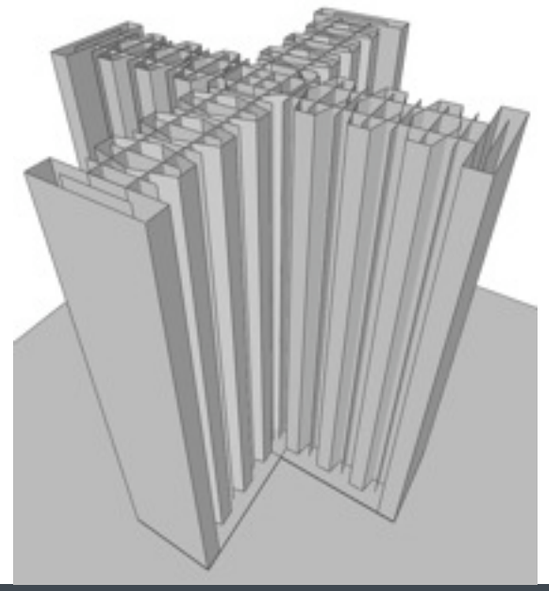
Design Patterns

Control attributes for volume:

BUILDING_H = 220
BUILDING_W = 100
GROUNDFLOOR_H = 6
WING_W = 16
SPINE_W = 50
TEETH_PROJ = 10
TEETH_DIST = 12





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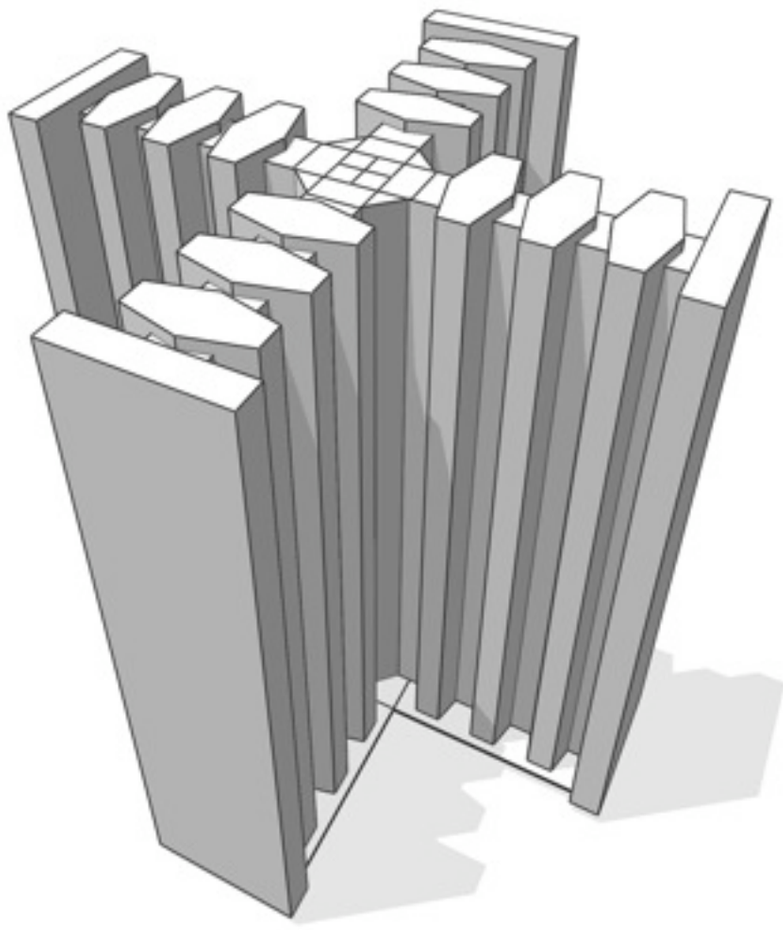
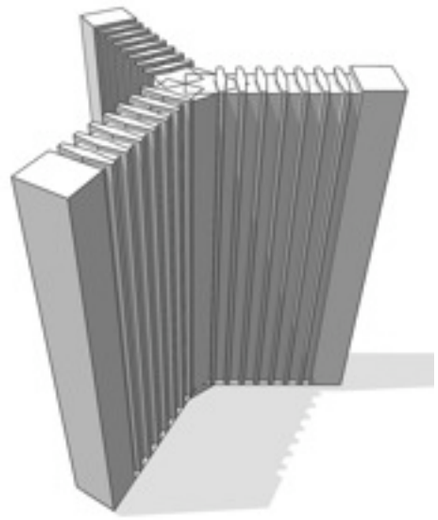
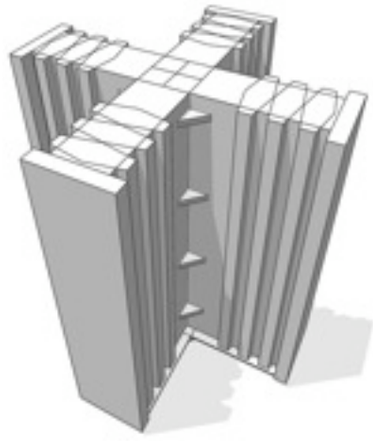
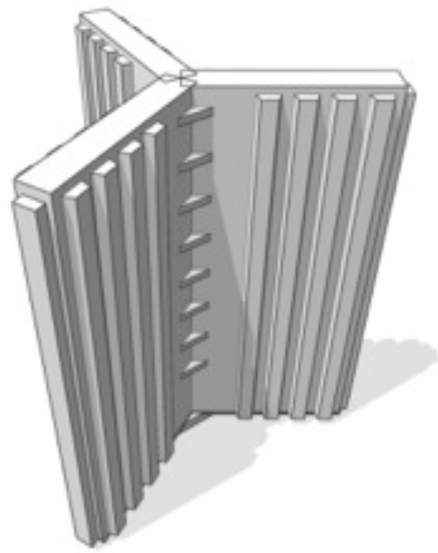
Design Patterns

Example: Parameterized Patterns









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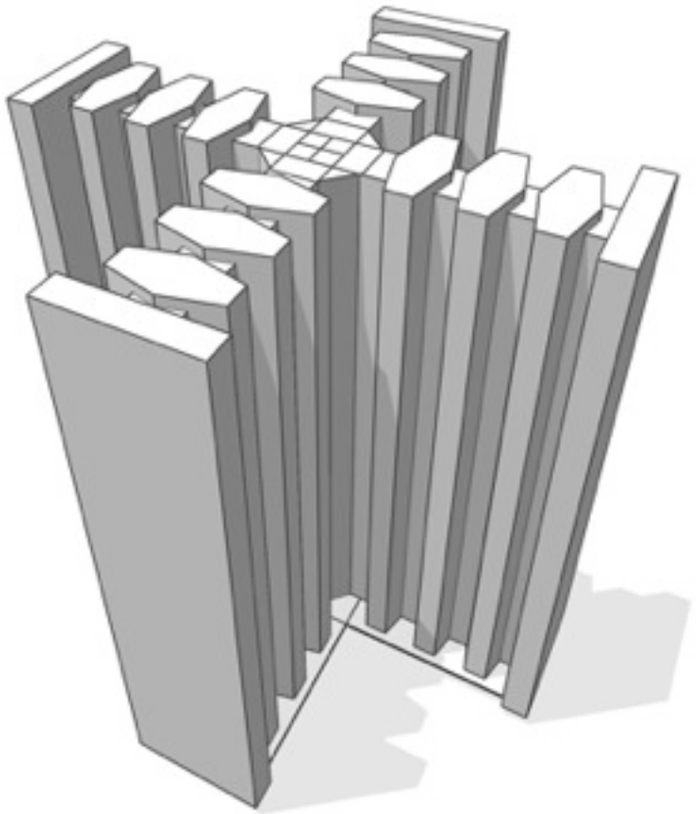
Design Patterns

Example: Parameterized Patterns



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Overview

Case Studies

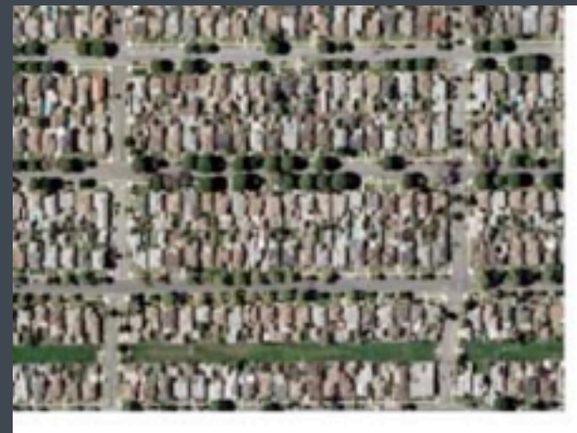
Grammar-based modelling of urban scenarios

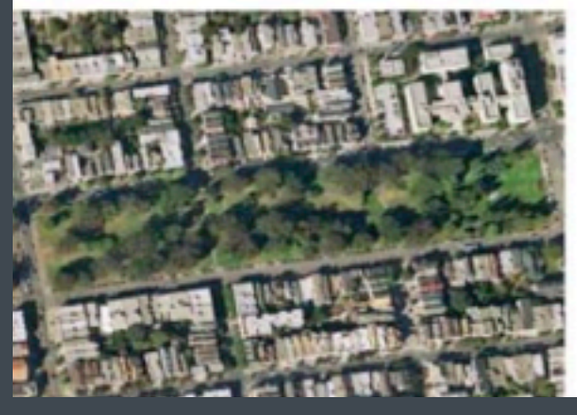
Case Studies

Case Studies

Urban pattern example: Open Space Generation

- blue: building blocks
- yellow: avenue zones
- green: parks and courtyards





Grammar-based modelling of urban scenarios

Case Studies

Encoding building patterns: Digital Pungol

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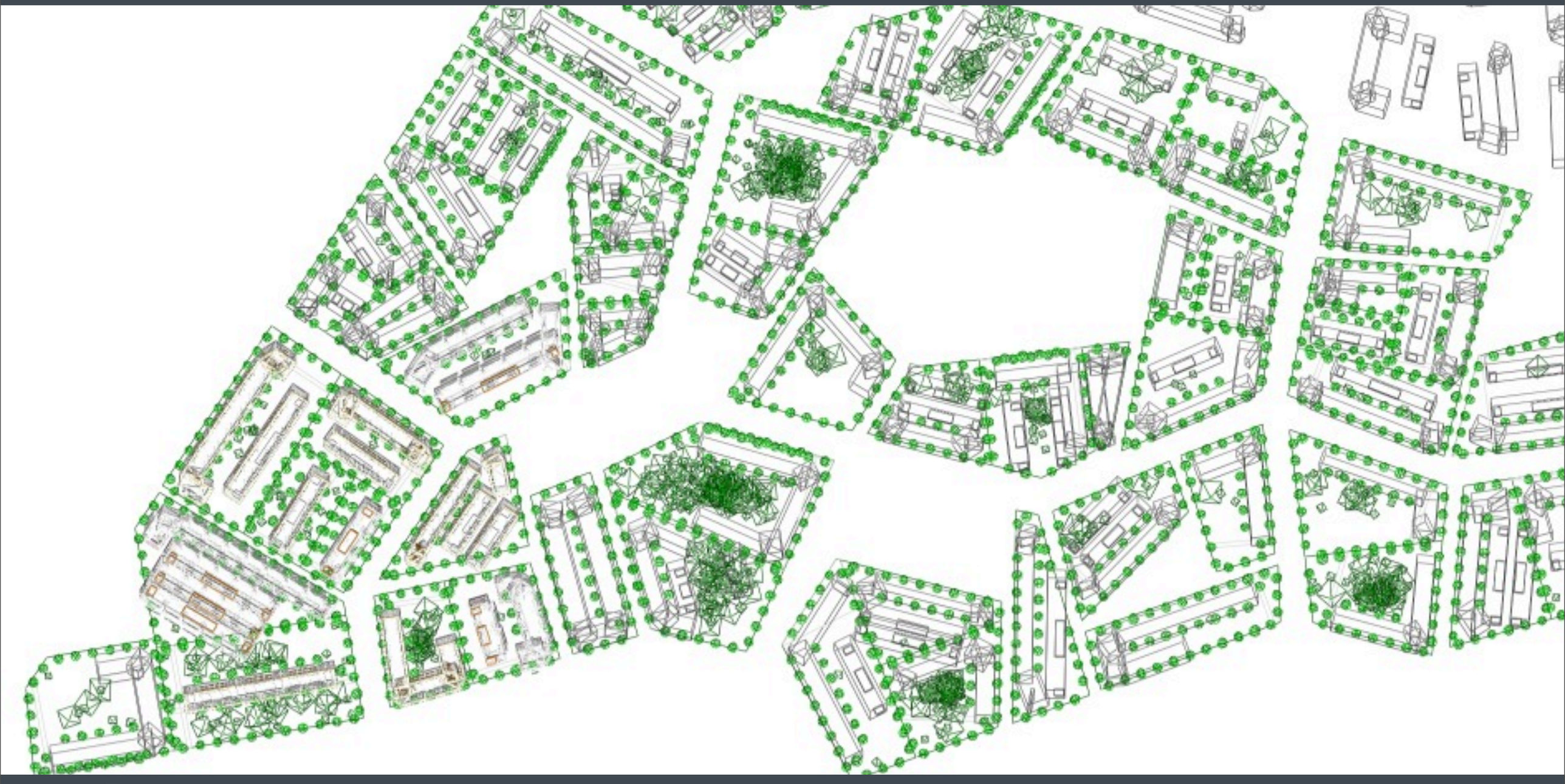
Case Studies

Urban pattern example: Open Space Generation



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Grammar-based modelling of urban scenarios

Case Studies

Urban pattern example: Open Space Generation

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Case Studies

Encoding building patterns: Digital Pungol

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Case Studies

Rome Reborn 2.0

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Procedural Inc., Zurich

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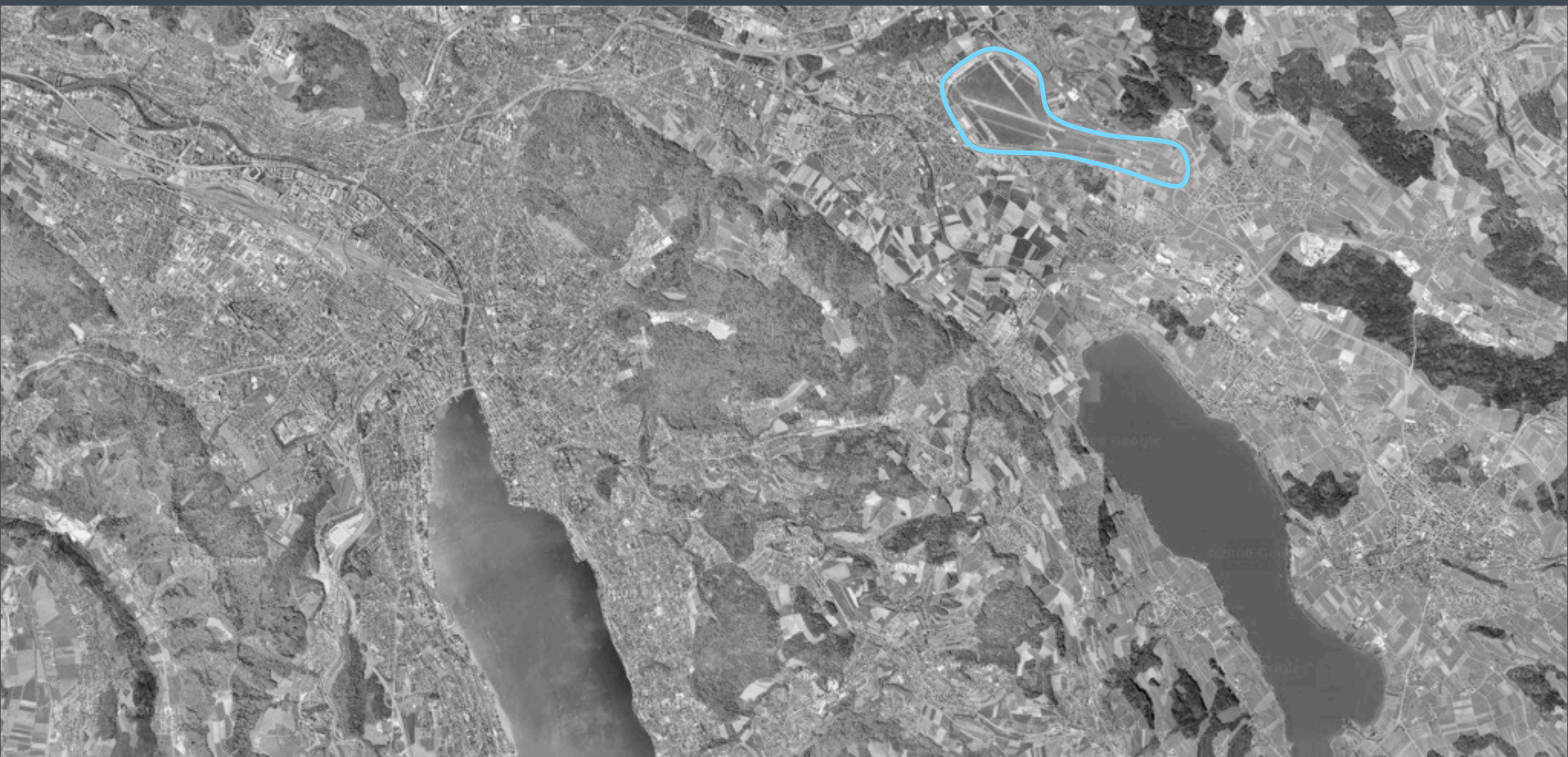
Case Studies

Use scenario Airport Duebendorf



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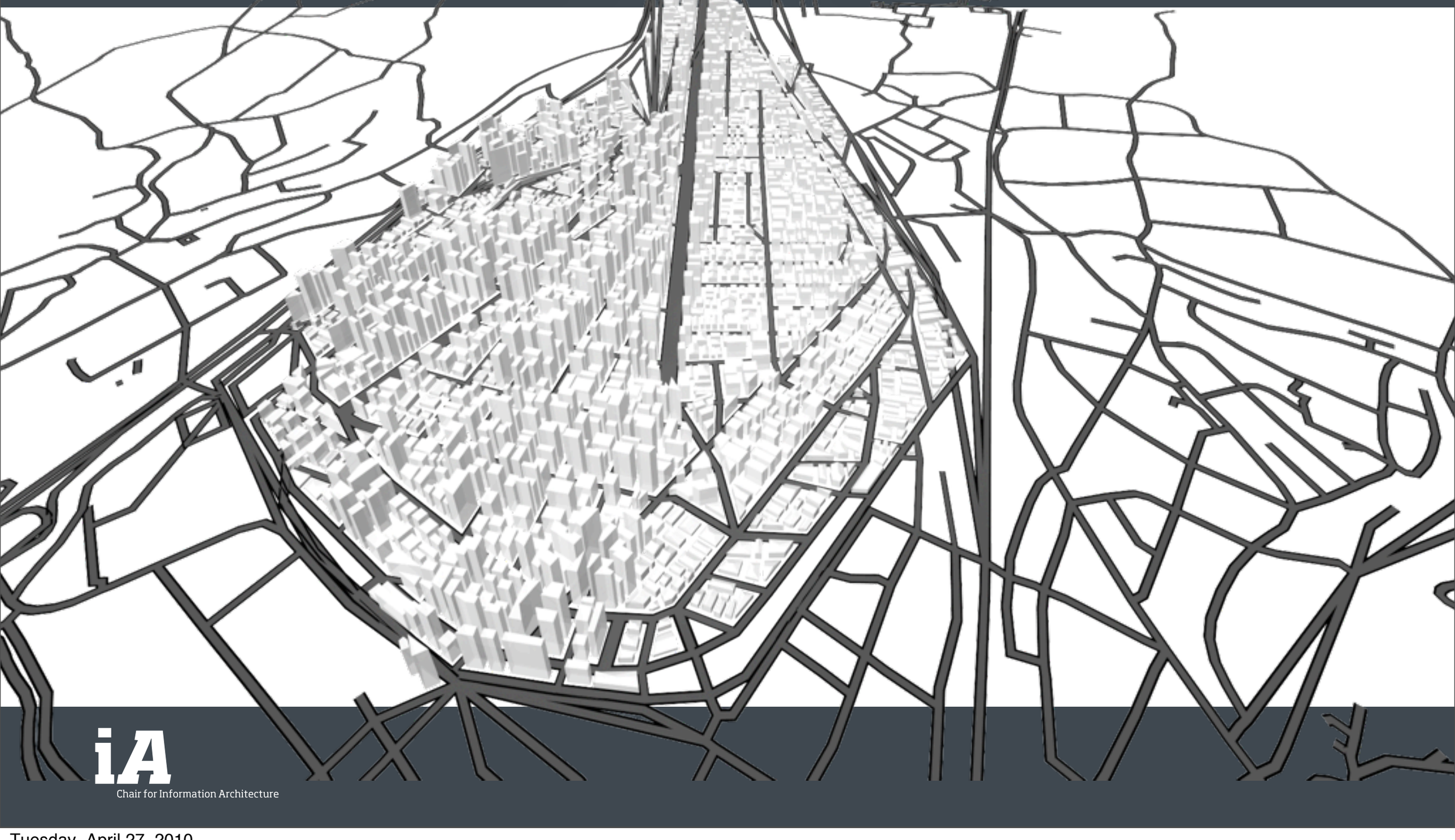
Use scenario Airport Duebendorf



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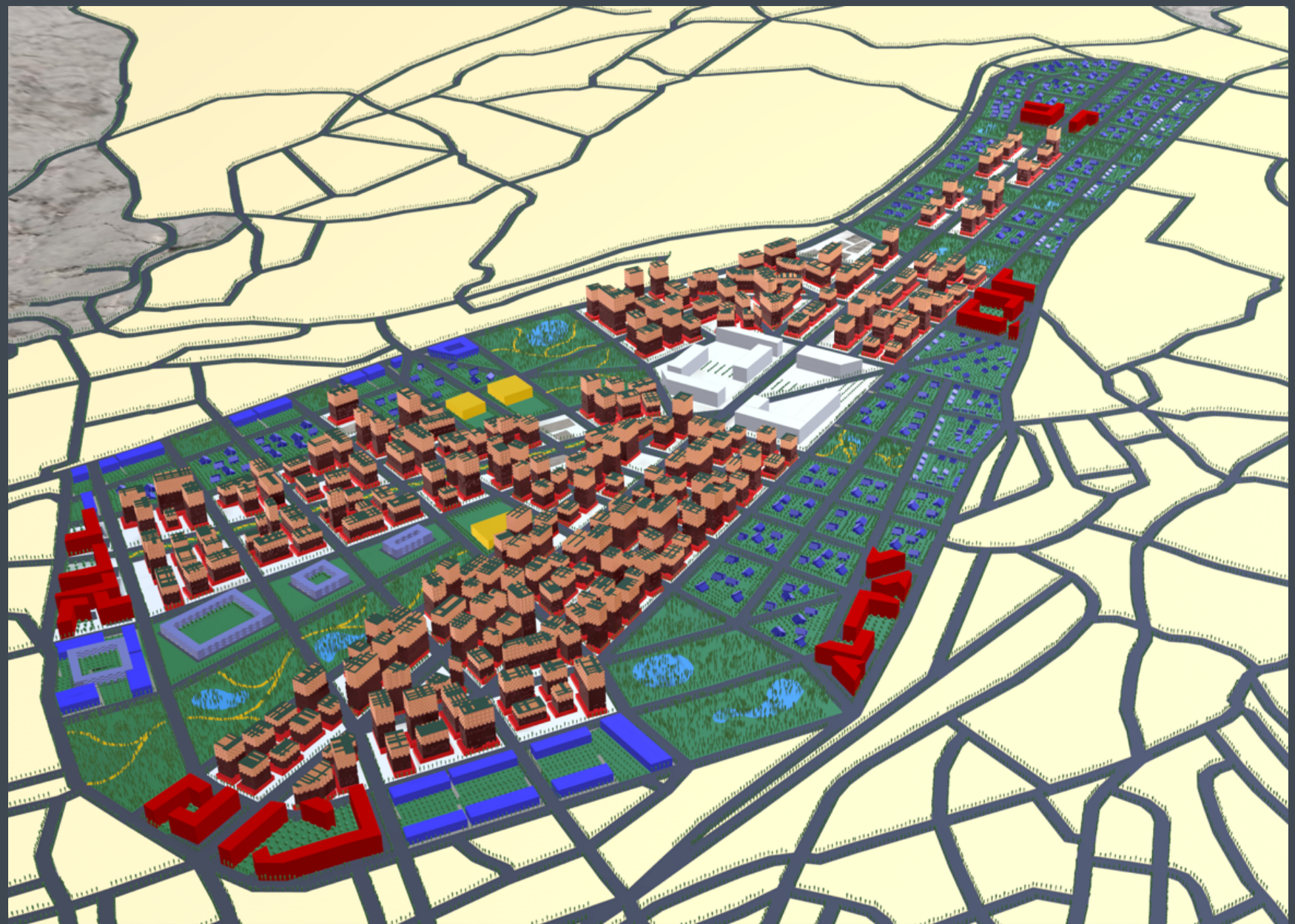
Case Studies

Use scenario Airport Duebendorf



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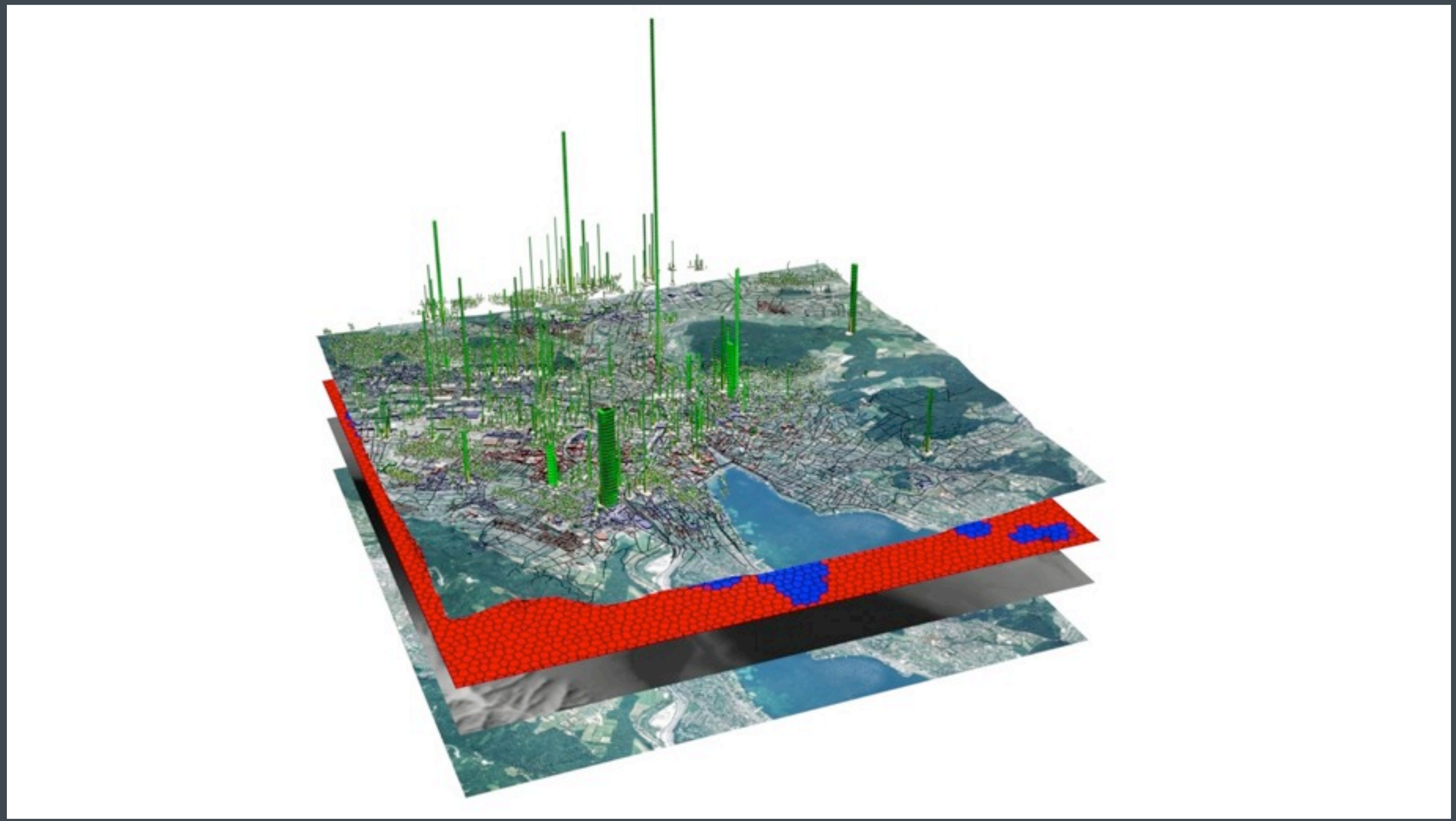
Case Studies

Prediction of urban energy consumption



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Case Studies

Scenario of a fossil fuel free Zurich

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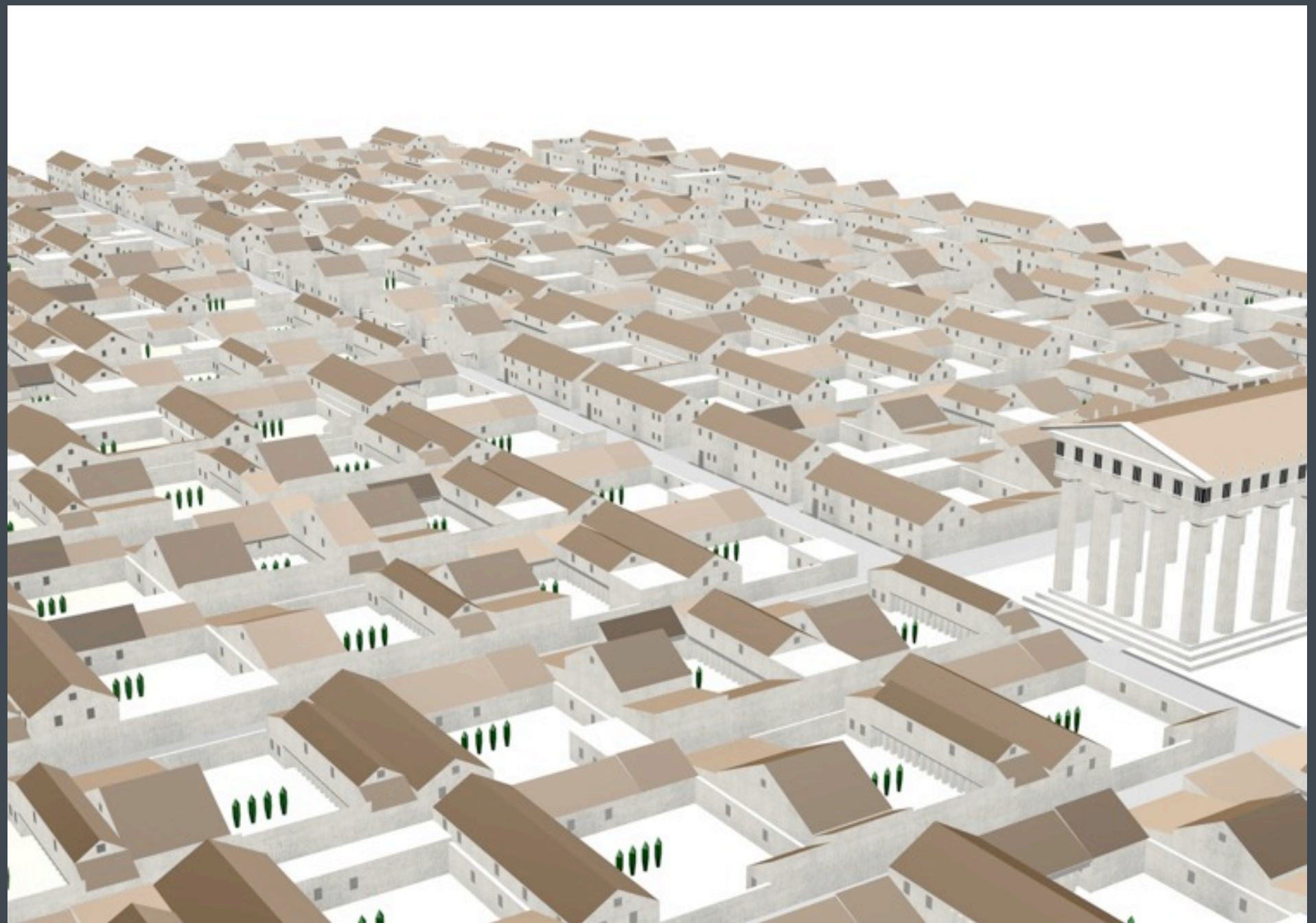
Case Studies

Simulation of an ancient Greece land use scenario



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Case Studies

Swiss Village Abu Dhabi, Masdar

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Overview

Merging Techniques

Grammar-based modelling of urban scenarios

Merging Techniques

Synthetic street growth

Pascal Mueller, ETH Zurich

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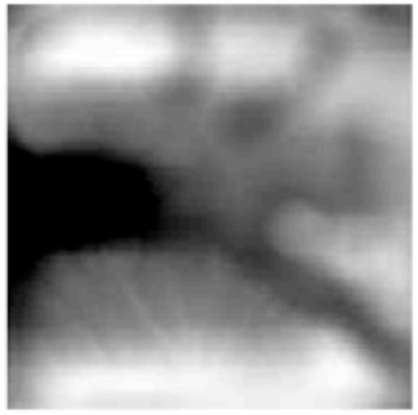
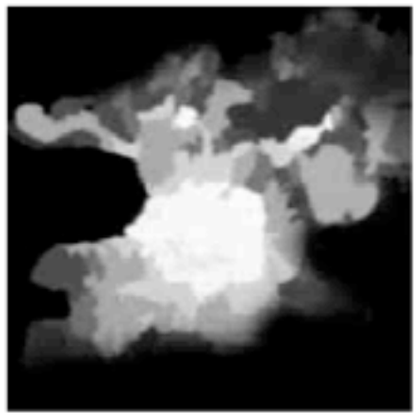
Merging Techniques

Lindenmeyer systems for virtual streets





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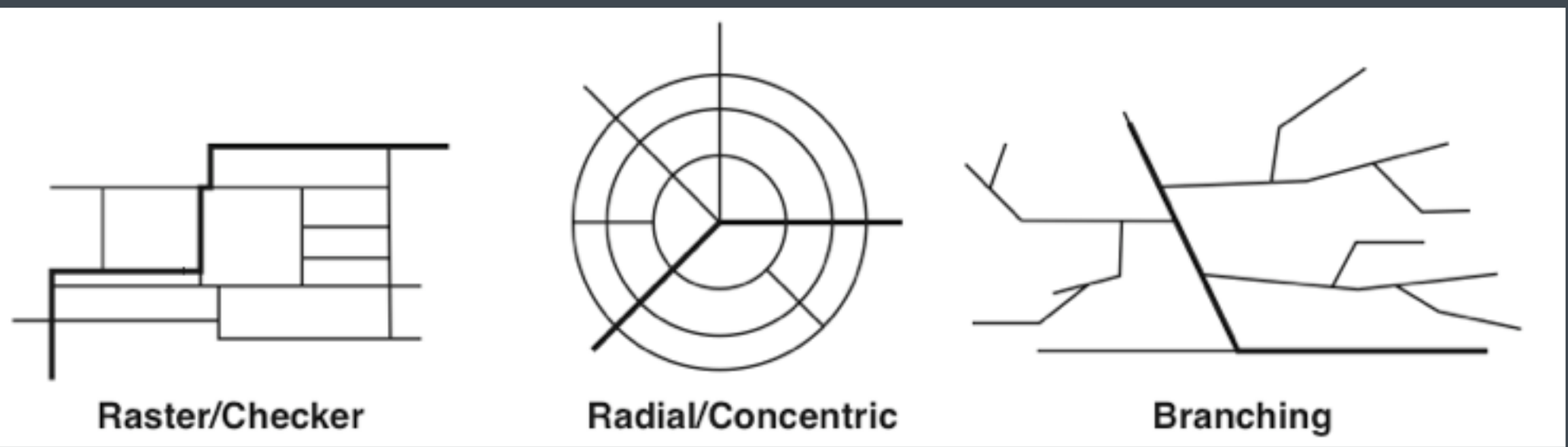
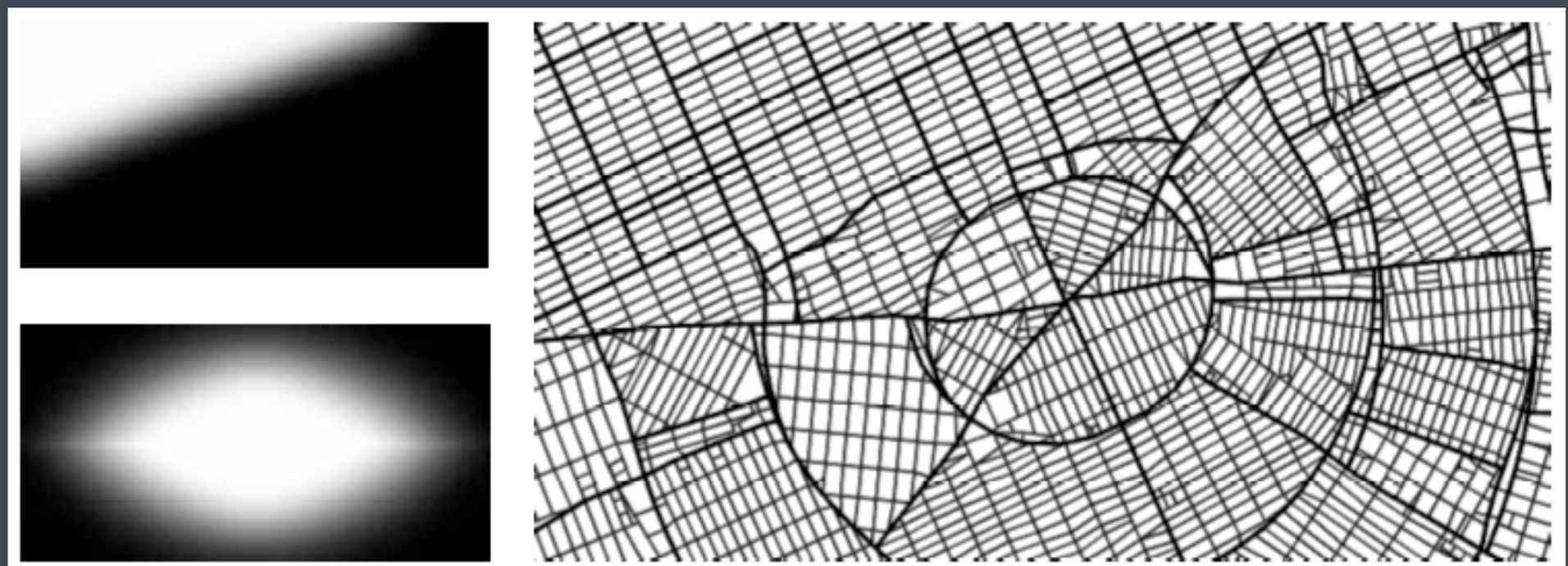
Merging Techniques

Lindenmayer systems for virtual streets





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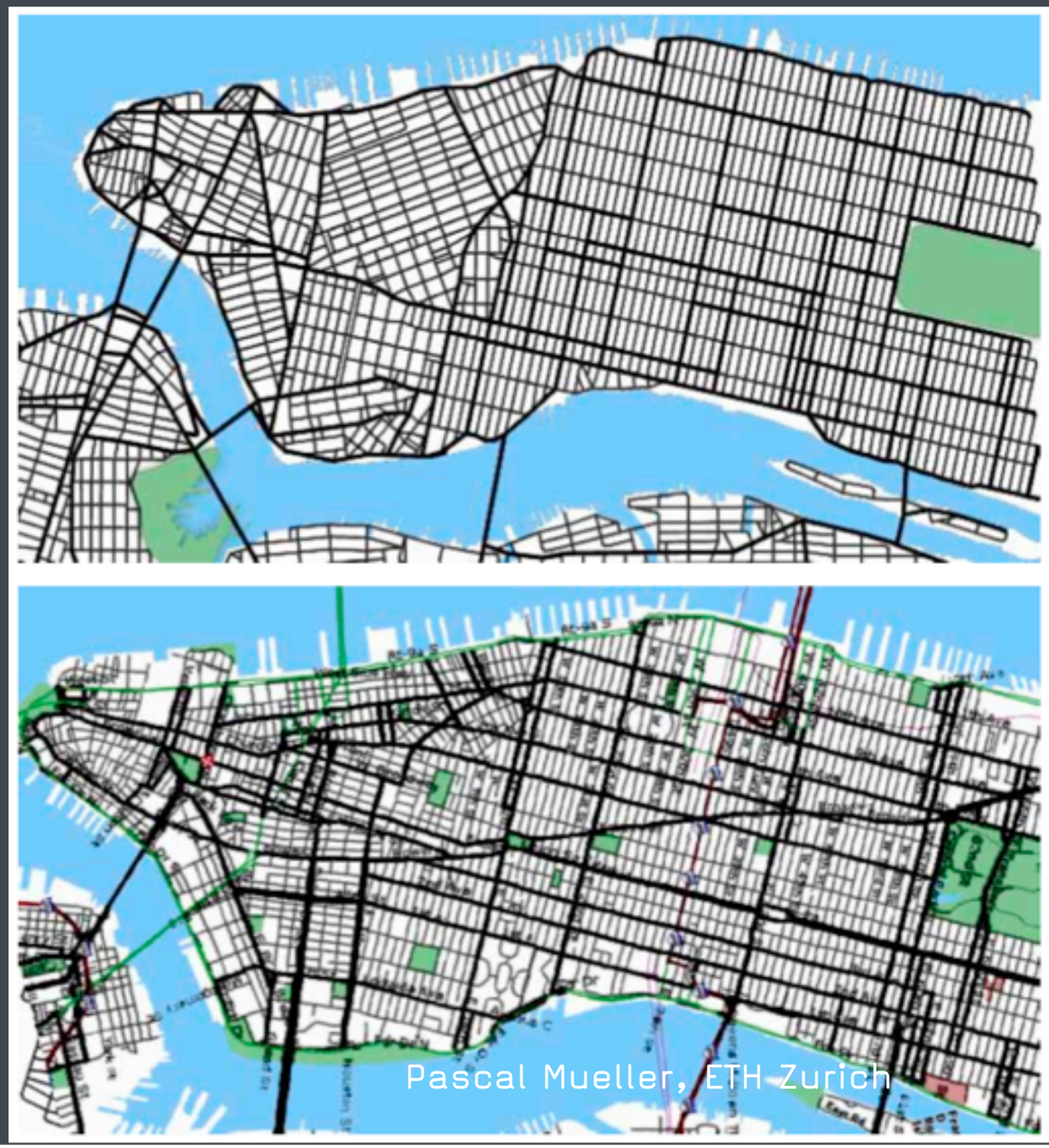
Merging Techniques

Lindenmayer systems for virtual streets

- Promising quantitative results
- Still needed: hand-made modifications



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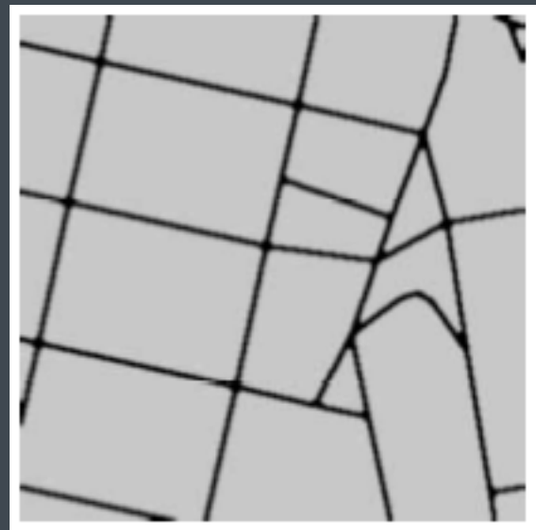
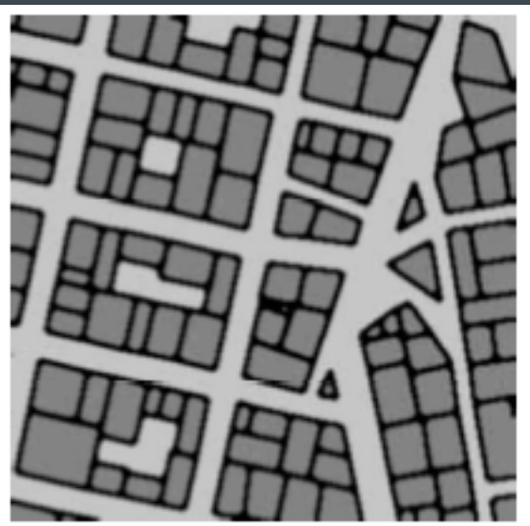
Merging Techniques

Automatic block derivation

- Street networks includes streetwidth etc.
- Major blocks
- Parcel subdivision fulfilling area thresholds





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Overview

Growth

Simulation

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Growth Simulation

Synthetic street growth

Basil Weber, ETH Zurich

New Methods in Urban Simulation

Growth Simulation

Las Vegas

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New Methods in Urban Simulation

Growth Simulation

Las Vegas

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New Methods in Urban Simulation

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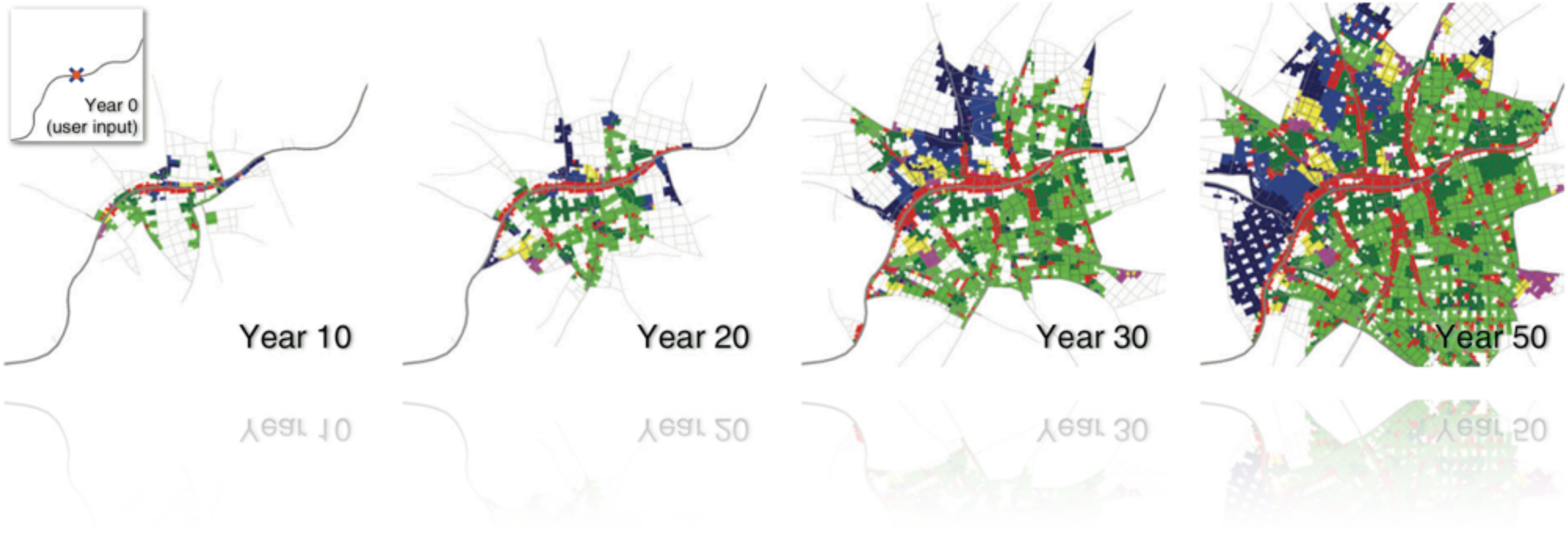

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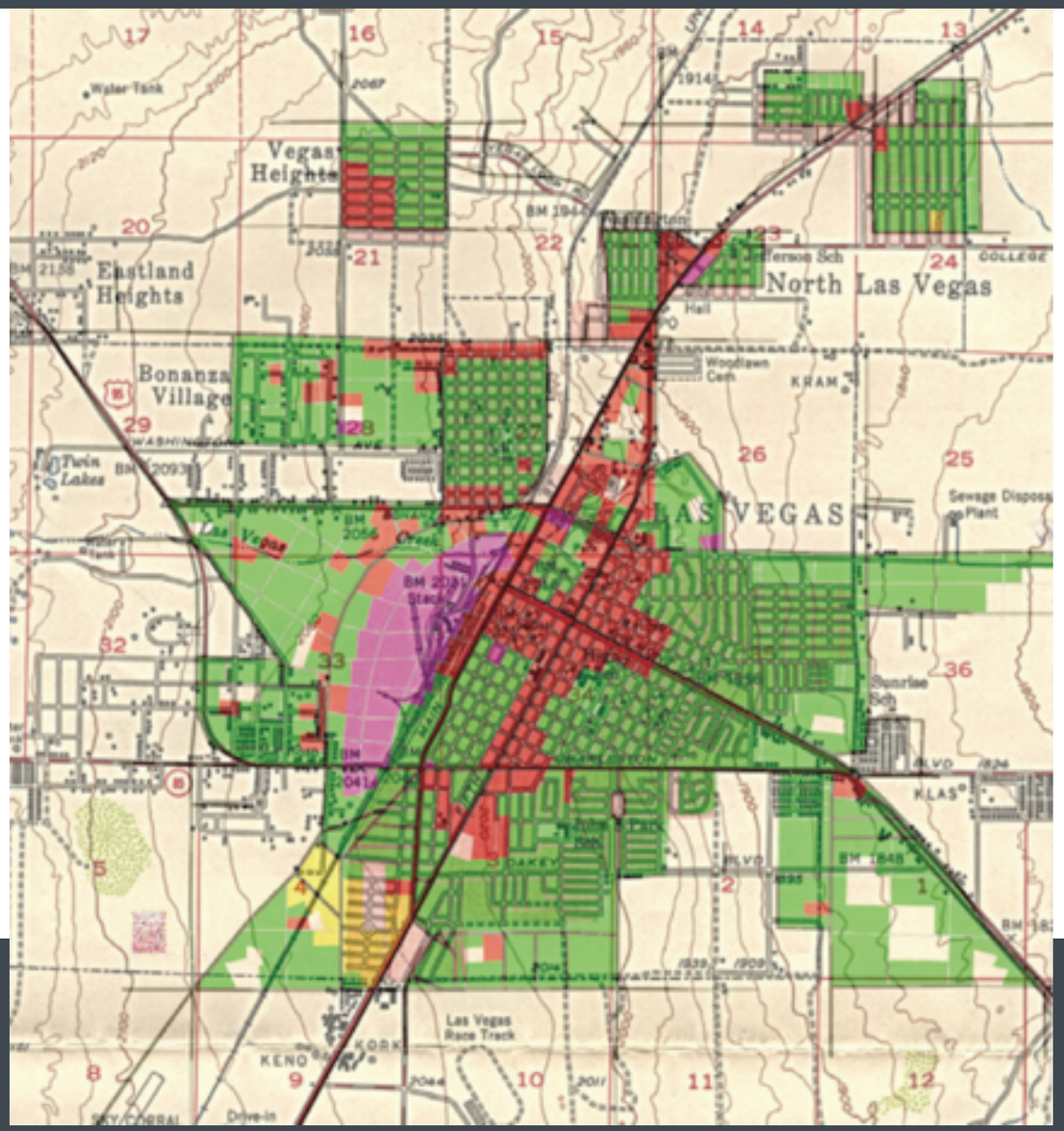
Basil Weber, ETH Zurich

New Methods in Urban Simulation

Growth Simulation

Las Vegas



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Basil Weber, ETH Zurich

New methods in urban simulation

Course ‘Vertiefungsfach (6ECTS)’ in fall 2010:
063-1357-09 NEW METHODS IN URBAN SIMULATION

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Elective Course Information Architecture

New Methods in Urban Simulation - Grammar-based modelling of urban scenarios

Jan Halatsch

April 26, 2010

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