USING SIMULATIONS IN DEVELOPMENT OF COMFORTABLE URBAN SPACES AND SUSTAINABLE BUILDING DESIGN

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CLASS SUMMARY

CLASS ID: AB6585

With the new functionalities and plug-ins for Revit software - such as Light Analysis for Revit software, Green Building Studio web-based energy analysis service, the Tally app, and the Dynamo visual programming language extension - new potentials have emerged during the last year. These developments have not only led to much easier work-flows, but also to a more holistic analysis of the building performance and urban comfort studies. In this lecture, these new potentials, work-flows, and methods for visualizing simulations are shown based on various consultancy tasks and a research project that seeks to add knowledge to architects' design processes as supported with simulation tools.

The research project also included a workshop where participants tested methods on unskilled architectural students. We will wrap this all up in the lecture and relate it to model detail levels, instead of the typical schematic design process related to design phases. In many cases, this does not reflect the actual design process. Design development is done in various detail levels at the same time, especially in the early design phases.

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KEY LEARNING OBJECTIVES

AT THE END OF THIS CLASS, YOU WILL BE ABLE TO

Get started with the newest simulation functionalities in Revit software from early conceptual design to detail design

Recognize possibilities and limitations within the different simulations related to model detail levels

Learn how to choose simulations and visualization methods to analyze urban spaces, indoor environment, and operational and embodied energy

Discover more effective use of simulations to minimize time consumption in the process of creating sustainable designs

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ABOUT THE SPEAKER

SUMMARY - CONTACT INFO - SOCIAL MEDIA



The Danish architect Daniel Nielsen became interested in sustainability in 2001, and he now has both a broad understanding and practical experience in creating architectural sustainability. Daniel works on projects of various scales—from buildings to planning—with the aim of creating high-quality architectural designs that take comfort, climate conditions, and resources into account. He integrates Green Building Information Modeling (BIM) into his work, using digital 3D BIM modeling and simulation tools to visualize and validate his designs. At the moment Daniel is involved in various research projects and education programs as external researcher and lecture at The Royal Danish Academy of Fine Arts, School of Architecture and Technical University of Denmark. Daniel also consults about architectural design at architecture firms.

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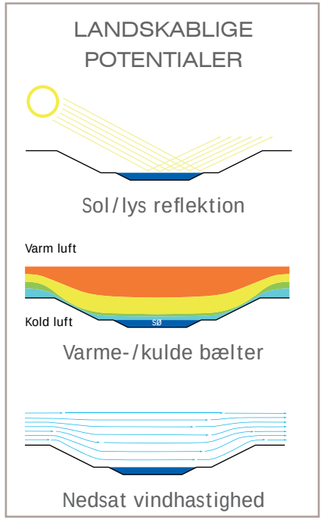
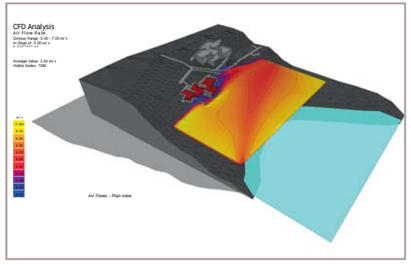
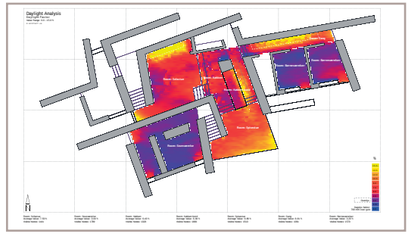
ABOUT THE SPEAKER

PROFESSIONAL REFERENCES



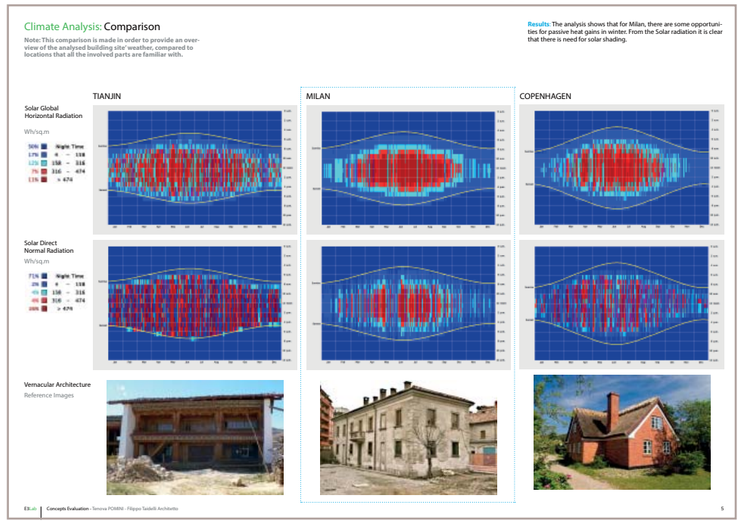




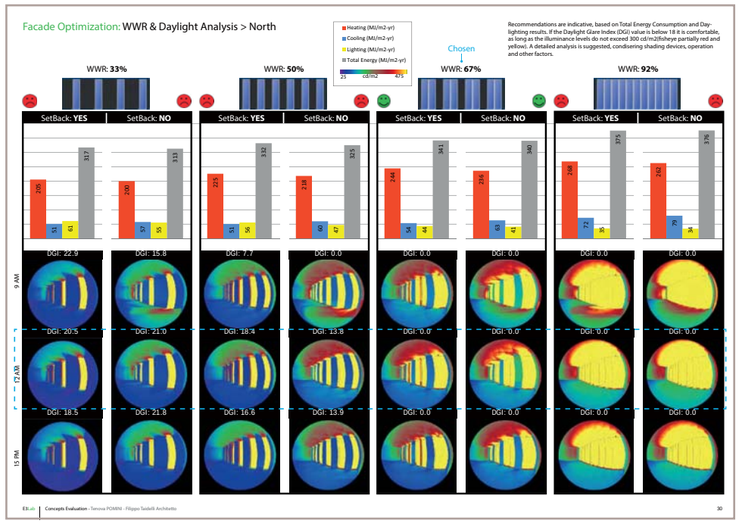




Organic Cube - CPH Wood festival 2009 by Søren Korsgaard + Daniel Nielsen



Corroboration with e3lab



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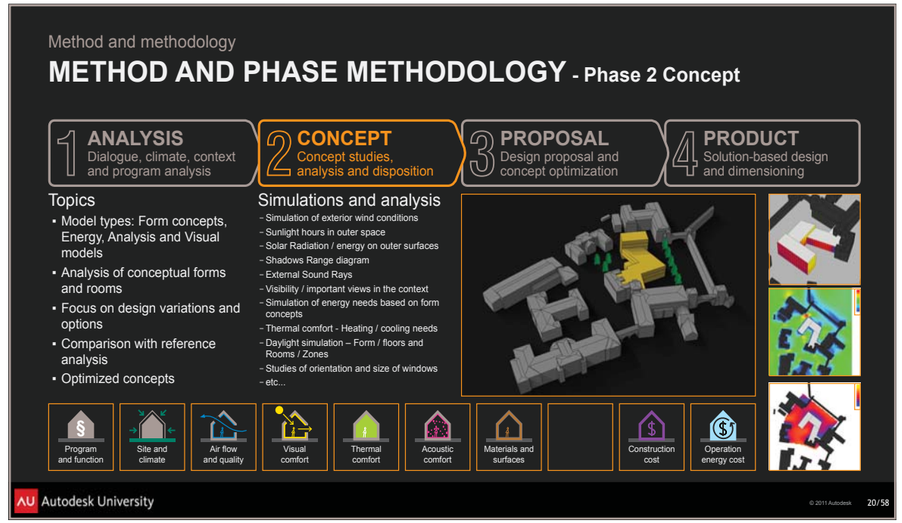

Corroboration with DTI

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ABOUT THE SPEAKER

RESEARCH-BASED TEACHING - CONSULTANCY - DESIGN

UNIVERSITIES

COMPANIES

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ABOUT THE SPEAKER

CONSULTANCY SERVICES



DESIGN ANALYSES

Environmentel design analysis of client design

Including visual reports with recomendations

Image link: http://www.translation-project-management.com/images/site/analysis.jpg



EDUCATIONAL COURSES

Arranging customized client workshops and courses

Courses focusing on tested and most used simulation, modeling and parametric design tools

Image link: http://assets3.bigthink.com/system/idea_thumbnails/49394/headline/Cloud-Learning.jpg?1360943427



DESIGN DEVELOPMENT

Proposing and developing environmental design and strategies

From conceptual design to detail design

Image link: http://webwhisperer.com.au/wp-content/uploads/2012/08/Designing1.png

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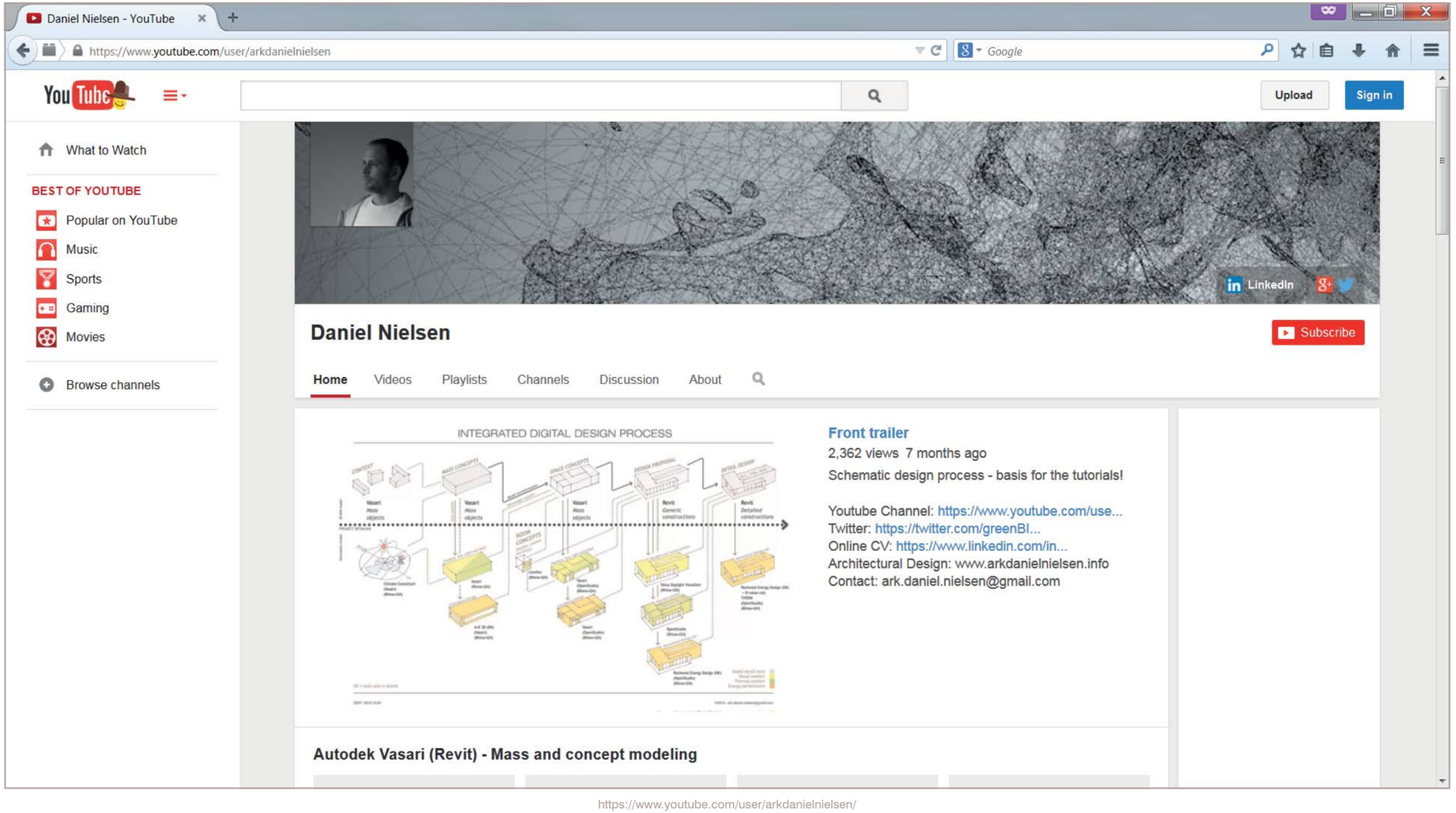
YOUTUBE CHANNEL



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[>]

INTRODUCTION

INTRODUCTION

THE CONTENT

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EDUCATIONAL CONTEXT

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DESIGN ANALYSES

[3]

PARAMETRIC POSSIBILITIES

[4]

EFFICIENT PROCESS

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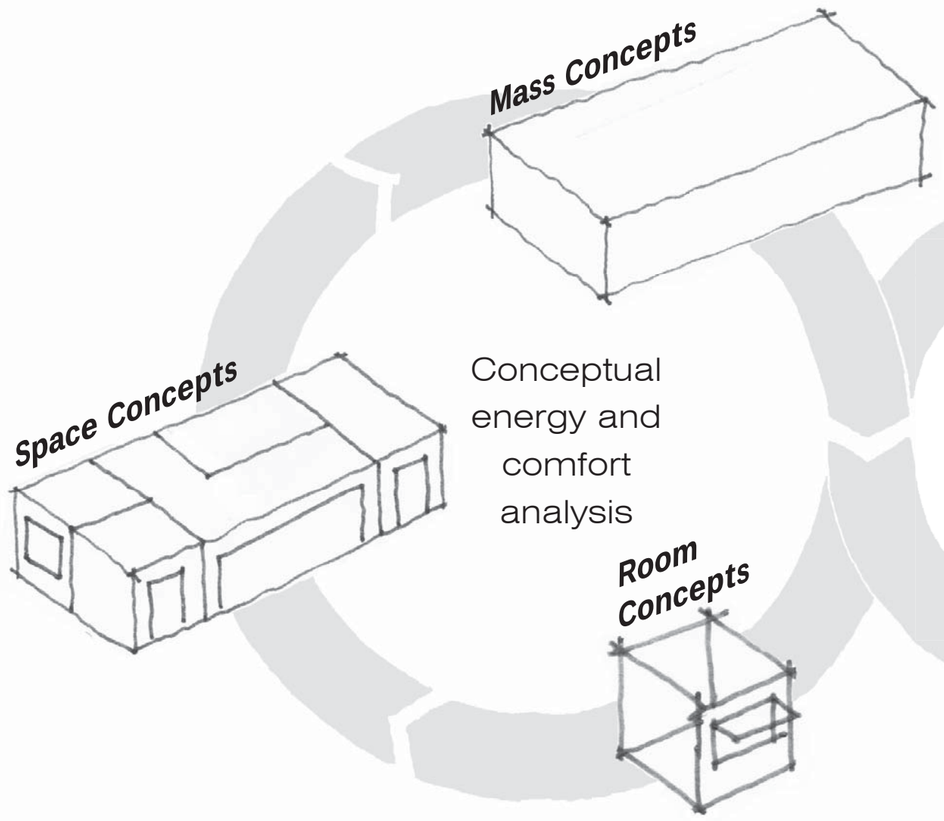
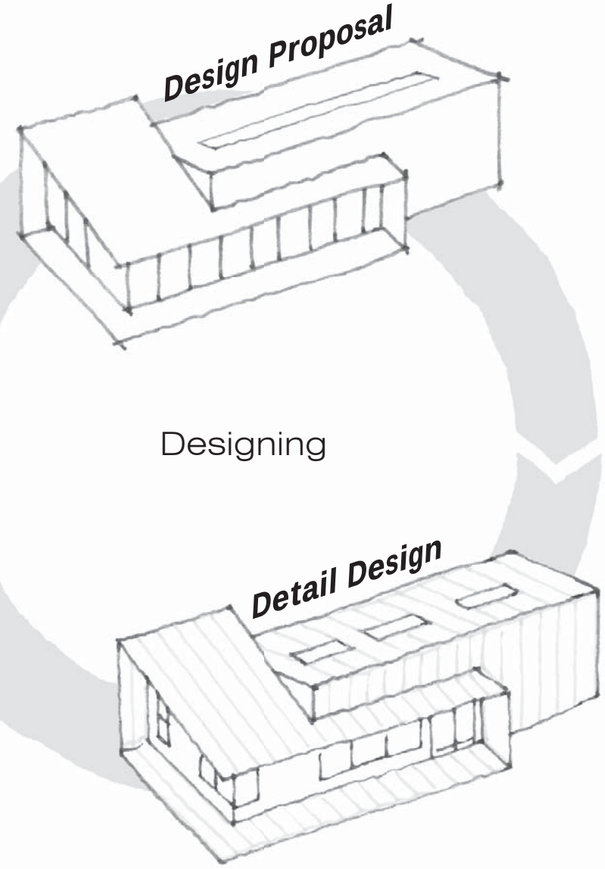
INTRODUCTION

DESIGN WITH KNOWLEDGE !

EARLY INSIGHT AND UNDERSTANDING OF DESIGN OPTIONS



QUALIFIED DESIGN DECISIONS AND SOLUTIONS



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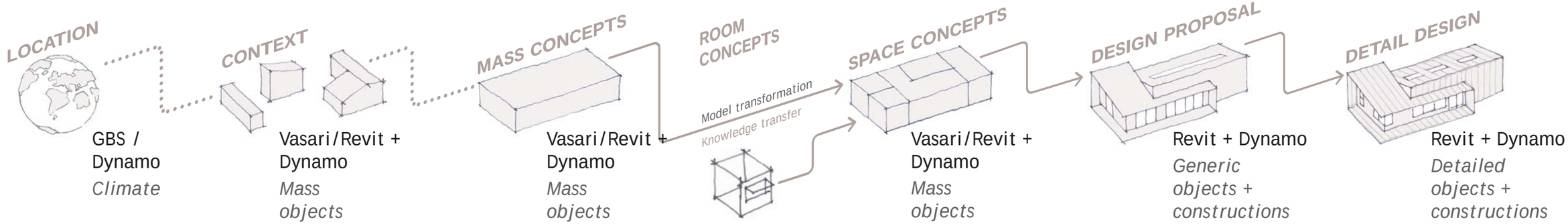
LEVEL OF MODEL DETAILING RELATED TO REVIT MODELING



3D BIM models

PROJECT DETAILING

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From a Architectural Point of View with a tough of engineering

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[1]

EDUCATIONAL CONTEXT

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Introduction to Autodesk Environmental Simulation Tools

How to read and understand Simulation Outputs

Case-studies from Student Courses and Design Practice

Learning from Educational Context

THE EDUCATIONAL CONTEXT

IS IT POSSIBLE TO COMPARE ONLY ONE “DESIGN” ?



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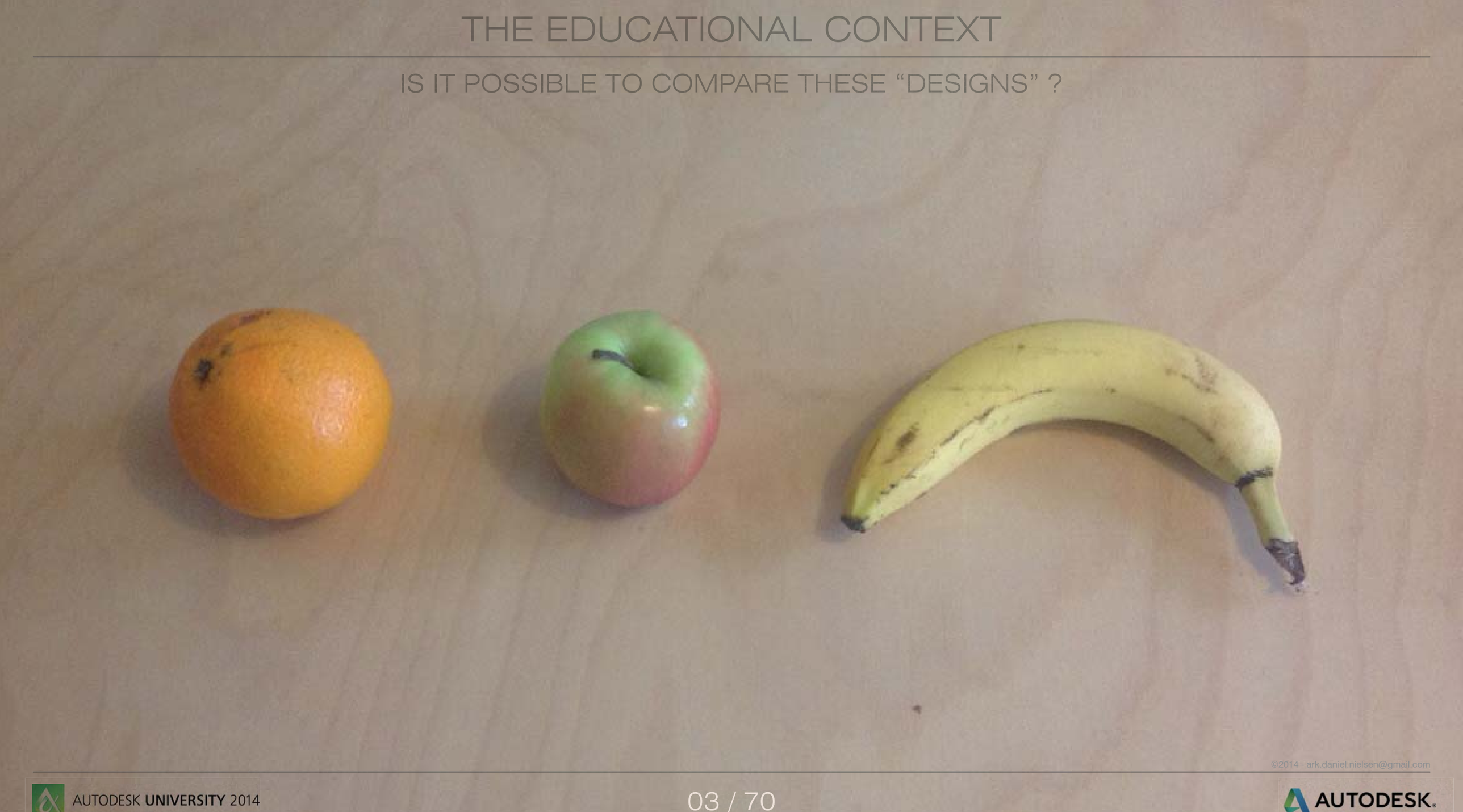
THE EDUCATIONAL CONTEXT

IS IT POSSIBLE TO COMPARE THESE “DESIGNS” ?



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THE EDUCATIONAL CONTEXT

IS IT POSSIBLE TO COMPARE THESE “DESIGNS” ?



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[1.1]

INTRODUCTION TO AUTODESK ENVIRONMENTAL SIMULATION TOOLS

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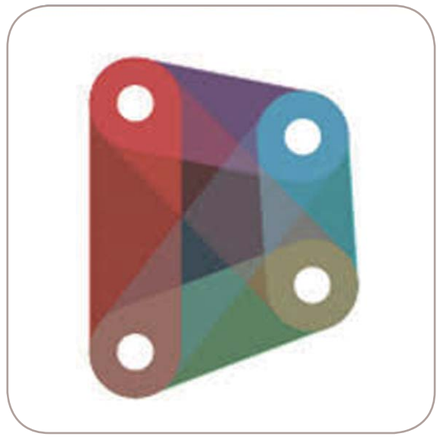
THE FAMILY TREE!

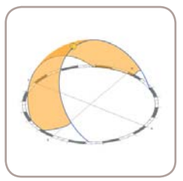
"THE PARENTS" - A MODERN FAMILY! ;)



"THE CHILDRENS"











"THE COUSINS"







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INTRODUCTION TO AUTODESK ENVIRONMENTAL SIMULATION TOOLS

A BORING TABEL ...

	Tools for Weather data visualization /analysis	Tools for Exterior Analysis	Tools for Interior Analysis	Tools for Constructions and Area Analysis	Tools for Visualization of simulations/ calculations
Revit	Revit+GBS - Climate studies (through R&C or GBS) Revit+Project Solon - Climate studies	Revit - Shadow studies Revit - Solar Radiation studies	Revit - Shadow studies Revit - Conceptual Energy studies Revit - Detailed Energy studies Revit - Daylight/Light Levels Revit+Light Analysis - Daylight/ Light Levels	Revit - Studies of surface areas and floor areas Revit - U-value studies of detailed constructions Revit - Conceptual LCA studies Revit+Tally - Detailed Object-based LCA	Revit - Sheets, model Views, Images etc. Revit+Project Solon - energy and climate data viz
Vasari	Vasari - Climate studies (through R&C or GBS) Vasari - Wind rose studies Vasari+Project Solon - Climate studies	Vasari - Shadow studies Vasari - Wind Pattern Vasari - Solar Radiation	Vasari - Shadow studies Vasari - Conceptual Energy studies Vasari - Solar Radiation Vasari - Wind Pattern	Vasari - Conceptual LCA studies Vasari - Studies of surface areas and floor areas	
GBS	GBS+Project Salon - Climate studies		GBS - Conceptual Energy studies and Detailed Energy studies		GBS+Project Salon - energy and climate data viz
FD		Flow Design - Wind Pattern Flow Design - Wind Pressure	Flow Design - Wind Pattern Flow Design - Wind Pressure		
Dynamo	Dynamo - Simulation Results	Dynamo - Solar Radiation	Dynamo - Energy studies Dynamo - Daylight/Light Levels (with Render in cloud) Dynamo - Solar Radiation		

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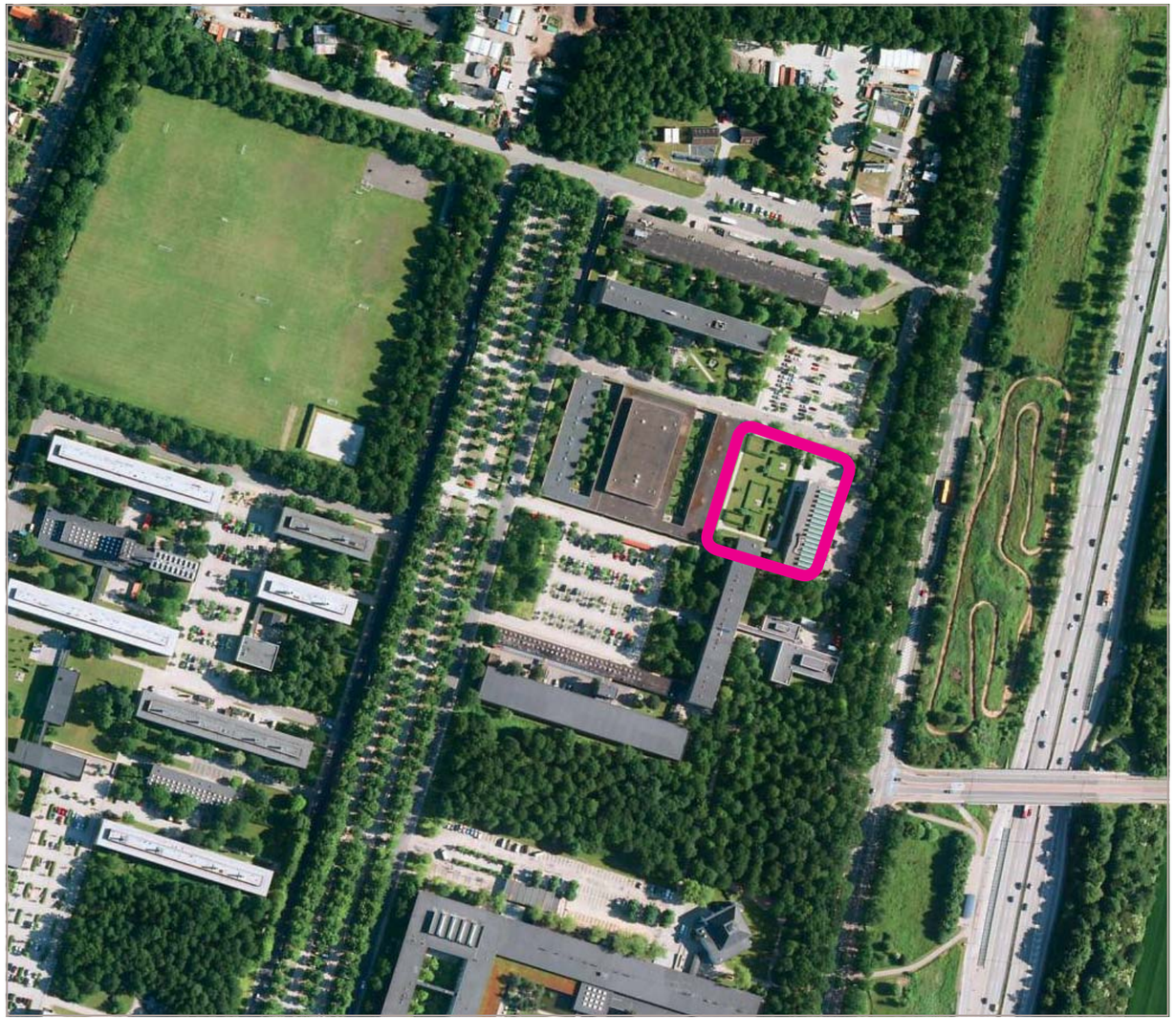
[1.2]

HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

CASE PROJECT - EXTENSION TO DTU CAMPUS





Google Earth

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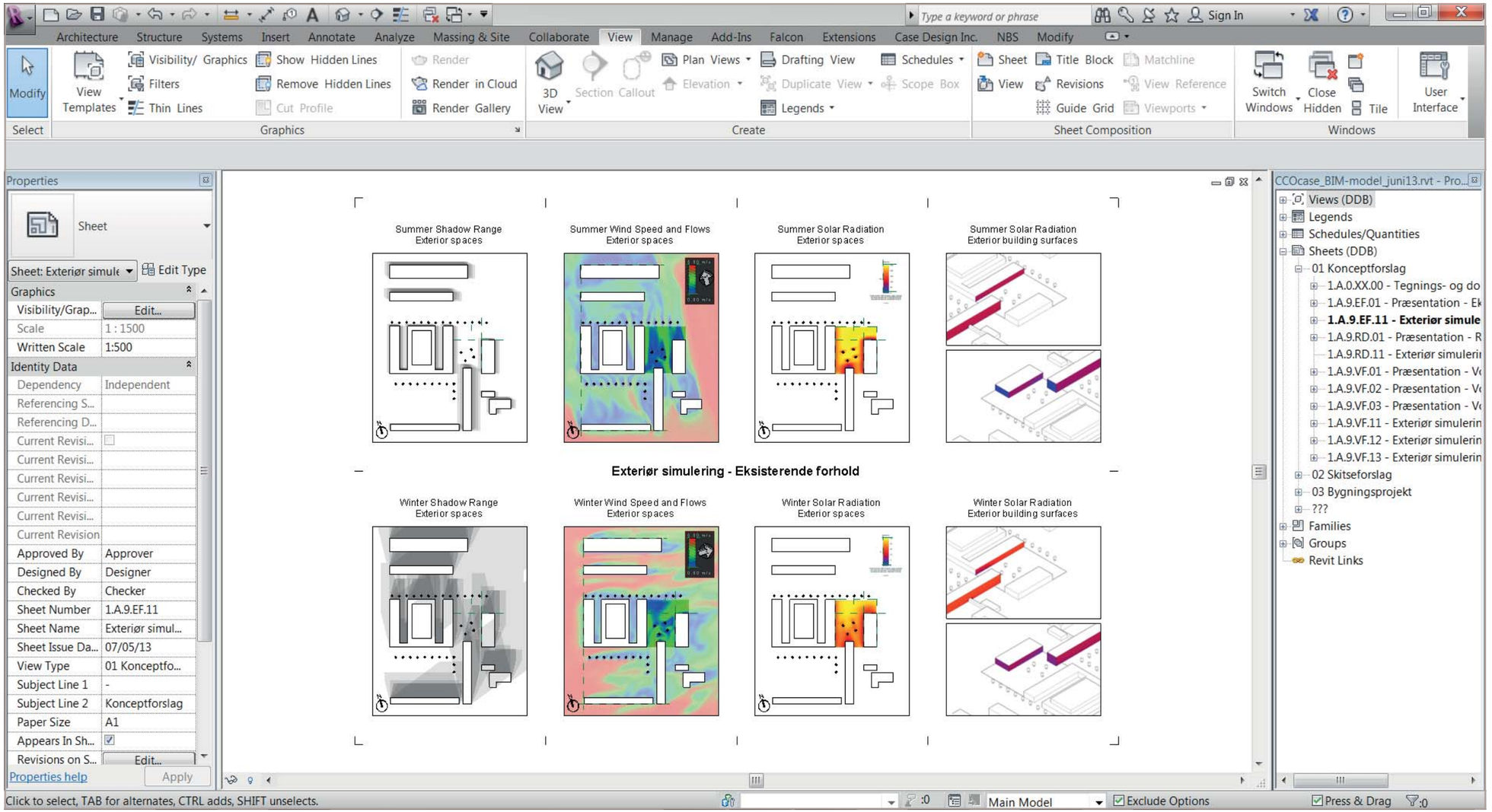
VISUALIZATION OF SIMULATIONS



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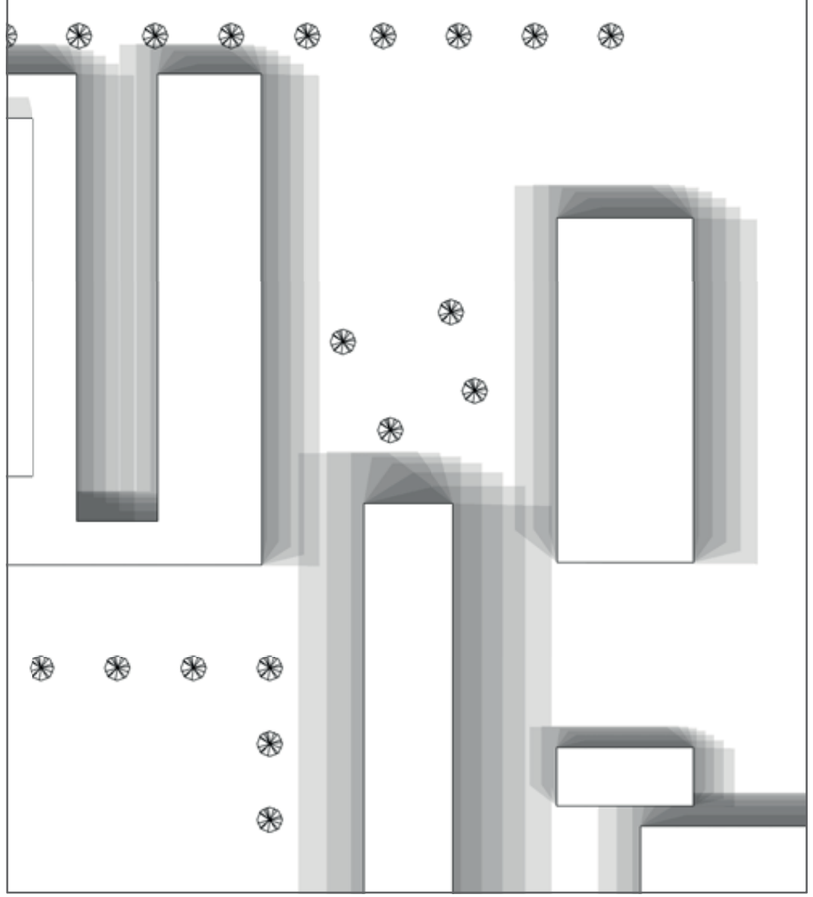
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

URBAN SHADOW STUDIES - PLAN VIEW

SHADOW RANGE - SUMMER

Outdoor Spaces

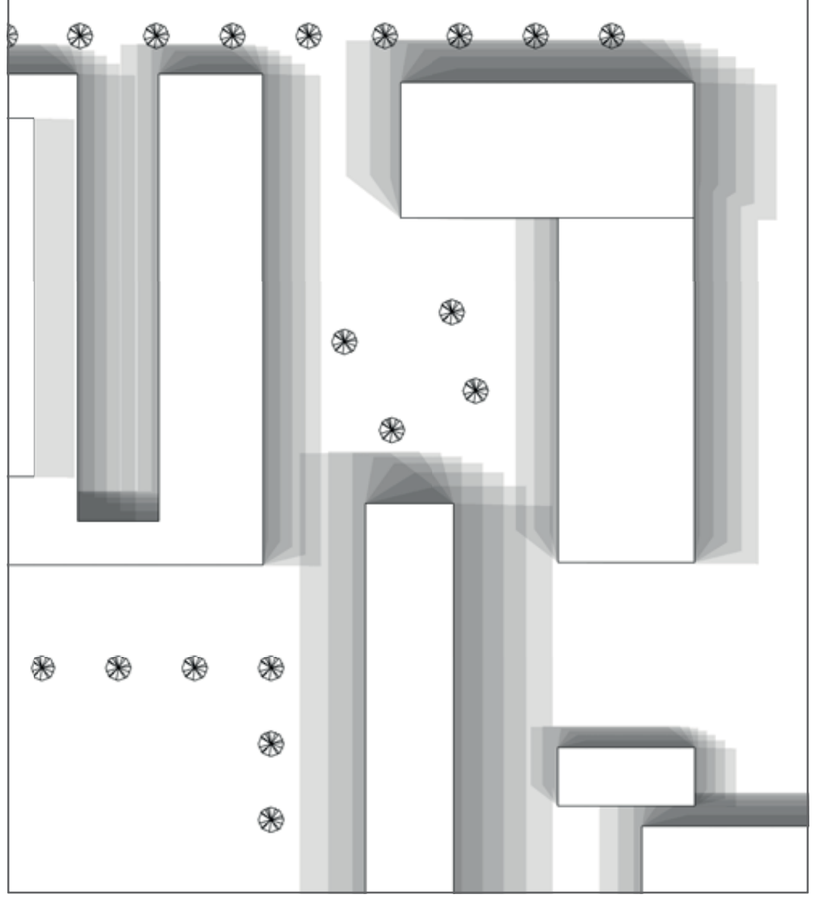
Original



SHADOW RANGE - SUMMER

Outdoor Spaces

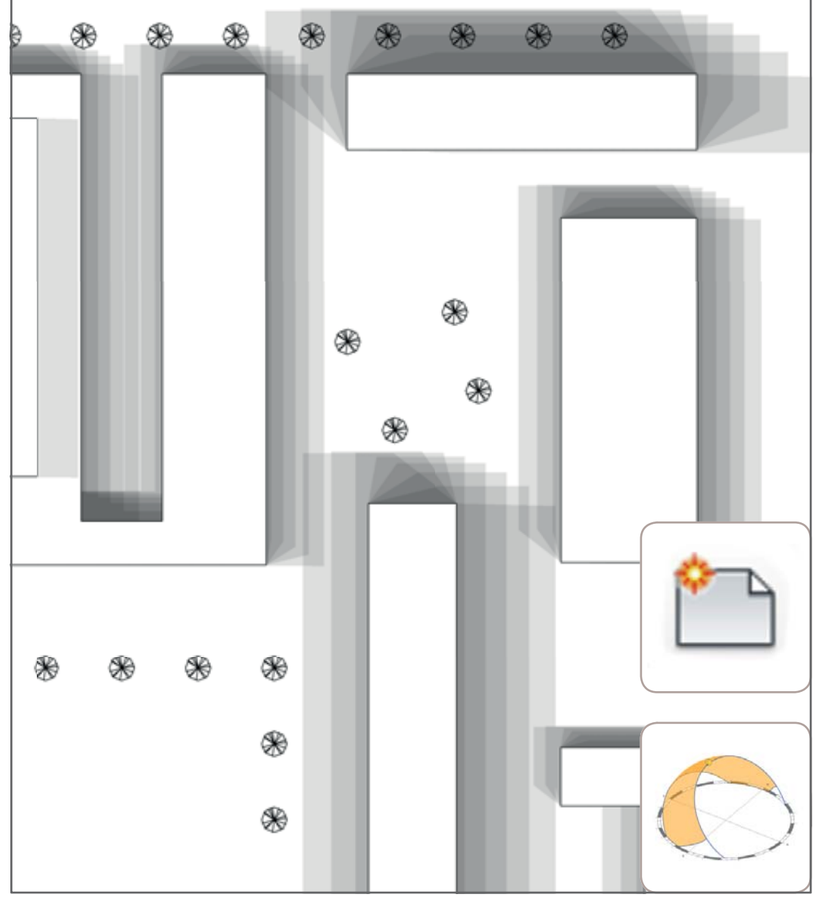
Option 1



SHADOW RANGE - SUMMER

Outdoor Spaces

Option 3



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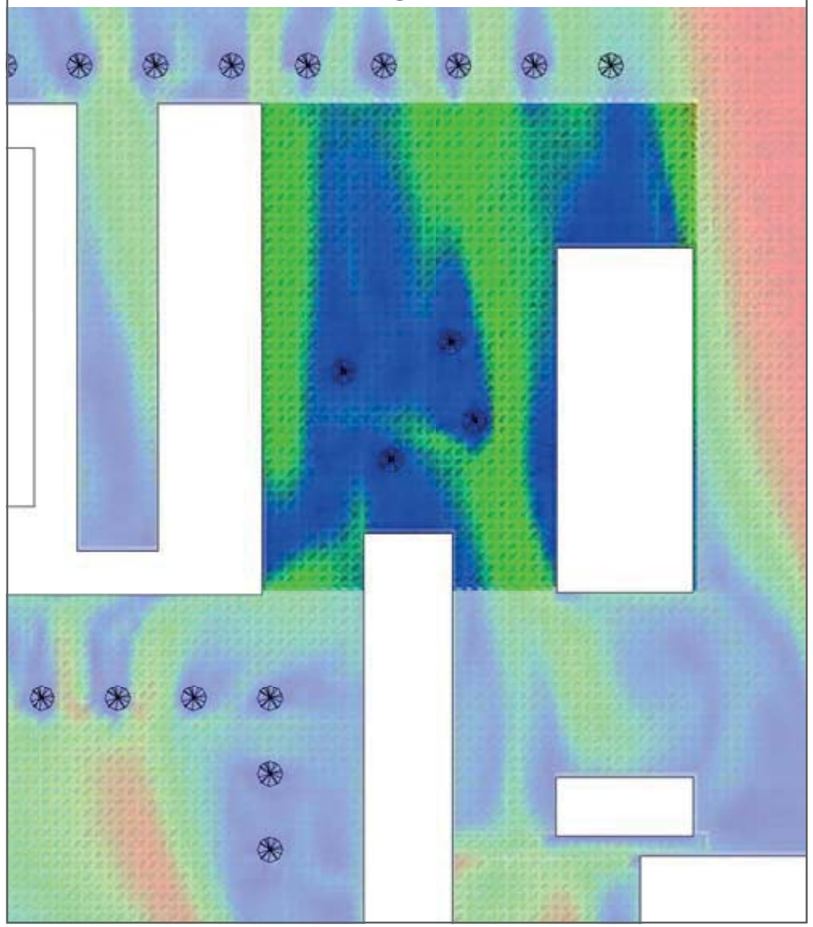
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

URBAN SHADOW STUDIES - PLAN VIEW

WIND PATTERN - SUMMER

Outdoor Spaces

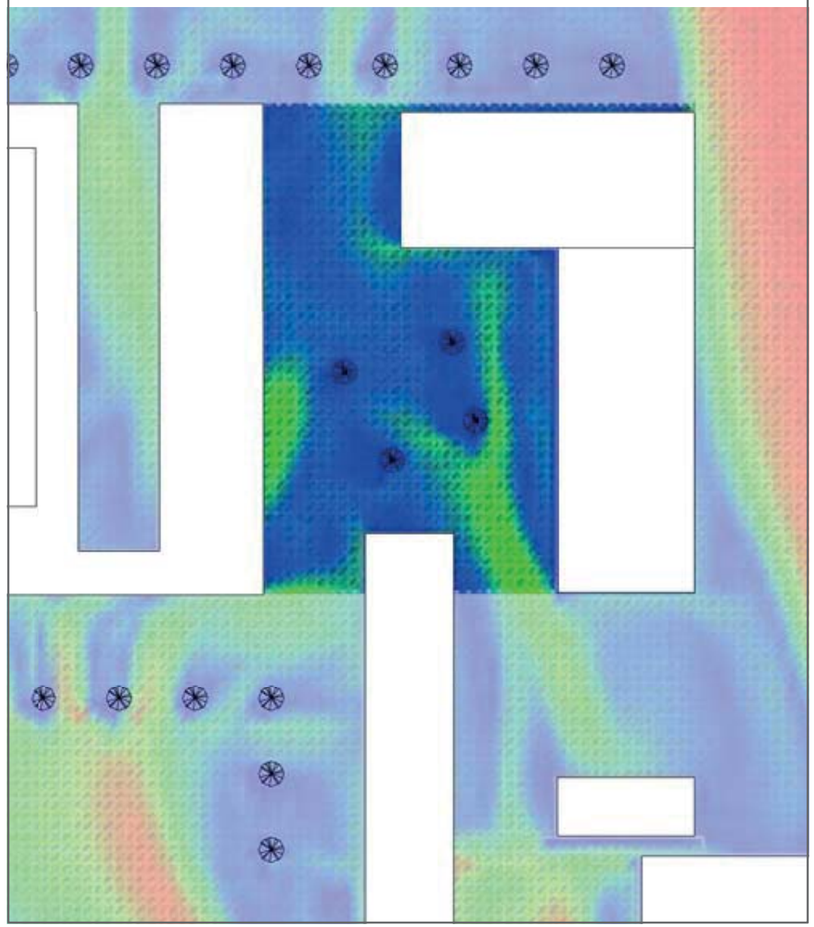
Original



WIND PATTERN - SUMMER

Outdoor Spaces

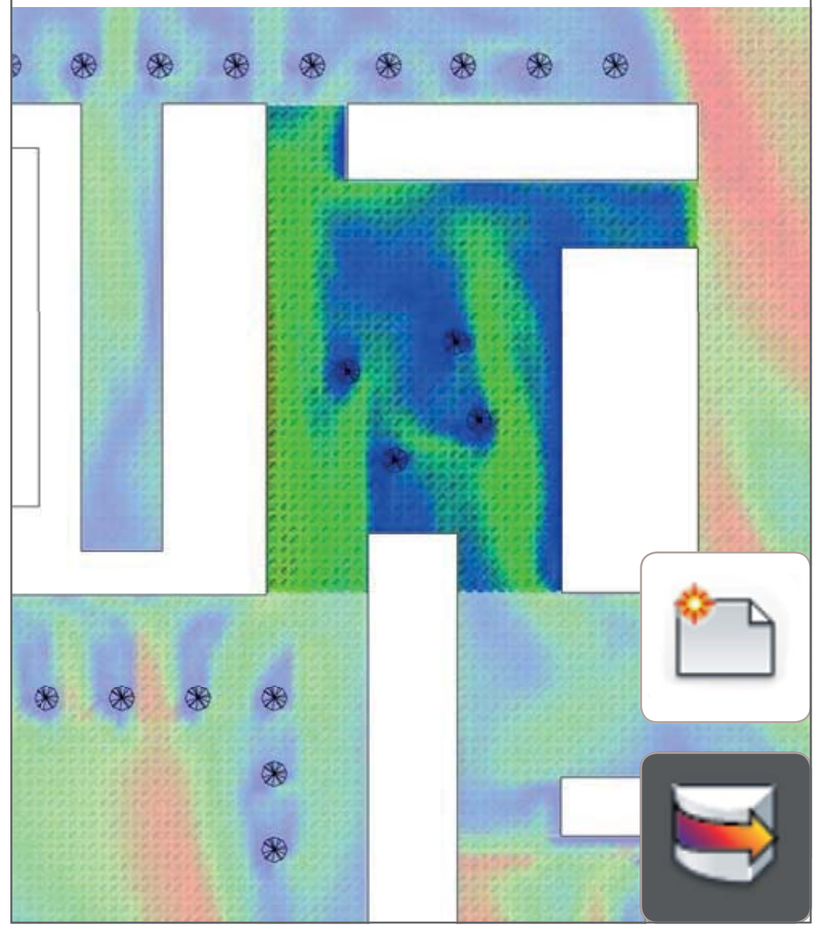
Option 1



WIND PATTERN - SUMMER

Outdoor Spaces

Option 3



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A SIMPLE SCALE IN WIND SIMULATIONS



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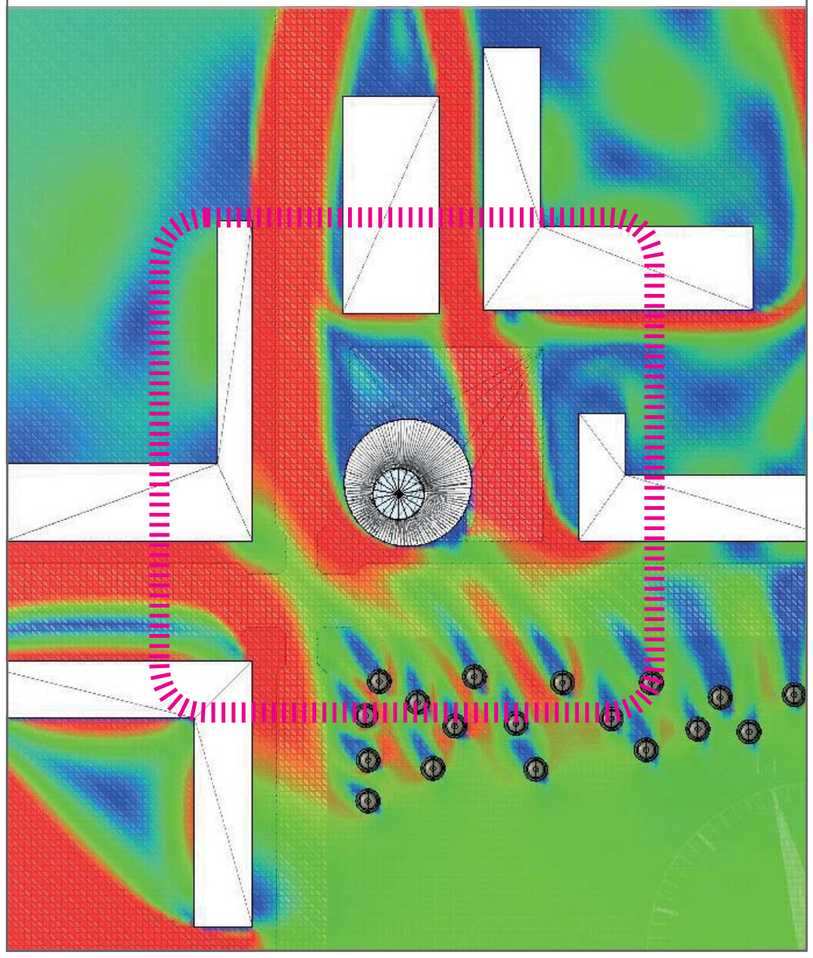
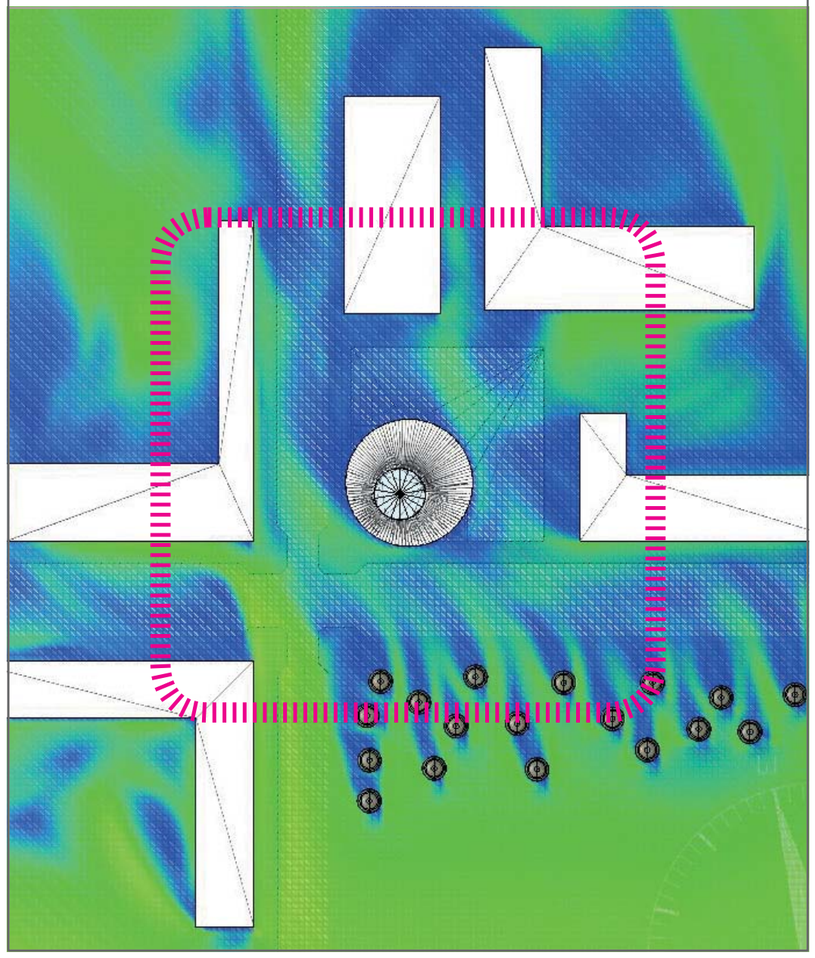
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

COMPARING - 2D / 3D SIMULATIONS AND THE COLOR SCALE RANGE

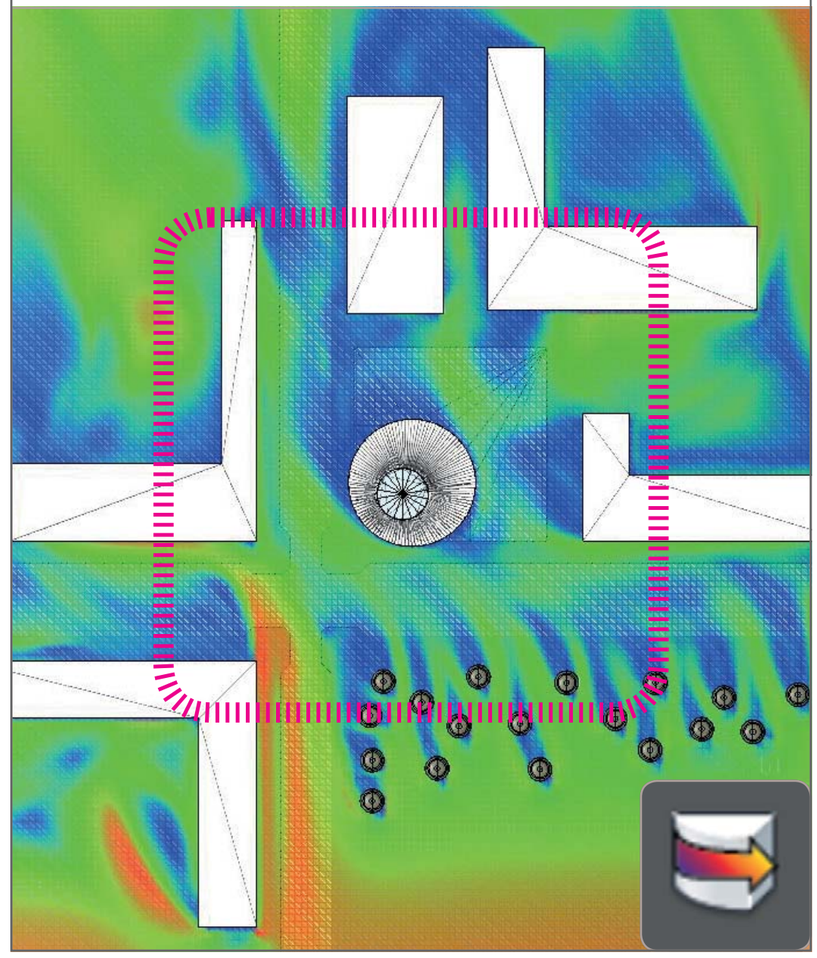
2D WIND TUNNEL SIMULATION
COLOR SCALE: 0-20 M/S



2D WIND TUNNEL SIMULATION
COLOR SCALE: 0-20 M/S



2D WIND TUNNEL SIMULATION
COLOR SCALE: 0-15 M/S



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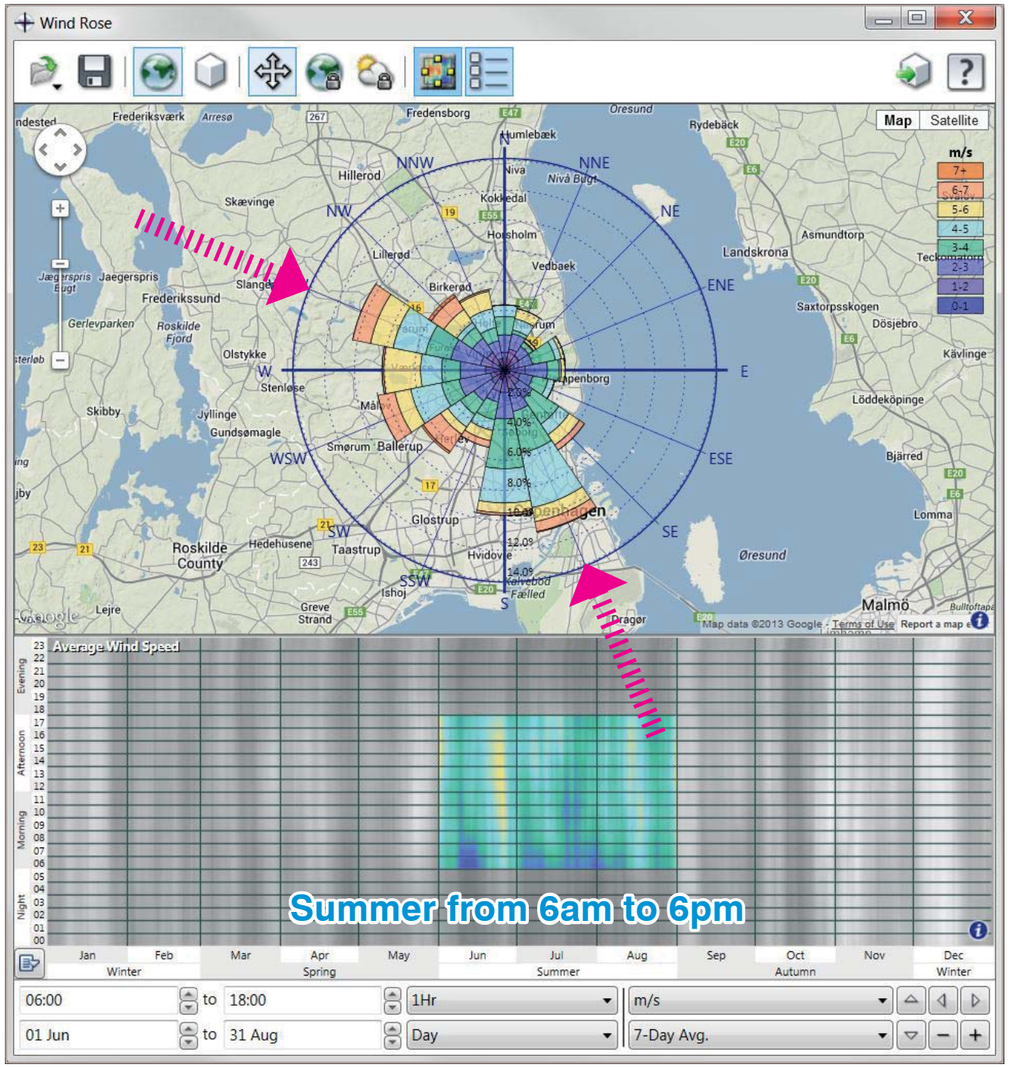
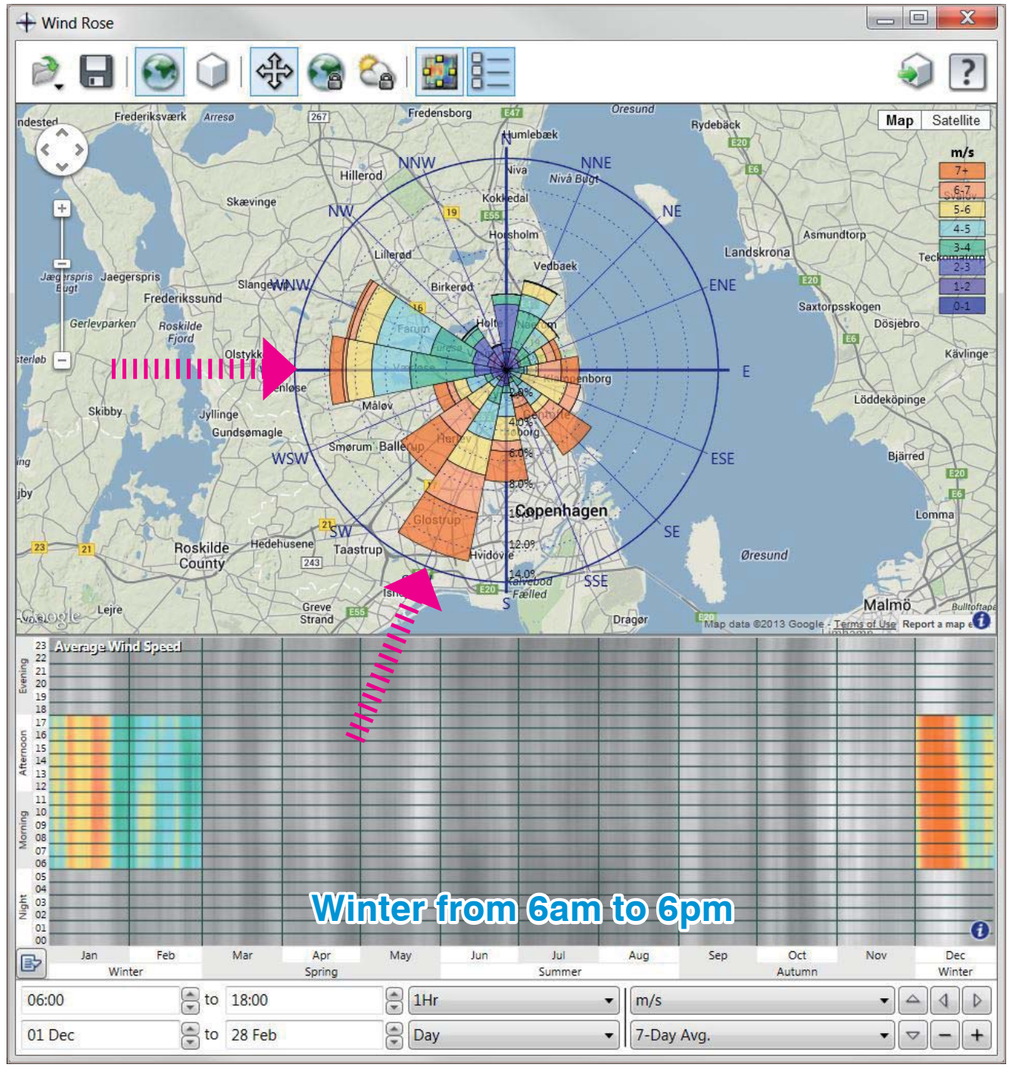
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

ANALYZING PREVAILING WIND DIRECTION





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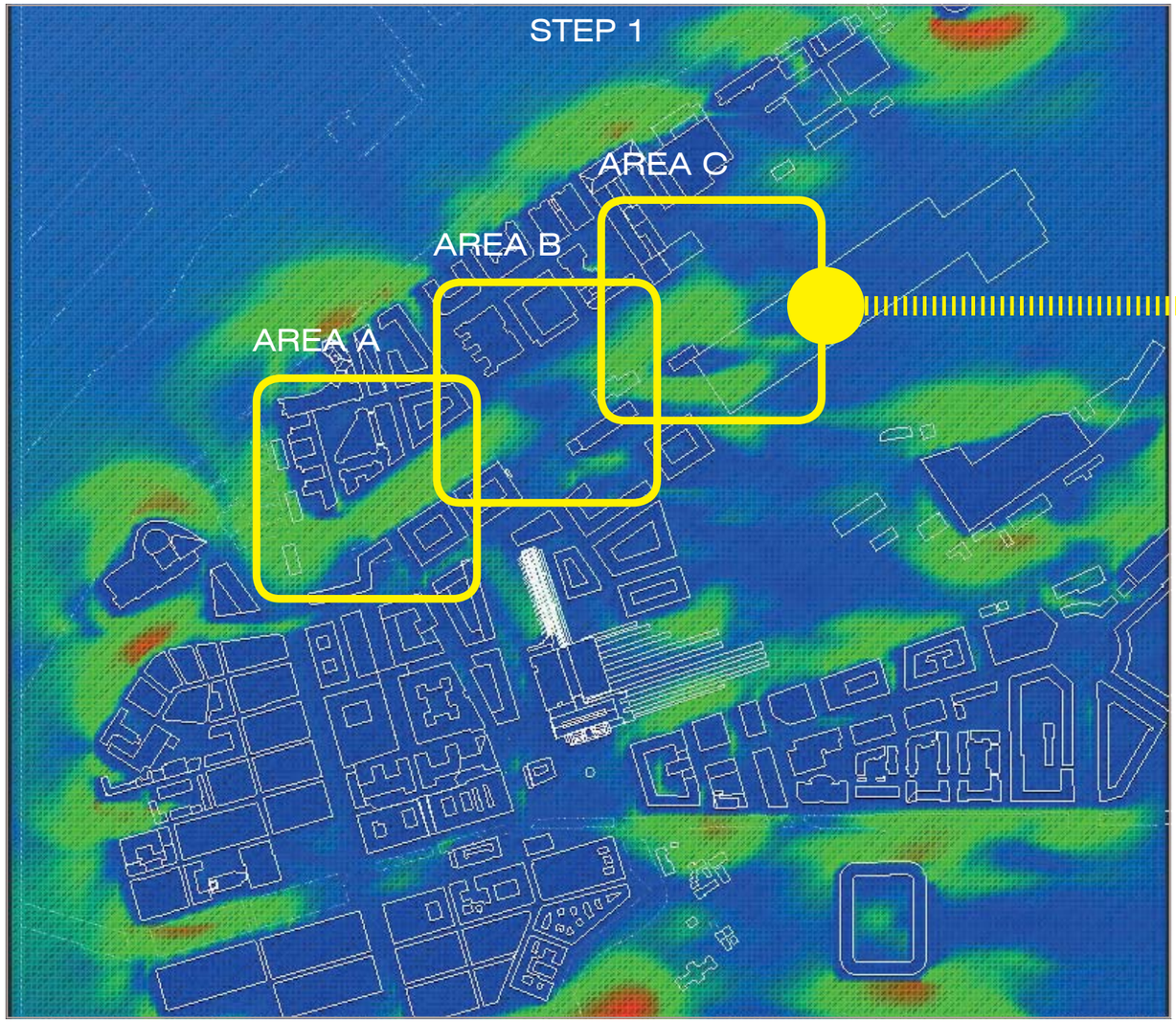
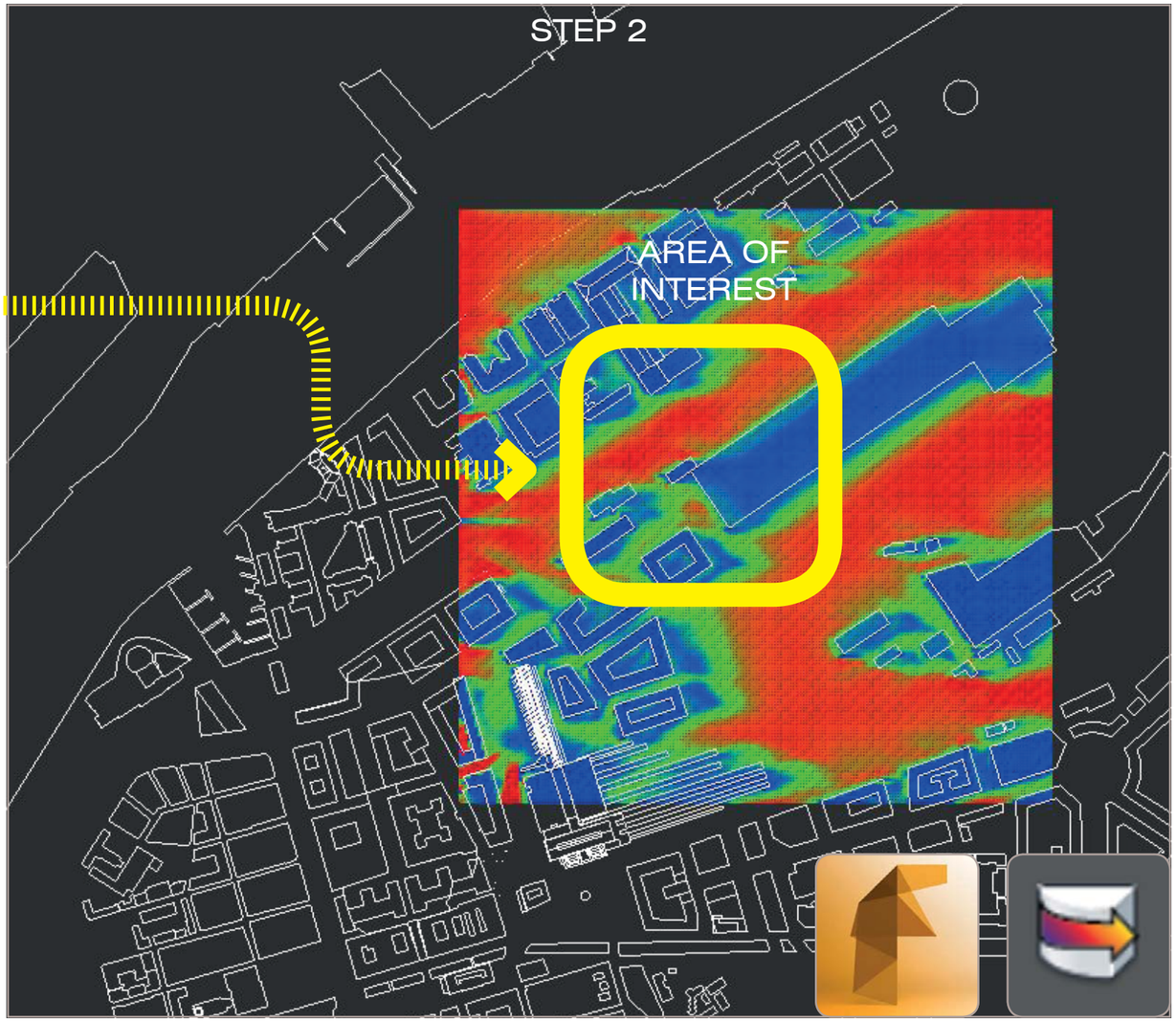
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

WIND STUDIES - SIMULATION DONE IN DETAILED STEPS





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HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

COMPARING WIND PATTERN AND SPEED WITHIN FLOW DESIGN

WIND SPEED: 2.5 M/S



WIND SPEED: 5 M/S



WIND SPEED: 10 M/S



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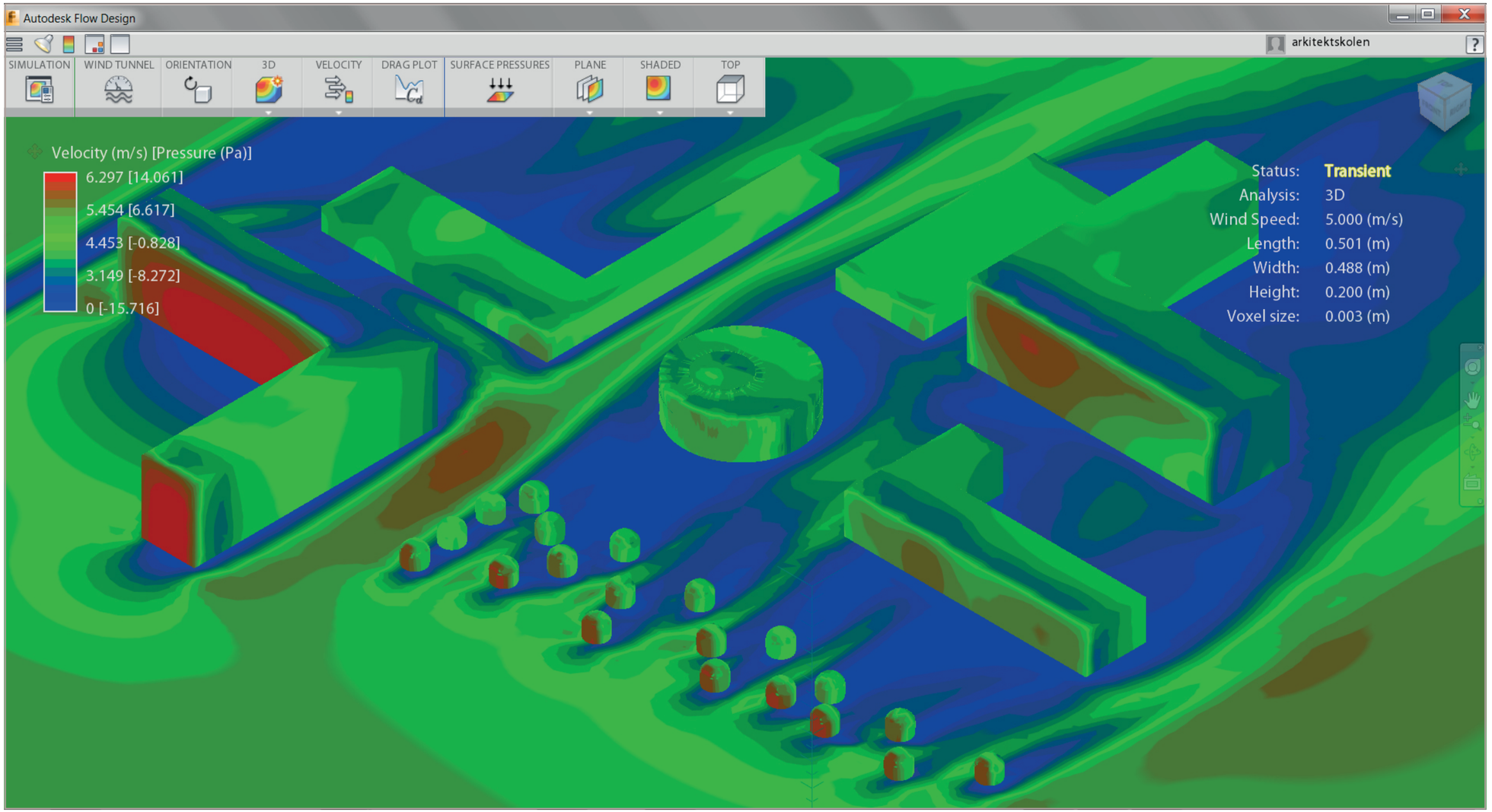
CROSS VENTILATION POTENTIALS - SURFACE PRESSURE WITH FLOW DESIGN



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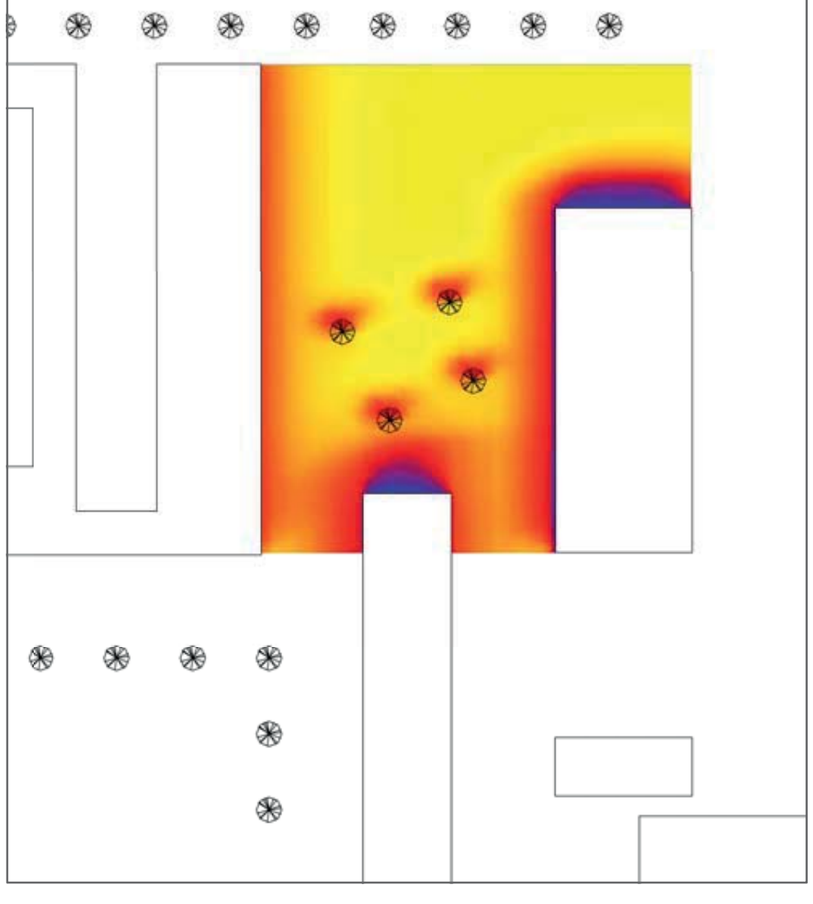
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

URBAN SOLAR RADIATION - PLAN VIEW

SOLAR RADIATION - SUMMER

Outdoor Spaces

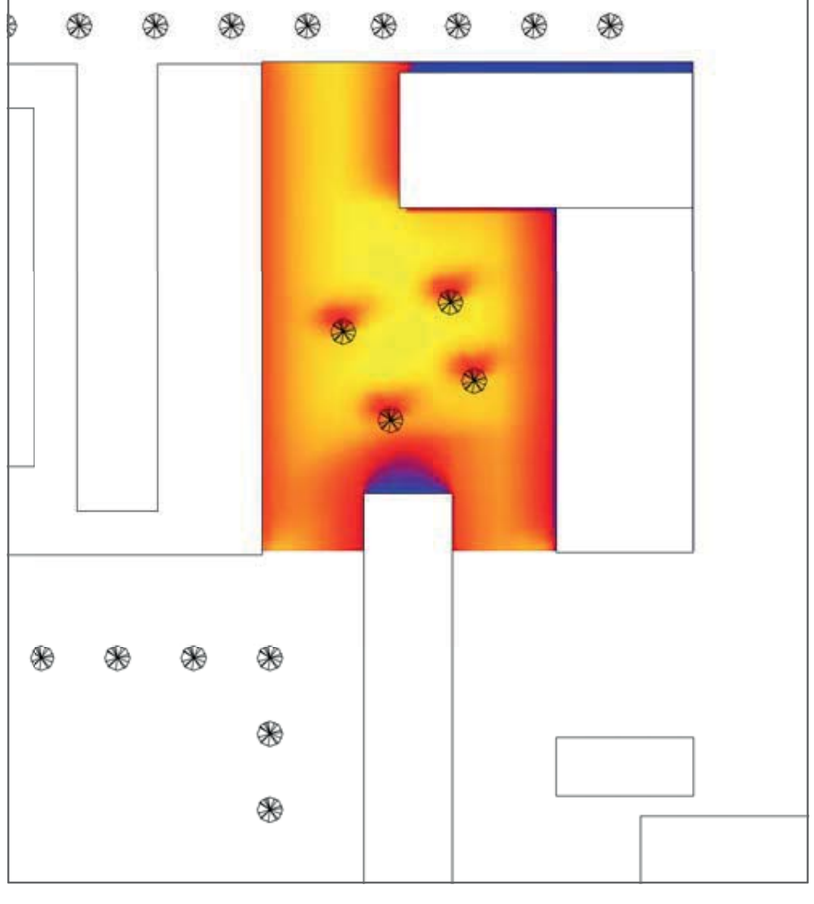
Original



SOLAR RADIATION - SUMMER

Outdoor Spaces

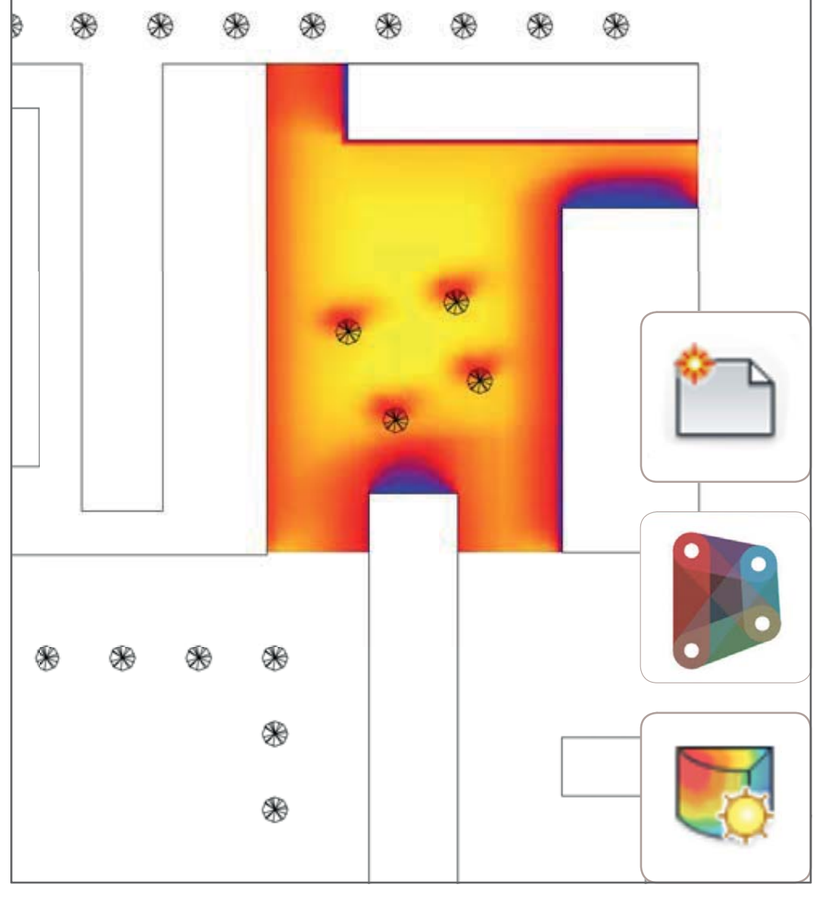
Option 1



SOLAR RADIATION - SUMMER

Outdoor Spaces

Option 3



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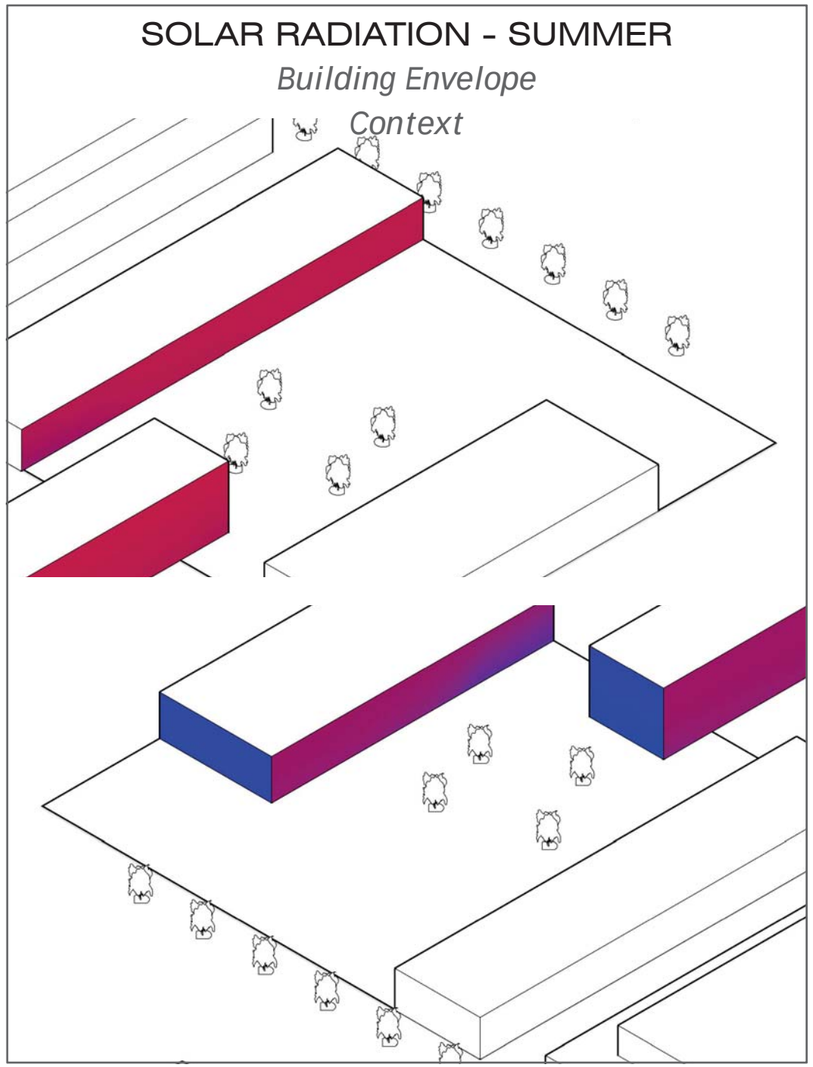
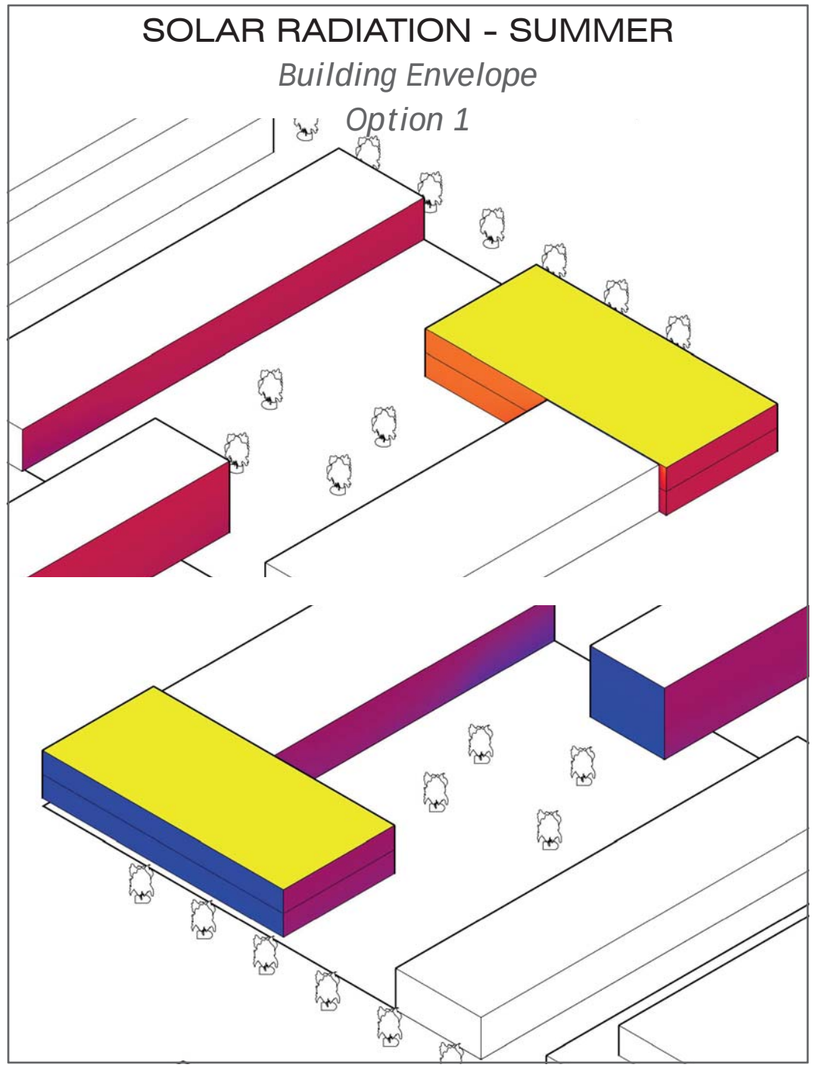
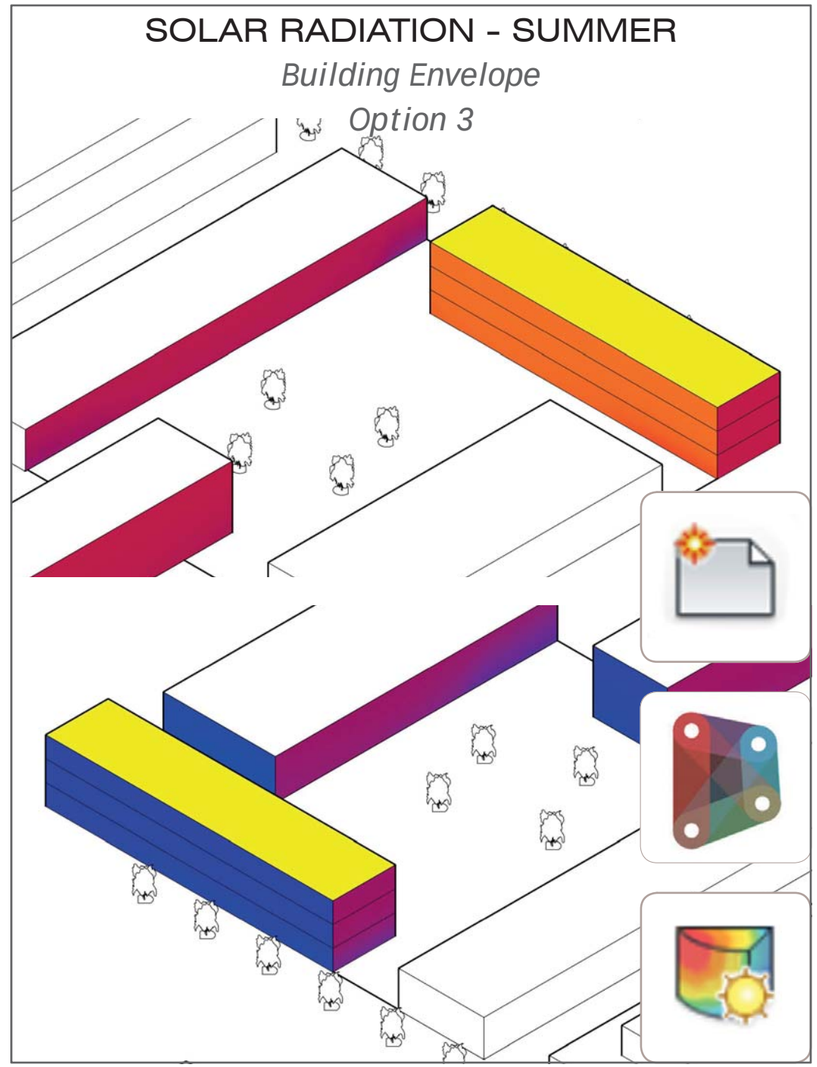
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

URBAN SOLAR RADIATION - ISOMETRIC VIEWS







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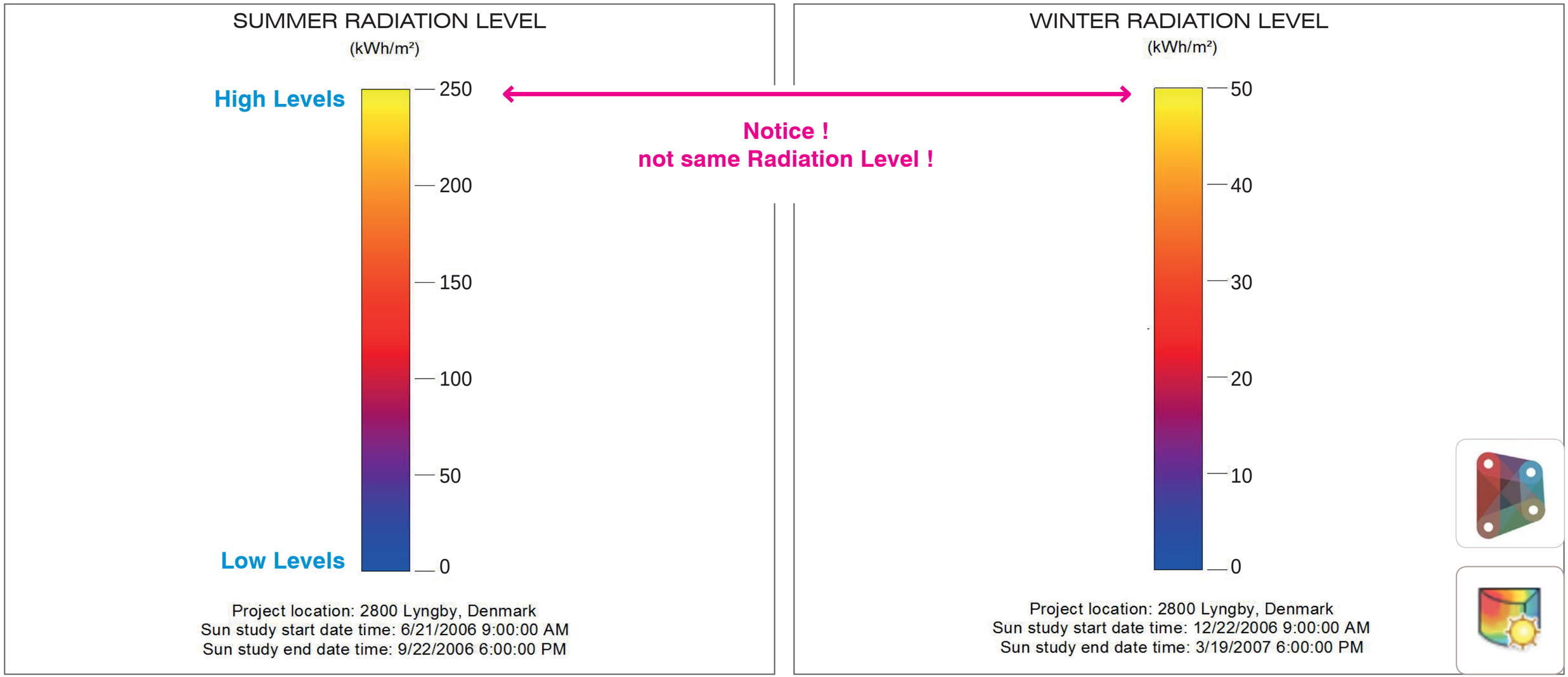
SOLAR RADIATION - AFLÆSNING AF SKALA SOMMER OG VINTER



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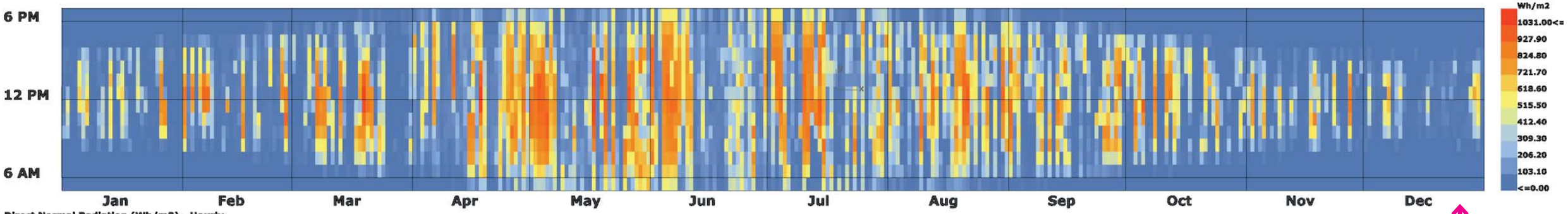
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

THE RELATION BETWEEN SOLAR RADIATION AND ILLUMINANCE LEVELS

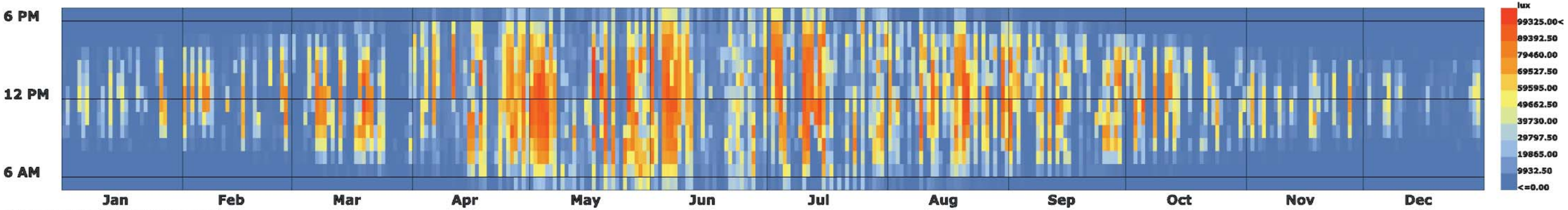
RADIATION LEVELS



Direct Normal Radiation (Wh/m2) - Hourly
Copenhagen_DEN
1 JAN 6:00 - 31 DEC 19:00

Illuminance Levels is high when the Radiation is High!

ILLUMINANCE LEVELS



Direct Normal Illuminance (lux) - Hourly
Copenhagen_DEN
1 JAN 6:00 - 31 DEC 19:00

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http://media.tumblr.com/eaf2b33d9d4bc99fe12b0f573aae2e67/tumblr_inline_n4qj85baj51qjswyt.jpg

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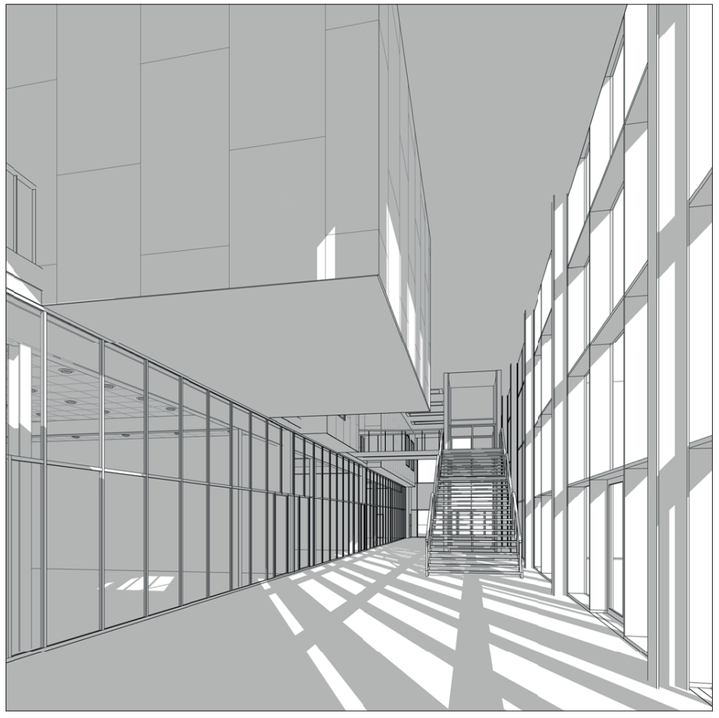
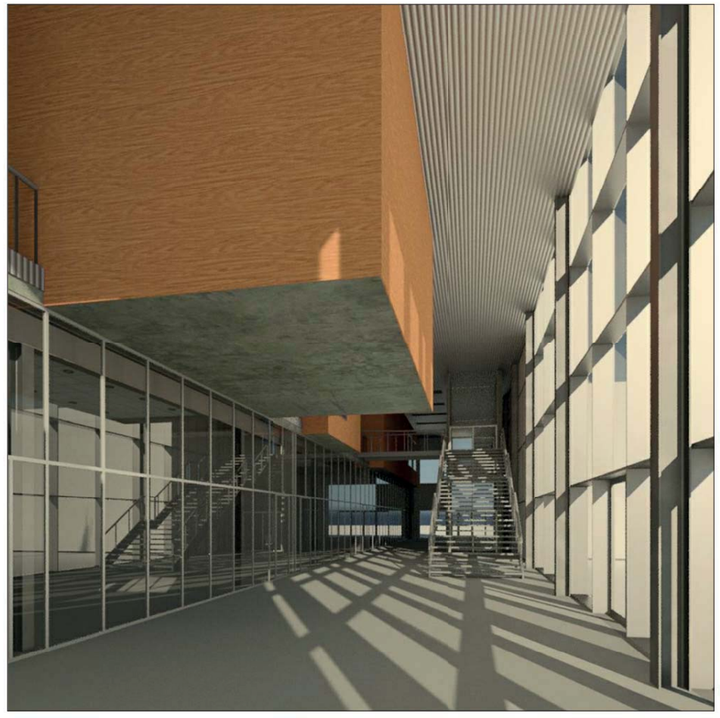
DAYLIGHT STUDIES - PERSPECTIVE VIEWS

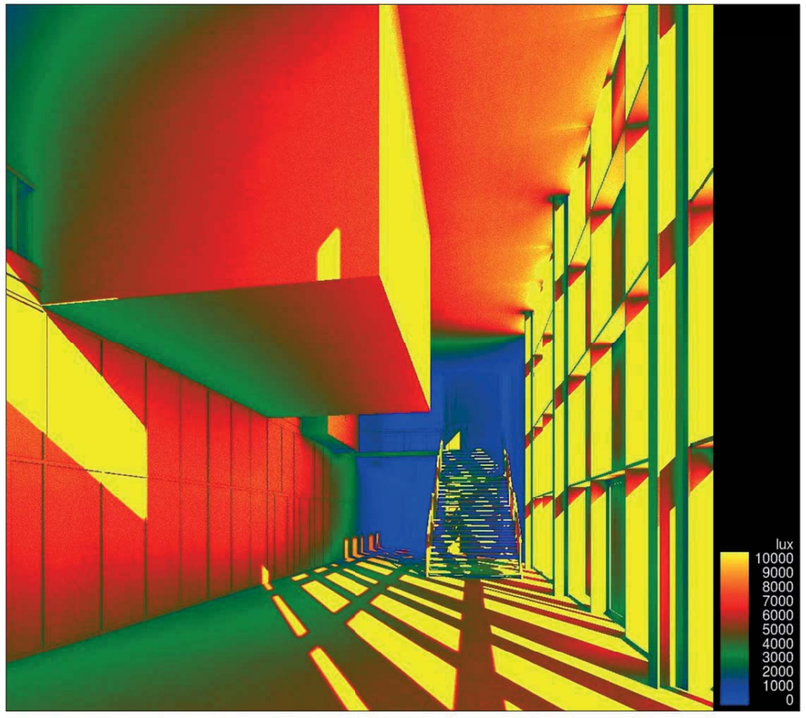


Shadow studies in the Revit model
Daylight settings - 21. of September at 3pm

Shadow studies from the 21. of june
from 4.00-20.00



Rendering with realistic materials
Daylight settings - 21. of September at 3pm



Illuminance simulation (scale 0-10.000 lux)
Daylight settings - 21. of September at 3pm
(same time and day as the rendering)

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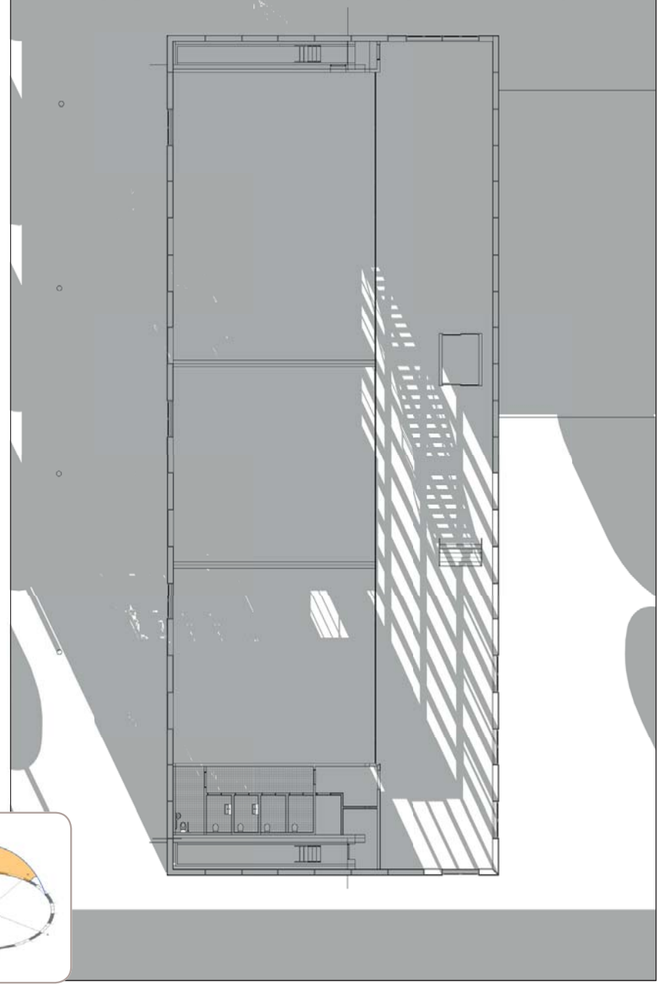
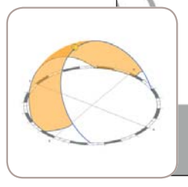
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

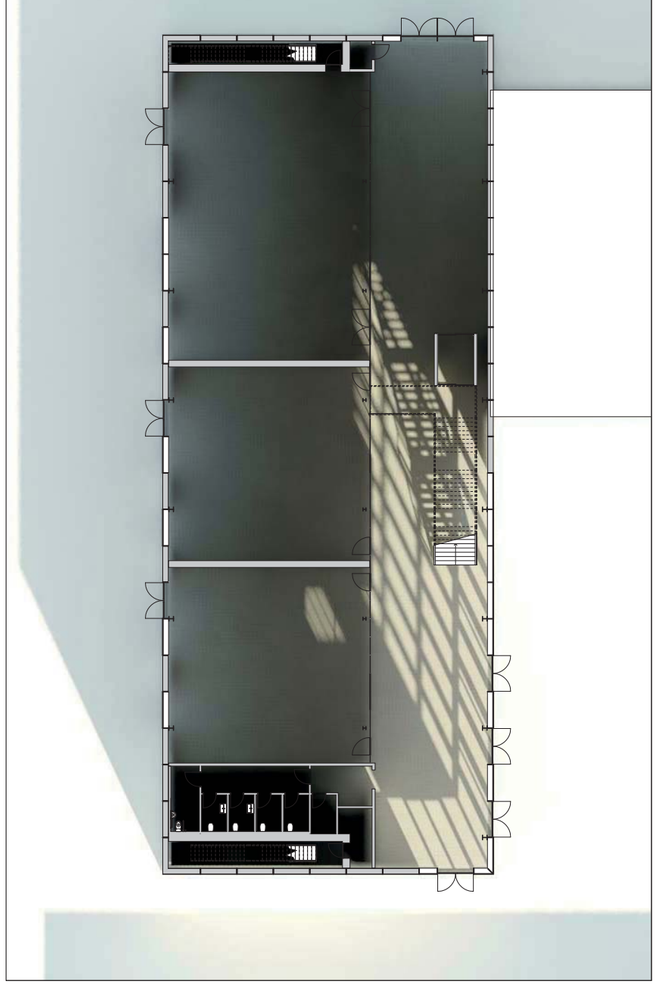
DAYLIGHT STUDIES - PLAN VIEWS

Shadow studies in the Revit model
Daylight settings - 21. of September at 3pm

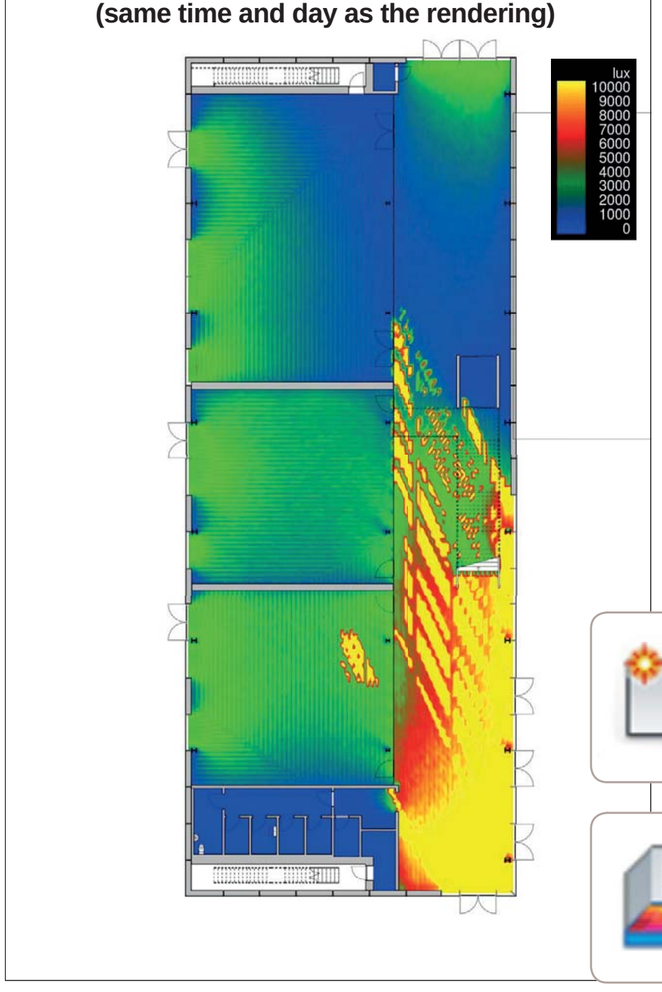


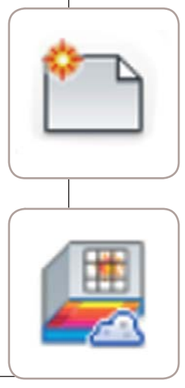


Rendering with realistic materials
Daylight settings - 21. of September at 3pm



Illuminance simulation (scale 0-10.000 lux)
Daylight settings - 21. of September at 3pm
(same time and day as the rendering)





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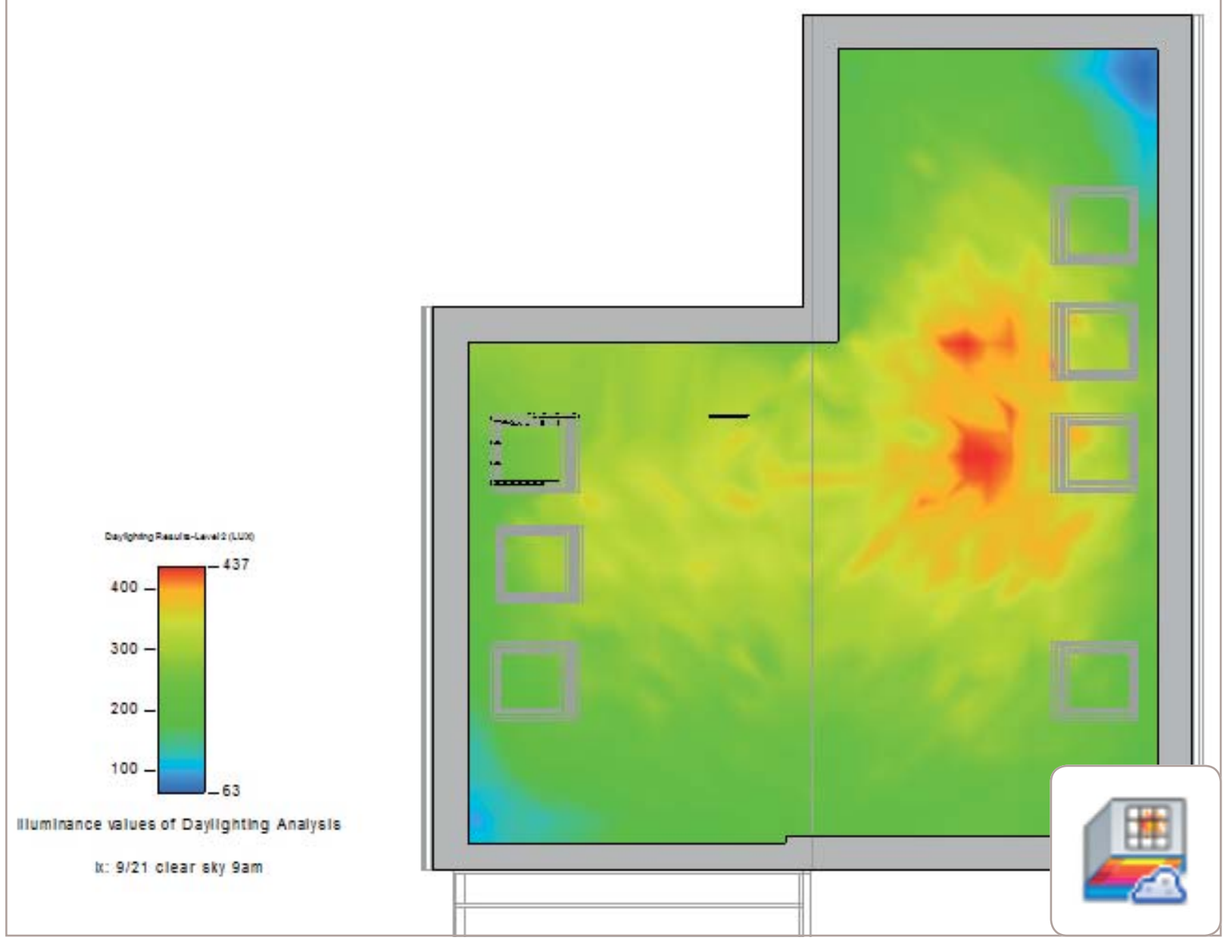
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

COLOR SCALES IN DAYLIGHT SIMULATIONS

Color Scale based on the pre-defined LEED scale



Color Scale addapted to the actual min/max values



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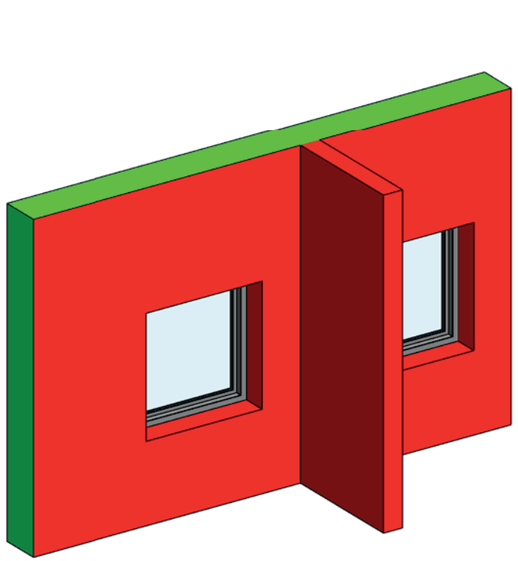
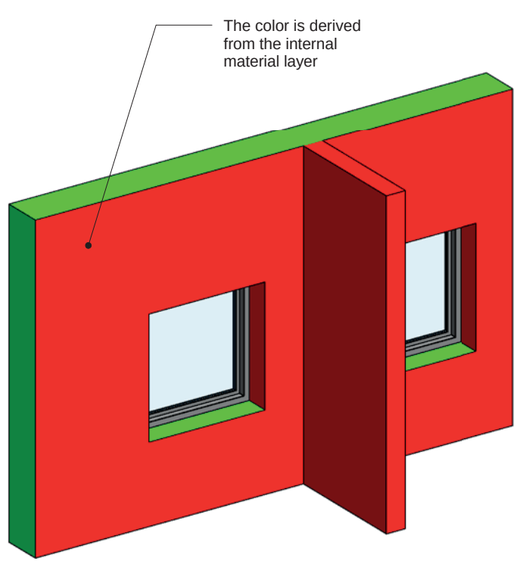
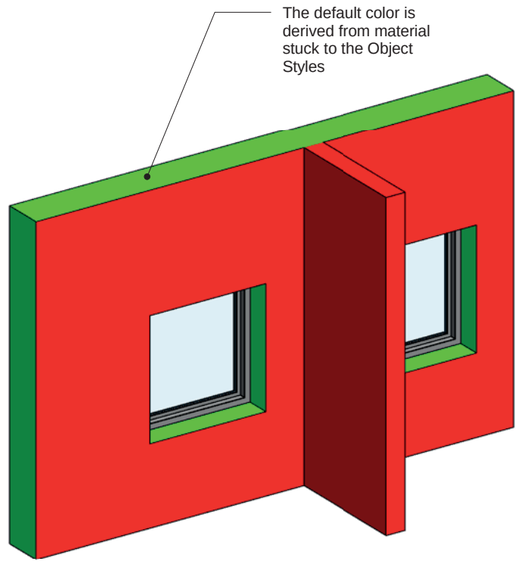
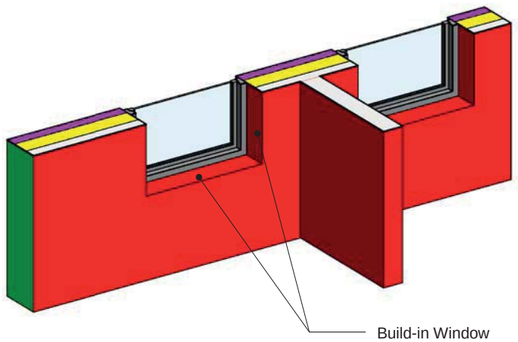
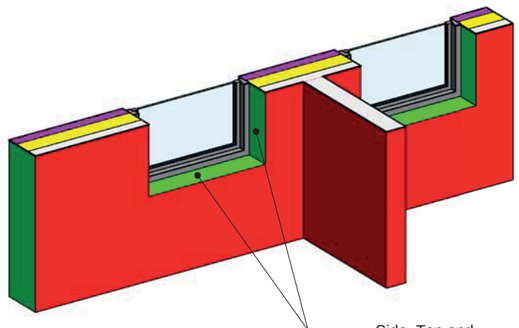
DAYLIGHT STUDIES - WINDOW EMBRASURE ISSUES

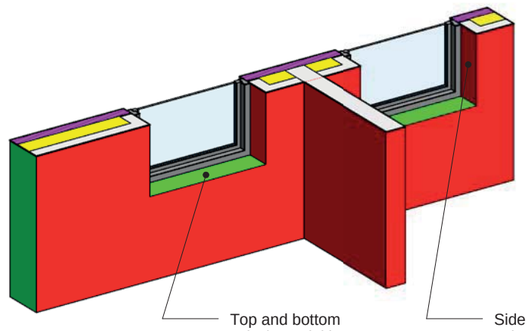












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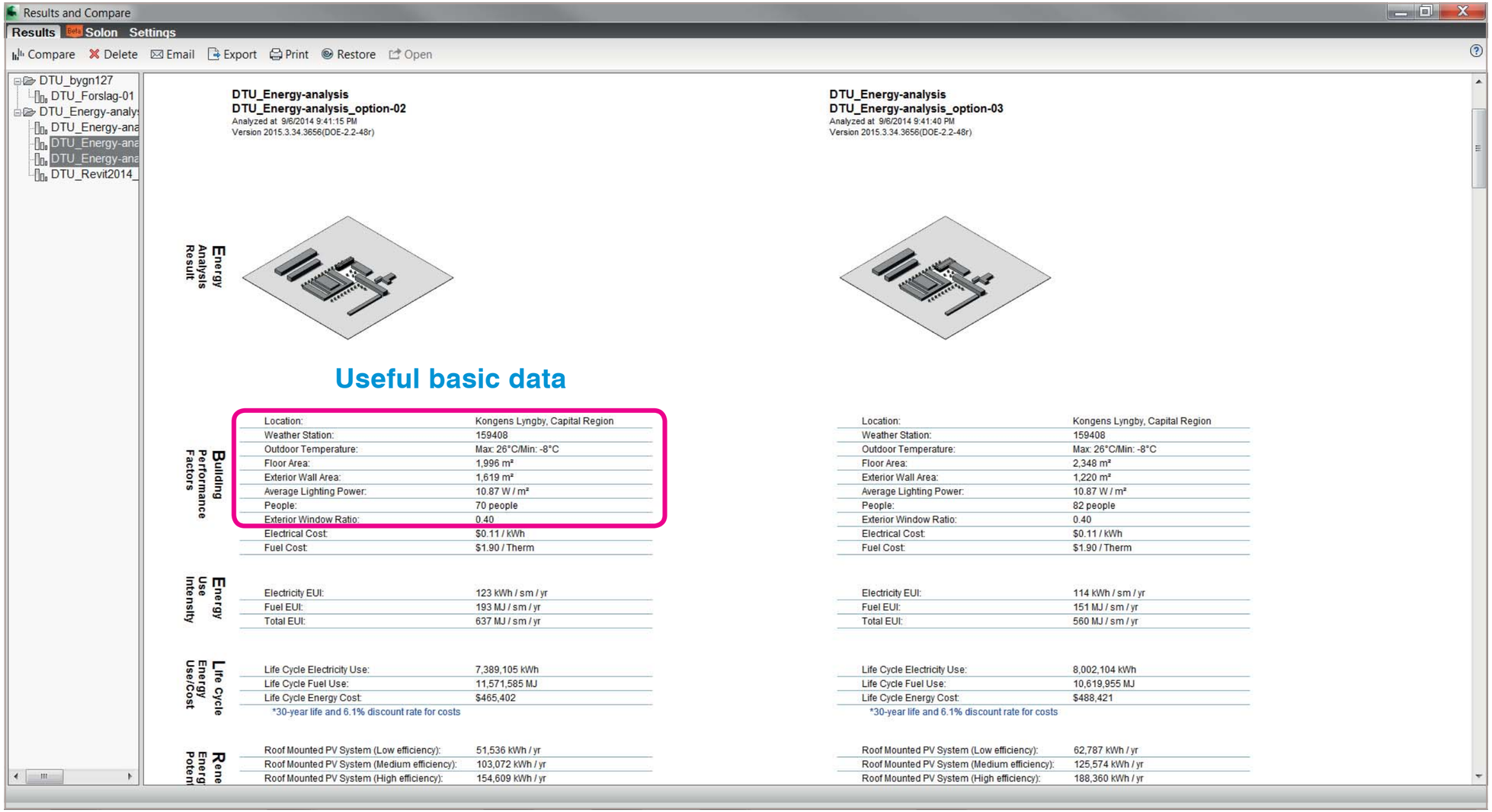
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS



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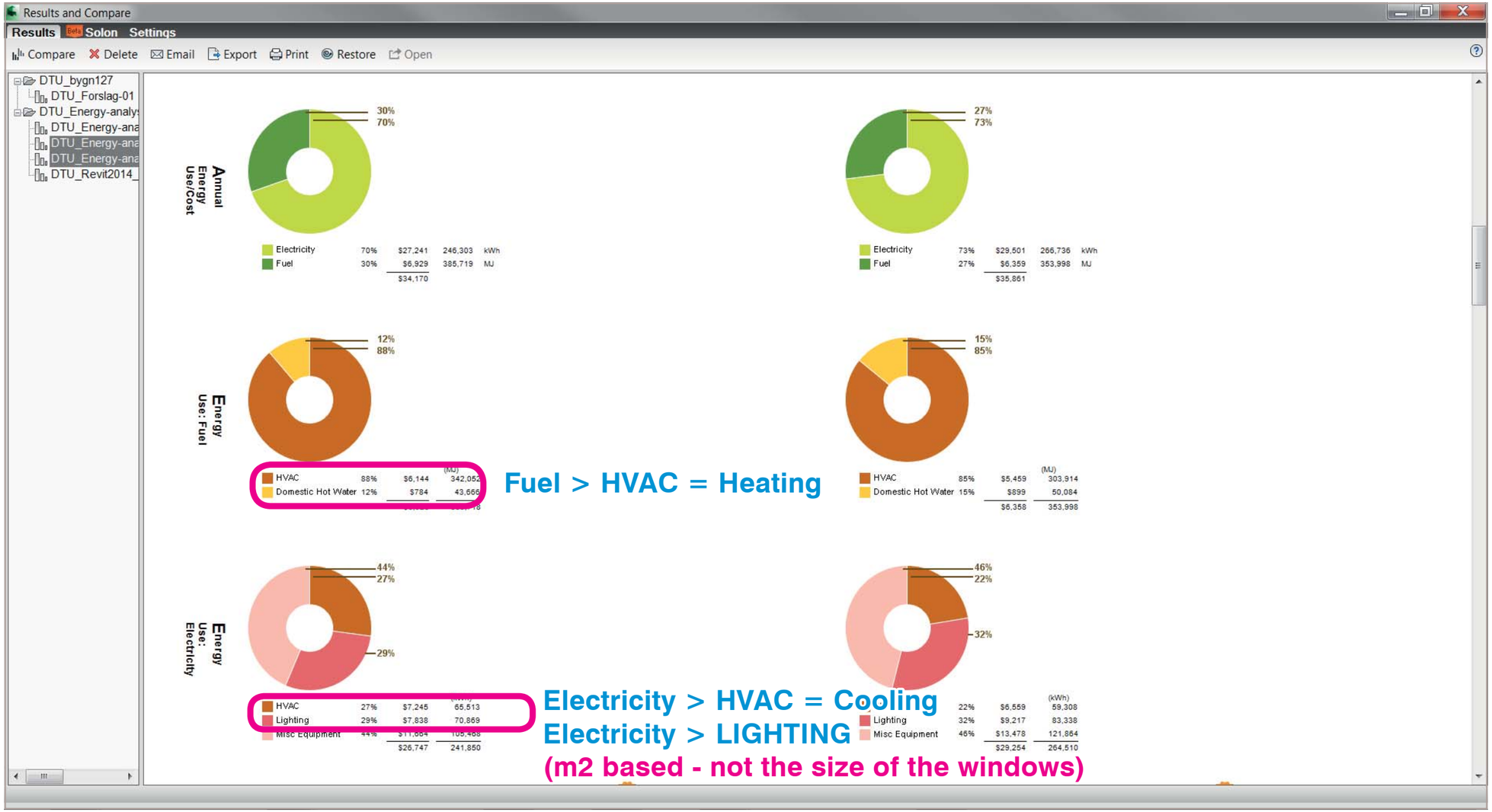
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS



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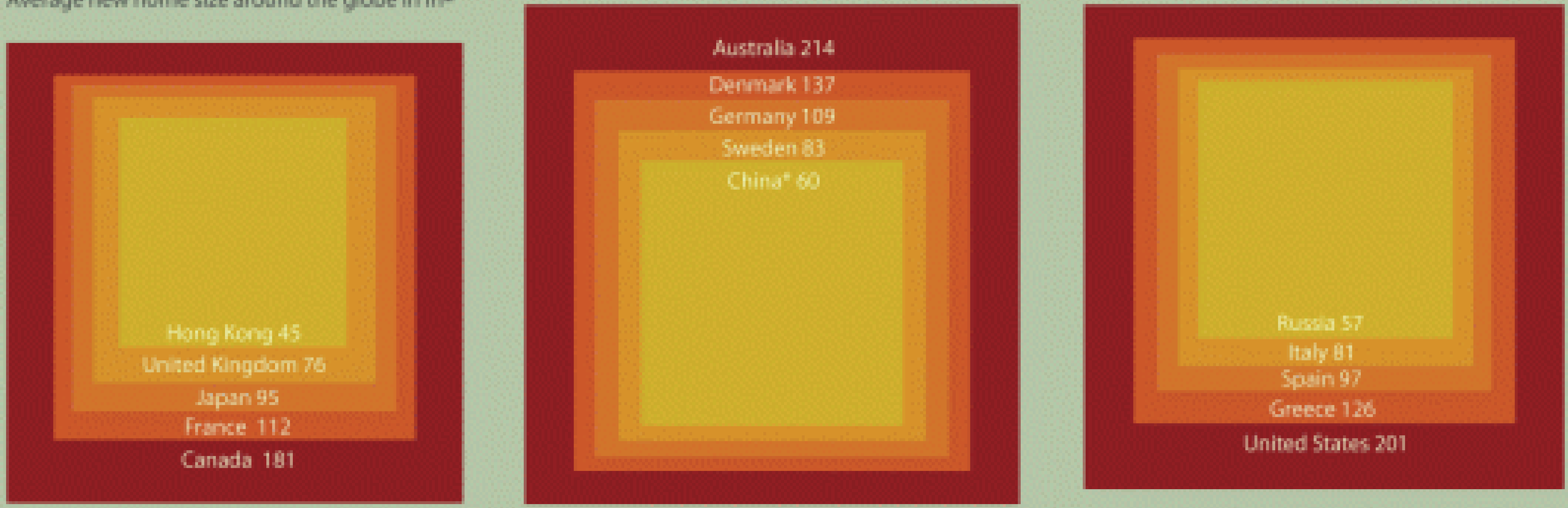
How big is a house?

Average new home size around the globe in m^2



Note: data for 2009 builds, * China figures urban only

Sources: CommSec, RBA, UN, US Census

shrinkthatfootprint.com

http://shrinkthatfootprint.com/how-big-is-a-house

http://newsimg.bbc.co.uk/media/images/46216000/gif/_46216562_houses_466_4.gif

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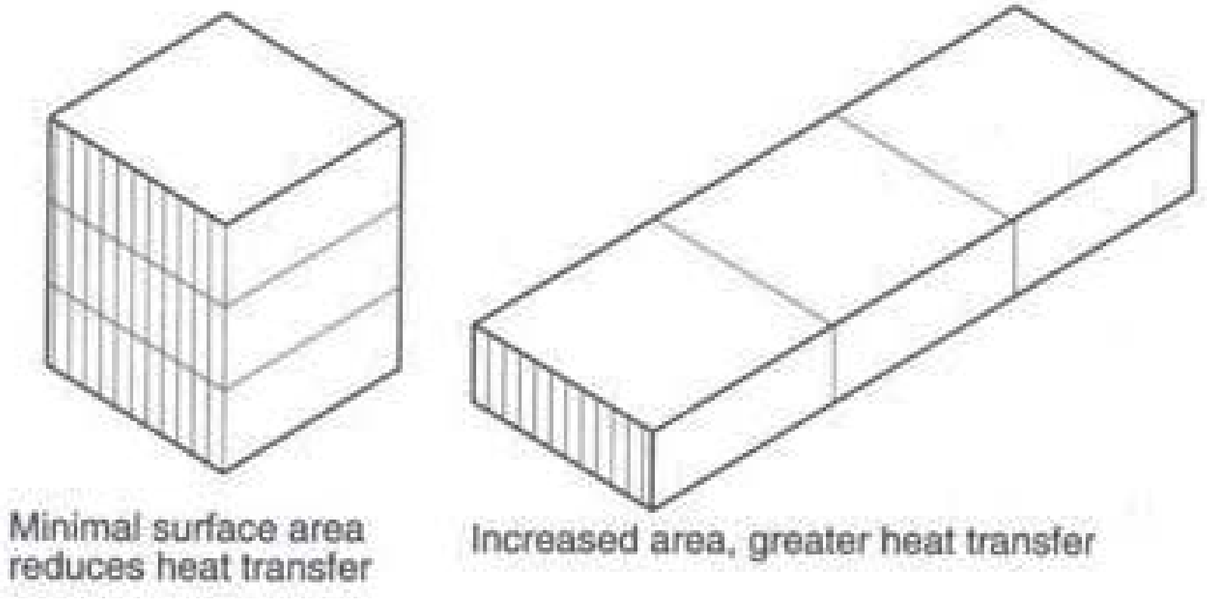
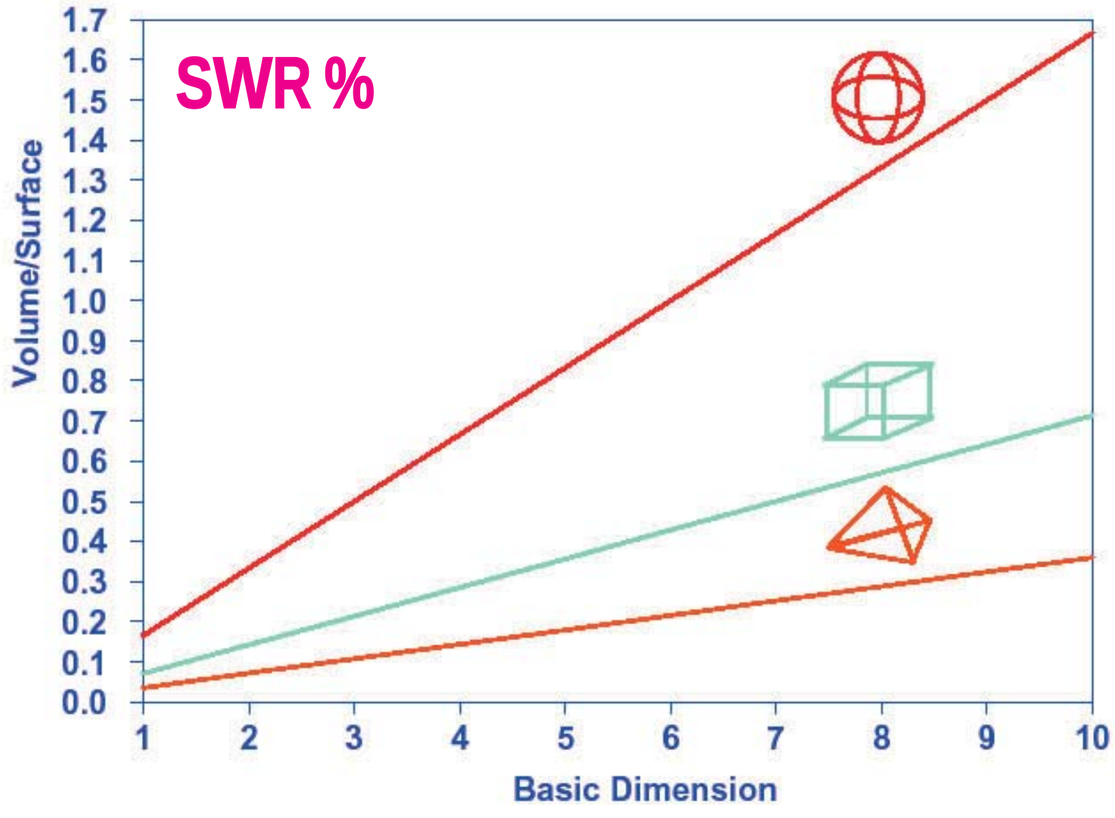
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

WHY LOOKING AT M2 !?

IMPACT?



HOW?



http://www.new-learn.info/packages/clear/thermal/buildings/configuration/surcafeareato_vol_ratio.html

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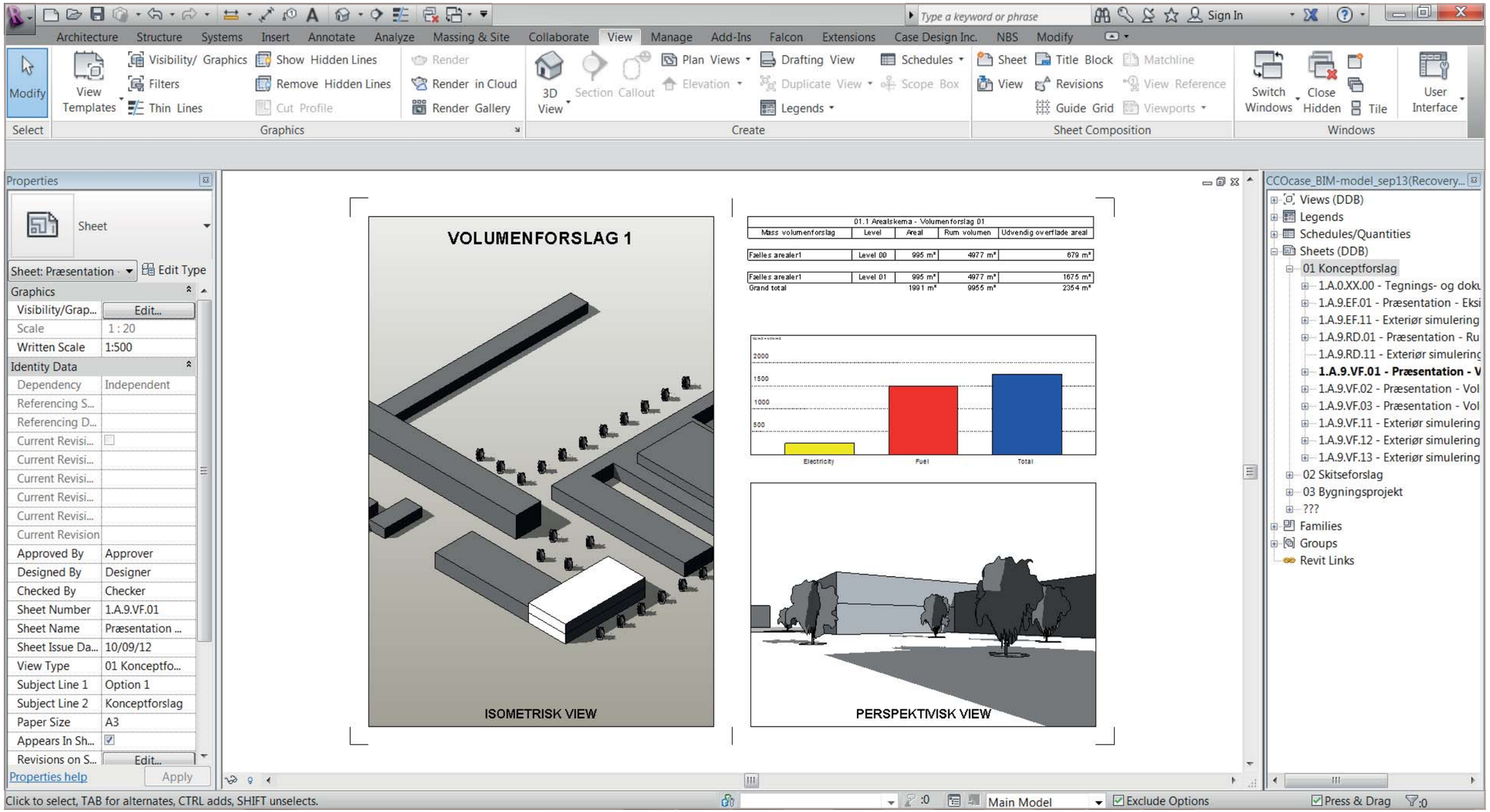
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

CUSTOMIZED MODEL VISUALIZING, M2 MANAGEMENT AND ENERGY PERFORMANCE



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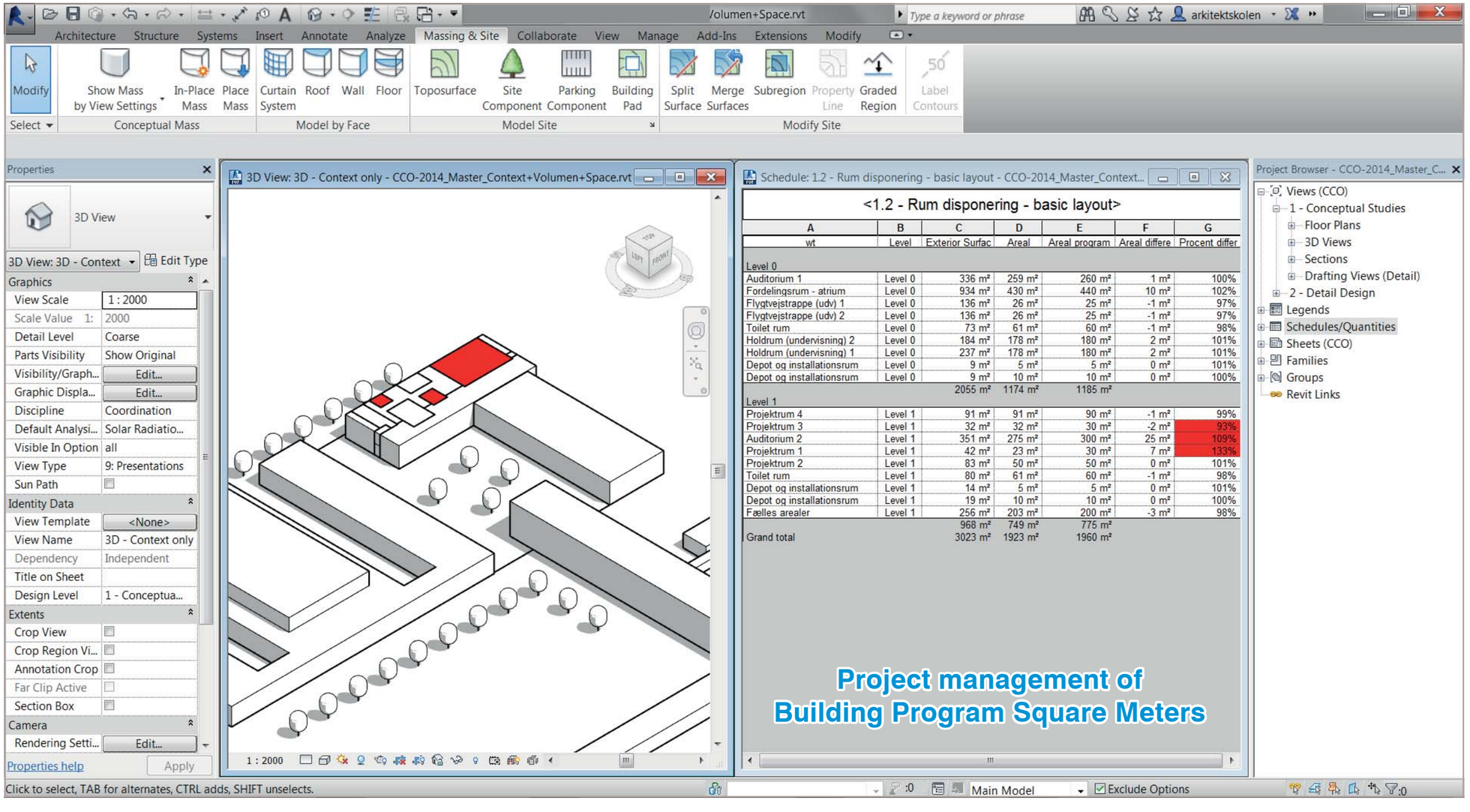
INFORMATIVE M2 SCHEDULING AND FILTRE



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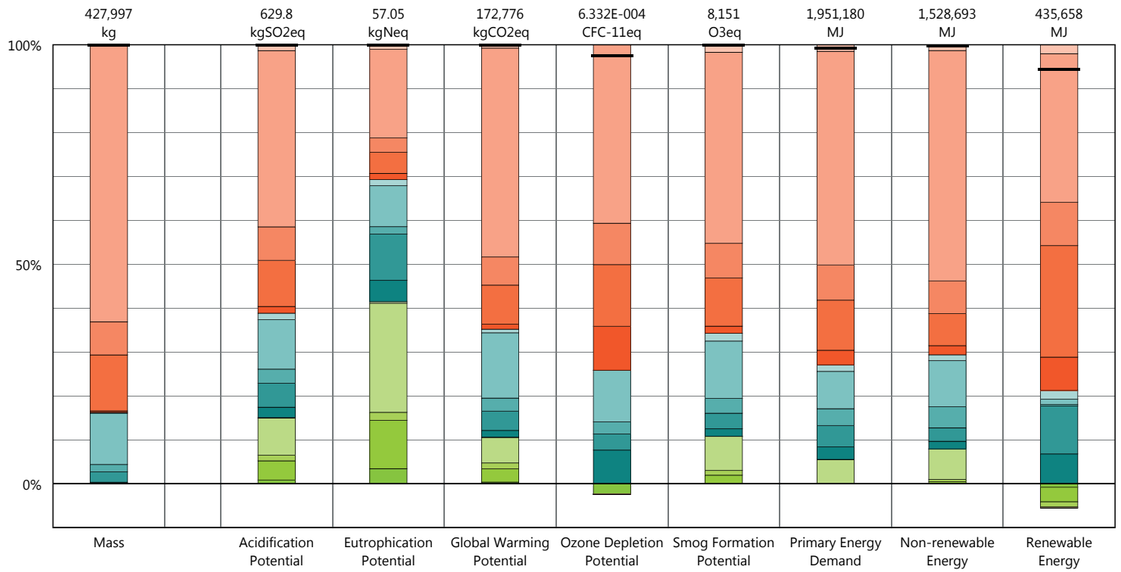
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

LIFE CYCLE ANALYSIS WITH PLUG-IN TALLY

Results per Life Cycle Stage, itemized by Revit Category



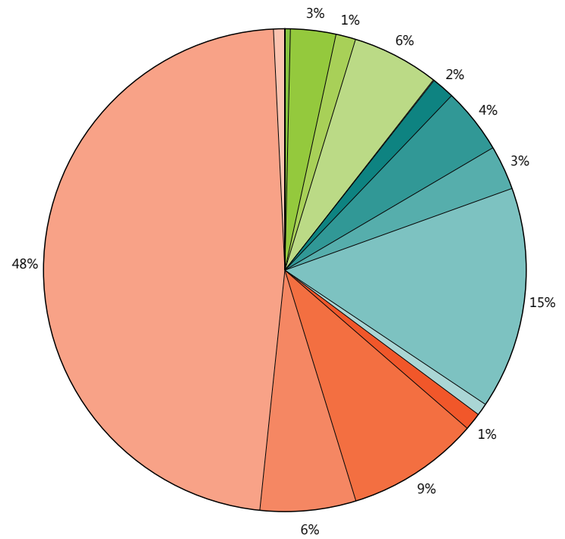
Legend

Net value (impacts + credits)

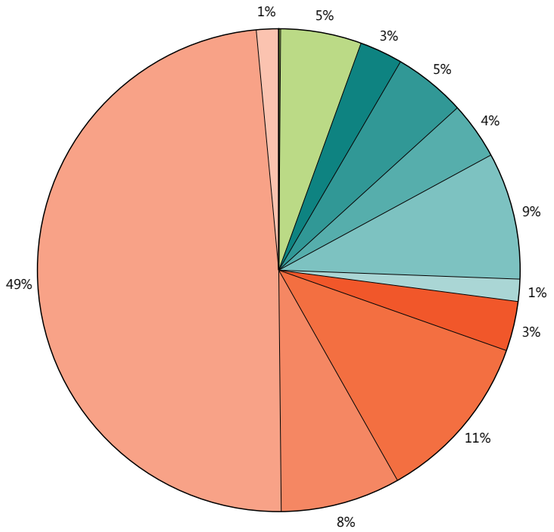
Manufacturing	Maintenance and Replacement	End of Life
Doors	Doors	Doors
Floors	Floors	Floors
Roofs	Roofs	Roofs
Walls	Walls	Walls
Windows	Windows	Windows

Based on Detailed Revit Obejcts

Results per Life Cycle Stage, itemized by Revit Category



Global Warming Potential



Primary Energy Demand

Legend

Net value (impacts + credits)

Manufacturing	Maintenance and Replacement	End of Life
Doors	Doors	Doors
Floors	Floors	Floors
Roofs	Roofs	Roofs
Walls	Walls	Walls
Windows	Windows	Windows

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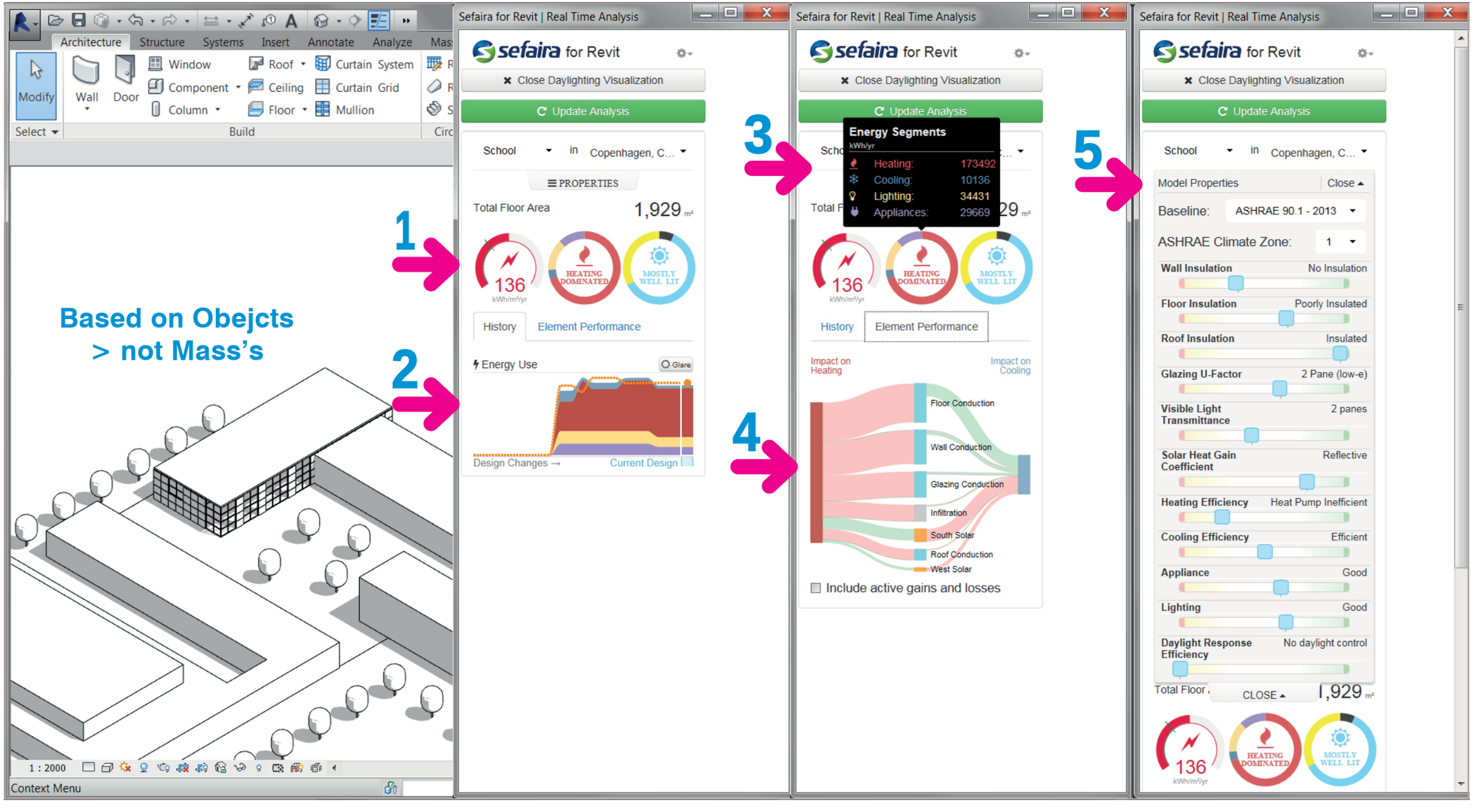
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

CONCEPTUAL ENERGY AND DAYLIGHT SIMULATION WITH PLUG-IN SEFAIRA



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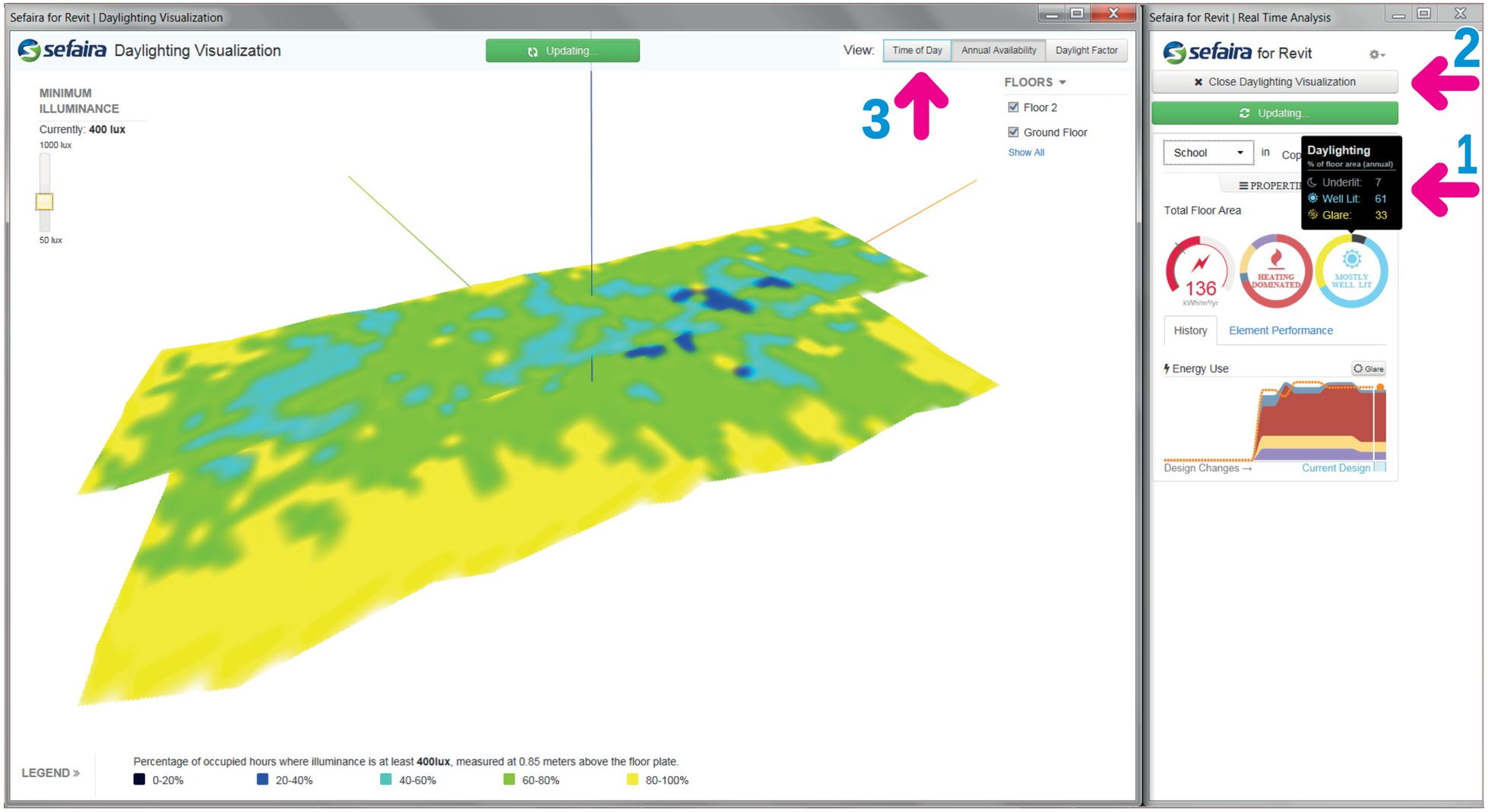
HOW TO READ AND UNDERSTAND SIMULATION OUTPUTS

CONCEPTUAL DAYLIGHT SIMULATION WITH PLUG-IN SEFAIRA



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[1.3ª]

CASE-STUDIES FROM STUDENT COURSES

CASE-STUDIES FROM STUDENT COURSES

STUDENT COURSE A AT KADK - TEK 5 2014










Link to course description: http://www.e3lab.org/tek5-20141 // Images: Alix Hendry

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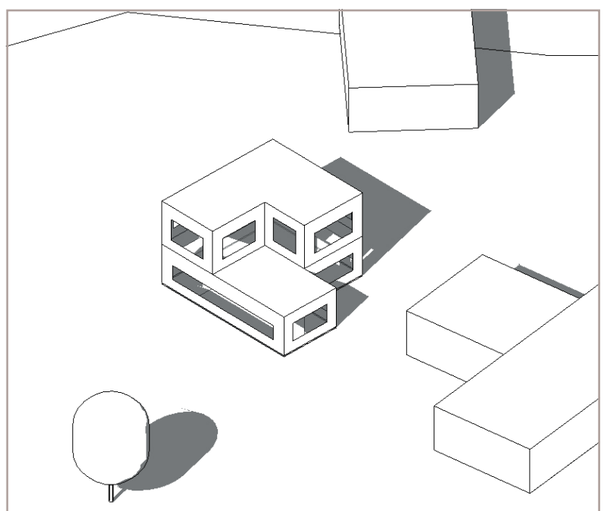
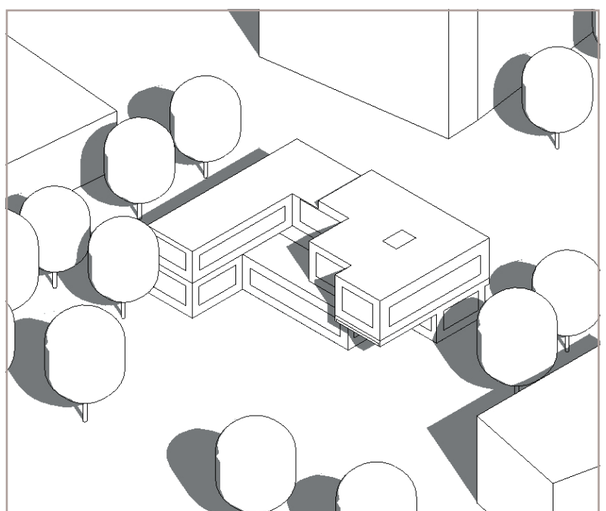
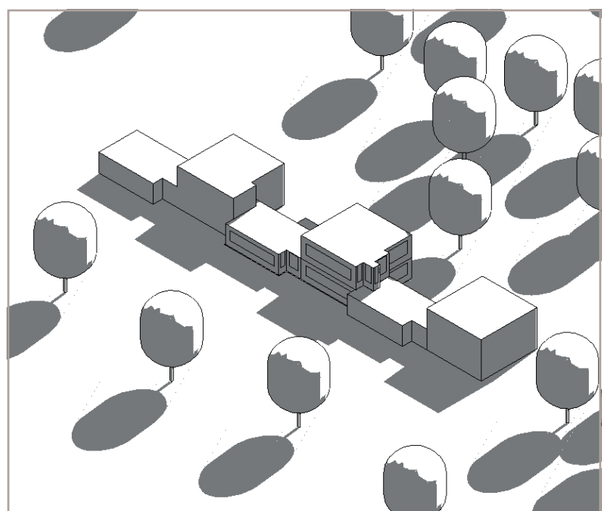
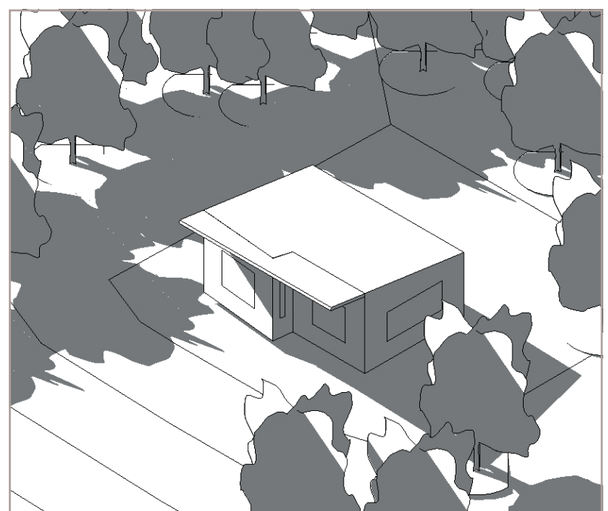
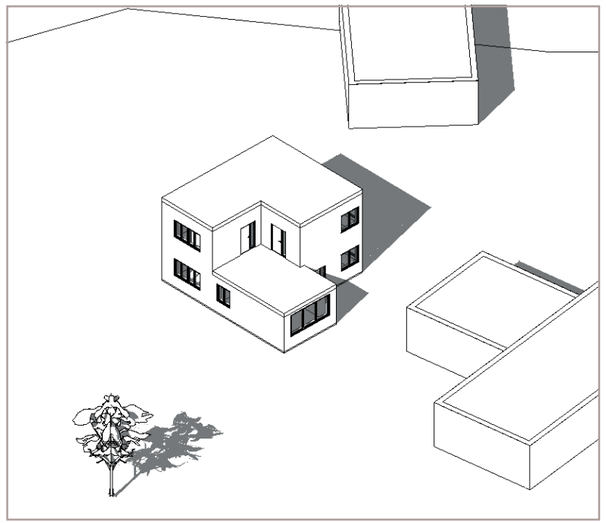
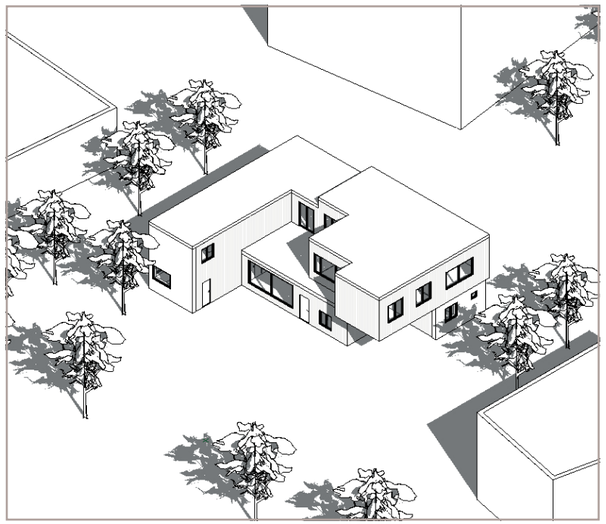
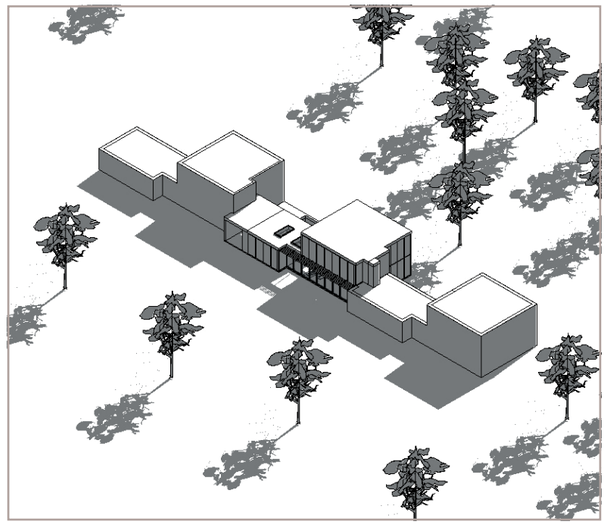
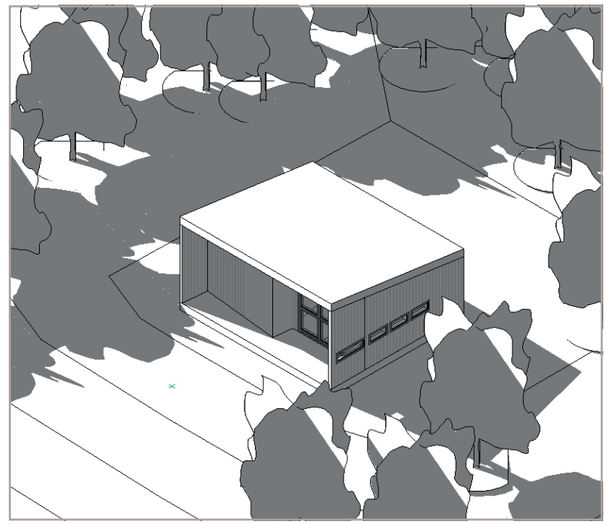
CASE-STUDIES FROM STUDENT COURSES

COURSE A - MODEL DETAIL LEVELS

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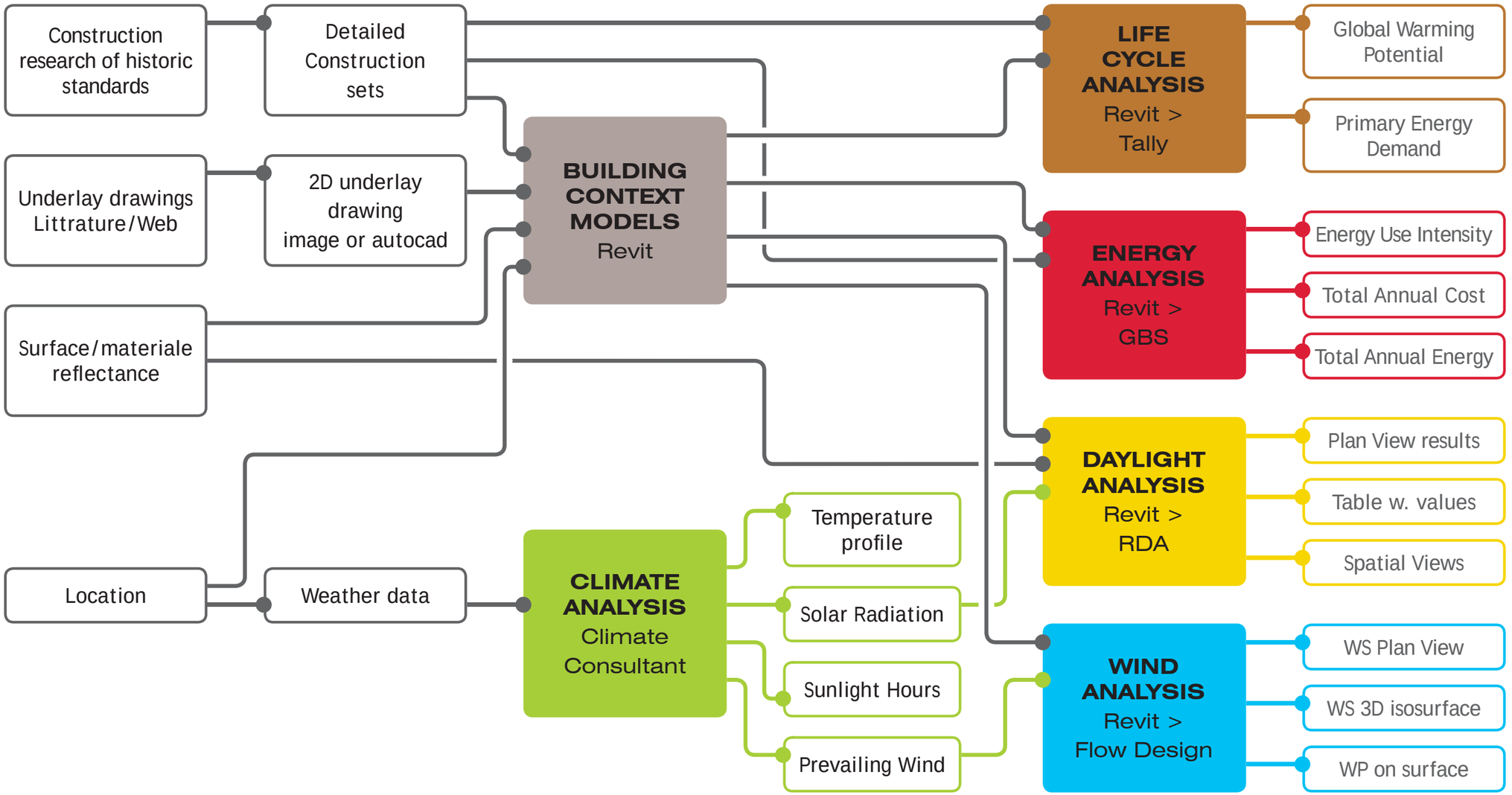
CASE-STUDIES FROM STUDENT COURSES

COURSE A - ASSIGNMENT WORK-FLOW



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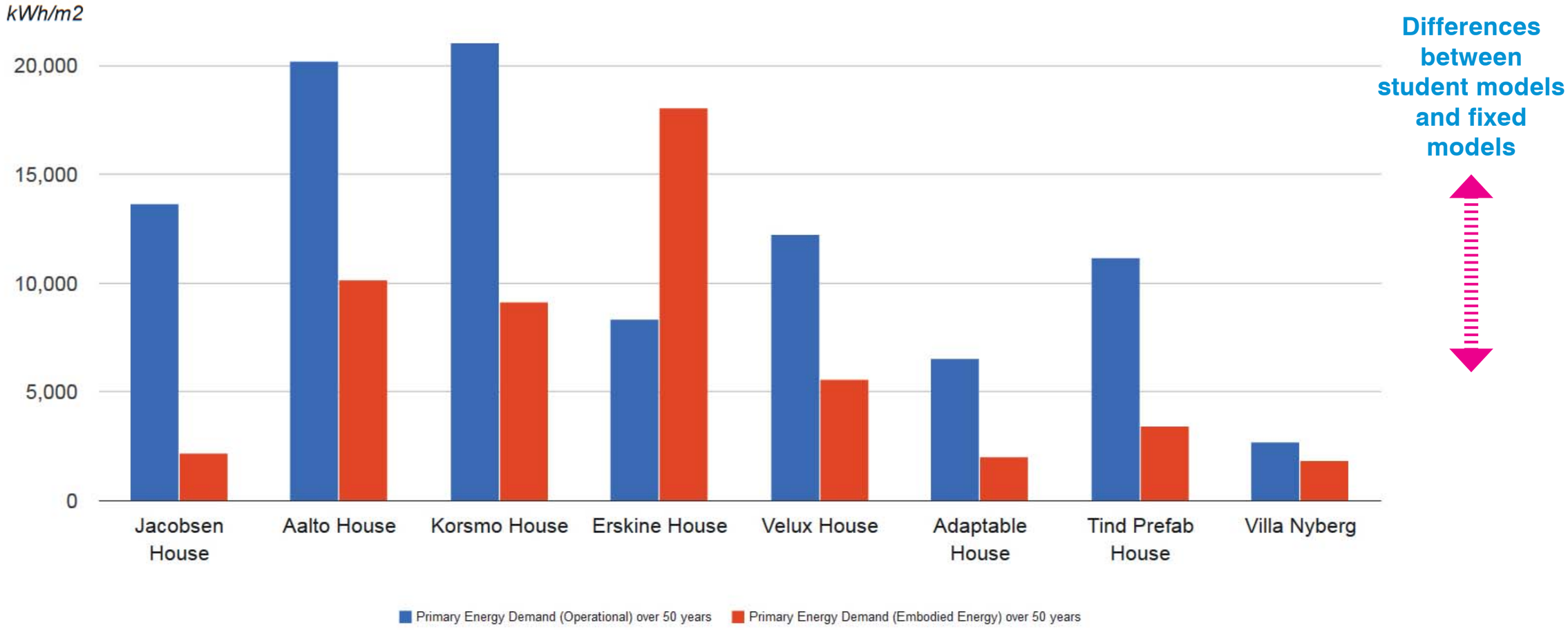
CASE-STUDIES FROM STUDENT COURSES

COURSE A - COMPARING OPERATIONAL VS EMBODIED ENERGY - FIXED RESULTS



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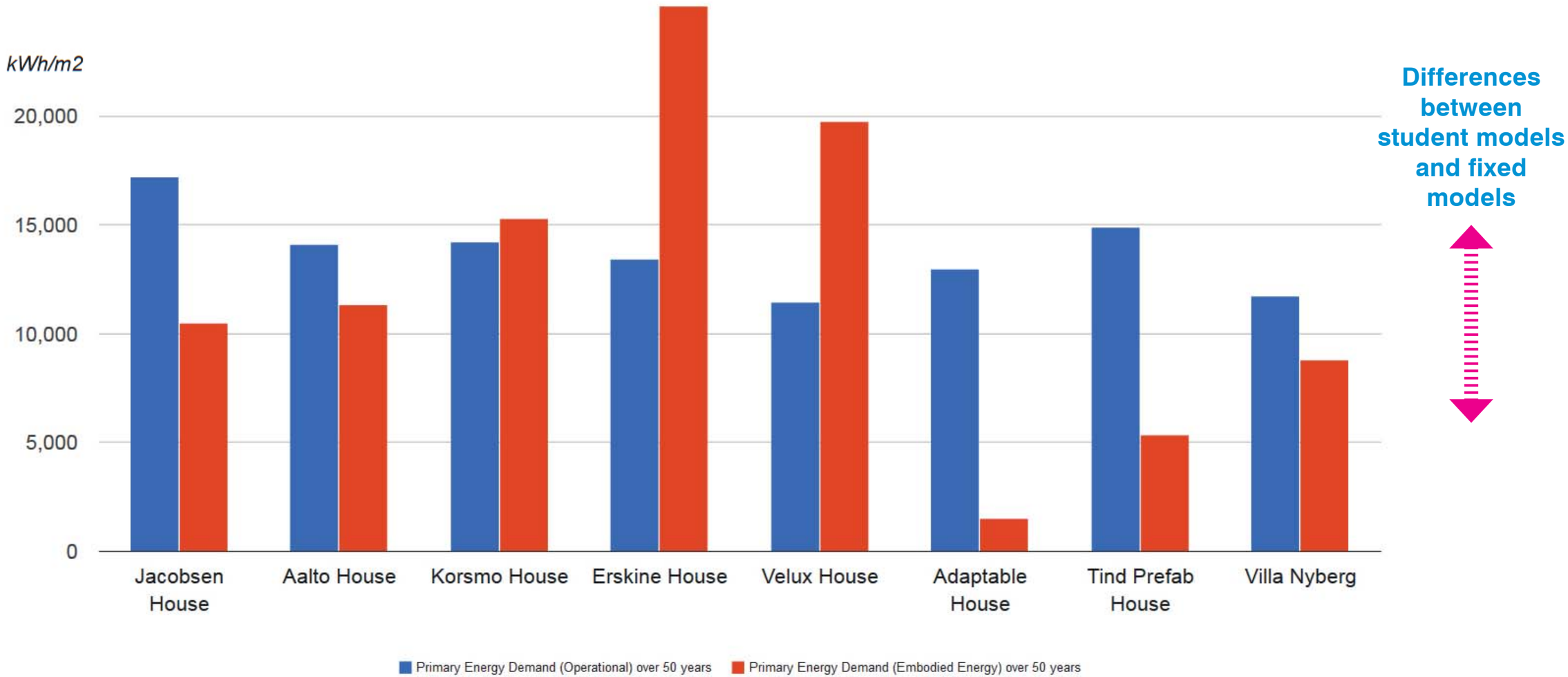
CASE-STUDIES FROM STUDENT COURSES

COURSE A - COMPARING OPERATIONAL VS EMBODIED ENERGY - ORIGINAL RESULTS



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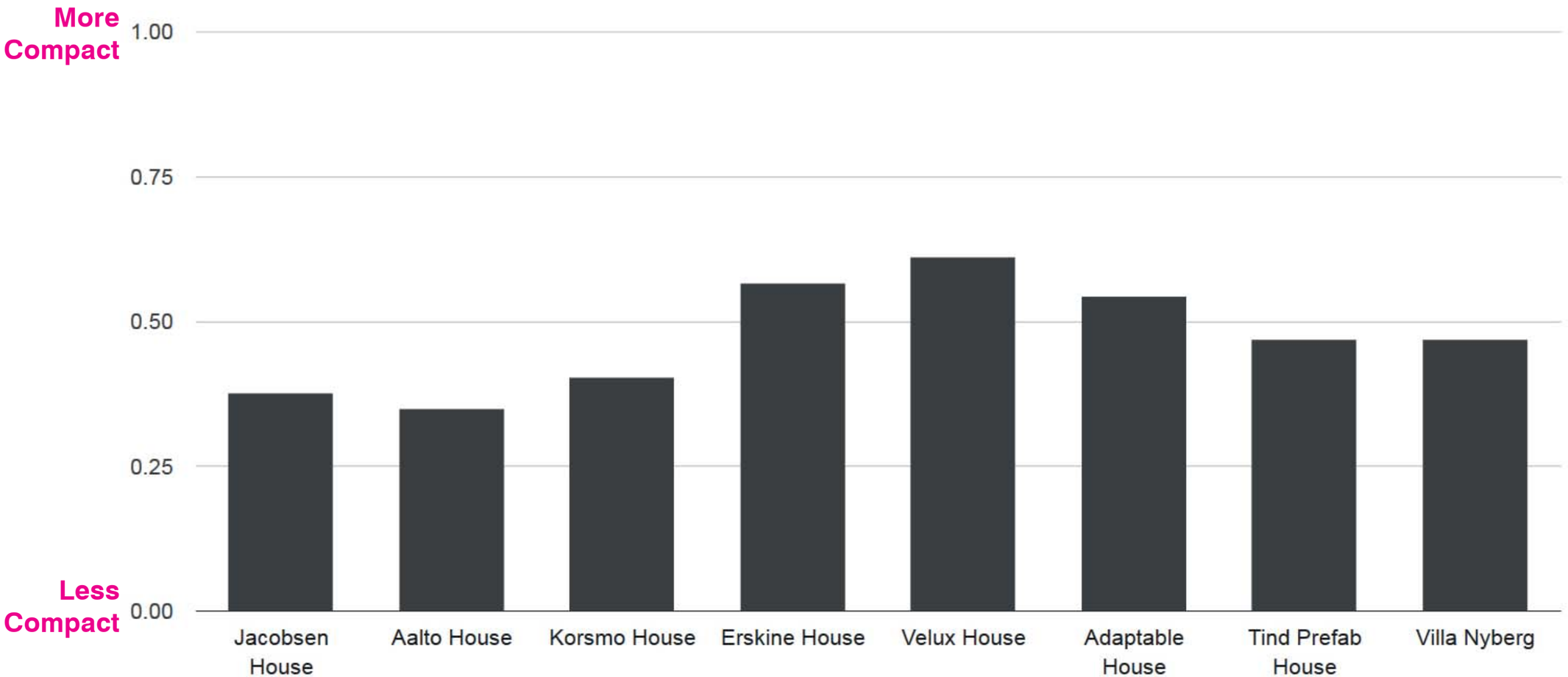
CASE-STUDIES FROM STUDENT COURSES

COURSE A - COMPACTNESS - EXTERIOR SURFACE TO VOLUME FACTOR



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CASE-STUDIES FROM STUDENT COURSES

COURSE A - MULTIPLE PARAMETER COMPARING

	Jacobsen House	Aalto House	Korsmo House	Erskine House	Velux House	Adaptable House	Tind Prefab House	Villa Nyberg
Compactness (S/V)	62%	57%	66%	92%	100%	89%	77%	77%
Window to Wall Ratio (WWR)	50%	35%	100%	28%	58%	49%	26%	15%
Avarage Daylight Level (Living room)	27%	16%	100%	38%	45%	54%	47%	22%
Heating - EUI (Kwh/m2/year)	68%	100%	98%	43%	52%	25%	47%	13%
Cooling - EUI (Kwh/m2/year)	46%	79%	100%	28%	75%	45%	69%	9%
Lighting - EUI (Kwh/m2/year)	70%	77%	80%	29%	88%	77%	100%	34%
Embodied Energy (kWh/m2 over 50 years)	12%	57%	51%	100%	31%	11%	19%	10%

% Factor of the maximum value — 0-19% | 20-39% | 40-59% | 60-79% | 80-99% | <99%

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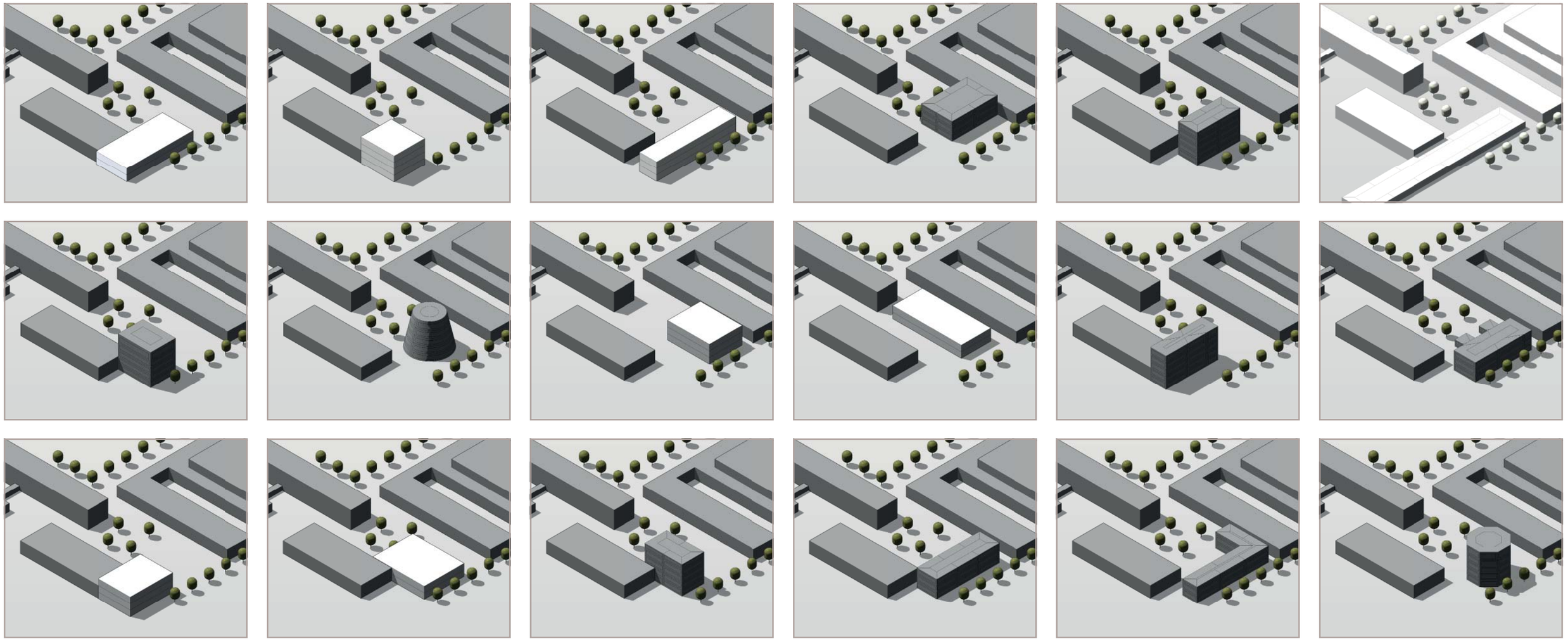
CASE-STUDIES FROM STUDENT COURSES

STUDENT COURSE B AT EASJ - SAO 2013



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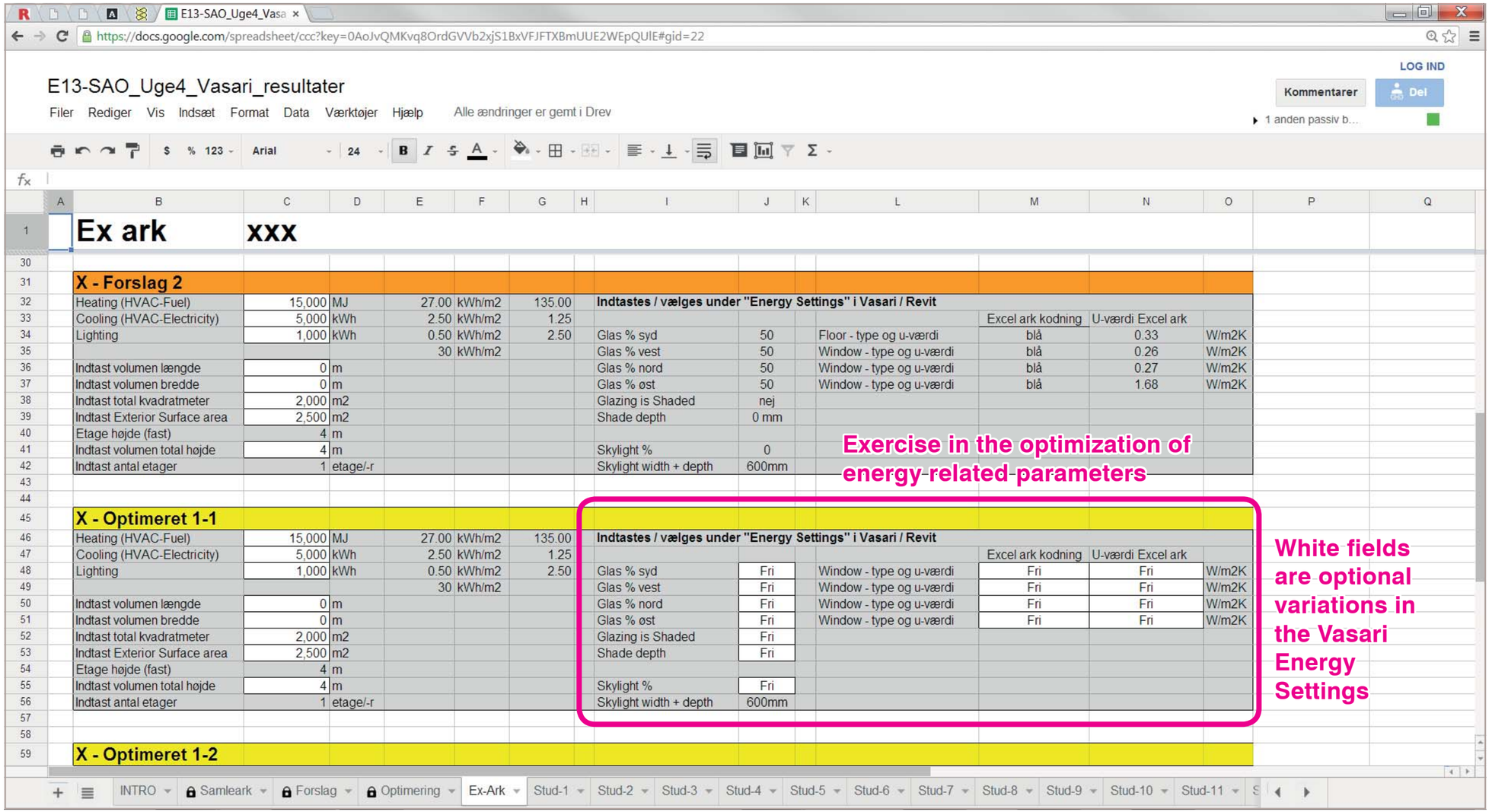
CASE-STUDIES FROM STUDENT COURSES

COURSE B - USING GOOGLE SPREADSHEET FOR COLLECTING RESULTS



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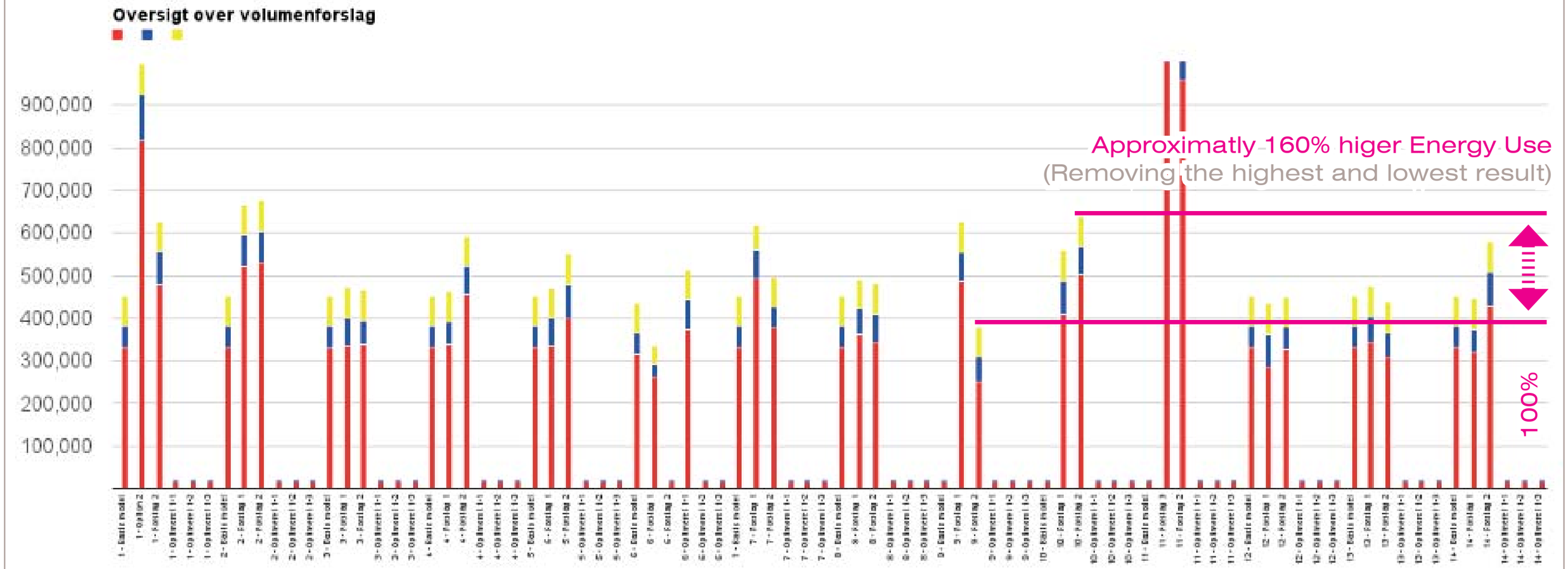
CASE-STUDIES FROM STUDENT COURSES

COURSE B - COMPARING OF OPERATIONAL ENERGY MASS STUDIES



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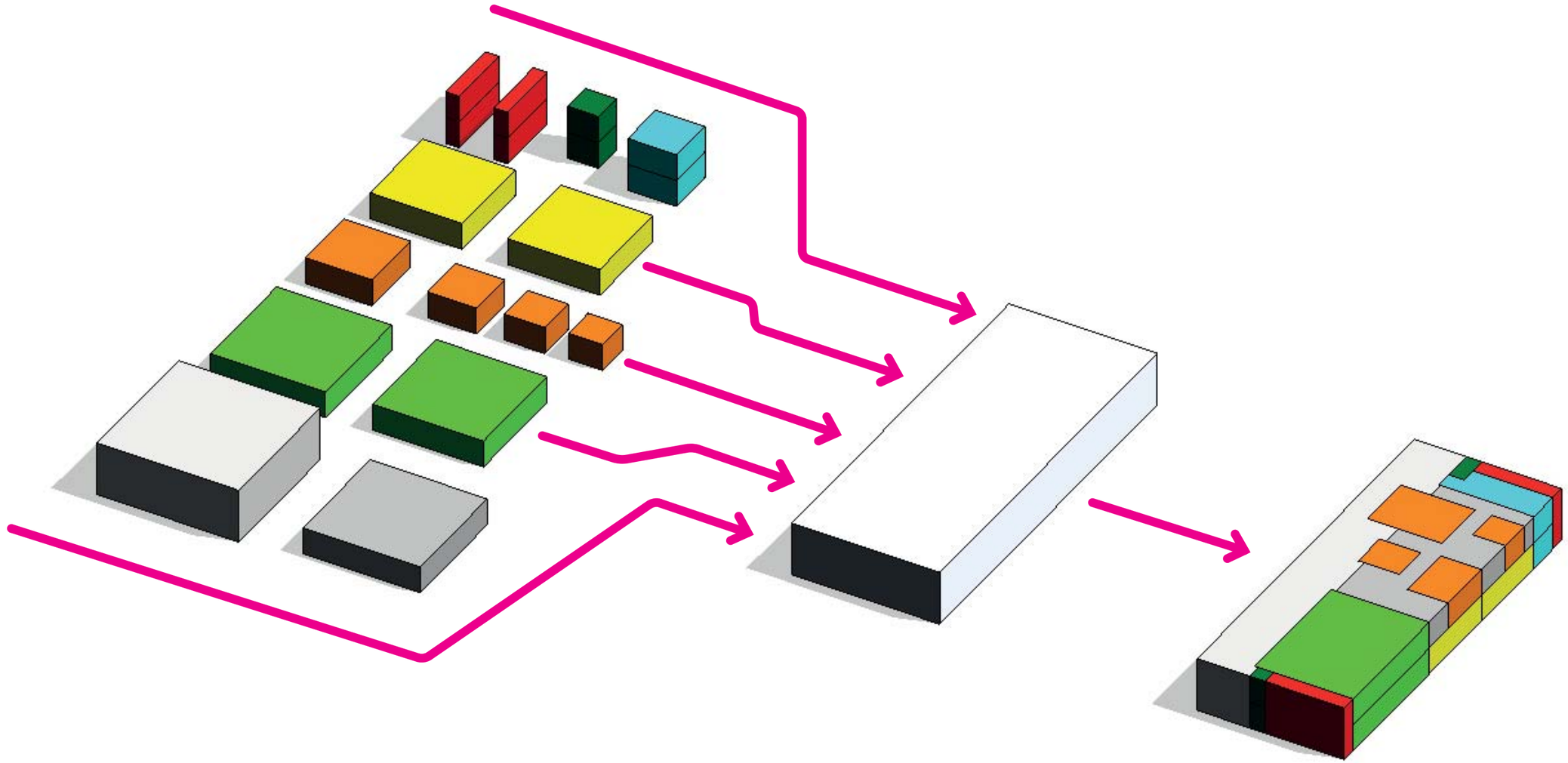
COURSE B - SPACE PLANNING STUDIES



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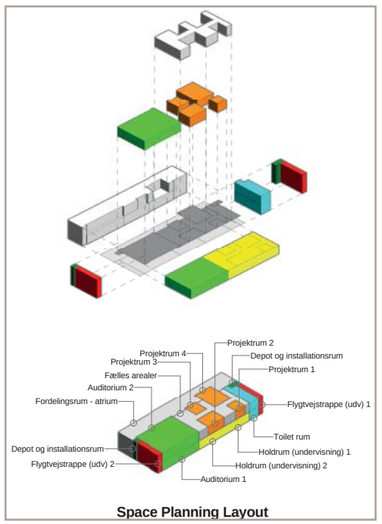
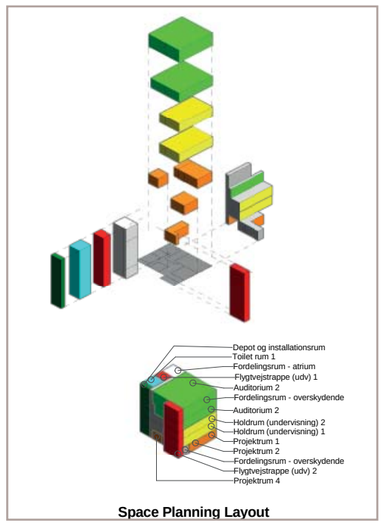
CASE-STUDIES FROM STUDENT COURSES

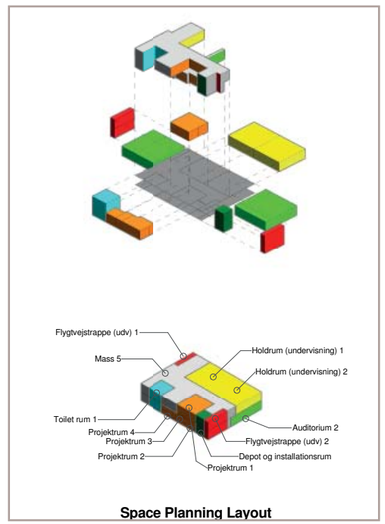
COURSE B - SPACE PLANNING STUDIES - EXPLODED VIEWS



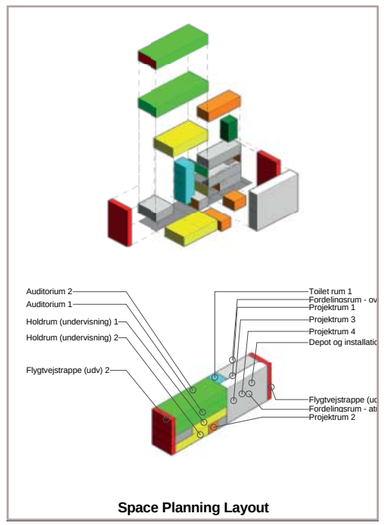
Space Planning Layout



Space Planning Layout



Space Planning Layout



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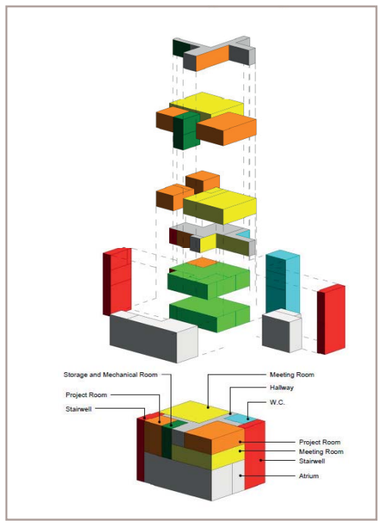

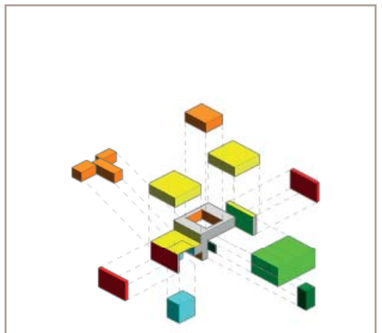

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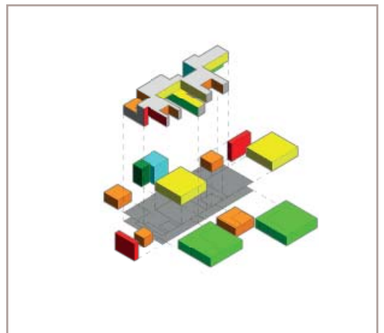

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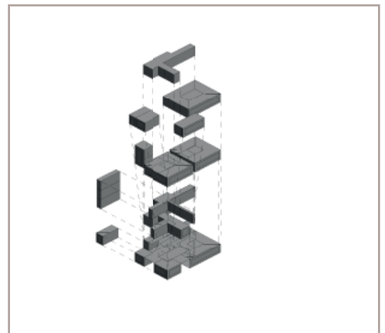
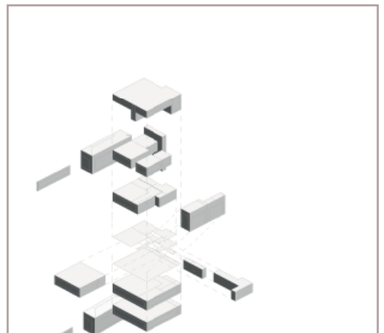


Space Planning Layout



Space Planning Layout



Space Planning Layout

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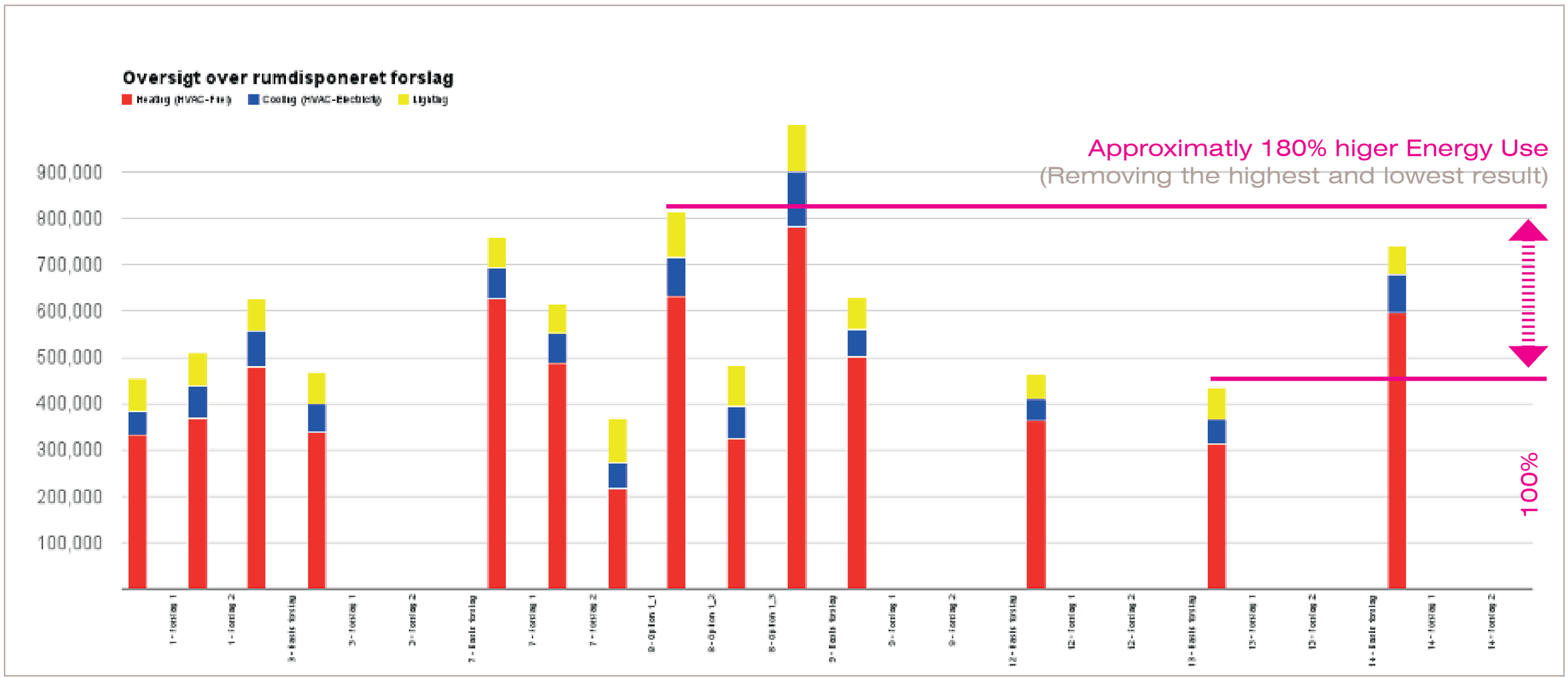
CASE-STUDIES FROM STUDENT COURSES

COURSE B - COMPARING OF OPERATIONAL ENERGY - SPACE PLANNING



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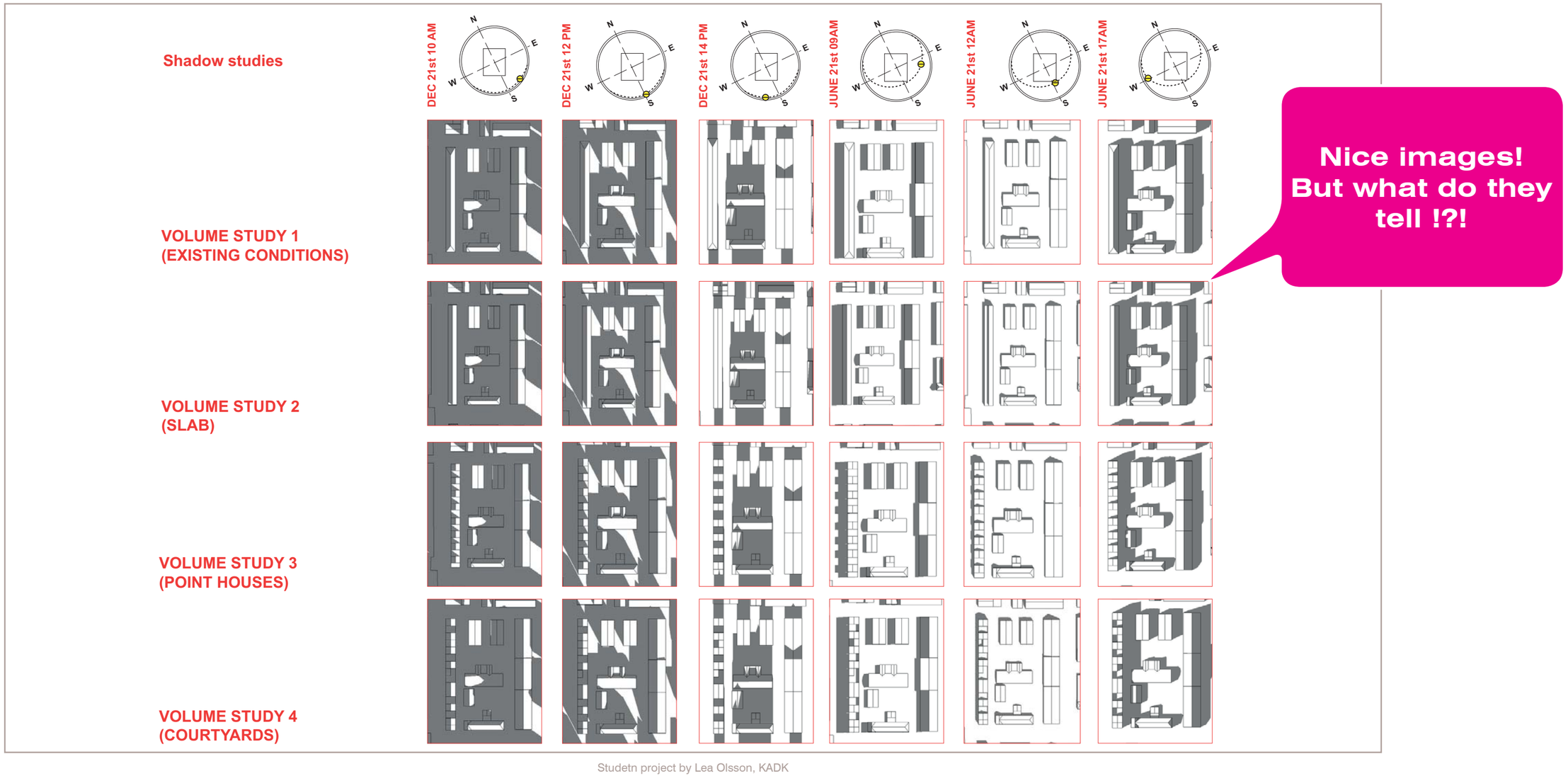
CASE-STUDIES FROM STUDENT COURSES

VARIOUS STUDENT EXAMPLES



Studetn project by Lea Olsson, KADK

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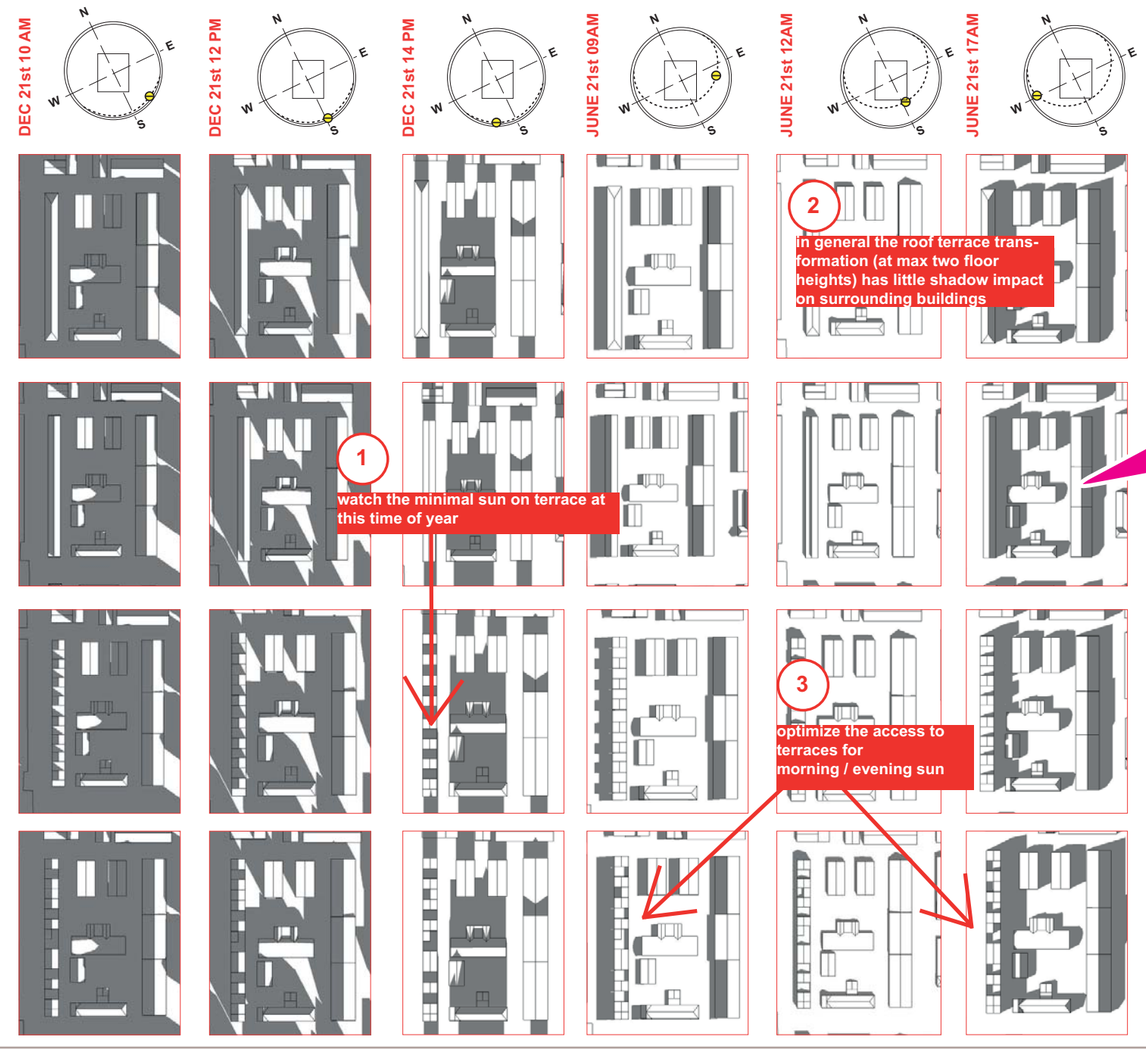
CASE-STUDIES FROM STUDENT COURSES

VARIOUS STUDENT EXAMPLES

Shadow studies

SUMMARY



With comments simulations communicate much better!

Text about strategies and ideas!

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CASE-STUDIES FROM STUDENT COURSES

VARIOUS STUDENT EXAMPLES

EXTENSIONS COLLECT MORE RADIATION THAN CURRENT FACADE

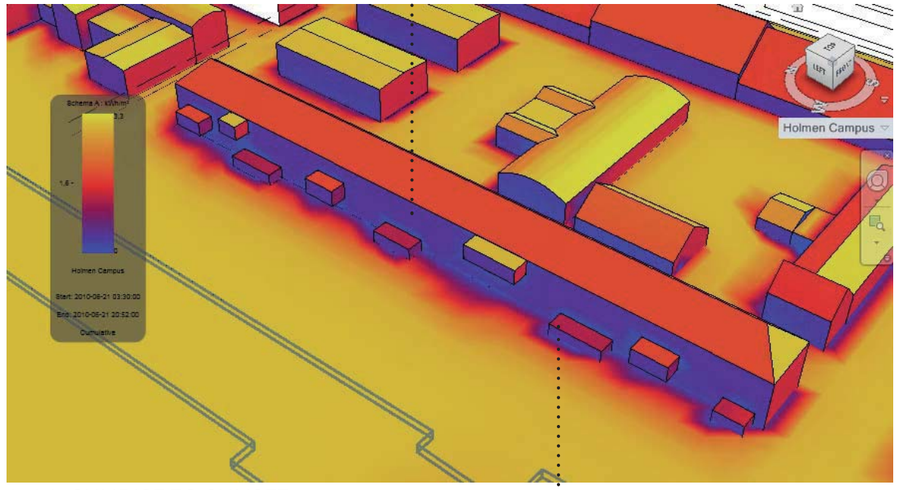
POTENTIAL FOR USING THE OPPOSITE FACADE AS WELL

BIG EXTRUSION ON UPPER LEVELS CASTS MORE SHADOW

THE UPPER BOXES ARE THE MOST EFFICIENT

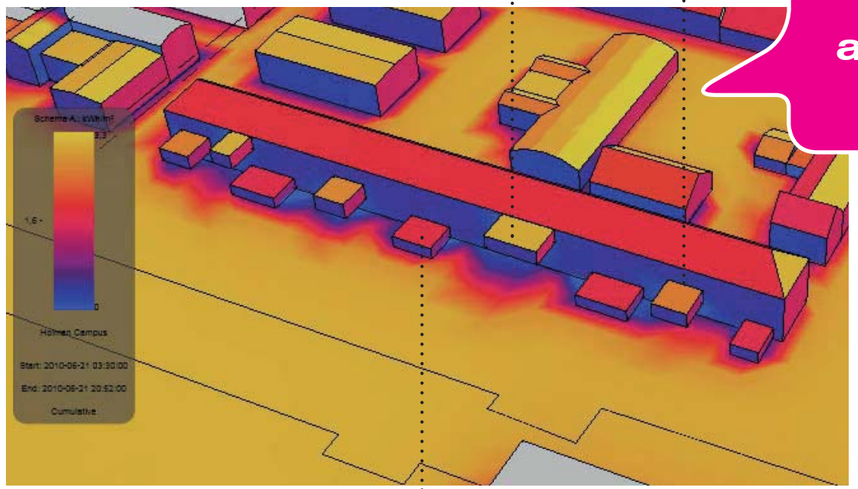
THE EXISTING FACADE COLLECTS LITTLE RADIATION HEAT

4 METER EXTRUSION



21.06 SUNRISE TO SUNSET

8 METER EXTRUSION



21.06 SUNRISE TO SUNSET

THE MORE THEY ARE EXTRUDED THE MORE RADIATION

Simple text pointing out important highlights and strategial thoughts

Student project by Maria Louise Tolstrup & Marie Persson, KADK

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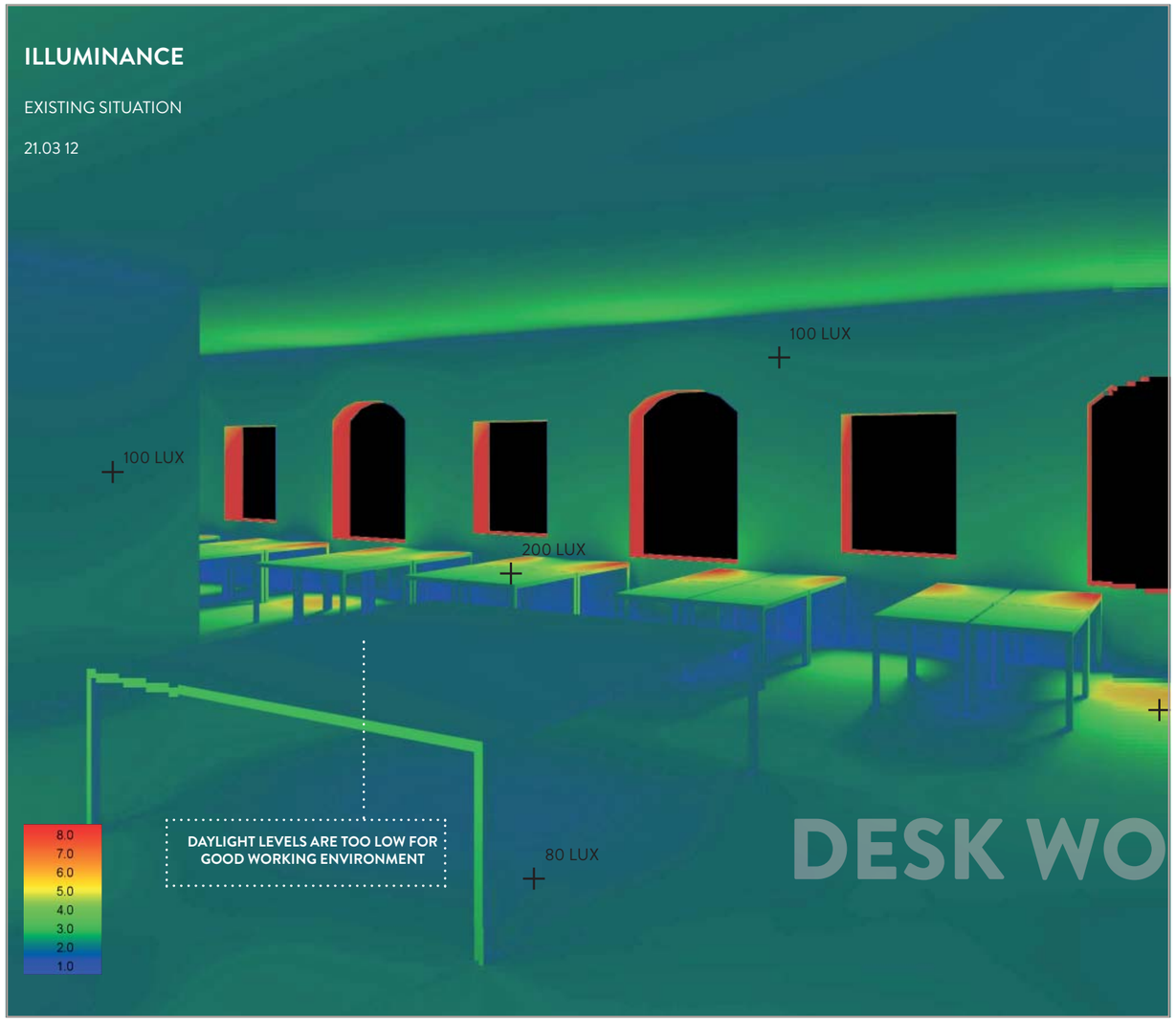
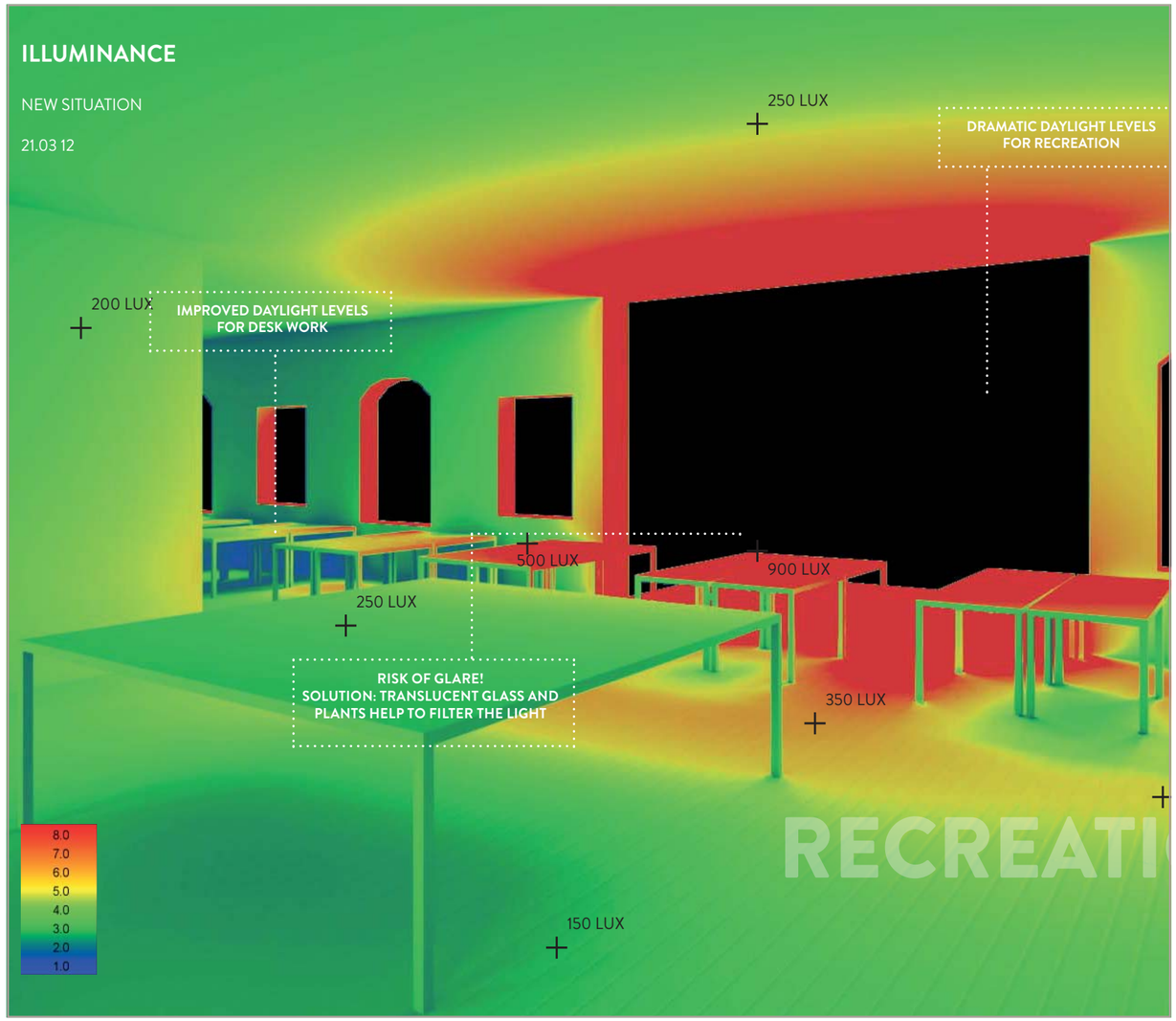
CASE-STUDIES FROM STUDENT COURSES

VARIOUS STUDENT EXAMPLES





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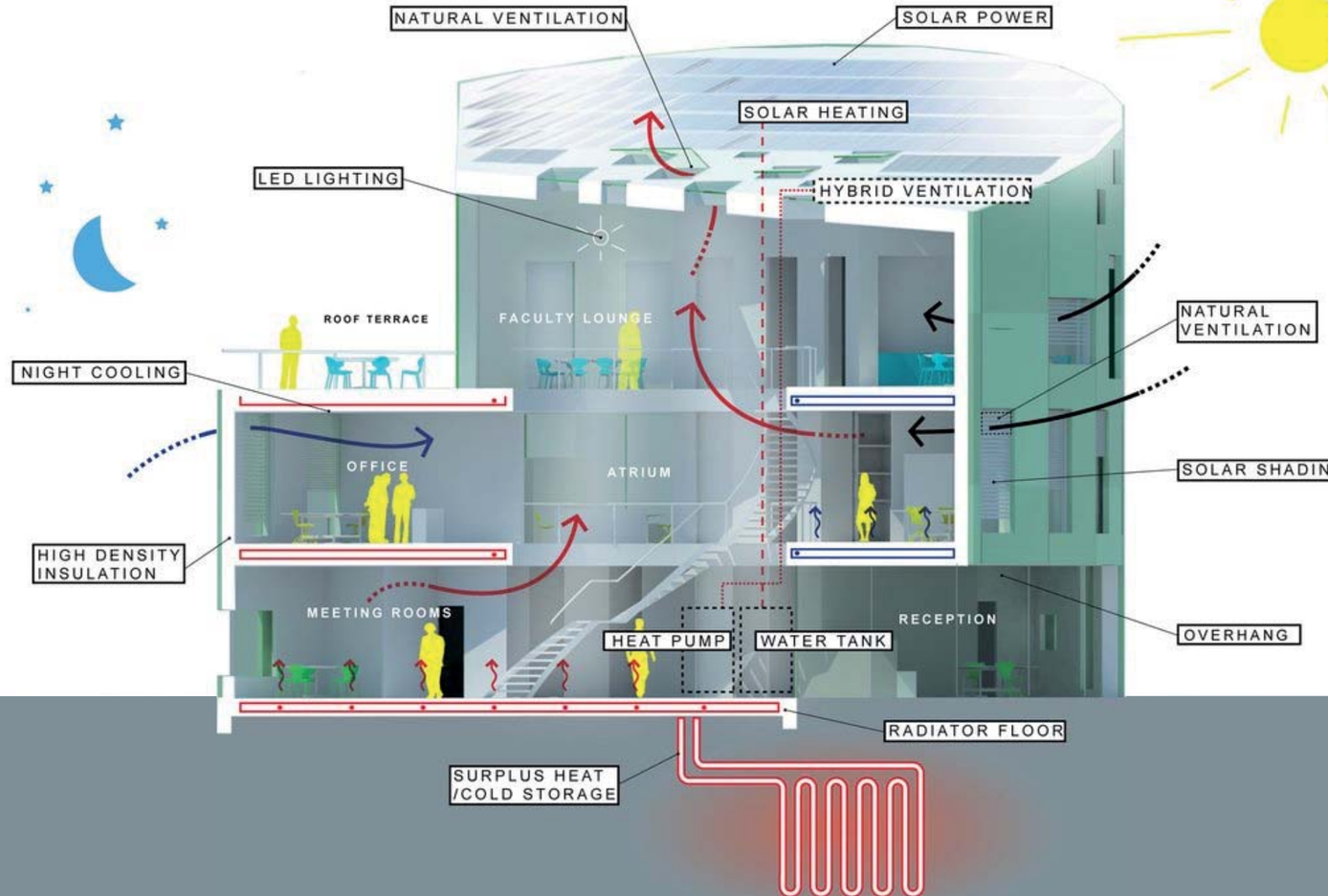
CASE-STUDIES FROM STUDENT COURSES

A “ENVIRONMENTAL SECTION”



This is done with Illustrator and/or InDesign

Is this possible within Revit?

Yes of course, so why not do it in Revit?!

Image by CCO architects

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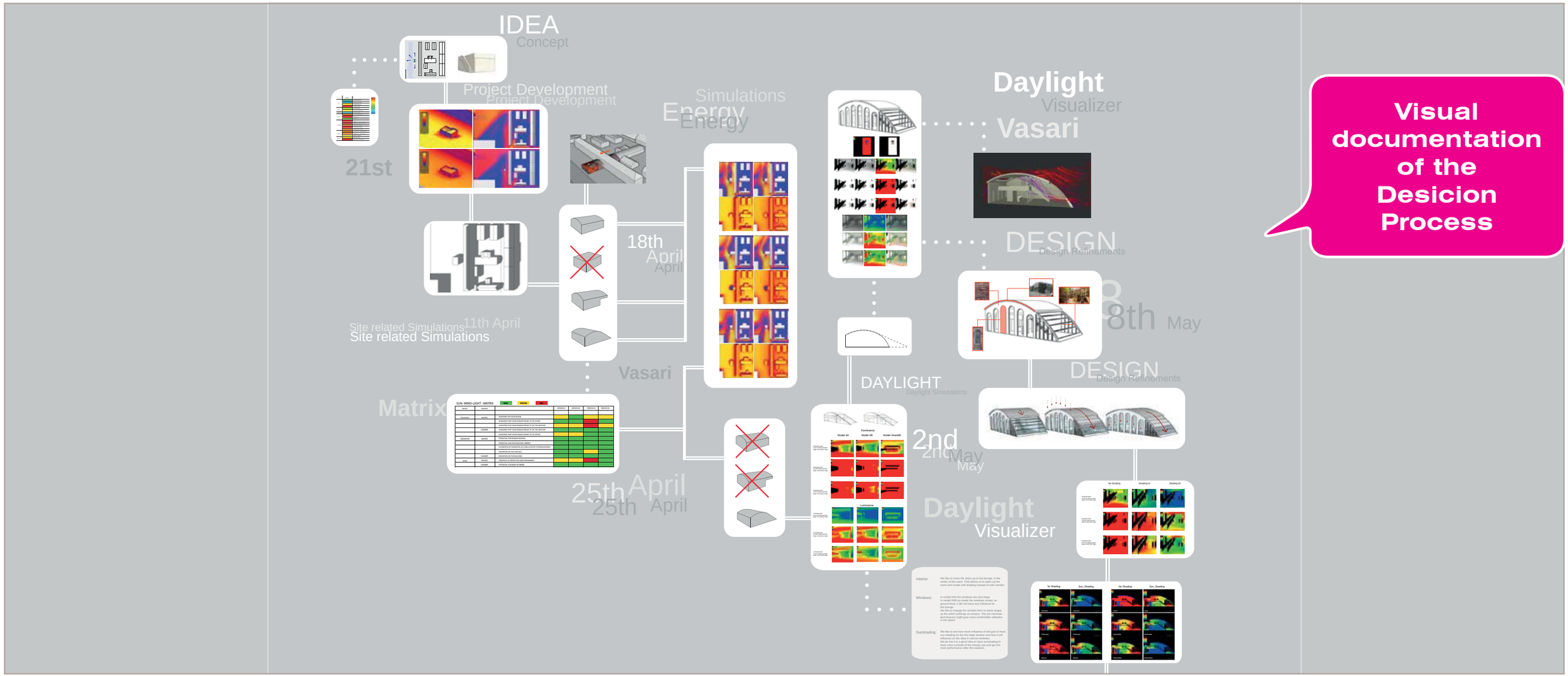
CASE-STUDIES FROM STUDENT COURSES

STUDENT EXAMPLE - VISUAL DISCISSION FLOW



Student project by xxx

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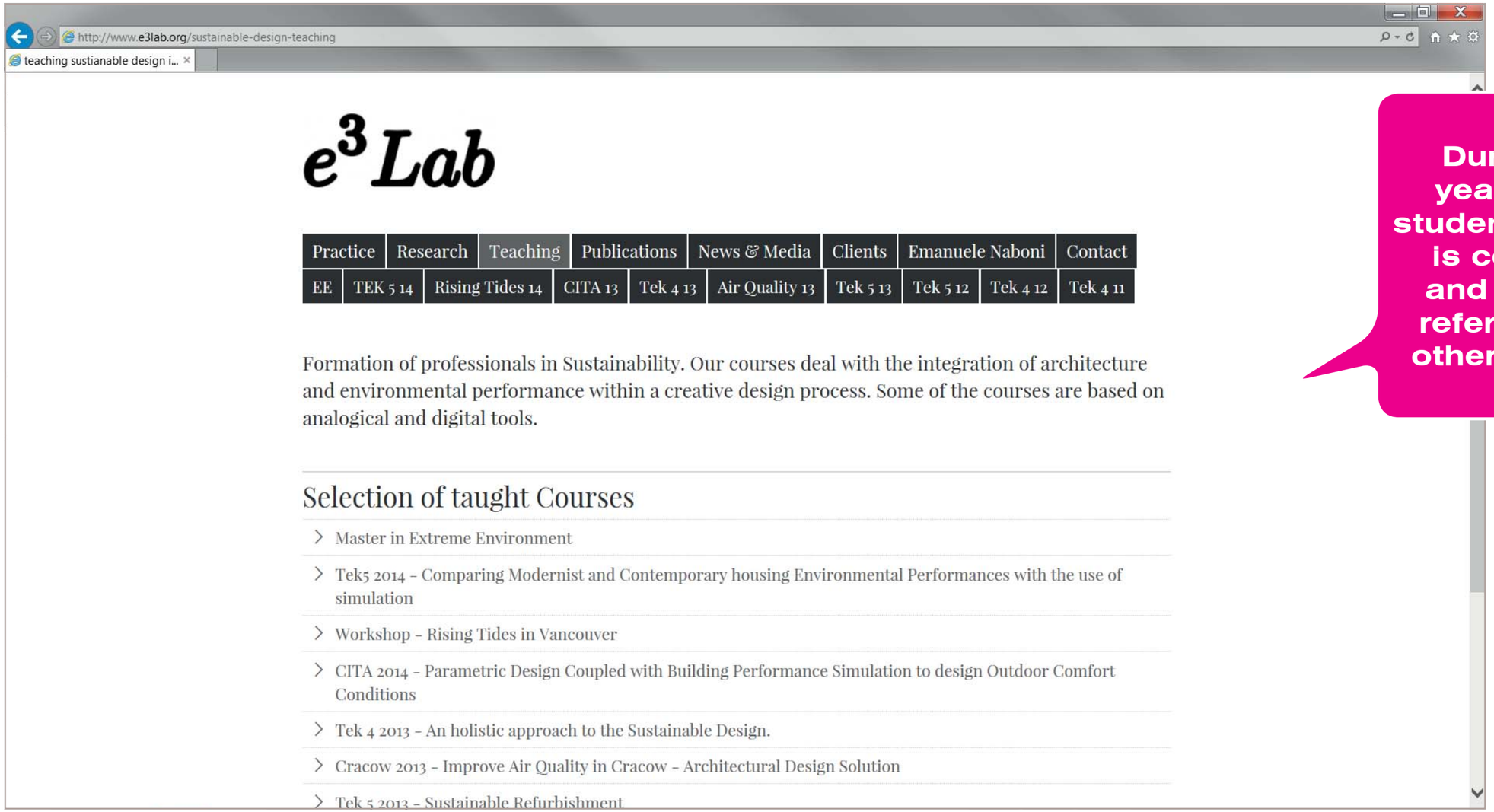
CASE-STUDIES FROM STUDENT COURSES

THE "BIG" DATABASE WITH GOOD EXAMPLES FROM STUDENTS



During the years good students results is collected and used as references in other courses

Link: http://www.e3lab.org/sustainable-design-teaching

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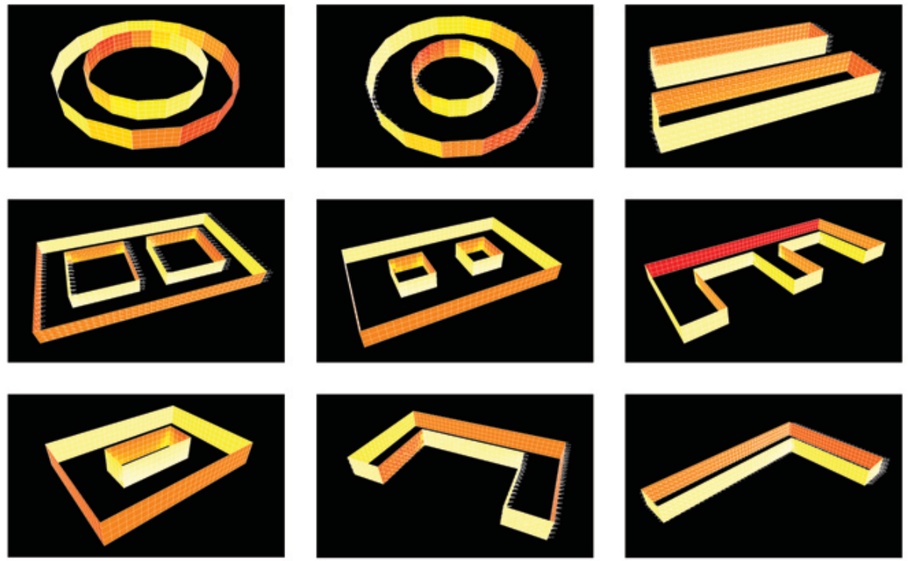
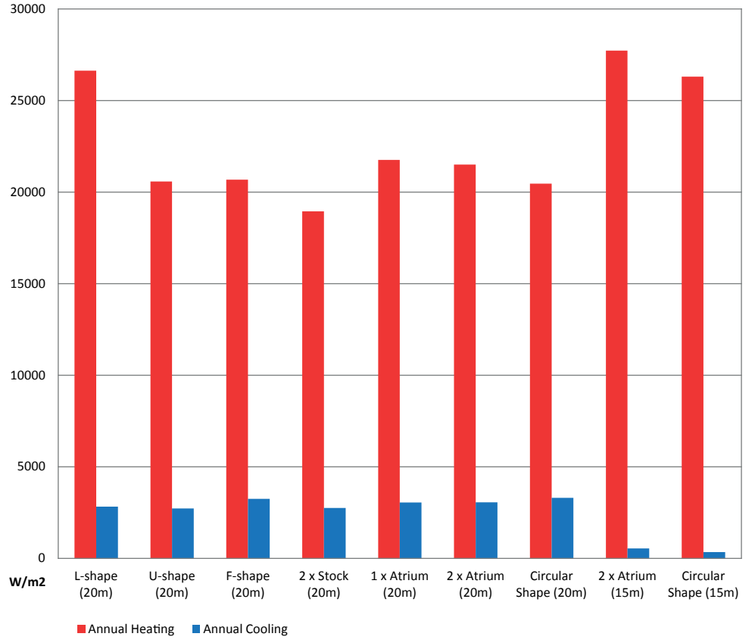
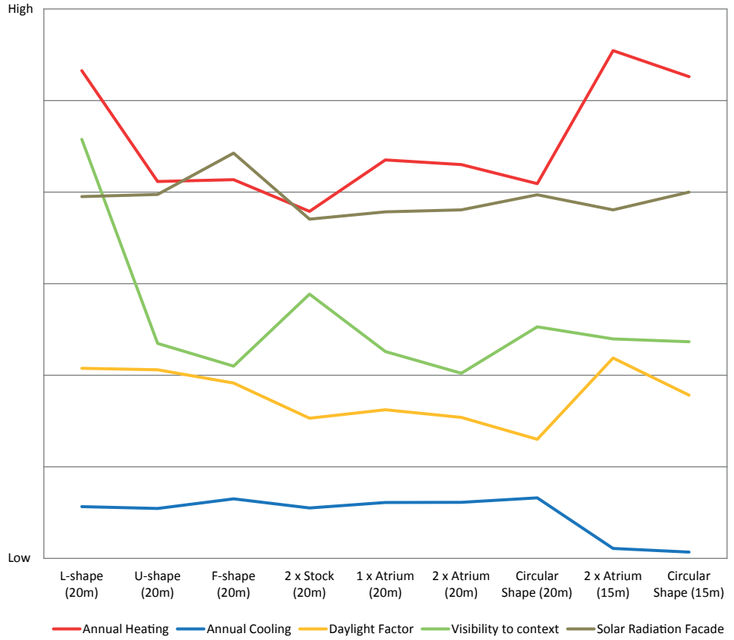
[1.3^{b}]

CASE-STUDIES FROM PRACTICE

CONCEPTUAL BUILDING TYPOLOGIES - VISUAL, THERMAL AND ENERGY PERFORMANCE







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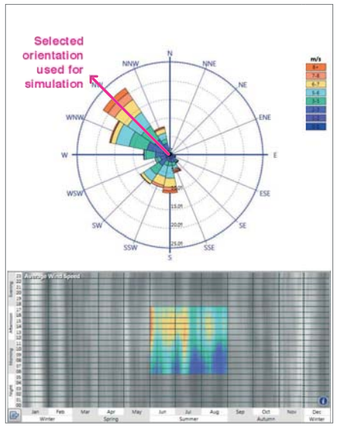
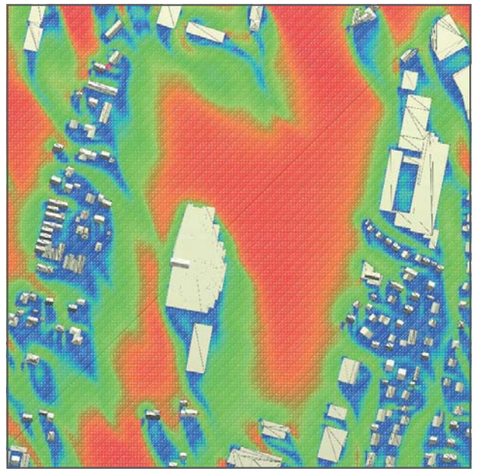
CASE-STUDIES FROM PRACTICE

URBAN COMFORT - AIR FLOWS AND TURBULENCE IN PLAN VIEW



without concepts



Summer

with concept 1

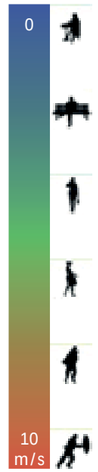


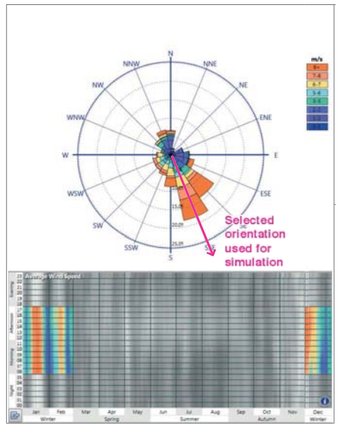
Summer

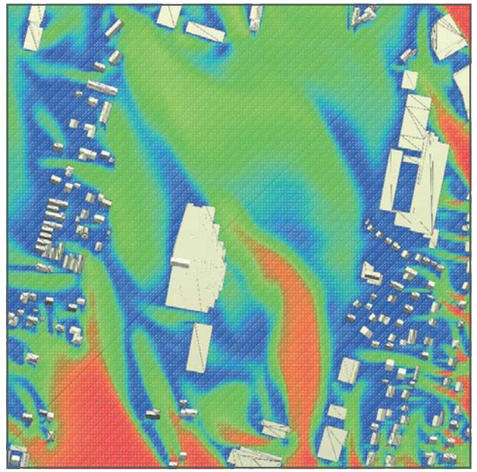
with concept 2 (13. dec.)



Summer







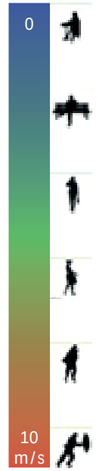
Winter



Winter



Winter



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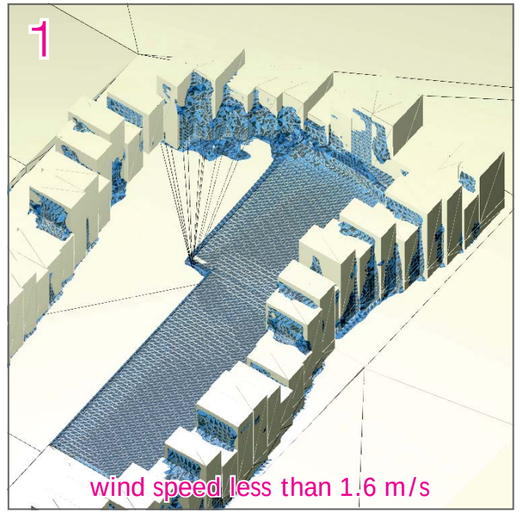
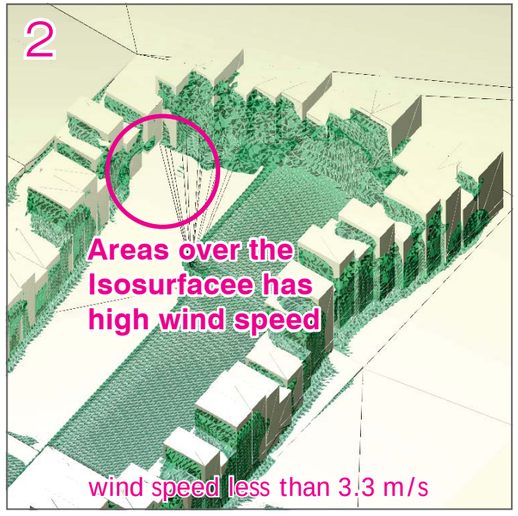
CASE-STUDIES FROM PRACTICE

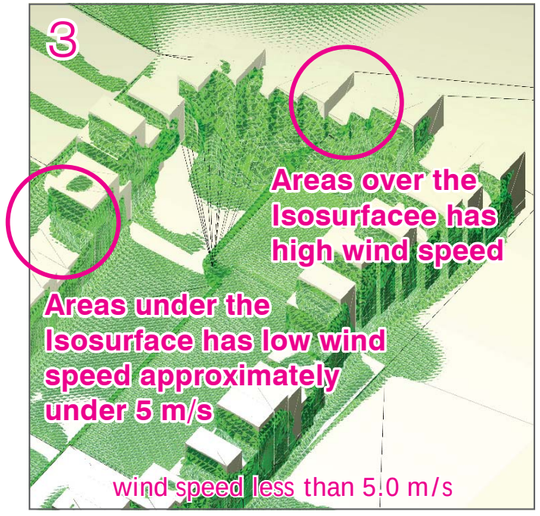
URBAN COMFORT - AIR FLOWS AND TURBULENCE IN ISOMETRIC VIEW

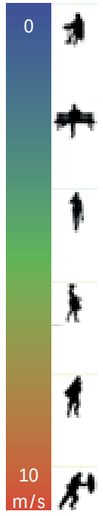
Threshold steps = showing a wind speed under a certain value







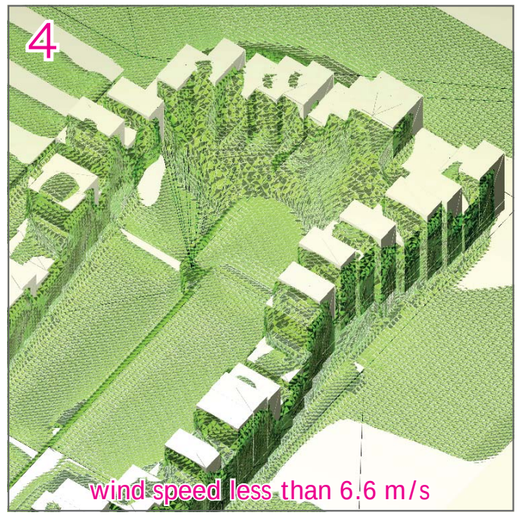




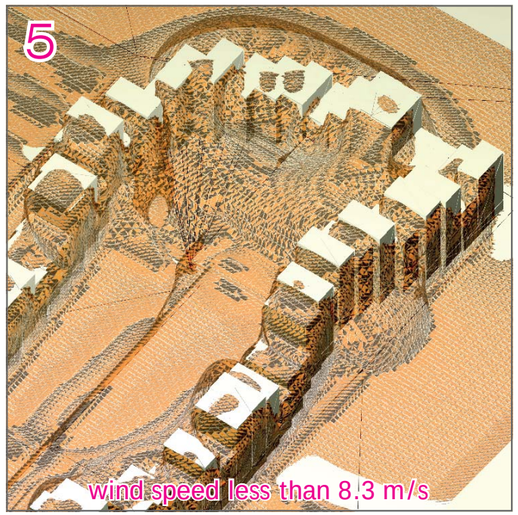
Wind speed legend scale

Summer



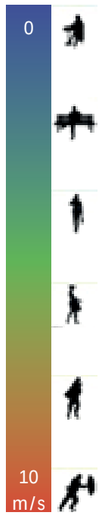


Summer



Summer





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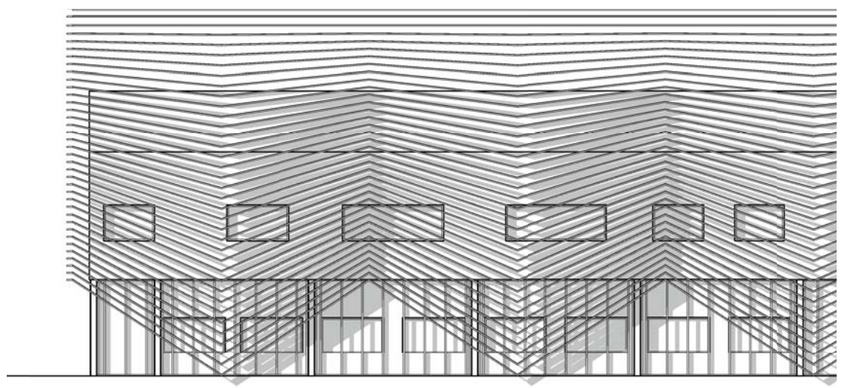
FACADE DESIGN AND VISUAL COMFORT

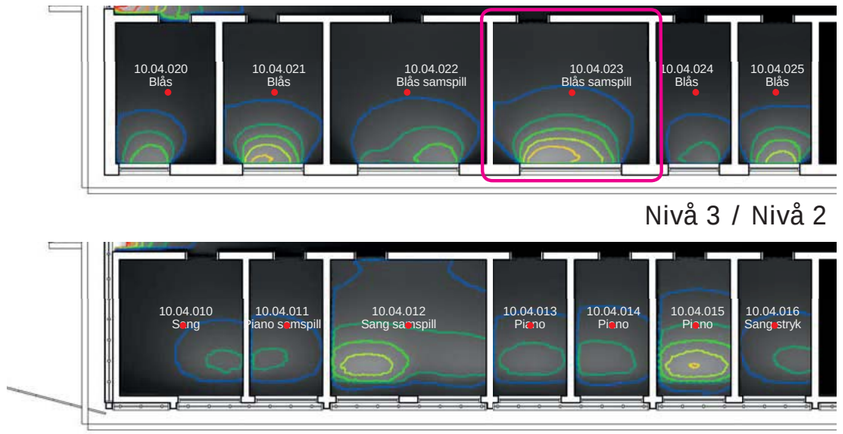


Sydfasade

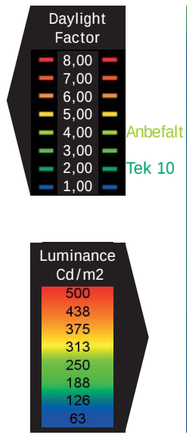
Hvordan fasaden ser ut med testet solavskjermingskonsept

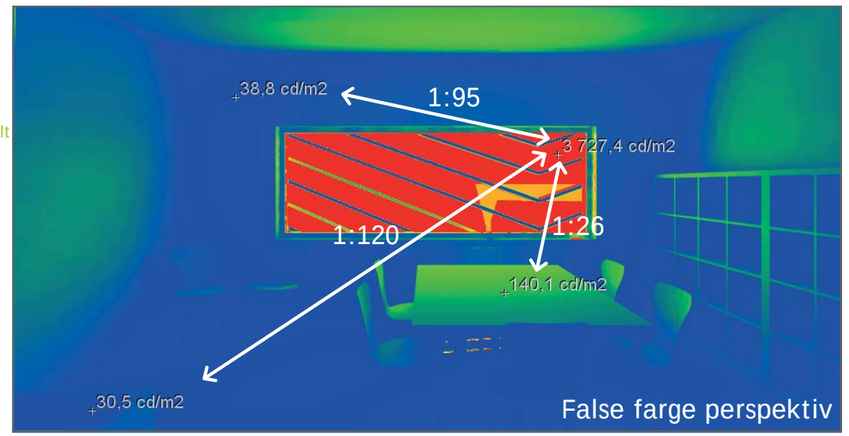


Rommet viser hvor mye dagslys som kommer inn med refleksjoner og materialegenskaper på overflater (21.Juni kl1200 = lyseste dagen i året)



Nivå 3 viser rommet som er studert med dagslysfaktor, TEK 10 stiller krav til 2% dagslysfaktor midt i rommet





Rommer viser at kontrastforhold mellom høyeste verdi og markerte punkter i perspektiv **bør være under 1:30** (21.Juni kl1200) Det betyr at i denne analysen, er det 120 ganger mer lys ute enn inne

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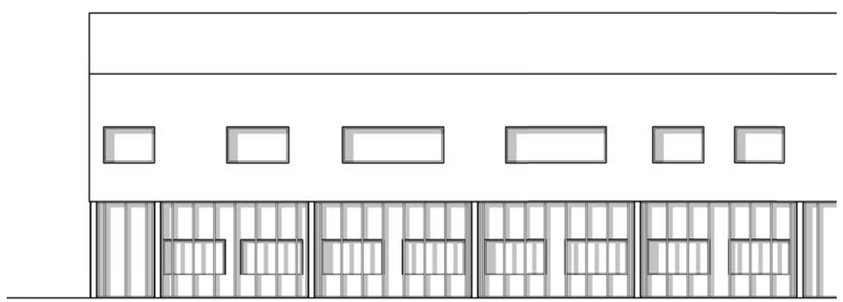
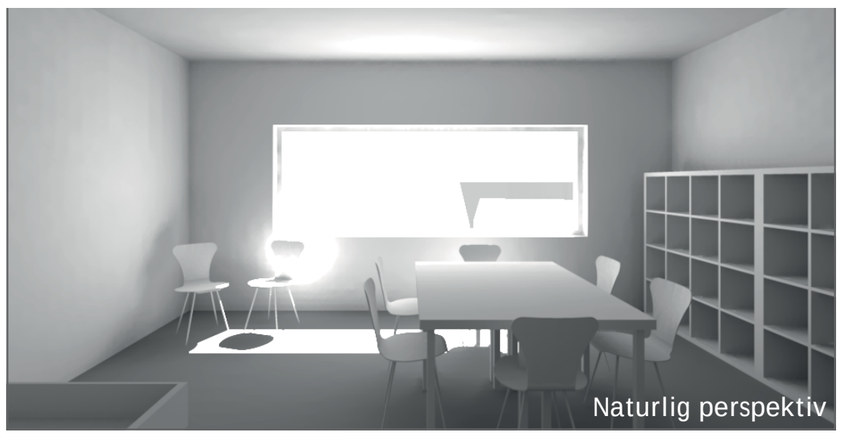
FACADE DESIGN AND VISUAL COMFORT

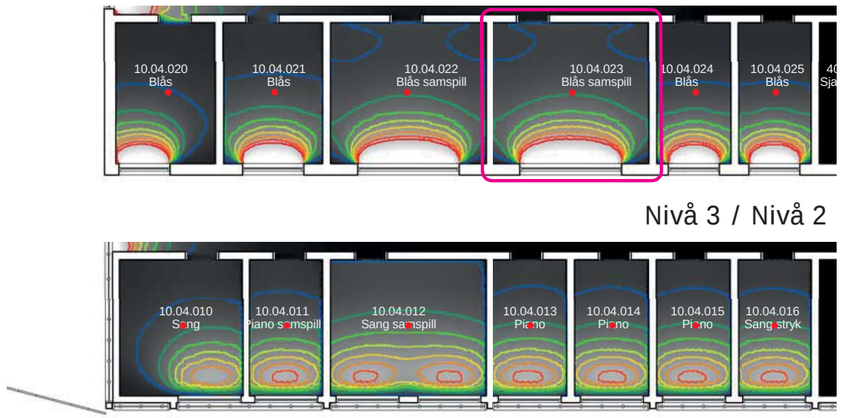


Sydfasade

Men hva er differansen uten solavskjerming?

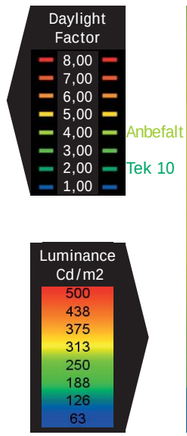


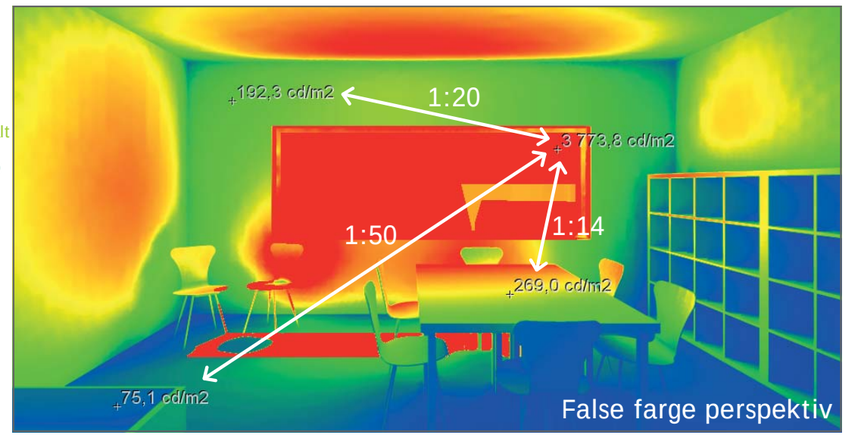
Her vises hvor mye naturlig dagslys det kan være (21.Juni kl1200 = lyseste dagen i året) Her vises hvor mye sollys kommer inn på gulvet. **Vi anbefaler ikke å sitte i direkte sollys**



Nivå 3 / Nivå 2

Her vises dagslysfaktor inn i rommet uten solavskjerming





Kontrast forhold mellom høyeste verdi og markede punkter er redusert fordi hele rommet er opplyst. Analysen viser ingen beskyttelse mot sollys (21.Juni kl1200 = lyseste dagen i året)

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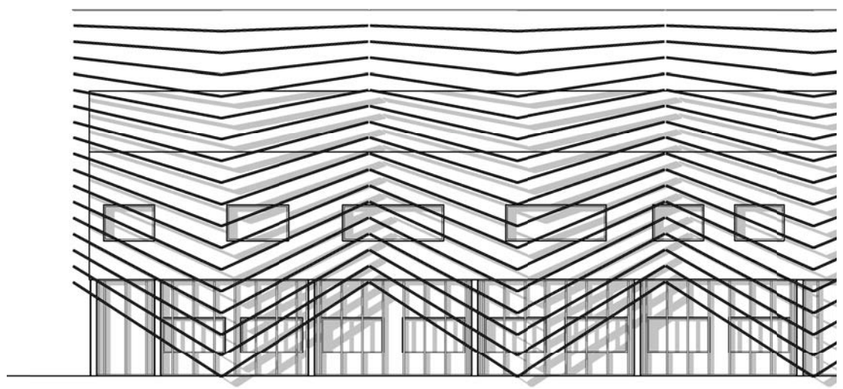
FACADE DESIGN AND VISUAL COMFORT

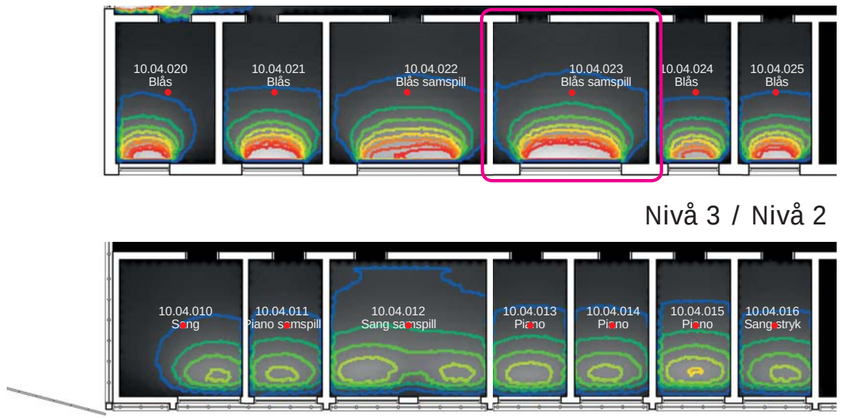


Sydfasade

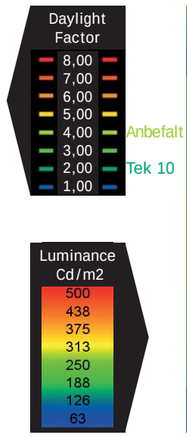
Tettheten av lamellene har blitt redusert fra 37 til 18.

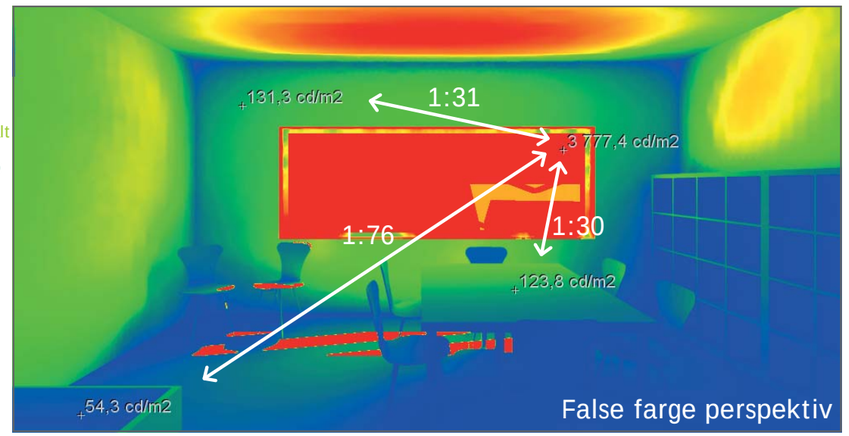


Her vises effekten av lavere tetthett (21.Juni kl1200 = lyseste dagen i året) med 75% VT i vinduer. **Vi anbefale justering av vinduer høyere opp for å få ekstra dagslys inn i bygget**



Her vises hvor mye dagslys som kommer inn i dette studiet. Nå er vi nærmere 2% i midt av rommet.





Kontrast forhold mellom høyeste verdi og markerte punkter i perspektiv **bør være under 1:30** (21.Juni kl1200). **Vi anbefale å bruke lyshyller for ekstra beskyttelse mot sollys/blending om sommeren**

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EXAMPLE OF A HOLISTIC REPORT

Bruno 'btco' Olivera - Goo... | Green Buildings Design

www.e3lab.org/green-buildings

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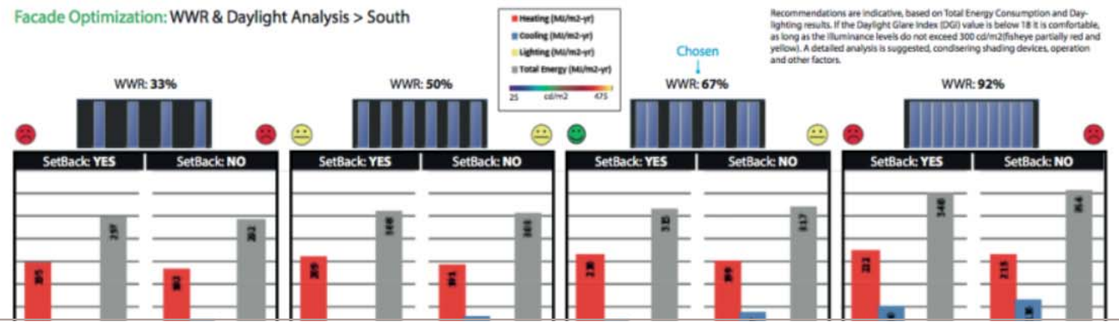
Green Buildings | Green Homes | Façades and Technologies | Green Cities | Services

Tenova Pomini - Sustainable Concept Development - with FTA

A consultancy for a 3600 m2 office building proposal, located in Milan (IT). In accordance to latest scientific evidence of the "early design stage" importance for achieving energy efficient buildings, the work was focused in the "performance based comparison of design alternatives". Four different typologies of 3600 m2 were compared. Then, from a pre-selection of the 3 most performative ones the final chosen concept was selected, which afterwards was optimized in relation to window-to-wall ratio and daylighting quality. The performance based comparison, assured the informed selection of the final proposal.

Check Link



http://www.e3lab.org/green-buildings

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[1.4]

Learning from EDUCATIONAL CONTEXT

Knowing how to read Simulations

Simulations is not a Analysis

Simulation results need after-processing

Knowing the degree of Feedback and Limitations

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[2]

DESIGN ANALYSES

Daniel Nielsen © architect maa + constructing architect © ark.daniel.nielsen@gmail.com

Climate and Strategy driven Design Studies

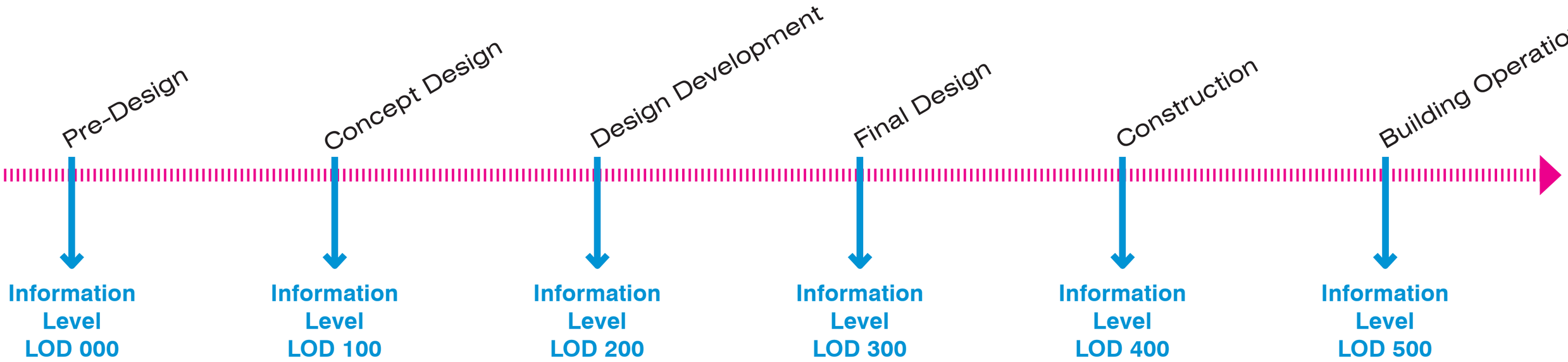
Mapping Design Strategies, Scale of Design and Simulations

Mapping Simulations with Model Detail Levels

Learning from Design Analyses

DESIGN ANALYSES

TRADITIONAL PROJECT PHASING AND INFORMATION LEVELS !



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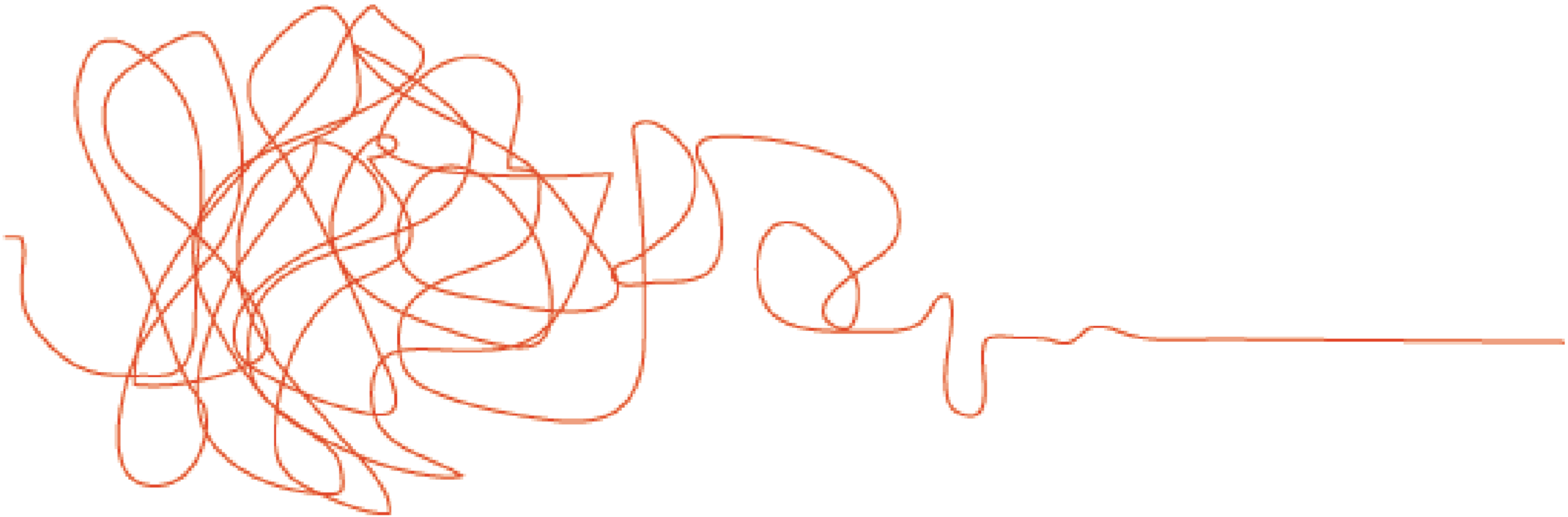
IN REALITY - THEREFOR !



the design process

for an architect

http://www.santafe-nm-webdesign.com/images/uploads/blog_images/design-process.png

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1 Urban Planning

2 Building Form

3 Facade Design

4 Fabric

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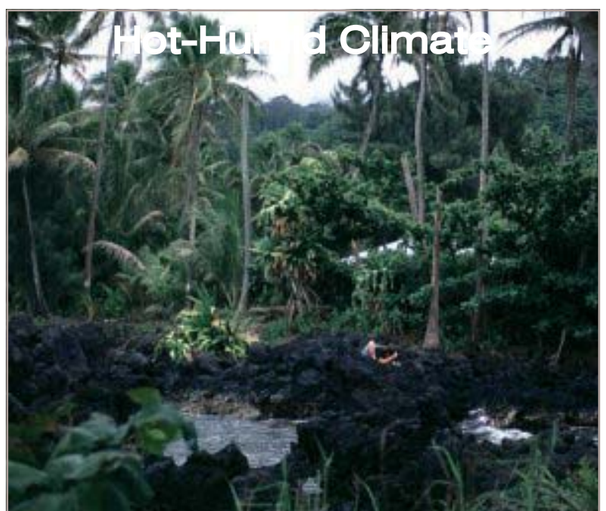
[2.1]

CLIMATE AND STRATEGY DRIVEN DESIGN STUDIES

CLIMATE AND STRATEGY DRIVEN DESIGN STUDIES

CLIMATE ADAPTED BUILDING DESIGN











http://www.weather-climate.org.uk/images/10b.jpg
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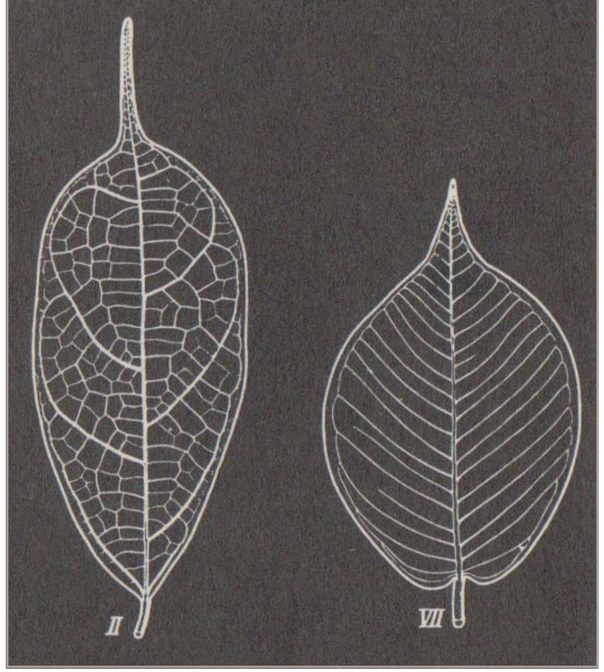
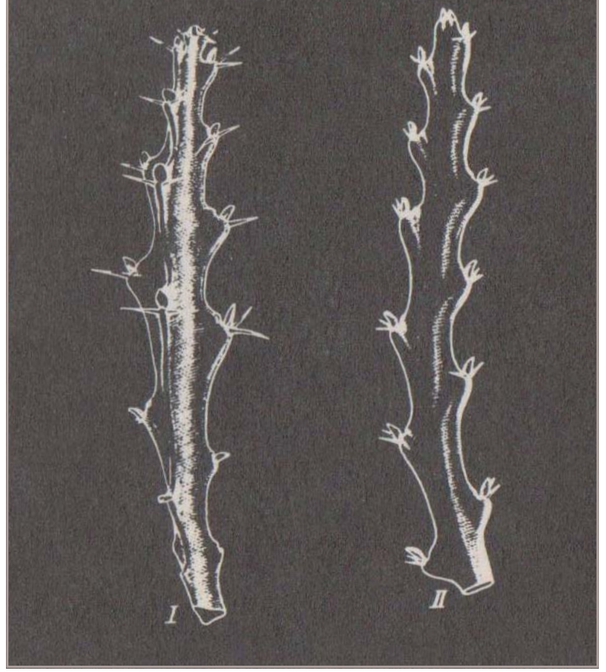
CLIMATE AND STRATEGY DRIVEN DESIGN STUDIES

NATURES ADAPTATION TO CLIMATE = BUILDING DESIGN !?

Hot-Humid Climate



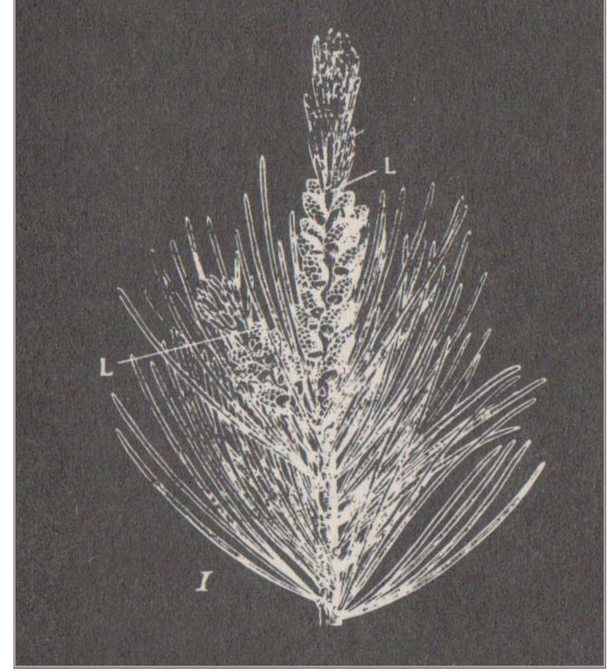
Hot-Dry Climate

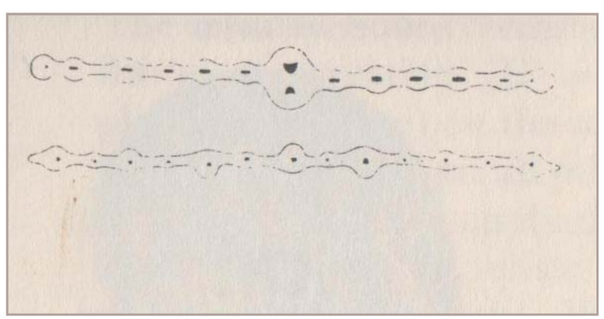


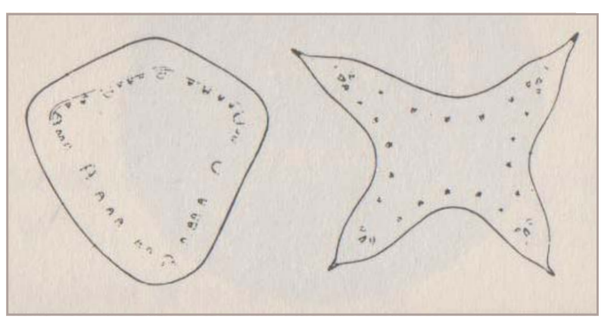
Temperate Climate

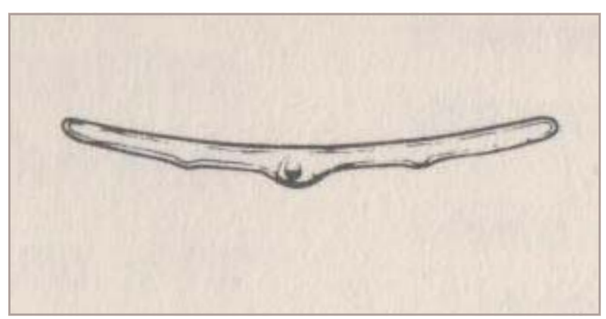


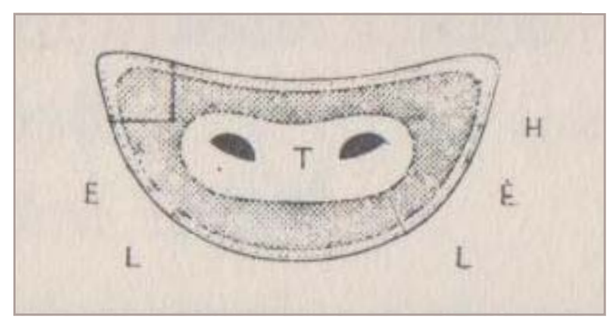
Cold Climate











Book: Design with Climate by Victor Olgyay

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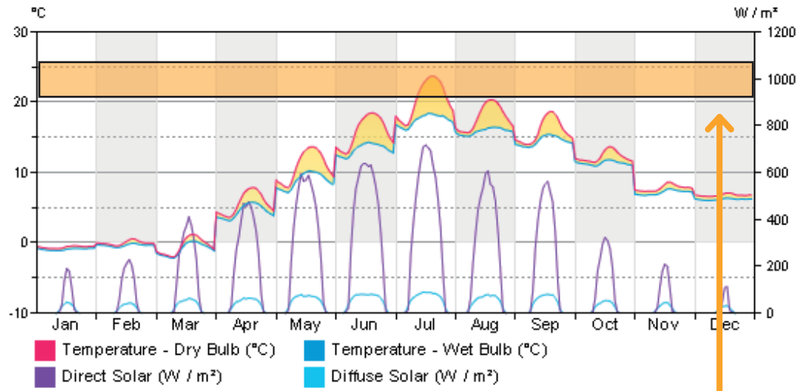
CLIMATE AND STRATEGY DRIVEN DESIGN STUDIES

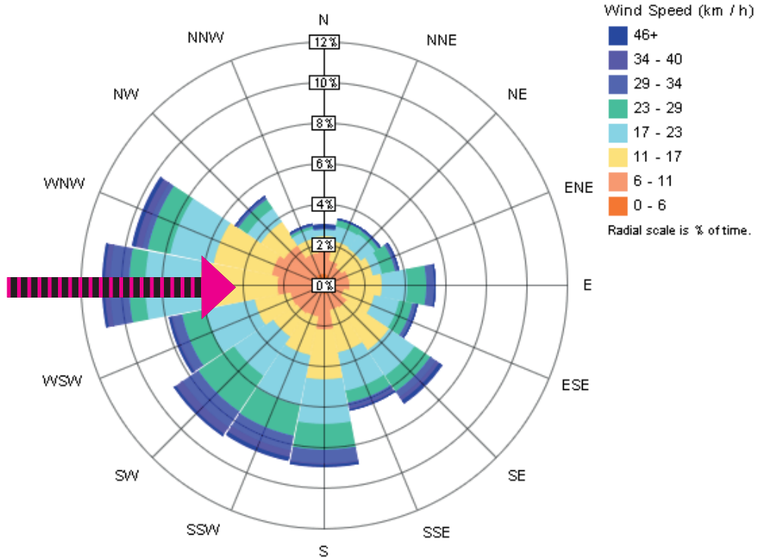
BASIC WEATHER DATA - TO UNDERSTAND CLIMATE

Temperature Range

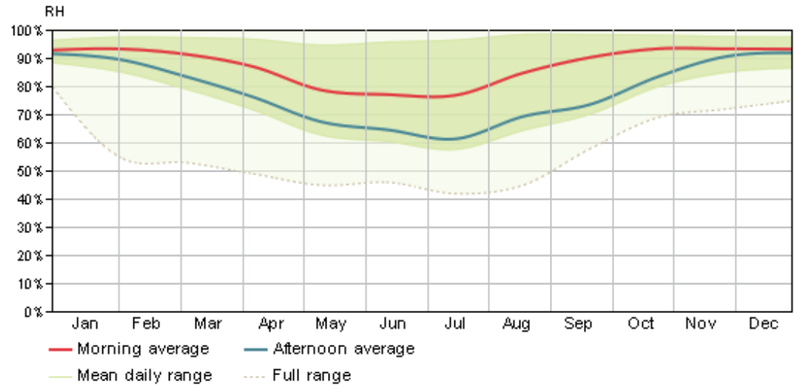


Defining Comfort Zone 20-26 degrees

Prevailing Wind Direction



Humidity



High or Low Humidity Level

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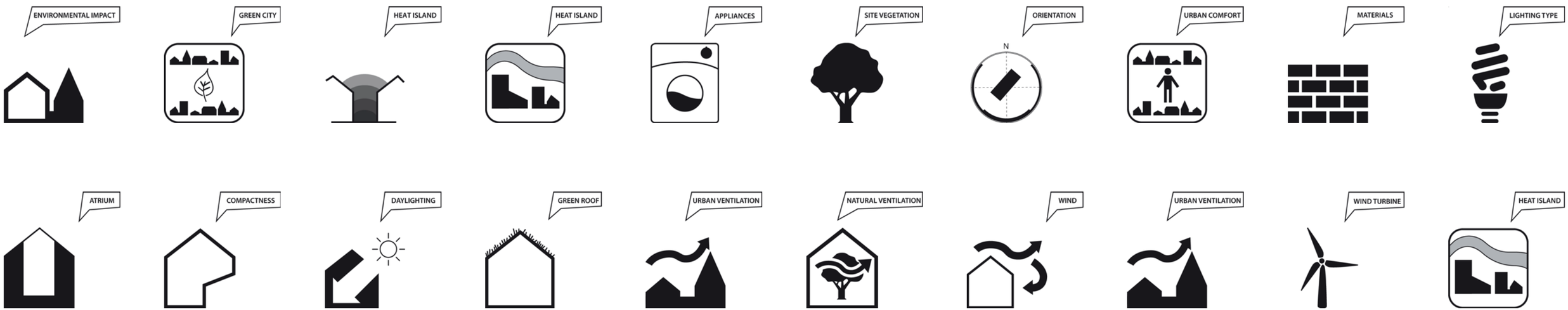
CLIMATE AND STRATEGY DRIVEN DESIGN STUDIES

CLIMATE AND PROJECT RELEVANT DESIGN STRATEGIES



Icon reference: Emanuele Naboni and Kasper Lyneborg

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[2.2]

MAPPING DESIGN STRATEGIES, SCALE OF DESIGN AND SIMULATIONS

MAPPING DESIGN STRATEGIES, SCALE OF DESIGN AND SIMULATIONS

INTEGRATED BUILDING DESIGN SYSTEM BY KOEN STEEMERS

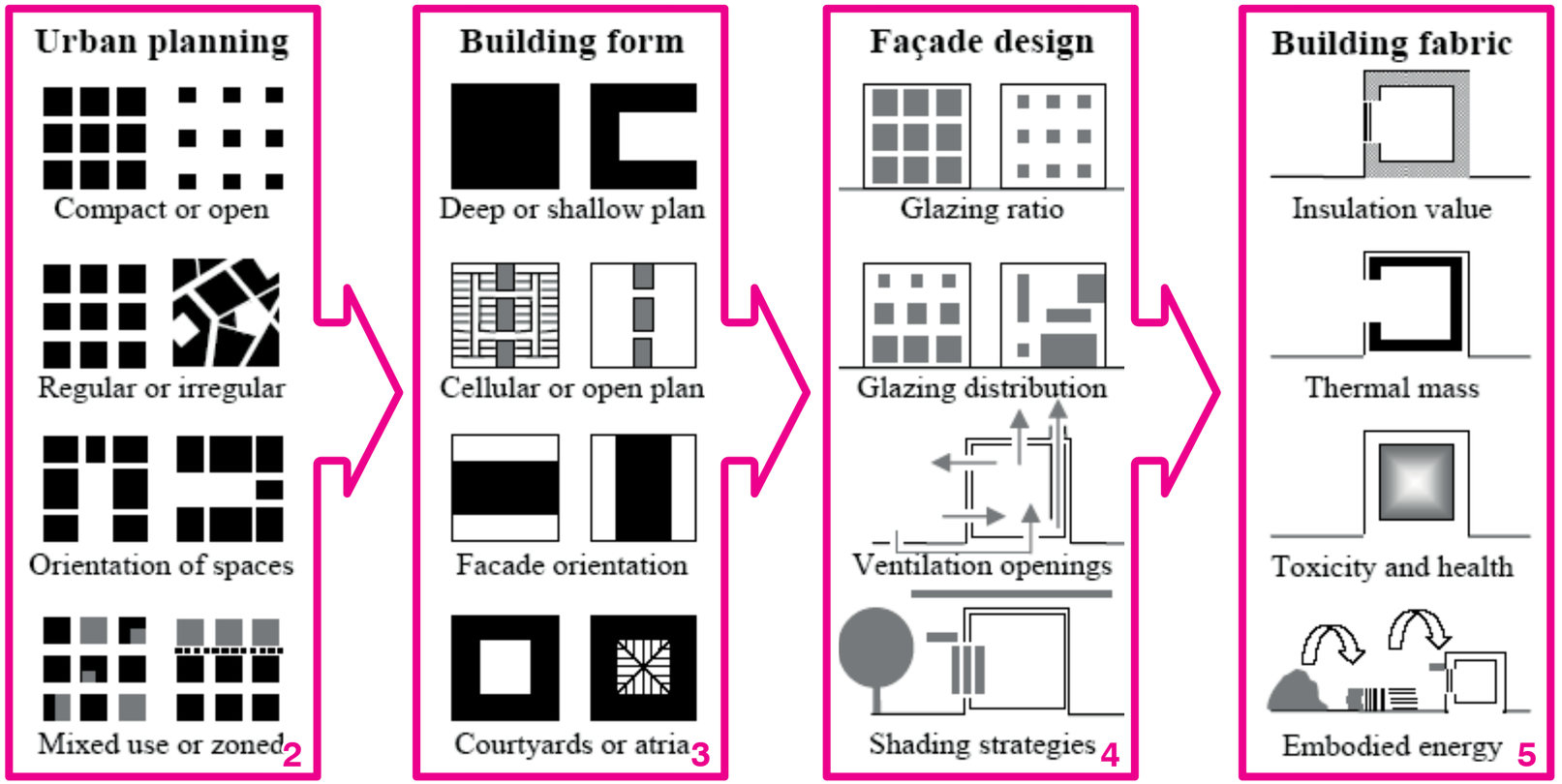

Image: Integrated Building design System (IBDS) by Koen Steemers, Cambridge University, 2006

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MAPPING DESIGN STRATEGIES, SCALE OF DESIGN AND SIMULATIONS

EXTENDED VERSION

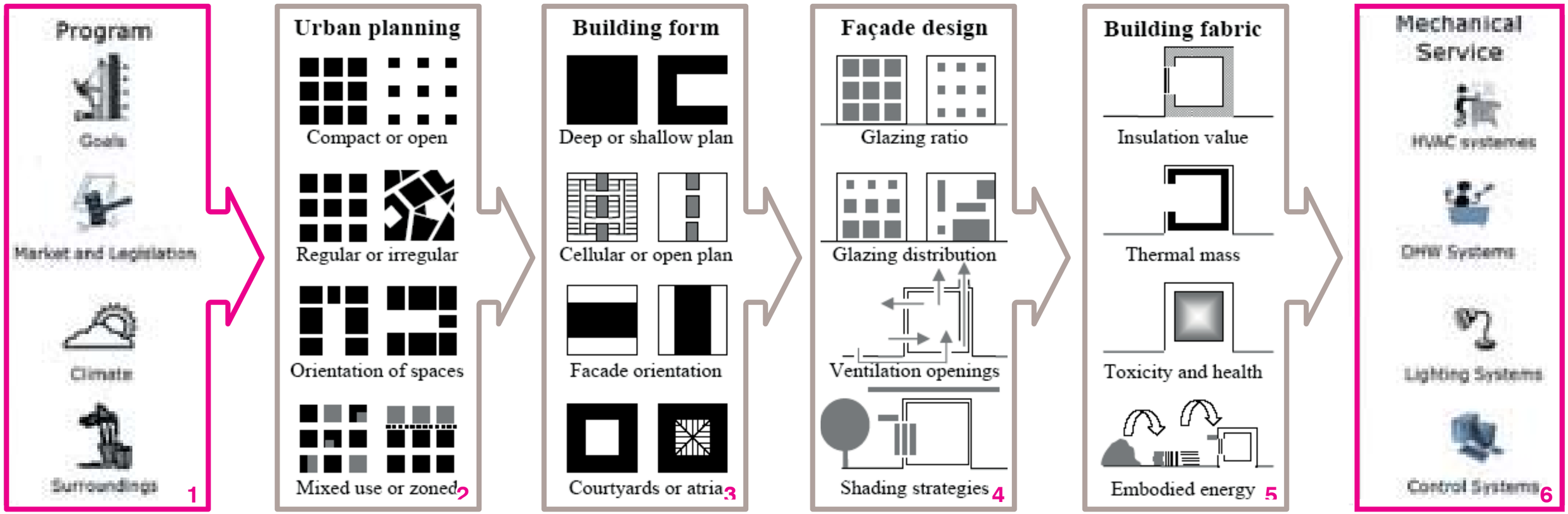

Image: Integrated Building design System (IBDS) by Koen Steemers, Cambridge University, 2006

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MAPPING DESIGN STRATEGIES, SCALE OF DESIGN AND SIMULATIONS

ADAPTED VERSION - "BOX" MAPPING DESIGN QUESTION TO SCALE OF DESIGN

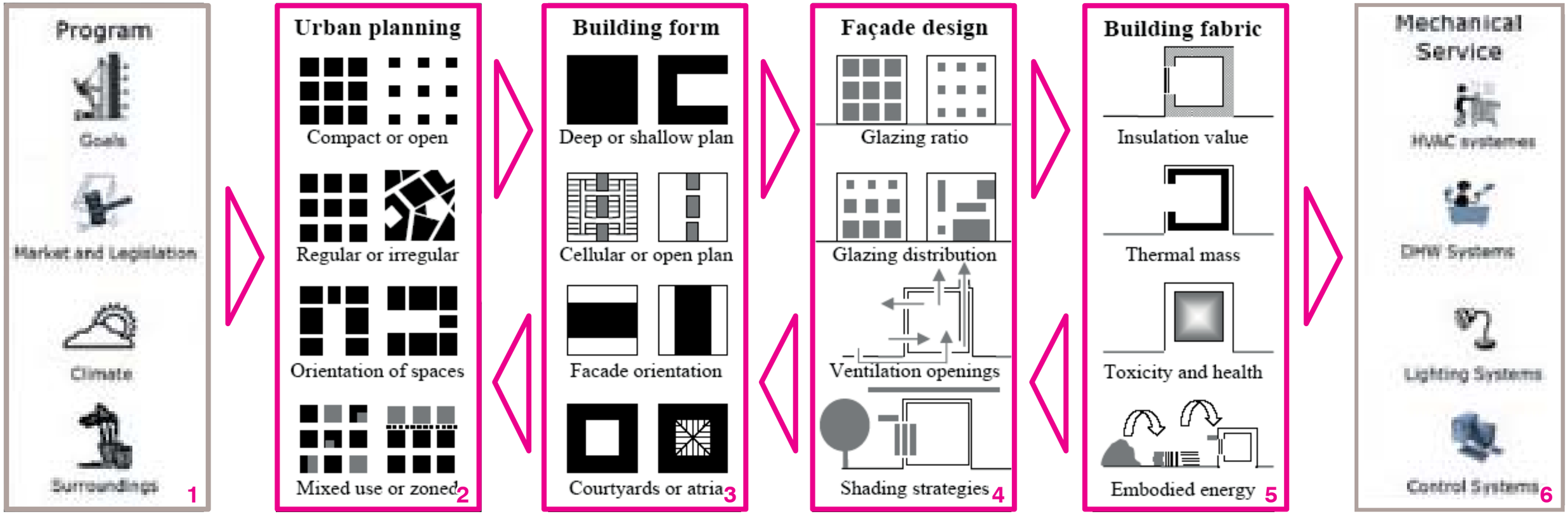

Image: Integrated Building design System (IBDS) by Koen Steemers, Cambridge University, 2006

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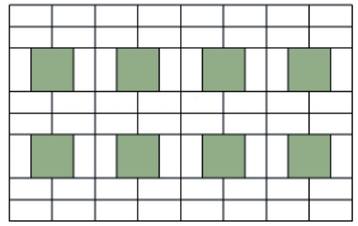
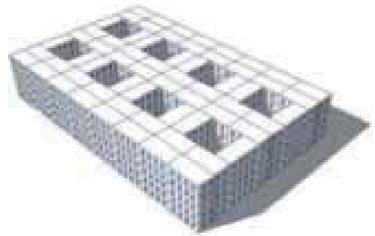
MAPPING DESIGN STRATEGIES, SCALE OF DESIGN AND SIMULATIONS

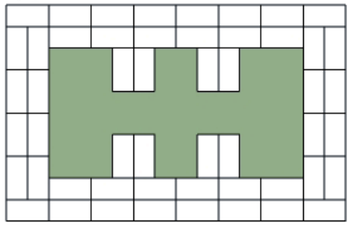
TYPOLOGY AND DENSITY STUDIES

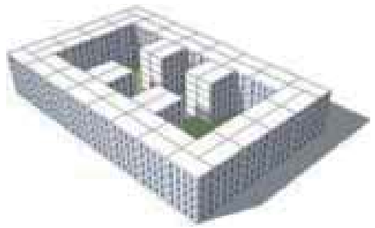
Type **A** *(Courtyards Block)*



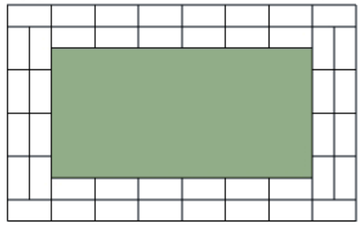


Type **B** *(Indented Block)*



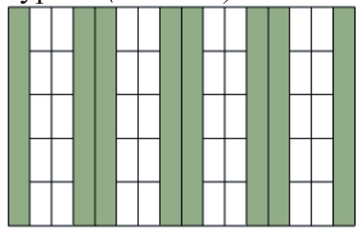


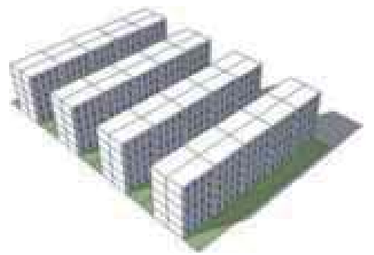
Type **C** *(Perimeter Block)*



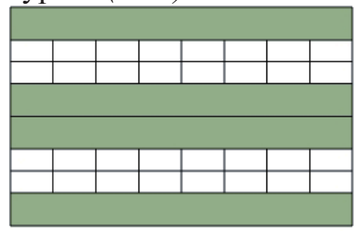


Type **D** *(Barcode)*



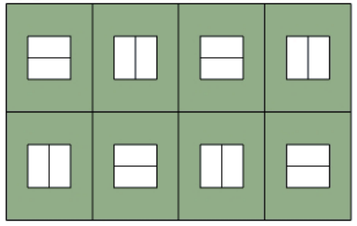


Type **E** *(Slab)*





Type **F** *(Tower)*





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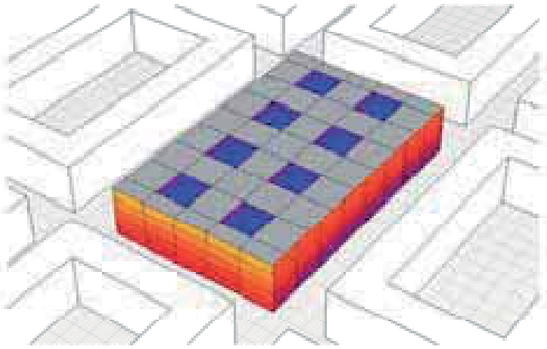
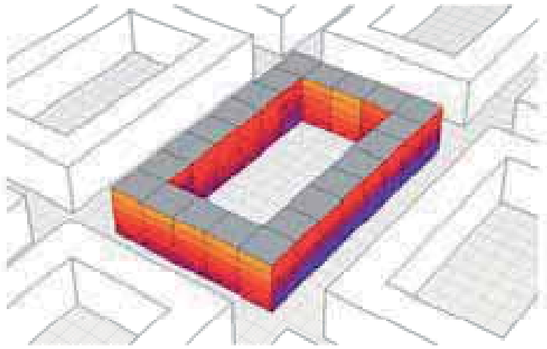
MAPPING DESIGN STRATEGIES, SCALE OF DESIGN AND SIMULATIONS

TYPOLOGY PERFORMANCE - ENERGY USE + SOLAR GAIN + DAYLIGHT AUTONOMY

Type **A**



Type **C**



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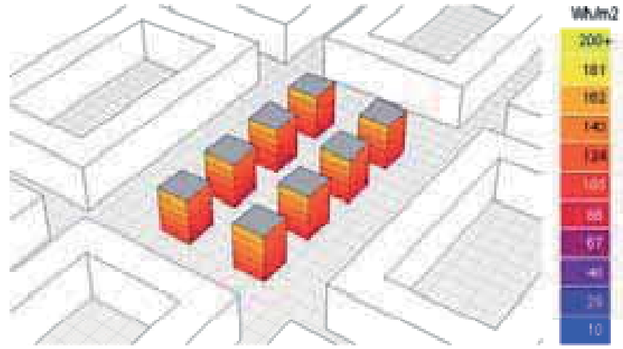

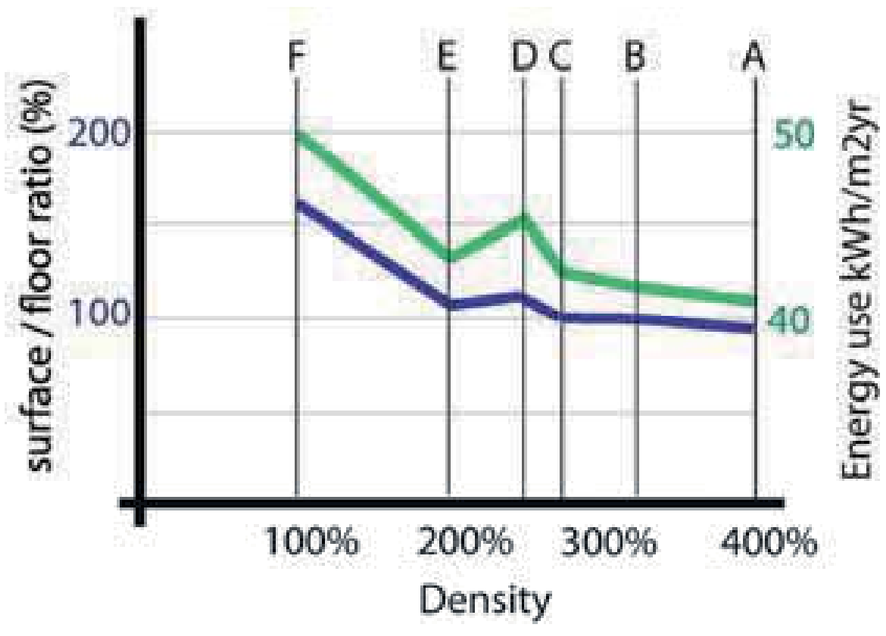

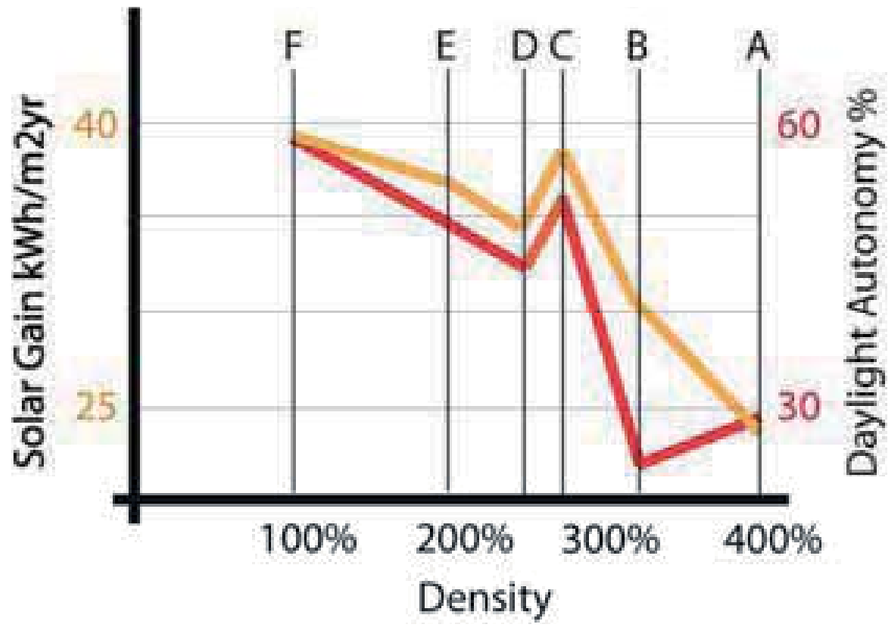

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MAPPING DESIGN STRATEGIES, SCALE OF DESIGN AND SIMULATIONS

DEFINING DESIGN QUESTIONS RELATED TO SCALE OF DESIGN WITH SIMULATIONS

		Urban				Form				Facade				Fabric			
	Design Strategy	Compact or Open	Regular or Irregular	Orientation of Spaces	Mixed use or Zoned	Deep or Shallow Form	Zoned or Open Plan	Facade Orientation	Courtyard or Atria	Glazing Ratio WWR	Glazing Distribution	Ventilation openings	Shading Strategies	Insulation Value	Thermal Mass	Embodied Energy	Toxicity and Health
Urban	Compact or Open	■				■		■	■	■	■	■	■	■			
	Regular or Irregular		■	■				■		■							
	Orientation of Spaces		■	■	■	■	■	■		■		■			■		
	Mixed use or Zoned			■	■	■	■	■	■	■		■	■				
Form	Deep or Shallow Form	■		■	■	■	■	■		■	■	■		■	■		■
	Zoned or Open Plan			■	■		■	■		■	■	■			■	■	
	Facade Orientation	■	■	■	■	■	■	■		■	■	■			■		
	Courtyard or Atria	■		■	■			■	■	■	■	■	■	■	■	■	
Facade	Glazing Ratio WWR	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■
	Glazing Distribution	■				■	■	■	■		■	■	■	■	■		
	Ventilation openings	■			■	■	■	■	■	■	■	■			■	■	■
	Shading Strategies	■		■	■		■	■	■	■	■		■		■		
Fabric	Insulation Value	■				■		■		■		■		■	■		
	Thermal Mass			■	■	■	■	■		■	■	■		■	■		
	Embodied Energy						■	■	■	■				■	■	■	
	Toxicity and Health					■				■		■					■

Original version of Koen Steemers, Cambridge University, 2006

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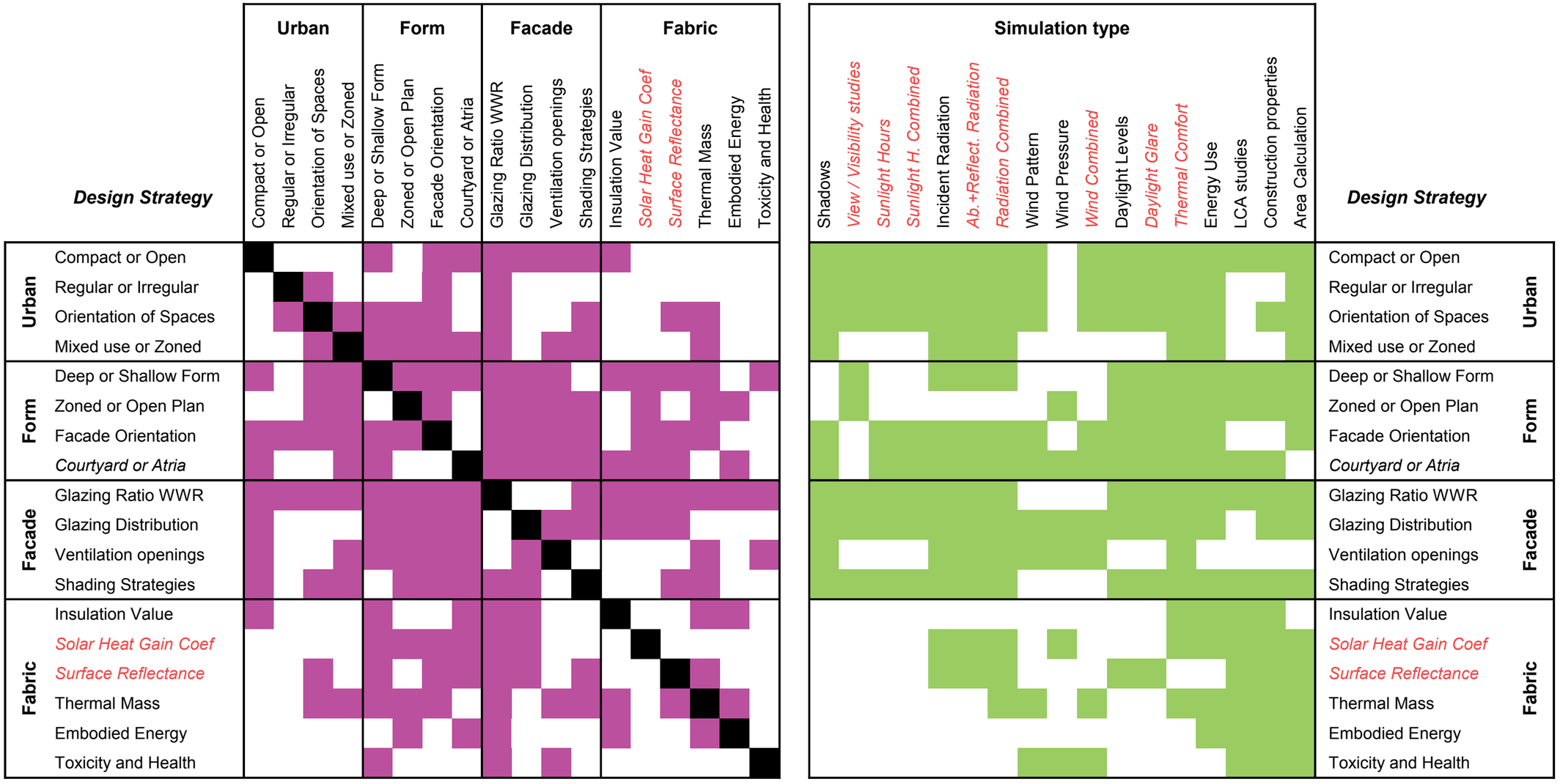
MAPPING DESIGN STRATEGIES, SCALE OF DESIGN AND SIMULATIONS

DEFINING DESIGN QUESTIONS RELATED TO SCALE OF DESIGN WITH SIMULATIONS



Strategy in Italic is added or original edit

Simulation Type in Italic = no Autodesk tools

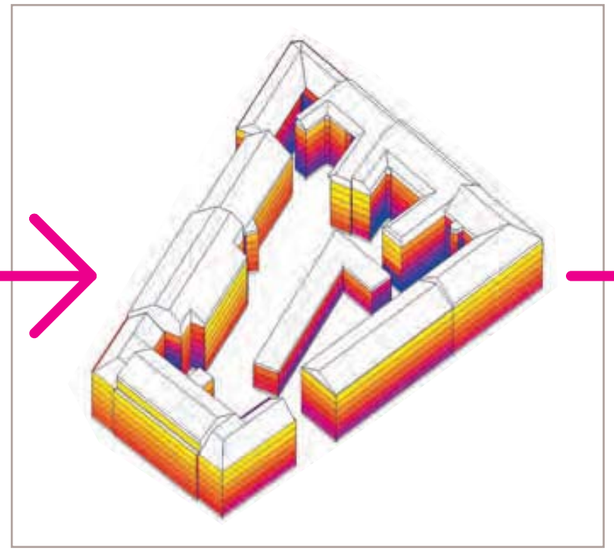
MAPPING DESIGN STRATEGIES, SCALE OF DESIGN AND SIMULATIONS

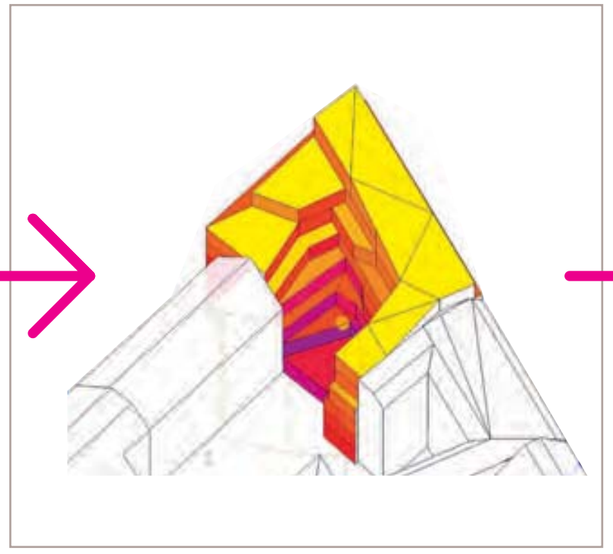
ENVIRONMENTAL IMPACT BETWEEN SCALE OF DESIGN

URBAN STUDIES



FORM STUDIES





FACADE (+ROOM) STUDIES



FABRIC (+CONSTRUCTION) STUDIES

From the Book "Design med viden" by Henning Larsen Architects

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[2.3]

MAPPING SIMULATIONS WITH MODEL DETAIL LEVELS

Method and methodology

METHOD AND PHASE METHODOLOGY - Phase 2 Concept

1 **ANALYSIS**
Dialogue, climate, context and program analysis

2 **CONCEPT**
Concept studies, analysis and disposition

3 **PROPOSAL**
Design proposal and concept optimization

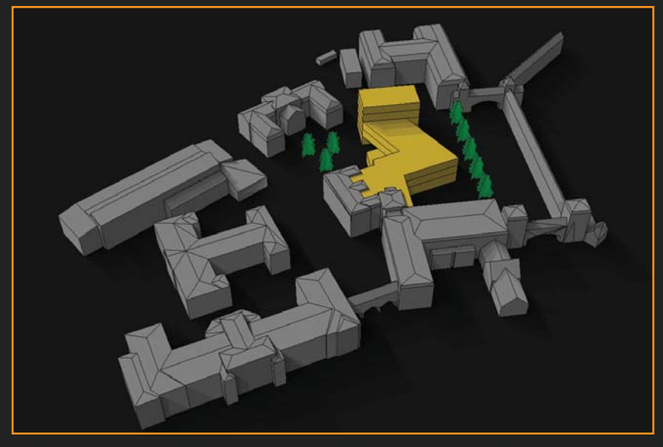
4 **PRODUCT**
Solution-based design and dimensioning

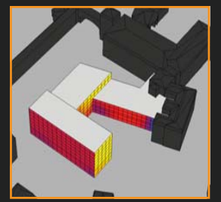
Topics

- Model types: Form concepts, Energy, Analysis and Visual models
- Analysis of conceptual forms and rooms
- Focus on design variations and options
- Comparison with reference analysis
- Optimized concepts

Simulations and analysis

- Simulation of exterior wind conditions
- Sunlight hours in outer space
- Solar Radiation / energy on outer surfaces
- Shadows Range diagram
- External Sound Rays
- Visibility / important views in the context
- Simulation of energy needs based on form concepts
- Thermal comfort - Heating / cooling needs
- Daylight simulation – Form / floors and Rooms / Zones
- Studies of orientation and size of windows
- etc...









Program and function | Site and climate | Air flow and quality | Visual comfort | Thermal comfort | Acoustic comfort | Materials and surfaces | Construction cost | Operation energy cost

Autodesk University

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Reference: Asbjørn Levring and Daniel Nielsen, AU2011

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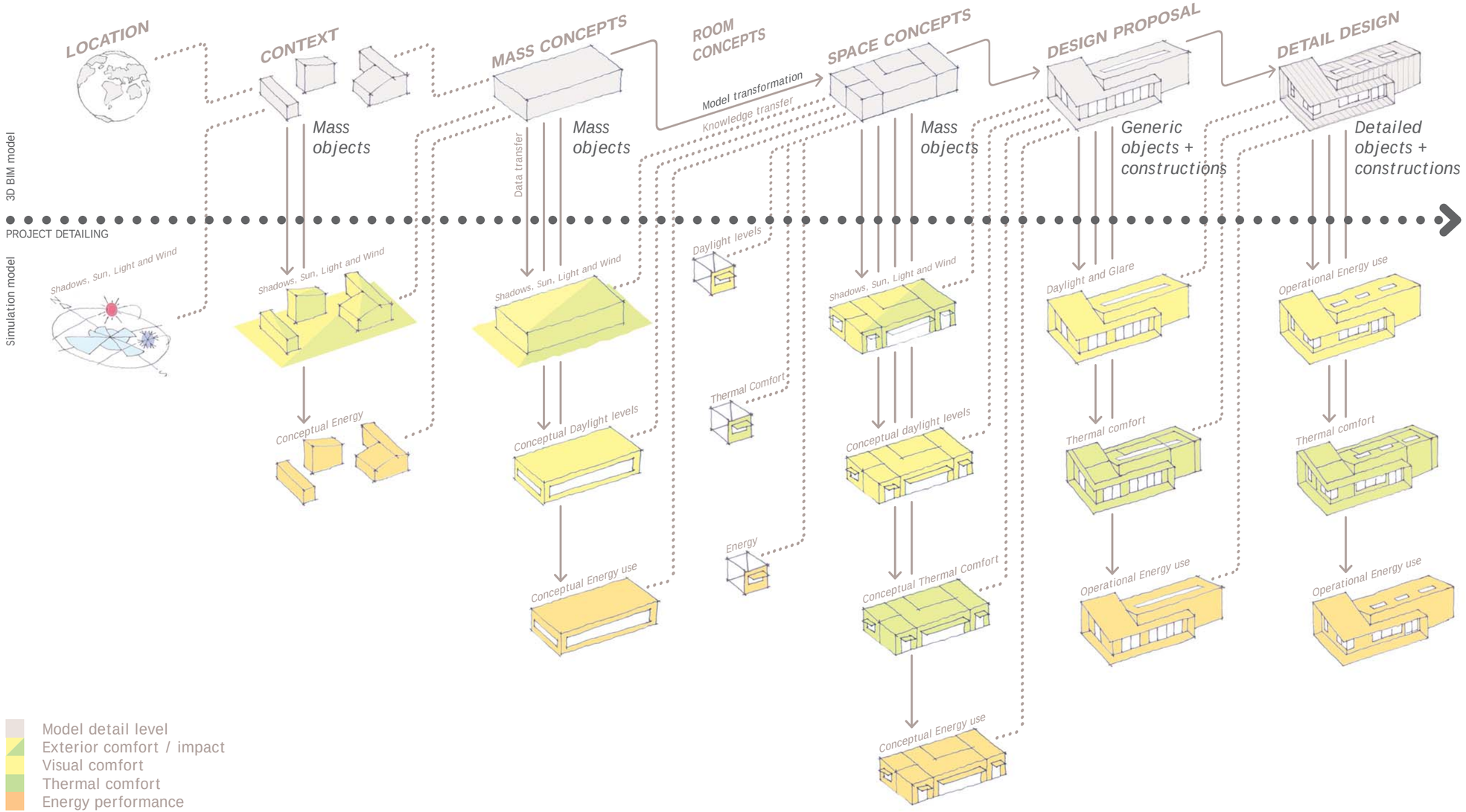
MAPPING SIMULATIONS WITH MODEL DETAIL LEVELS

THE DIAGRAM FOR BUILDING DESIGN



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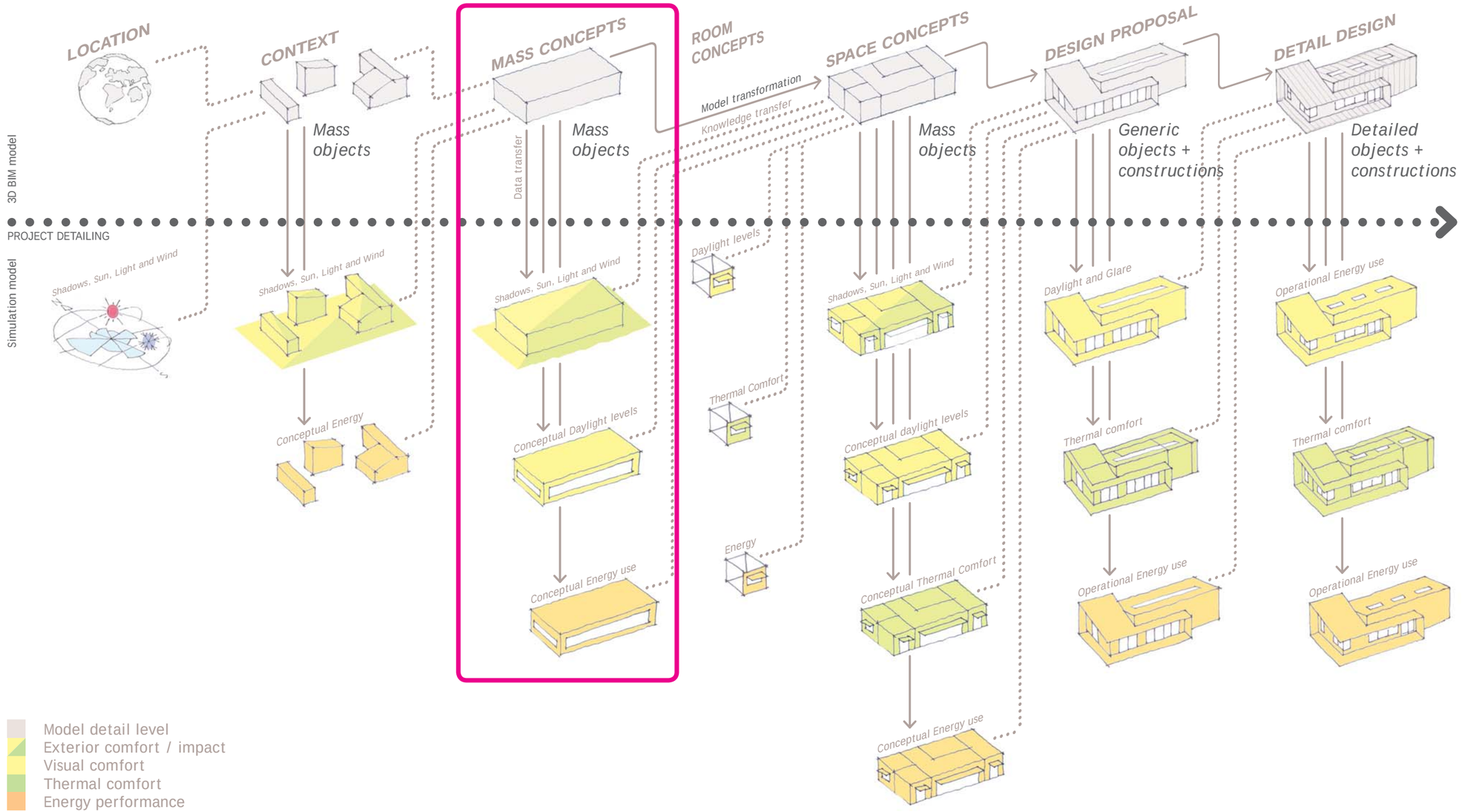
MAPPING SIMULATIONS WITH MODEL DETAIL LEVELS

"BOX" MAPPING MODELS WITH SIMULATIONS



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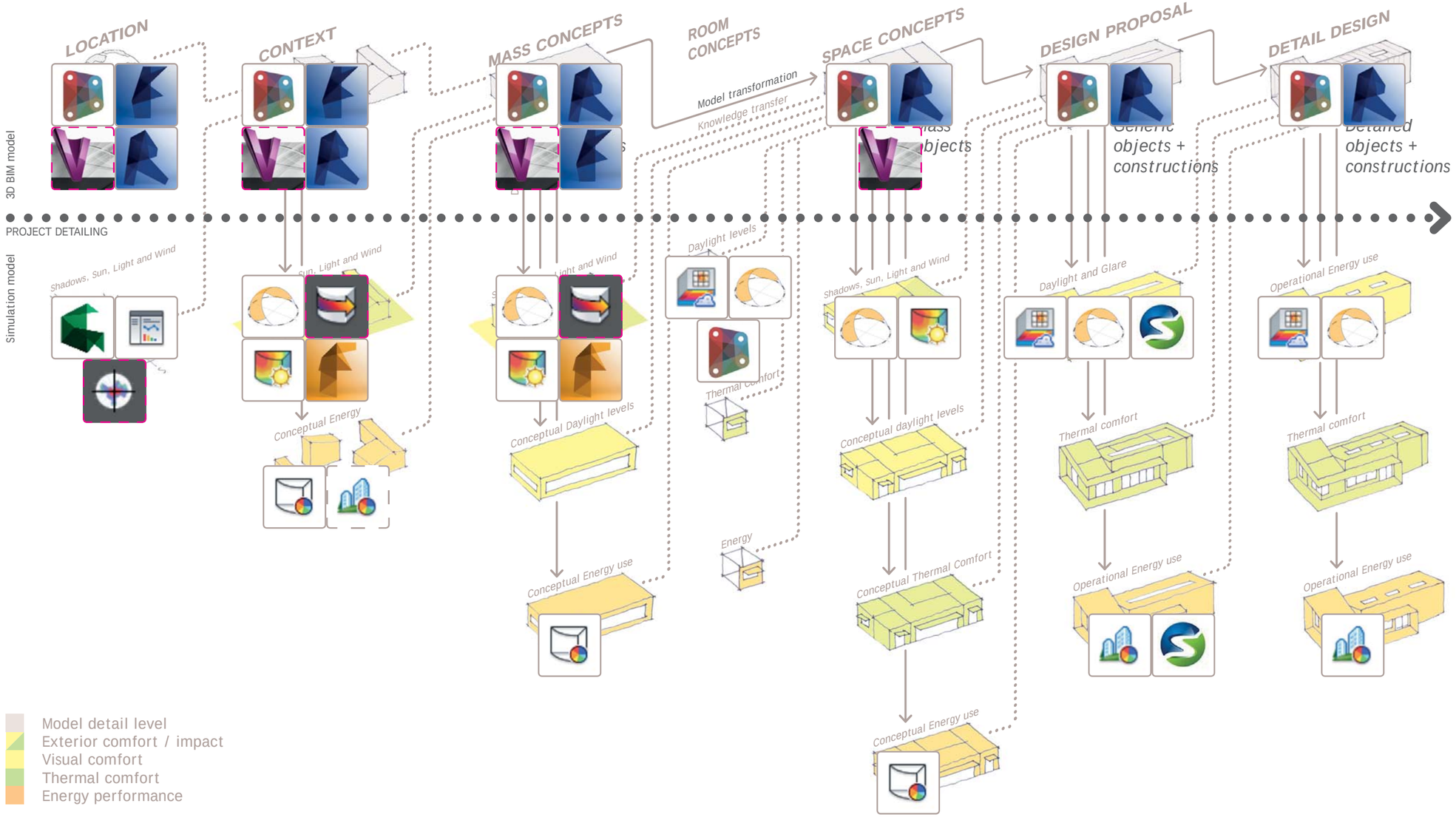
MAPPING SIMULATIONS WITH MODEL DETAIL LEVELS

MAPPED WITH AUTODESK RELATED MODELING AND SIMULATIONS TOOLS



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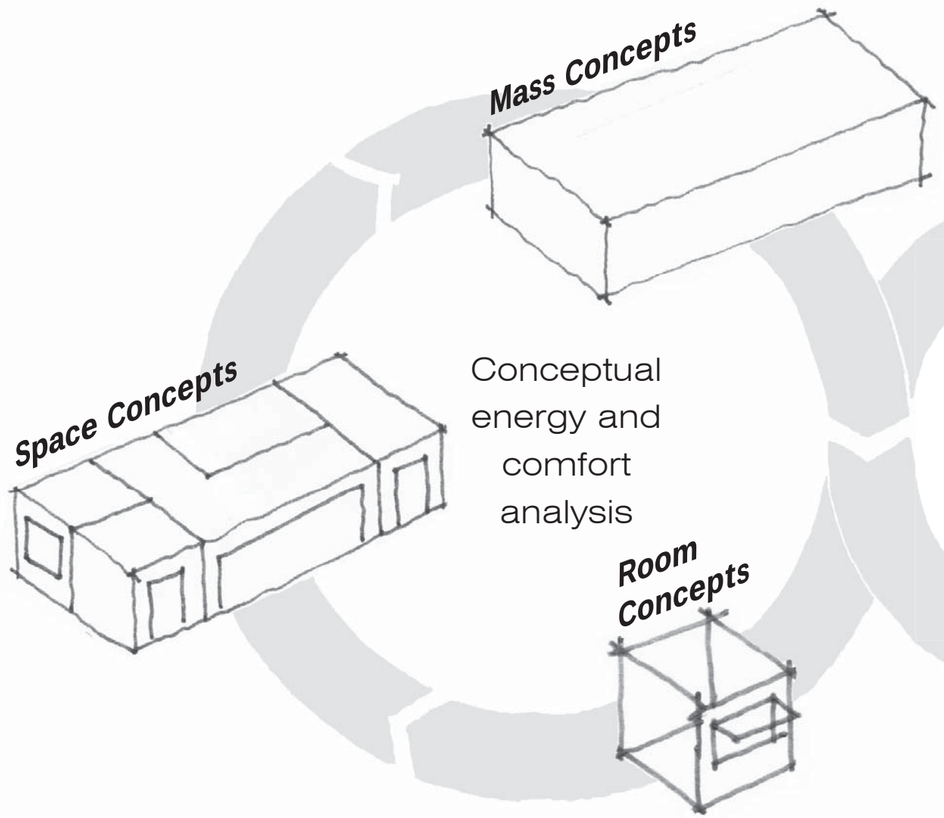
MAPPING SIMULATIONS WITH MODEL DETAIL LEVELS

DESIGN WITH KNOWLEDGE !

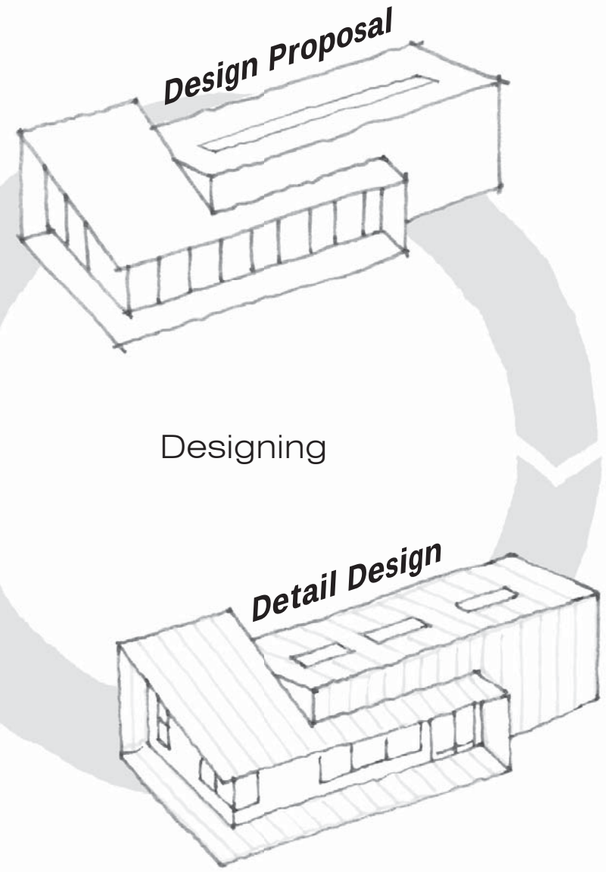
EARLY INSIGHT AND UNDERSTANDING OF DESIGN OPTIONS



Conceptual energy and comfort analysis

Design with knowledge

QUALIFIED DESIGN DECISIONS AND SOLUTIONS



Designing

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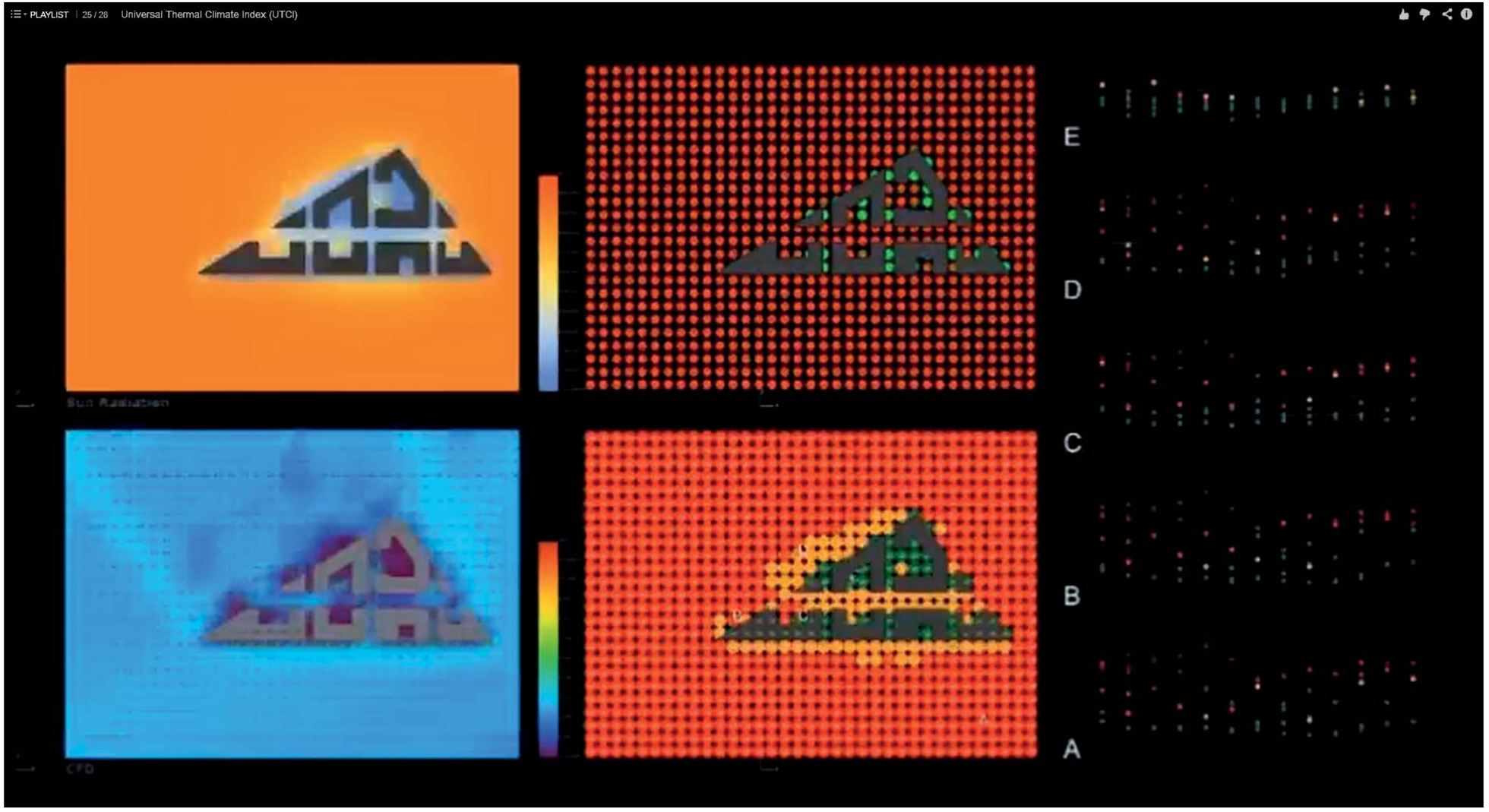
[2.4]

Learning from DESIGN ANALYSES

LEARNING FROM DESIGN ANALYSES

THE NEXT STEP - COMBINING SIMULATIONS AND METRICS



https://www.youtube.com/watch?v=m1d-ZXvBw0c

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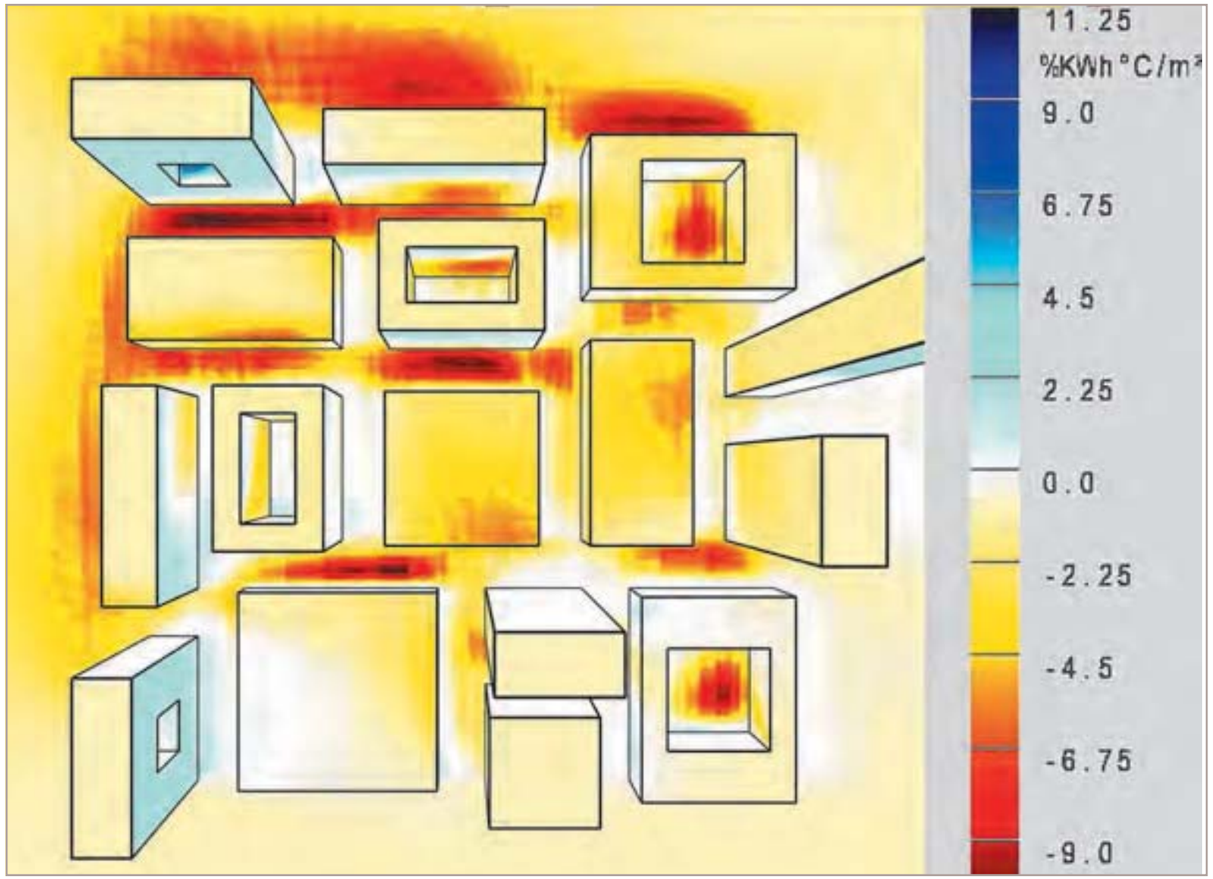
LEARNING FROM DESIGN ANALYSES

THE NEXT STEP - COMBINING SIMULATIONS AND METRICS

Solar Radiation



Index combination of Radiation and Temperature



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Simulation tool does not necessary need to be highly accurate but it should be a accurate enough to indicate the path to follow

This doesn't mean a more accurate feedback is not necessary

Designs should not be seen as a sum of individual optimized parts, but as a holistic optimized design

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[3]

PARAMETRIC POSSIBILITIES

Daniel Nielsen © architect maa + constructing architect © ark.daniel.nielsen@gmail.com

Parametric Methodology

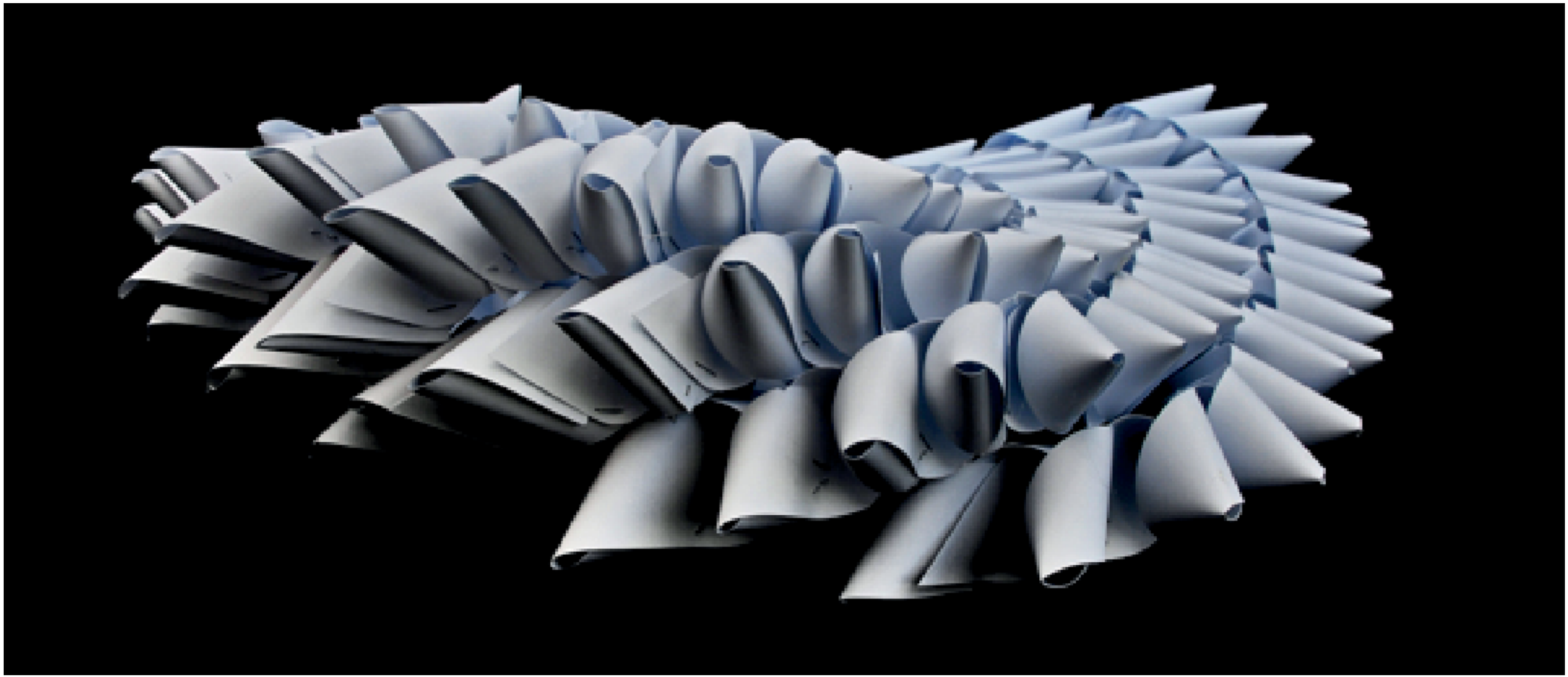
Parametric Models

Parametric Simulations

Learning from Parametric Possibilities

PARAMETRIC POSSIBILITIES

PARAMETRIC DESIGN - hm !



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PARAMETRIC POSSIBILITIES



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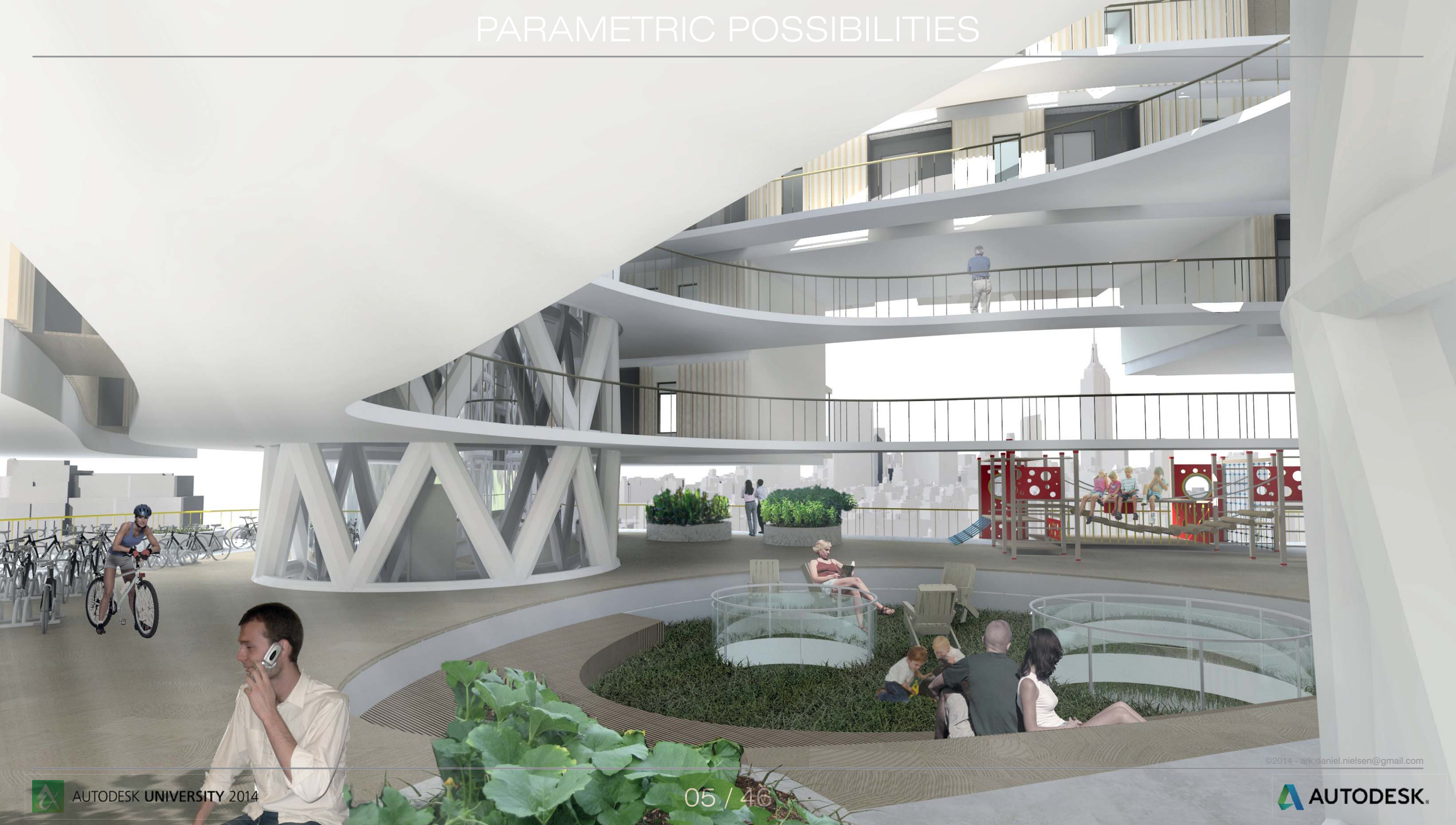
PARAMETRIC POSSIBILITIES



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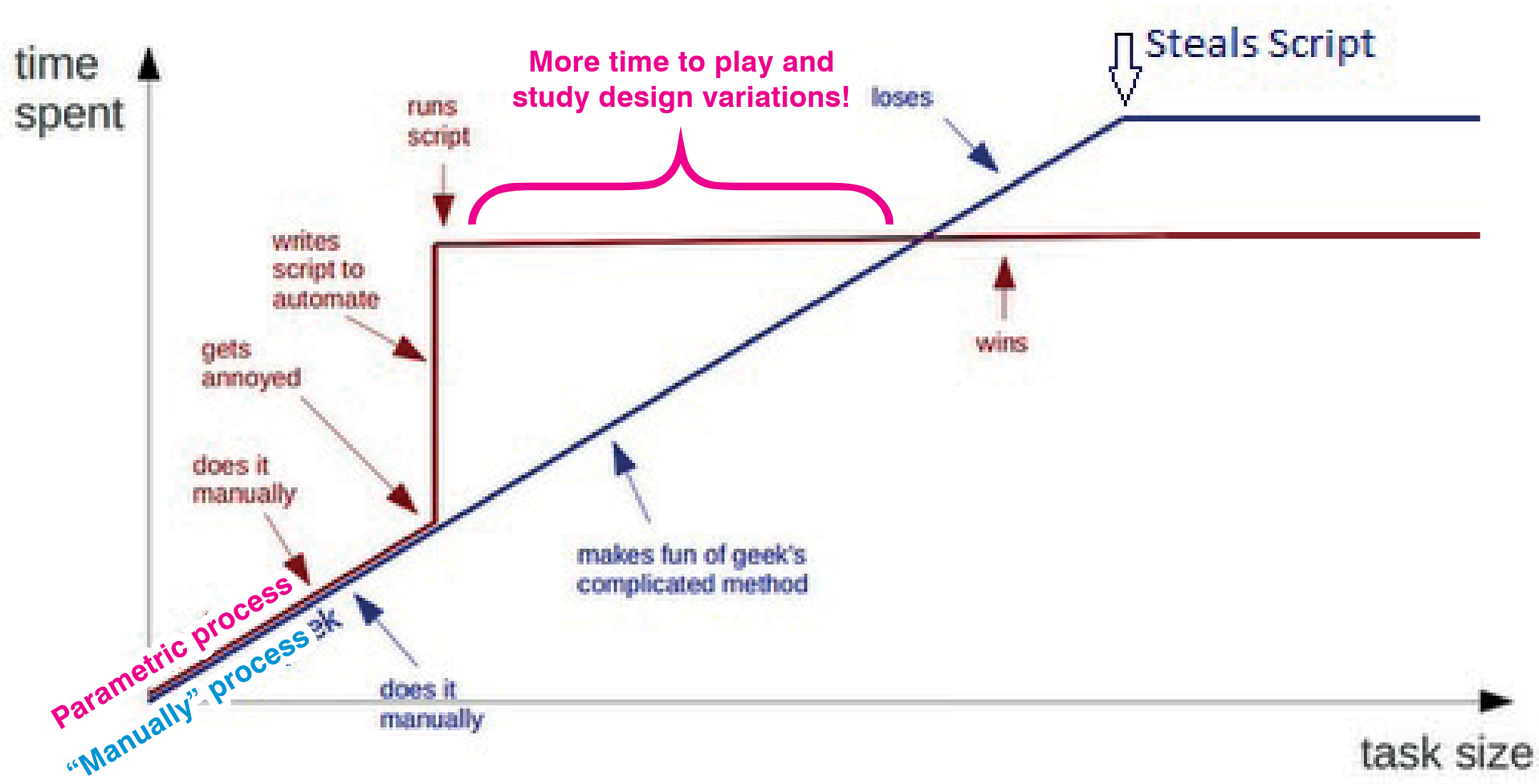
[3.1]

PARAMETRIC METHODOLOGY

WHY PARAMETRIC MODELS AND SIMULATIONS ?



Images: http://i.imgur.com/UDzXF.jpg

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PARAMETRIC DESIGN AND REVIT

http://buildz.blogspot.dk/2010/12/parametric-design-patterns.html

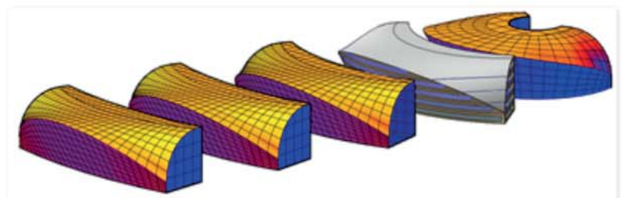
buildz: Parametric Design Pat...

buildz

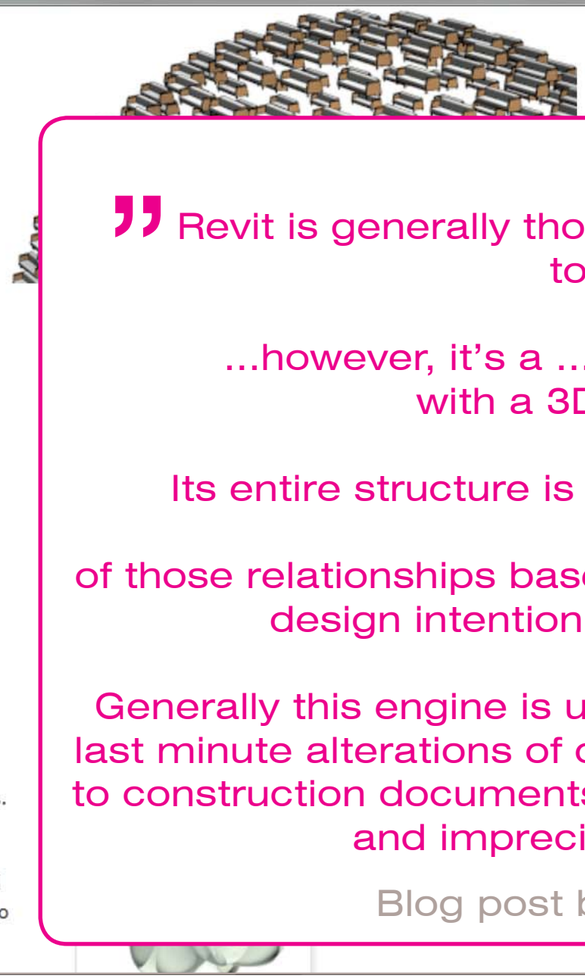
practical notes for making impractical things

20110117

Parametric Design Patterns: Index



Revit is generally thought of as a documentation tool, a medium for expressing a complete design ready for construction. At its core, however, it's a change engine, a relational database with a 3d front end. Its entire structure is around relationships and the constant reassessment of those relationships based on ongoing alterations of design intention and constraints. Forms are (or can be) a result of associations, not the cause. Generally this engine is used to allow for ongoing or last minute alterations of designs to directly percolate to construction documents without the need for costly and imprecise revisions. The same technology can be used throughout a project to create models that reflect fairly abstract relationships and ideas.



> "Revit is generally thought .. as a documentation tool...
>
> ...however, it's a ... relational database with a 3D front end
>
> Its entire structure is around relationships ...
>
> of those relationships based on ongoing alterations of design intention and constraints...
>
> Generally this engine is used to allow for ongoing or last minute alterations of designs to directly percolate to construction documents without the need for costly and imprecise revisions..."
>
> Blog post by Zach Kron

Link: http://buildz.blogspot.dk/2010/12/parametric-design-patterns.html

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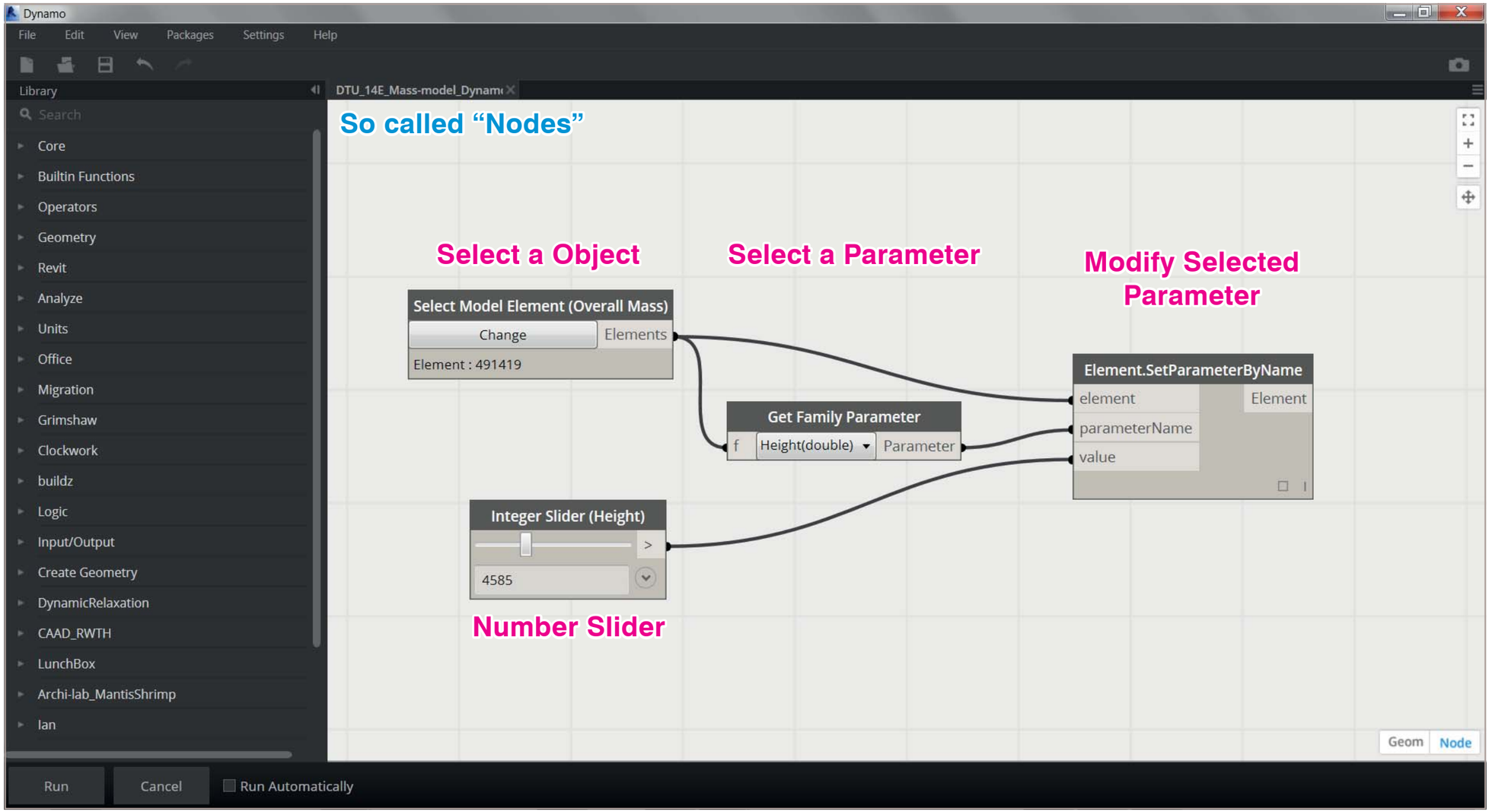
PARAMETRIC METHODOLOGY

VISUAL PROGRAMMING WITH DYNAMO



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PARAMETRIC METHODOLOGY

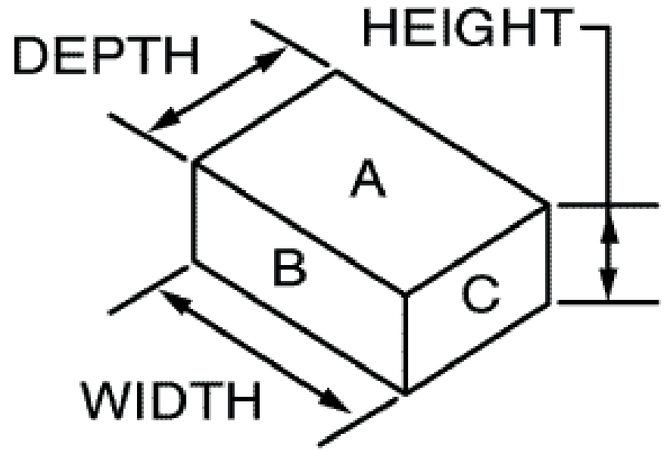
DEFINING DESIGN CONSTRAINTS, VARIABLES AND OBJECTIVES

CONSTRAINTS



http://business901.com/wp-content/uploads/2009/08/iStock_000008482342XSmall.jpg

VARIABLES



http://dealertraining.cat.com/suppliertraining/Printreading/prmod1/images1/m14104.gif

OBJECTIVES



http://www.velaction.com/lean-information/wp-content/uploads/2009/06/improvement-objectives-300x299.jpg

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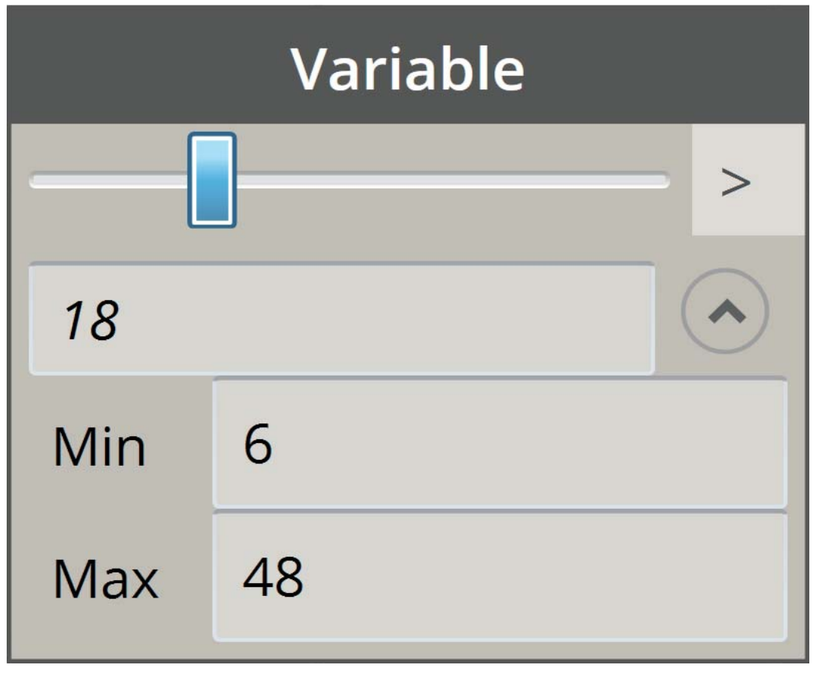
VARIABLE AND CONSTRAIN EXAMPLE - IN / WITH DYNAMO

A dimensional Variable



A dimensional Constrain

A DYNAMO INTEGER SLIDER

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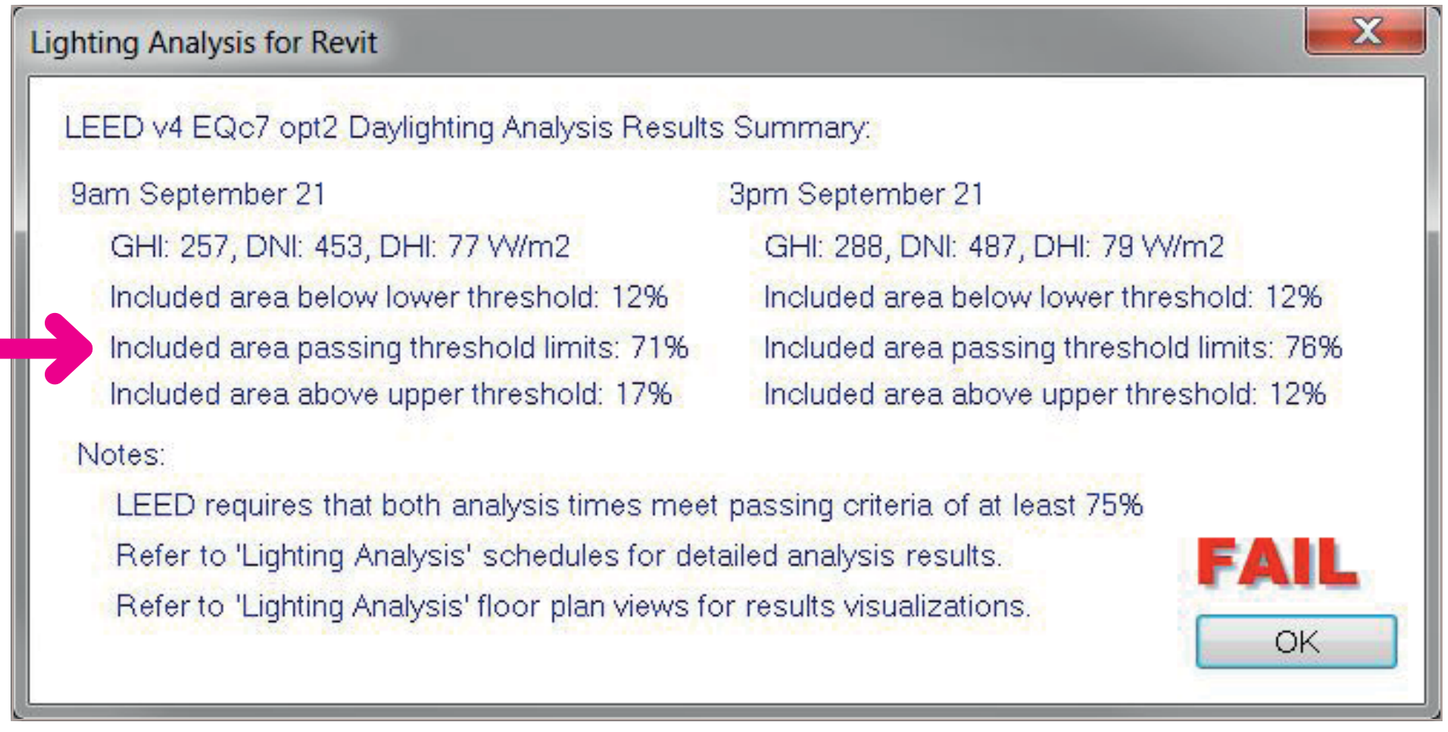
OBJECTIVE EXAMPLE - LEED CREDIT

LEED Credit a Objective



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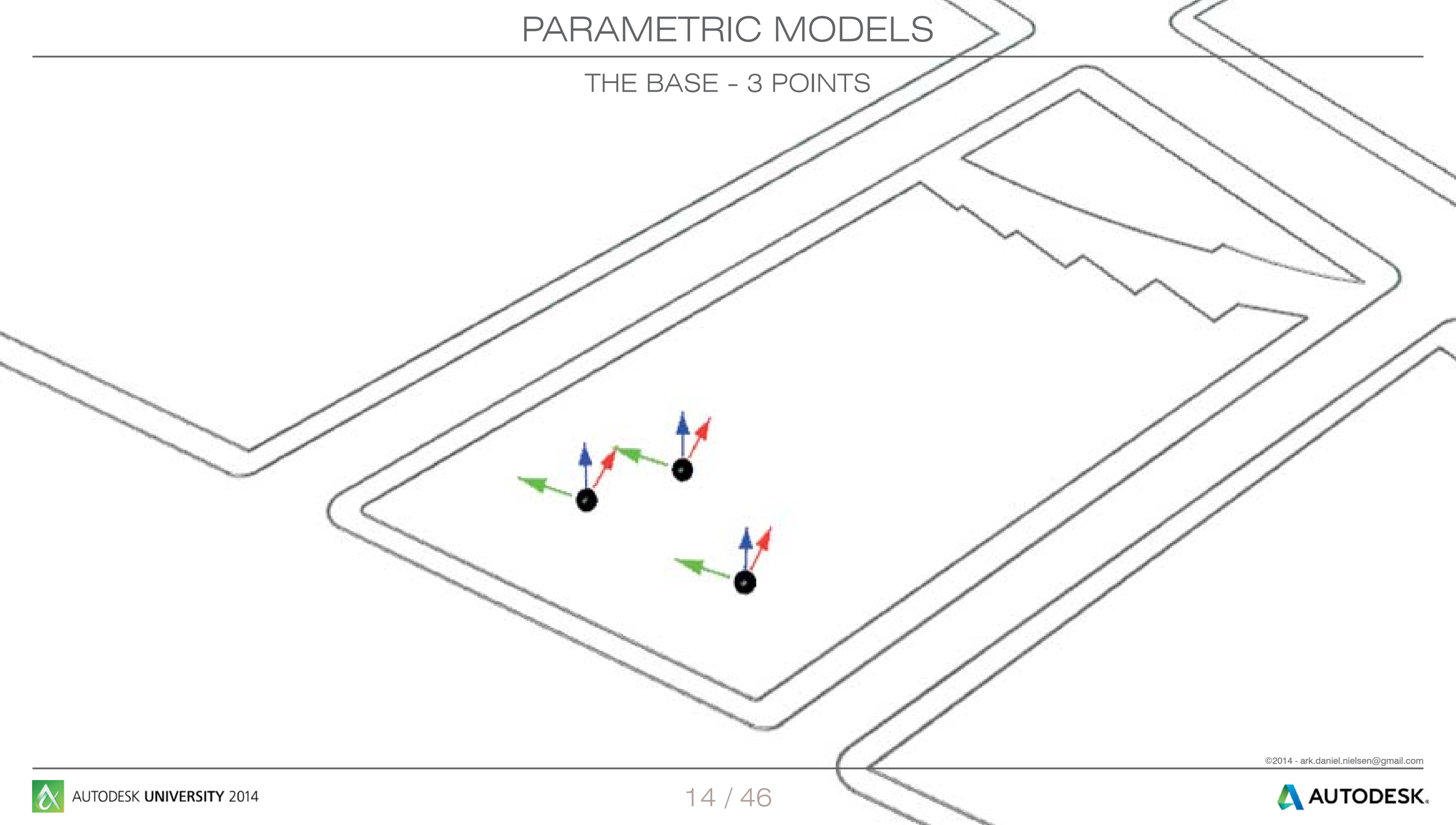
[3.2]

PARAMETRIC MODELS

PARAMETRIC MODELS

THE BASE - 3 POINTS



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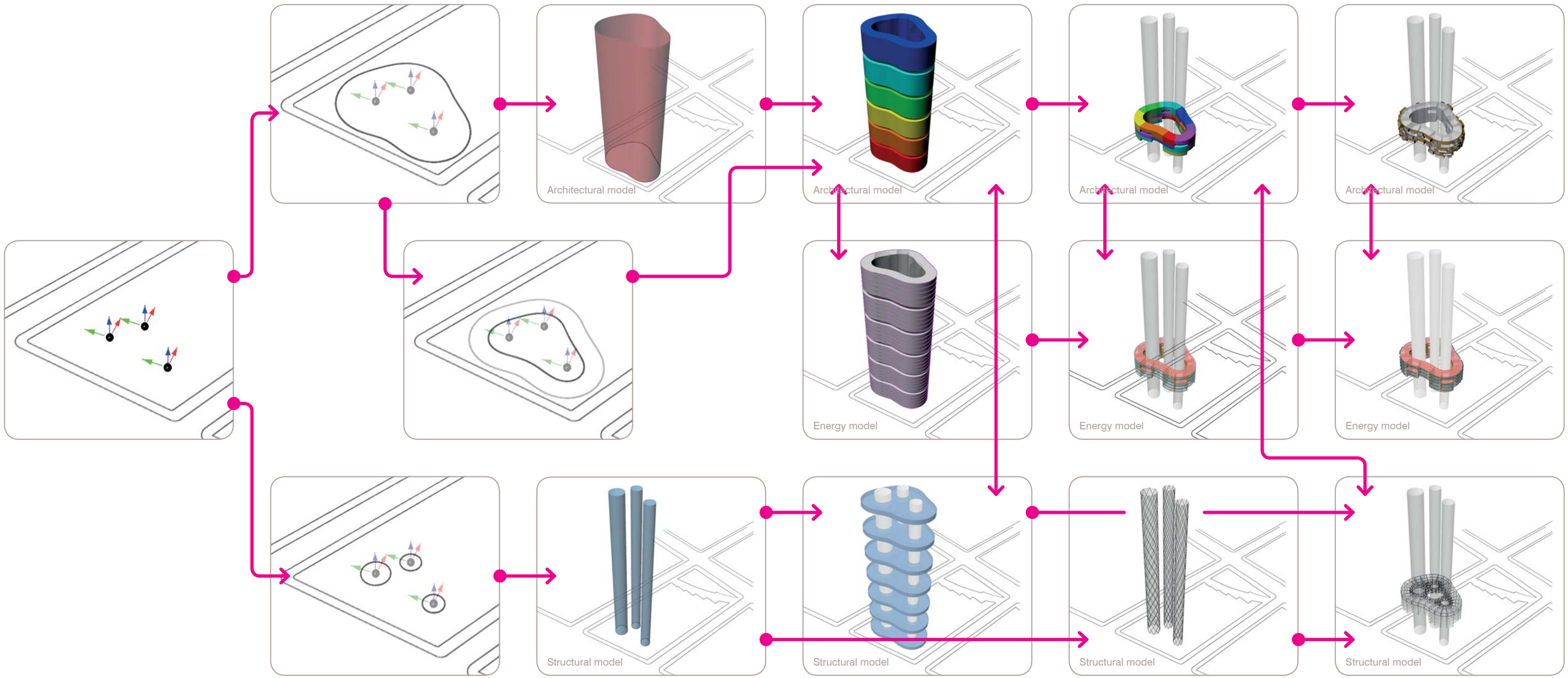
PARAMETRIC MODELS

OVERALL MODEL RELATIONS



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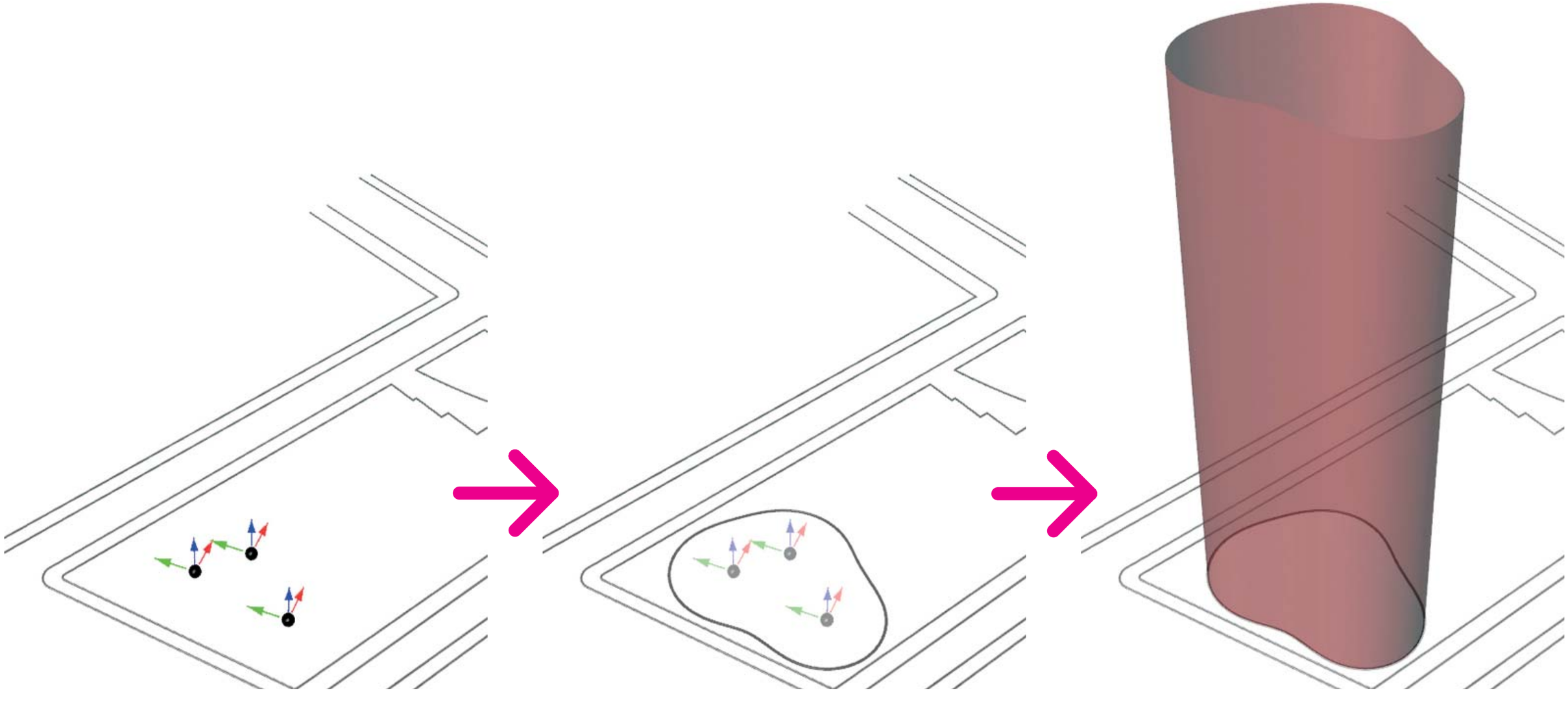
PARAMETRIC MODELS

OVERALL SHAPE CONCEPT



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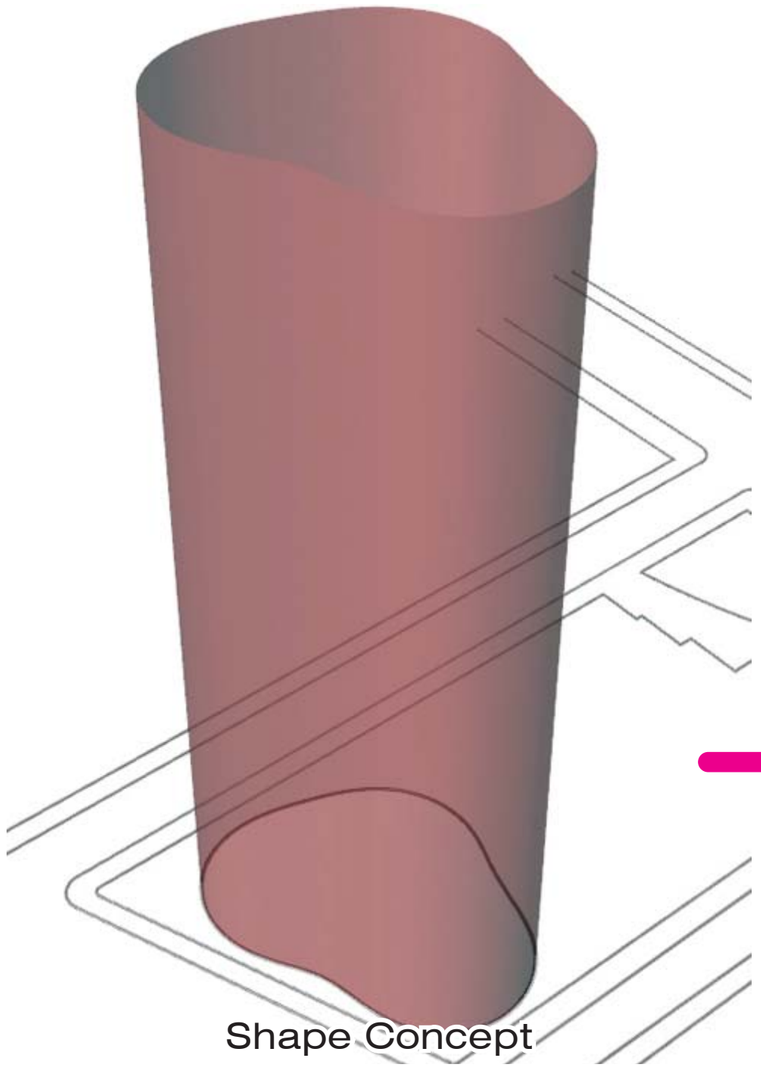
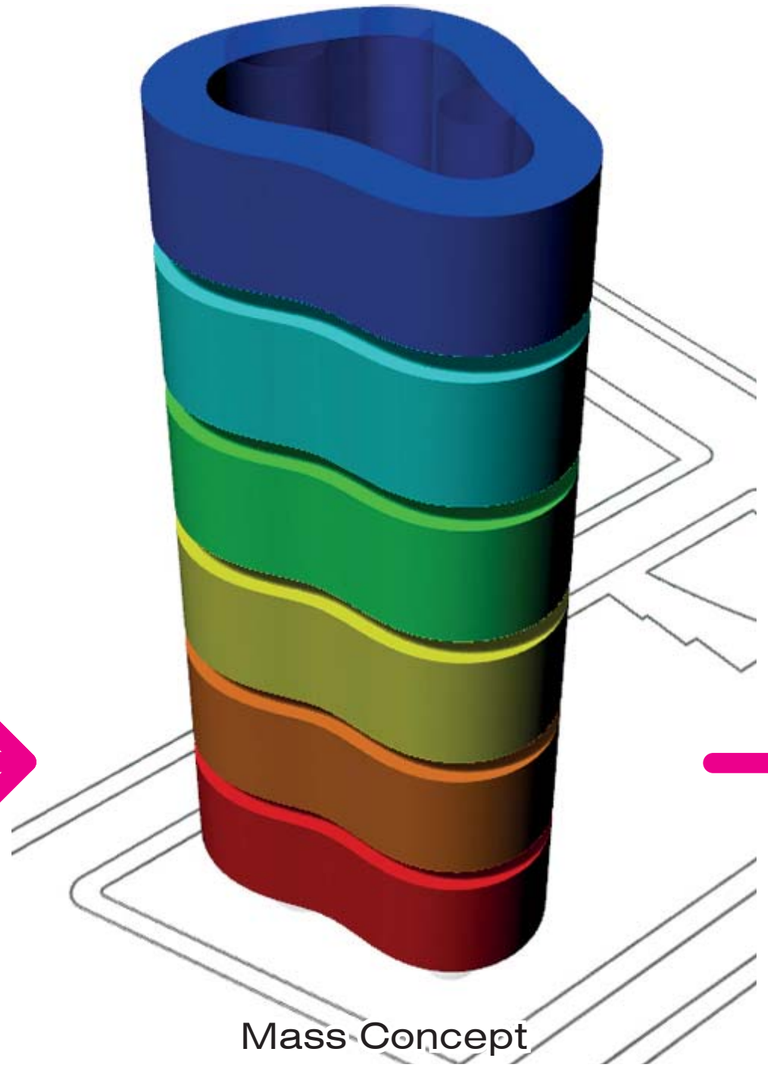
PARAMETRIC MODELS

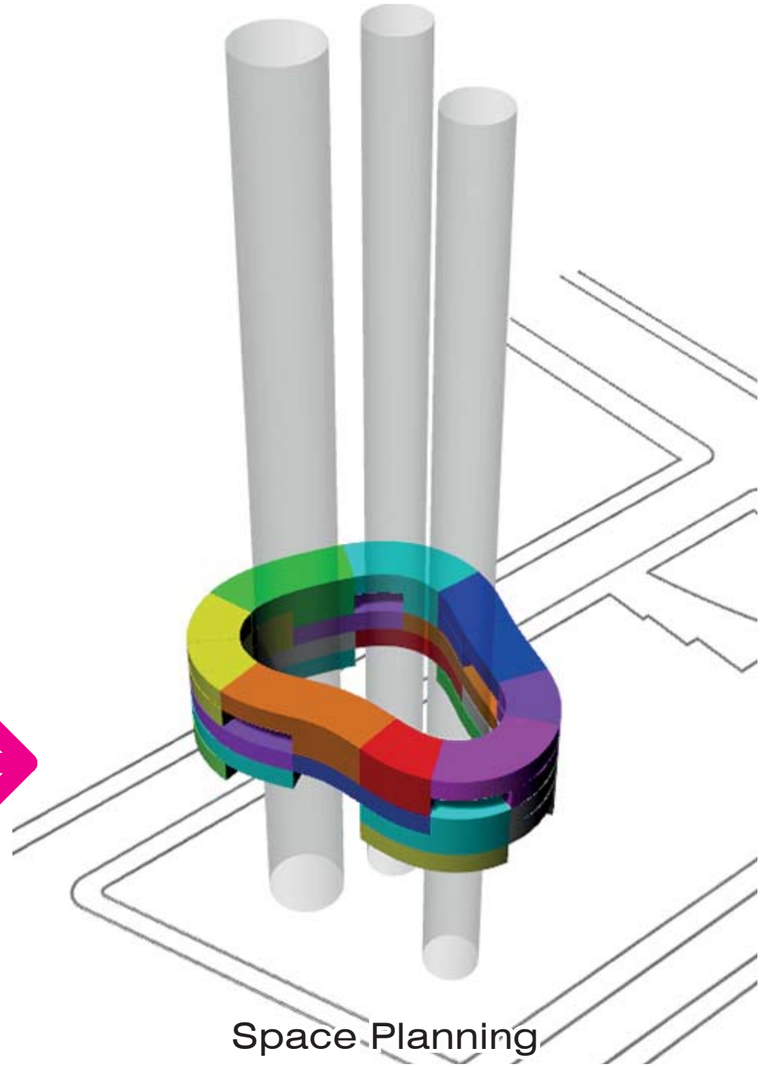
FROM SHAPE CONCEPT TO SPACE PLANNING



Shape Concept



Mass Concept



Space Planning

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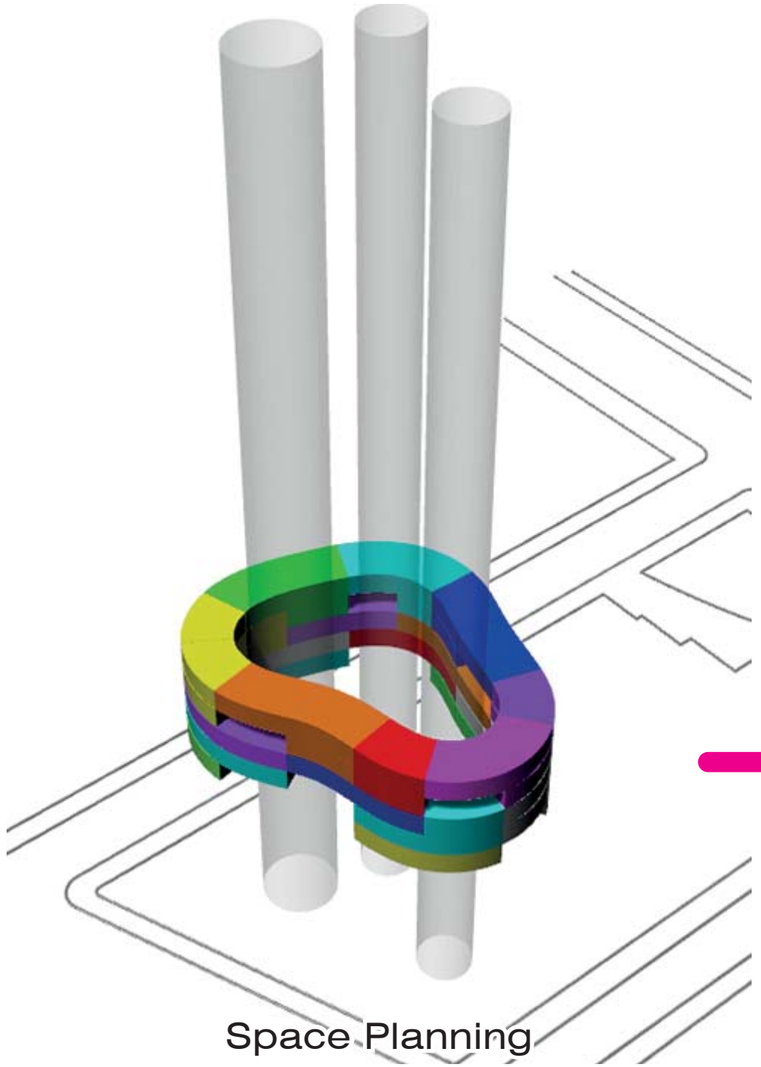
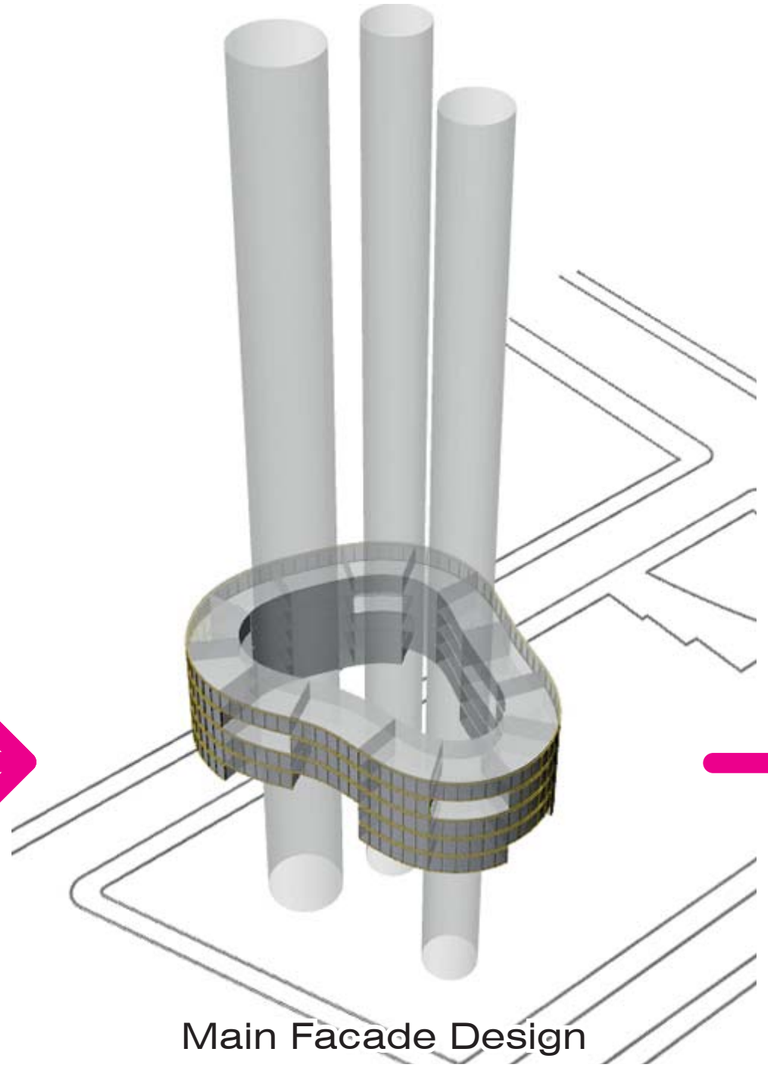
PARAMETRIC MODELS

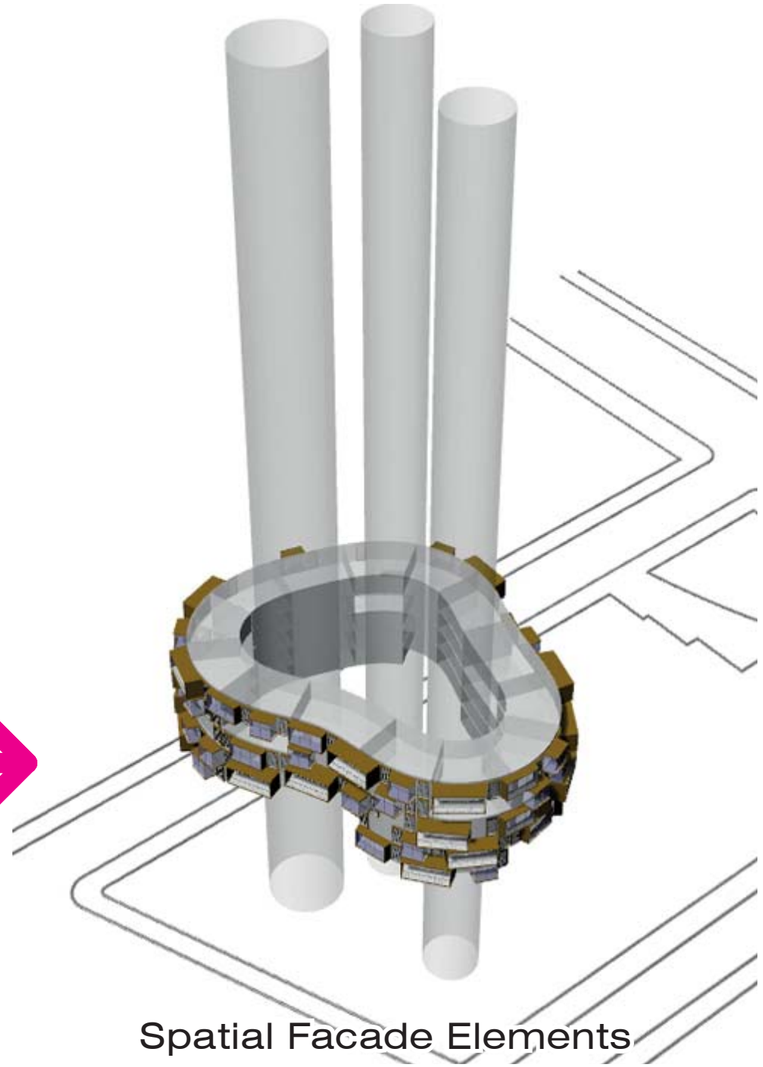
FROM SPACE PLANNING TO FACADE DESIGN



Space Planning



Main Facade Design



Spatial Facade Elements

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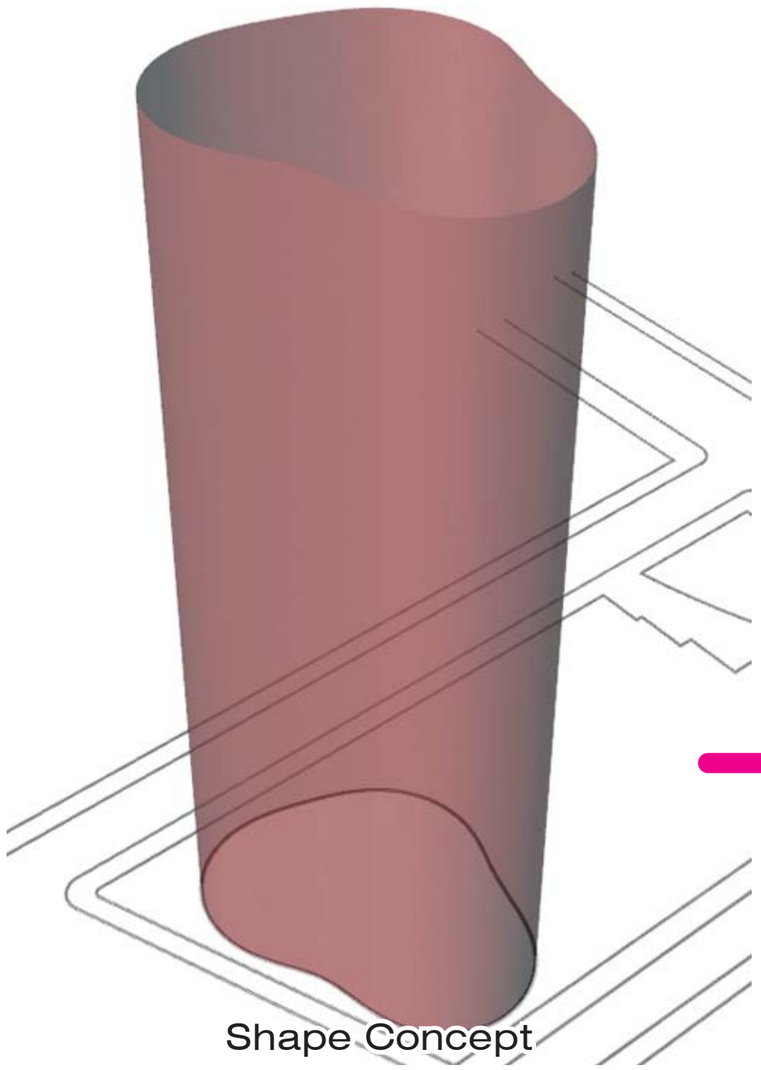
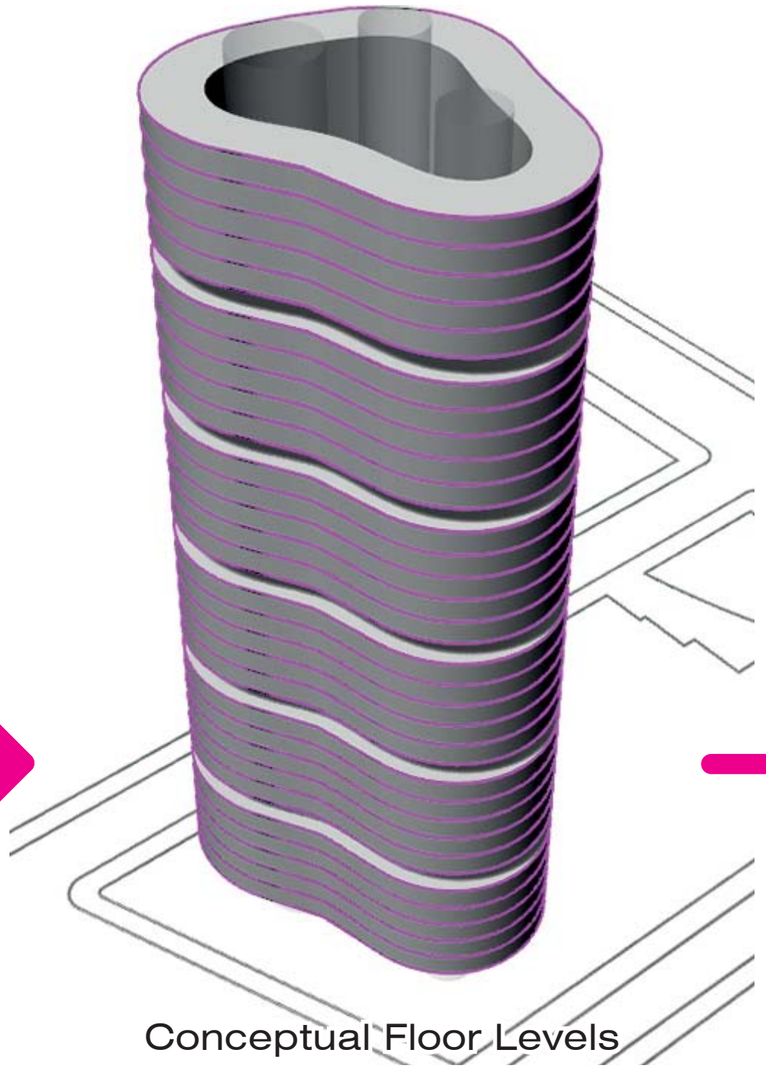
PARAMETRIC MODELS

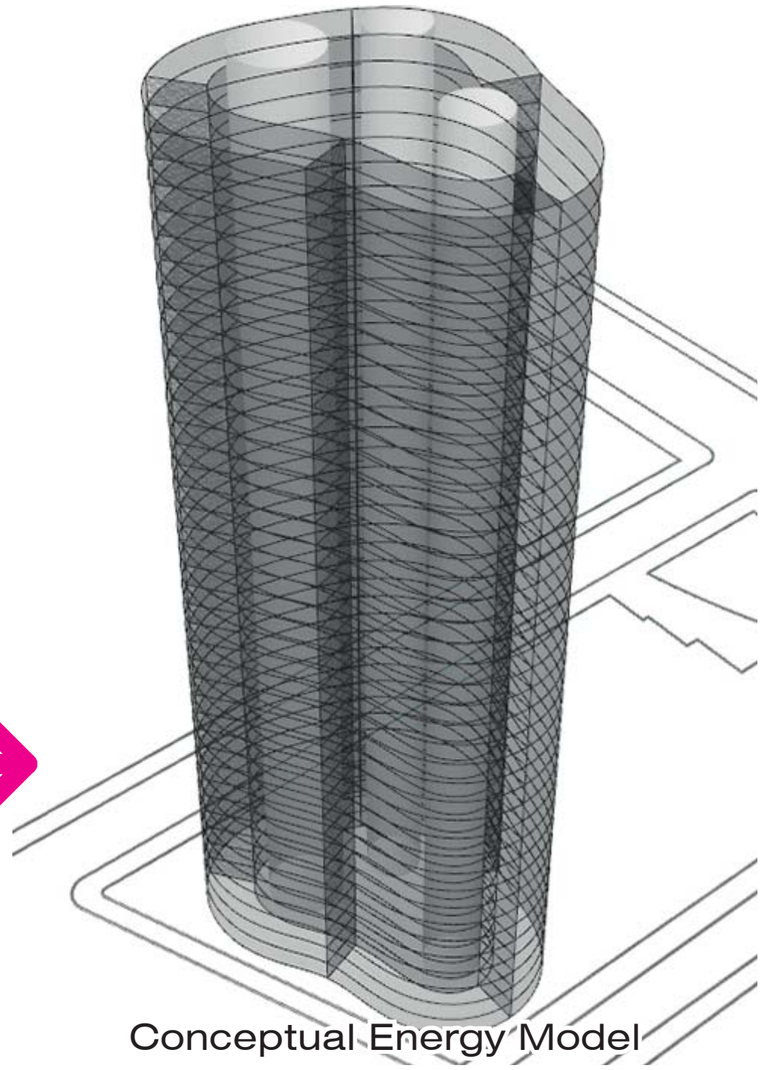
FROM SHAPE CONCEPT TO CONCEPTUAL ENERGY MODEL



Shape Concept



Conceptual Floor Levels



Conceptual Energy Model

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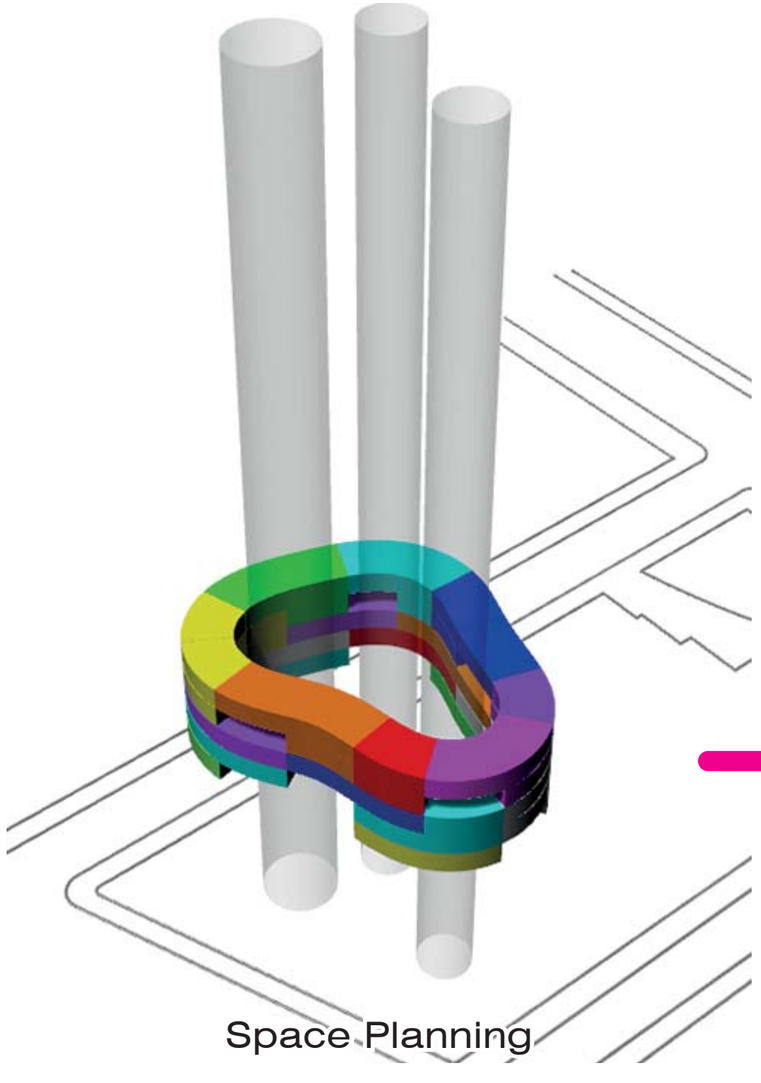
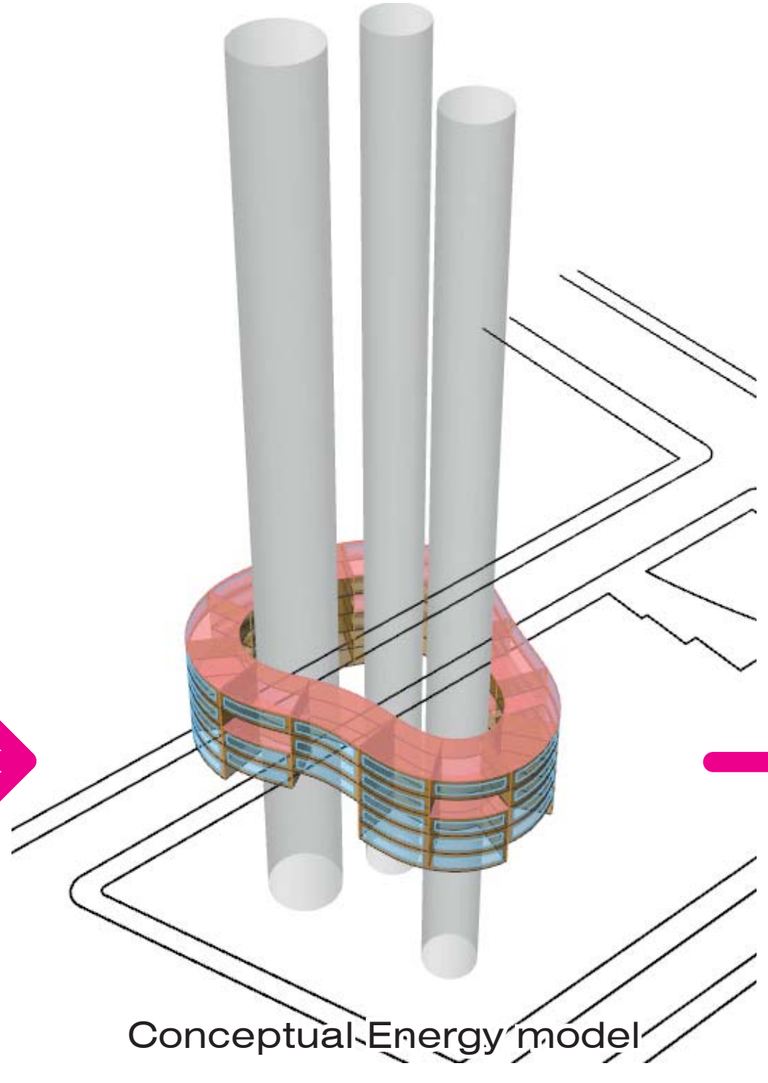
PARAMETRIC MODELS

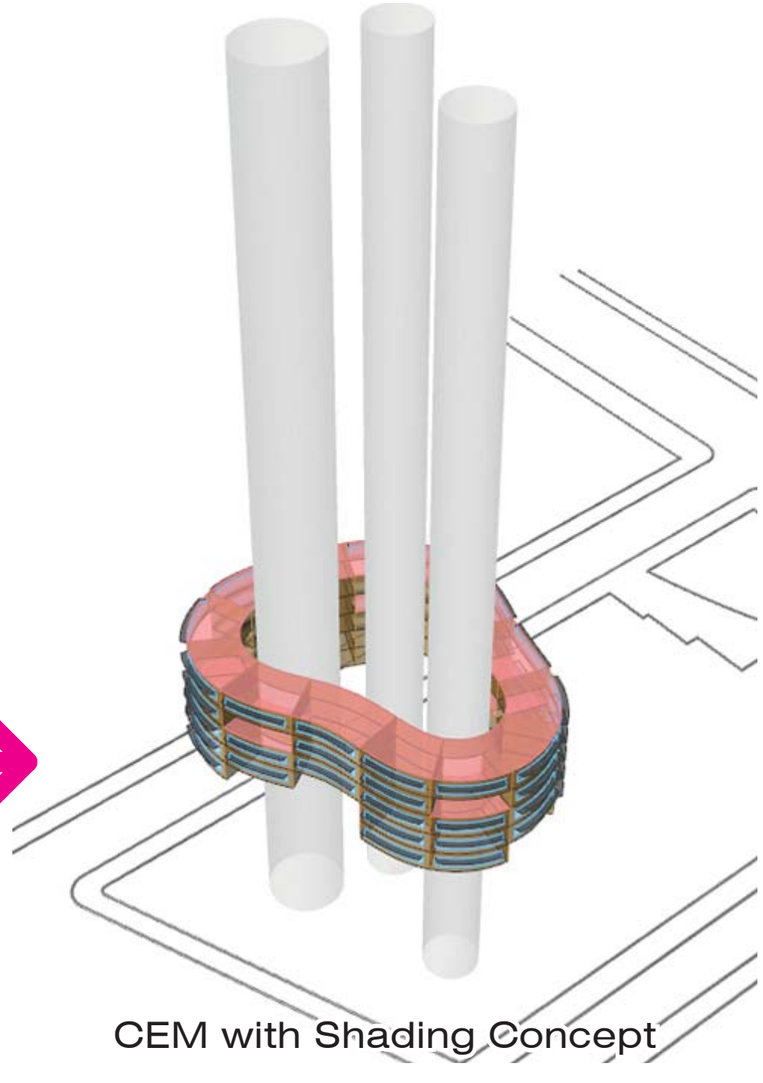
FROM SPACE PLANNING TO ENERGY MODEL



Space Planning



Conceptual Energy model



CEM with Shading Concept

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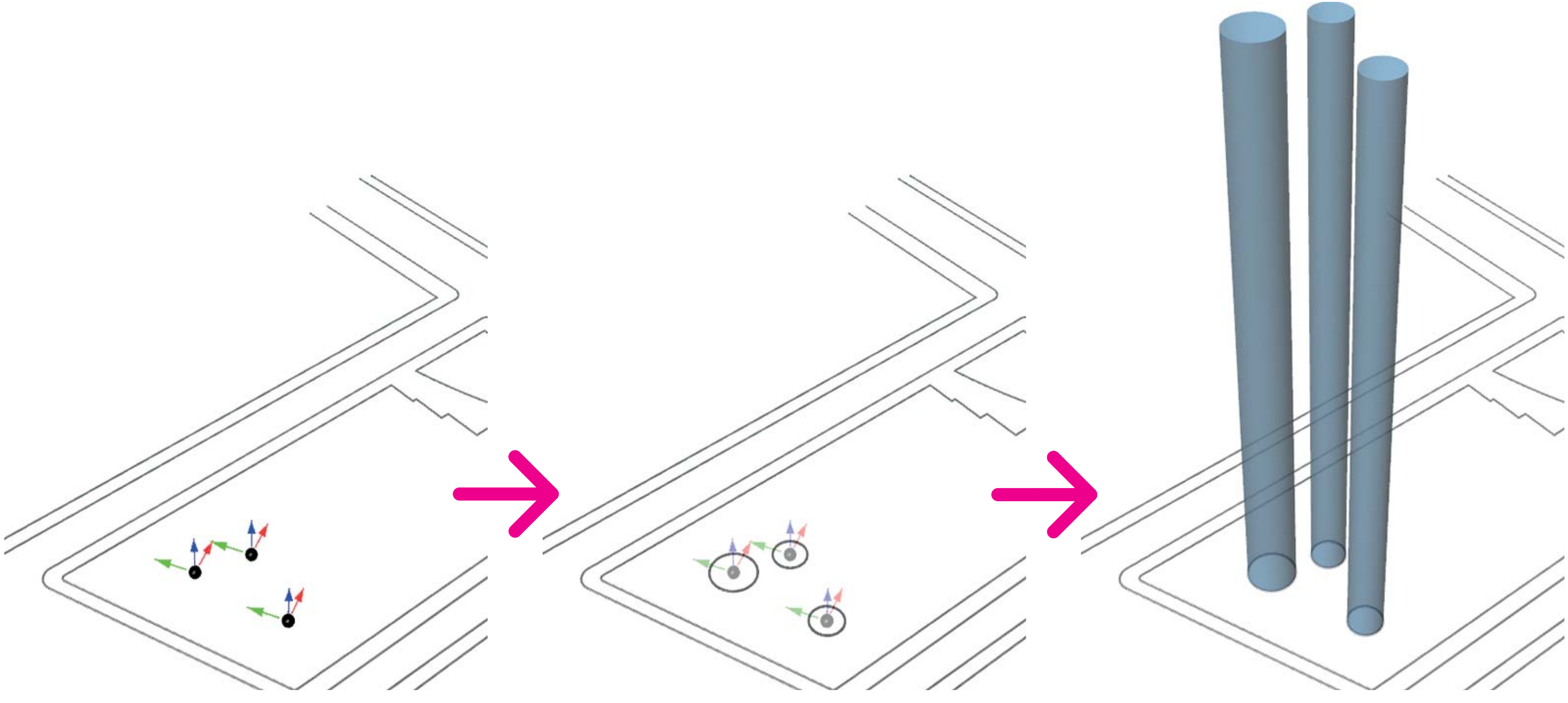
PARAMETRIC MODELS

OVERALL CORE CONCEPT



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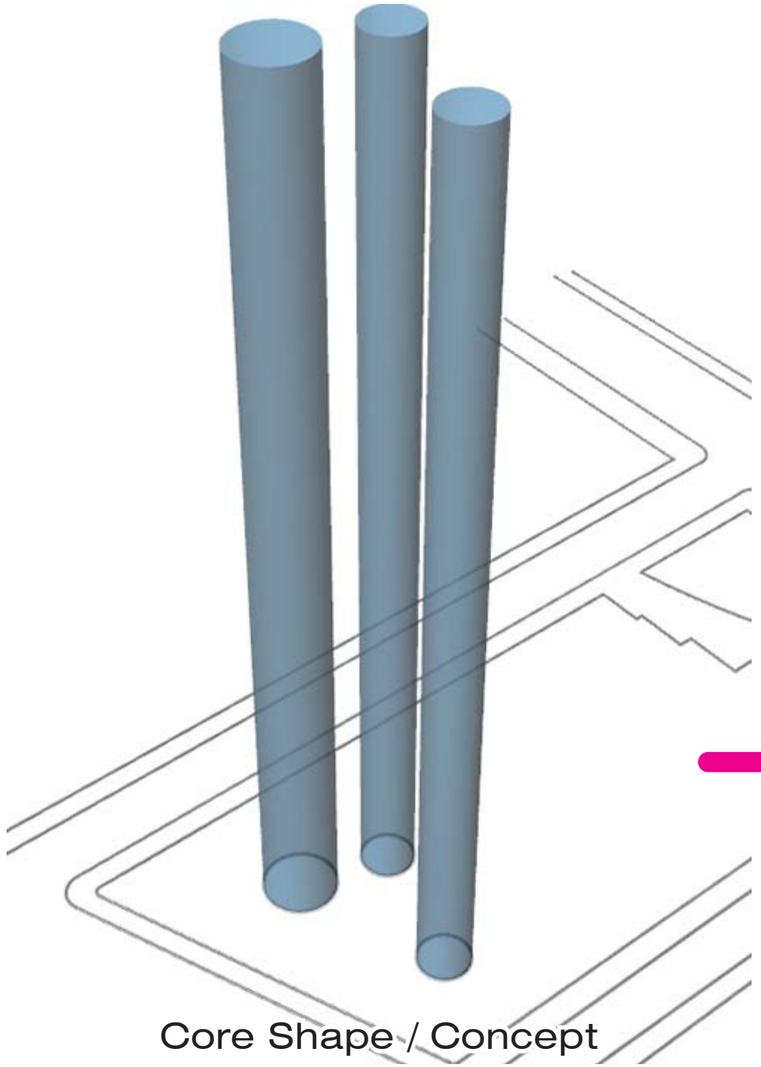
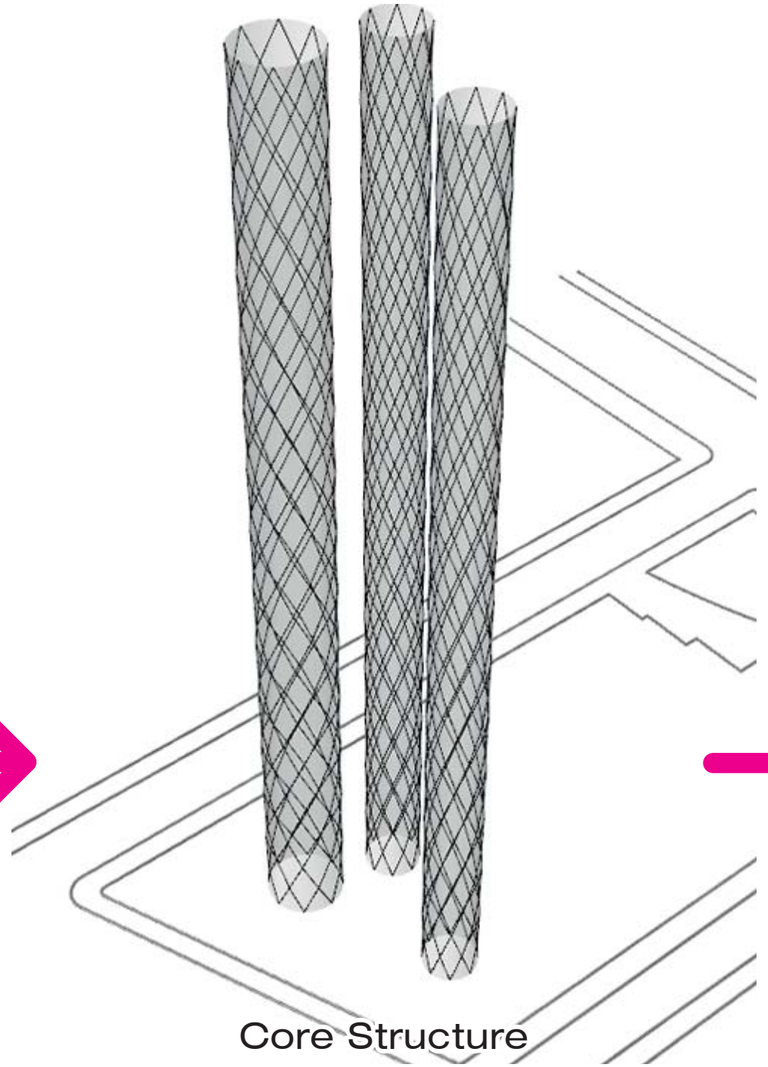
PARAMETRIC MODELS

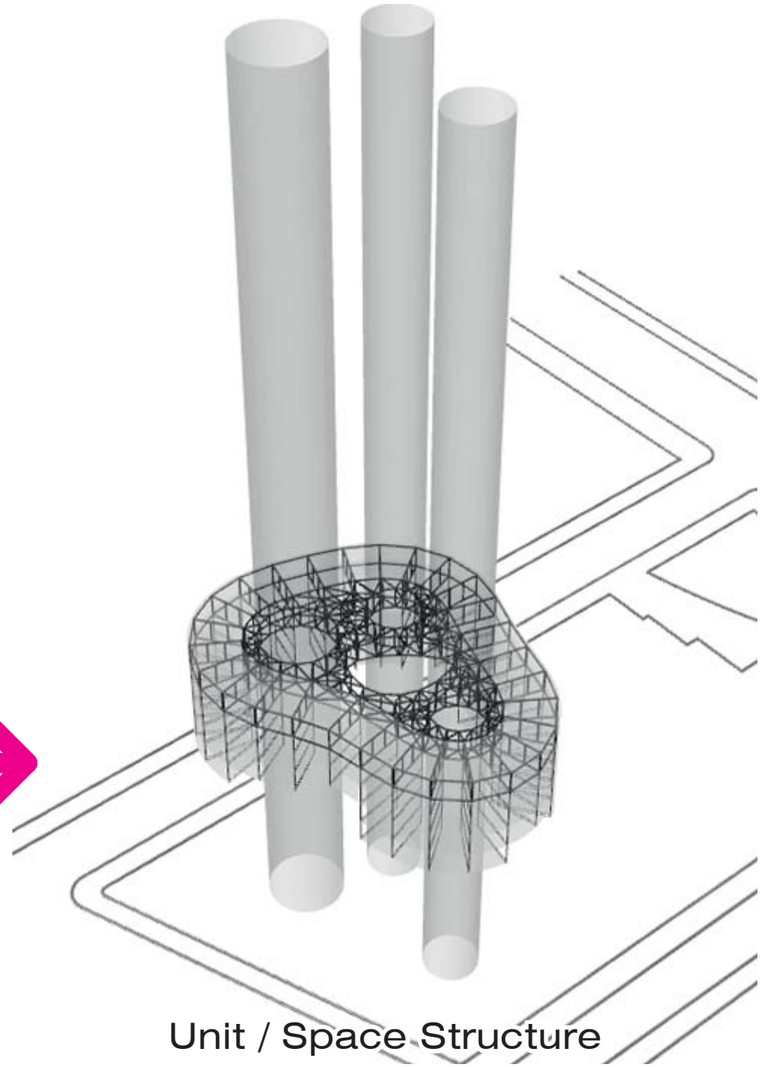
FROM CONCEPTUAL CORE TO STRUCTURAL MODEL



Core Shape / Concept



Core Structure



Unit / Space Structure

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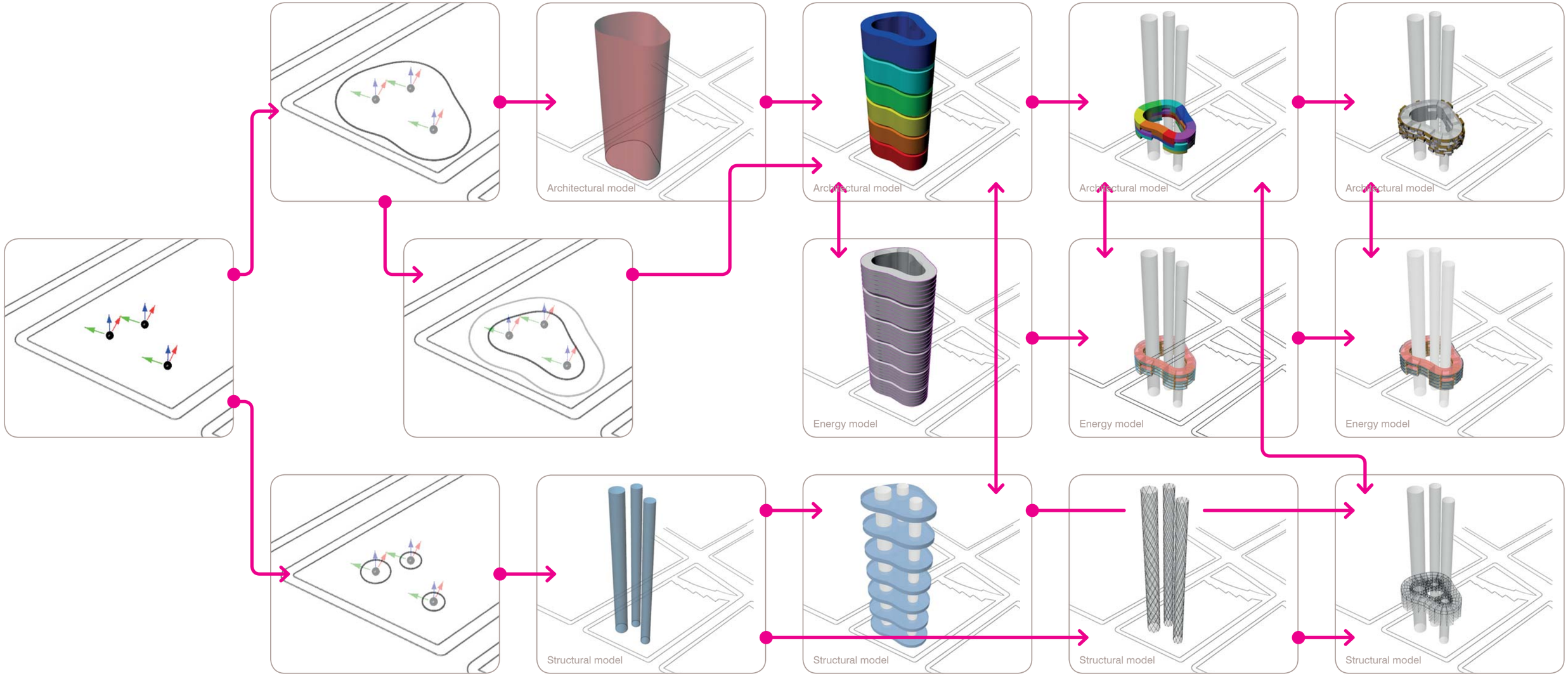
PARAMETRIC MODELS

OVERALL MODEL RELATIONS



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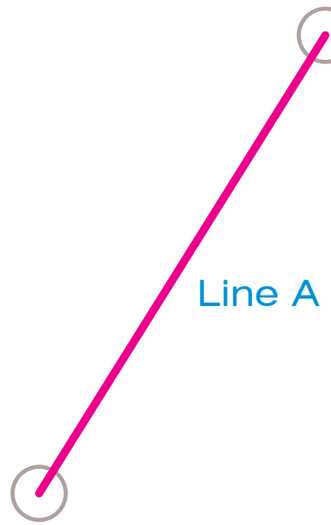
PARAMETRIC MODELS - HOW? BASICS TO CREATE GEOMETRY

1



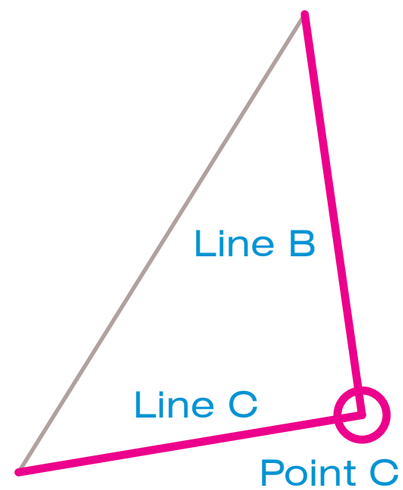
First step - creating points / coordinates

2



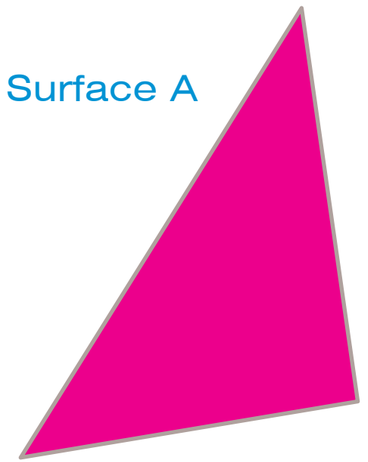
Between to points it is possible to Create a Line

3



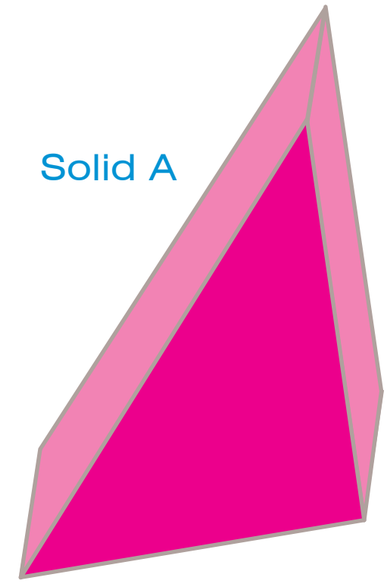
By adding one more point it is possible to create a closed curve

4



A closed curve can create a single surface

5



A surface can be extruded to a solid object

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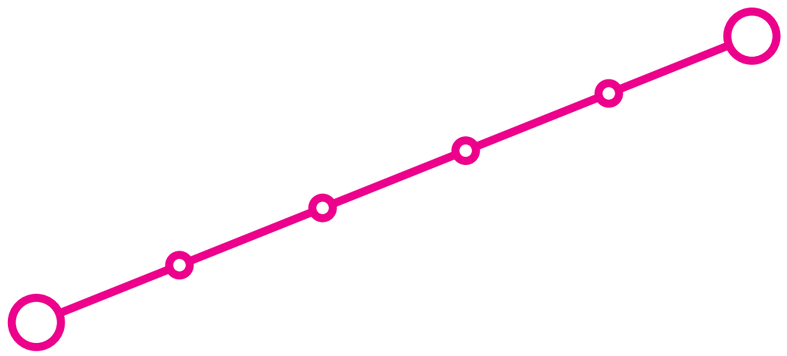
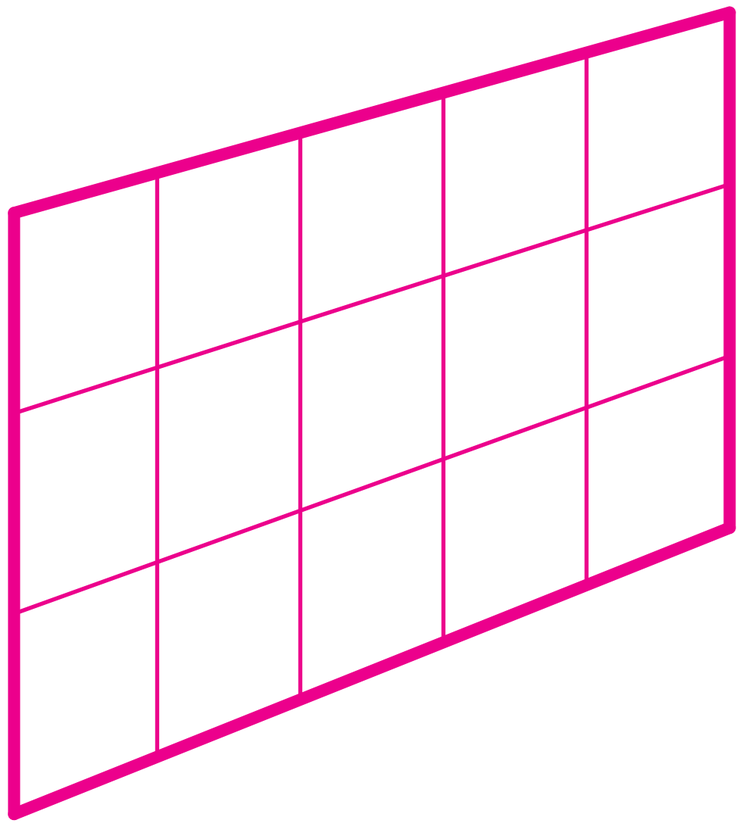


How to subdivide a line and a surface

That is all you need to know!



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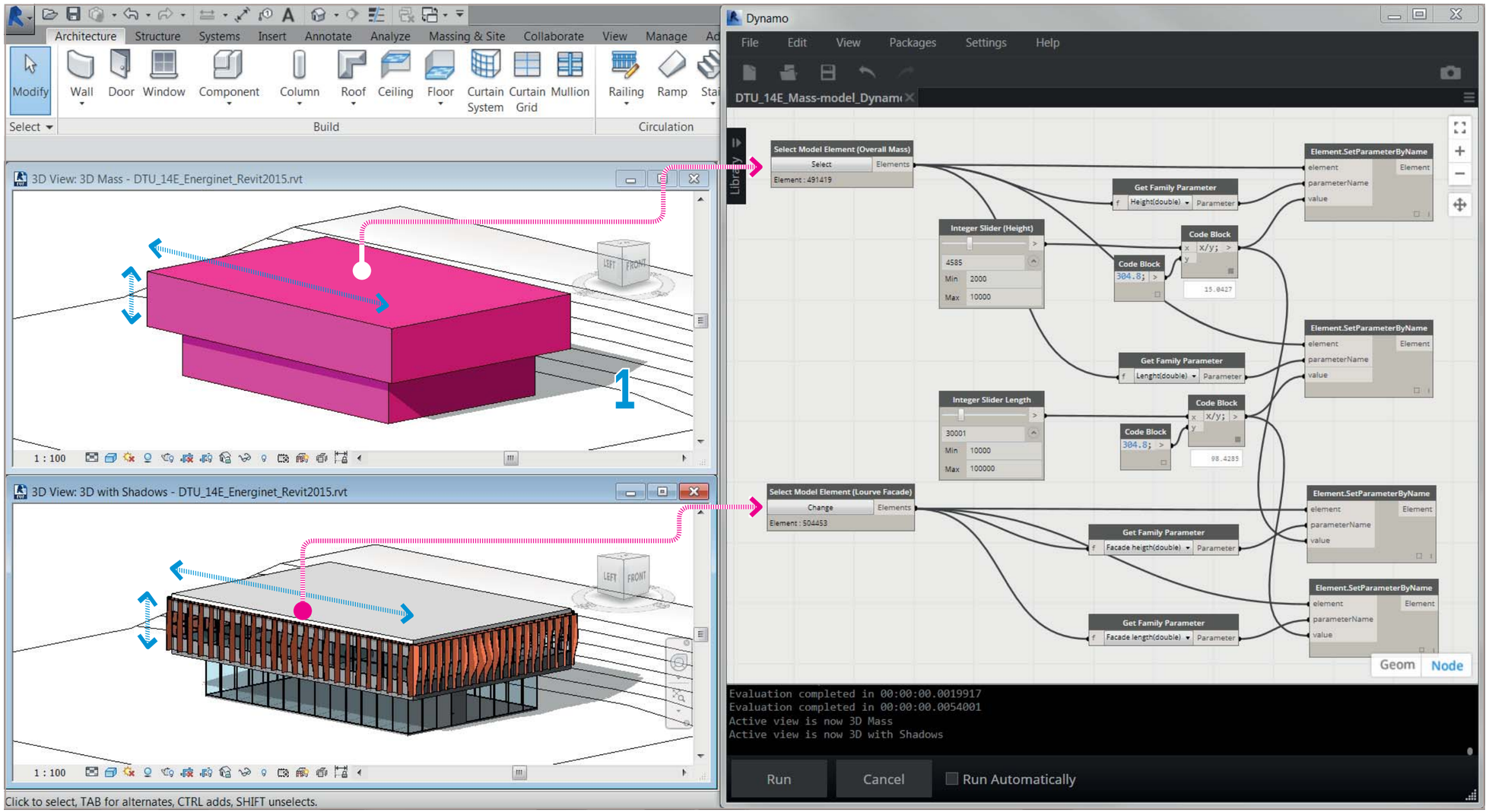
PARAMETRIC MODELS

DYNAMO EXAMPLE - LINKING MASS MODEL WITH DETAILED OBJECTS



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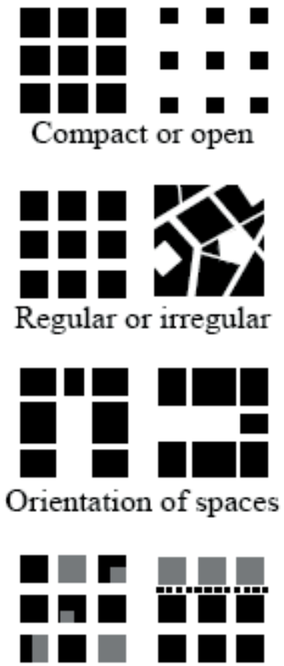
PARAMETRIC MODELS AND SCALE OF DESIGN

Creating geometrical relations

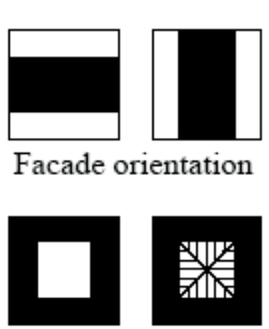
Input > Concept

Urban planning



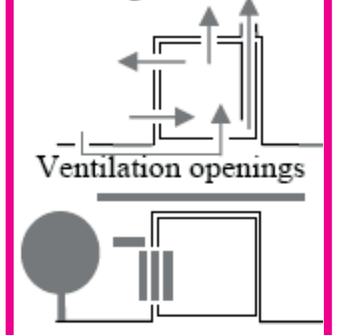
2

Building form



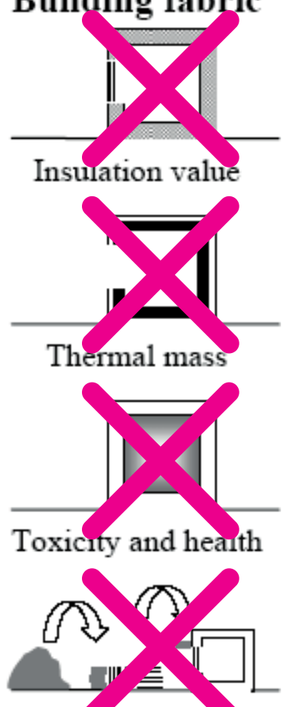
3

Façade design



4

Building fabric



5

Output > Design

at all scale of design !

Image: Integrated Building design System (IBDS) by Koen Steemers, Cambridge University, 2006

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A Parametric model

=

Parameterized Geometry

at all scale of design!

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[3.3]

PARAMETRIC SIMULATIONS

PARAMETRIC SIMULATIONS

WHAT IS PARAMETRIC SIMULATIONS !?

The basic principle of parametric design is to iteratively modify different parameters of the design while evaluating its performance

Noting new in that !
Gaudi worked with parametric performance around 1900...

http://www.johnaubin.com/spanish-architecture-2/

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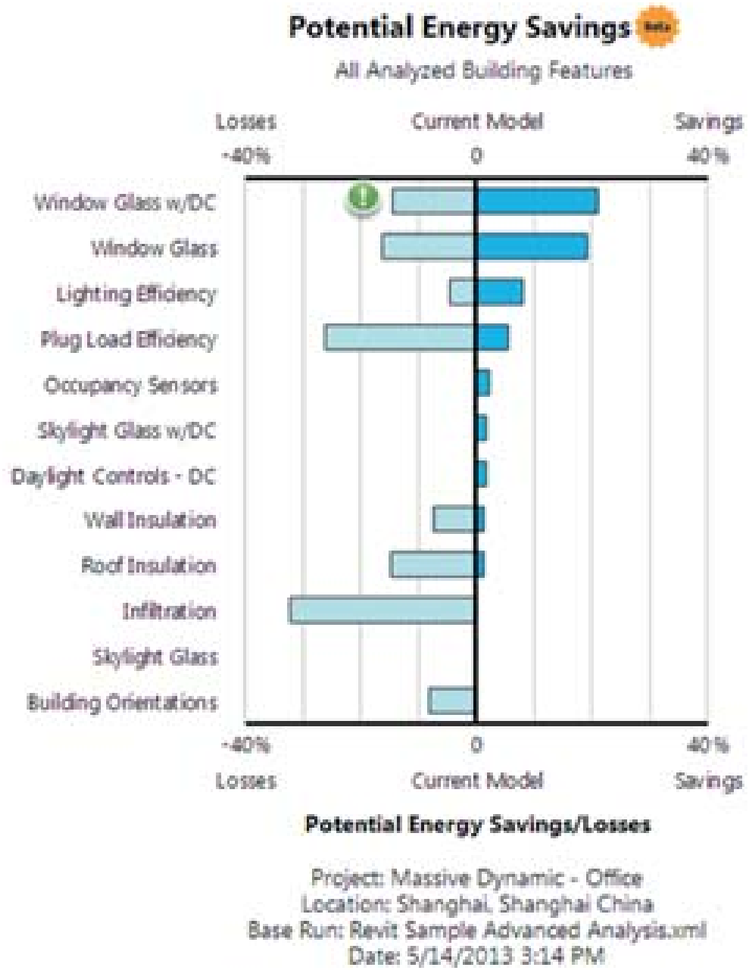
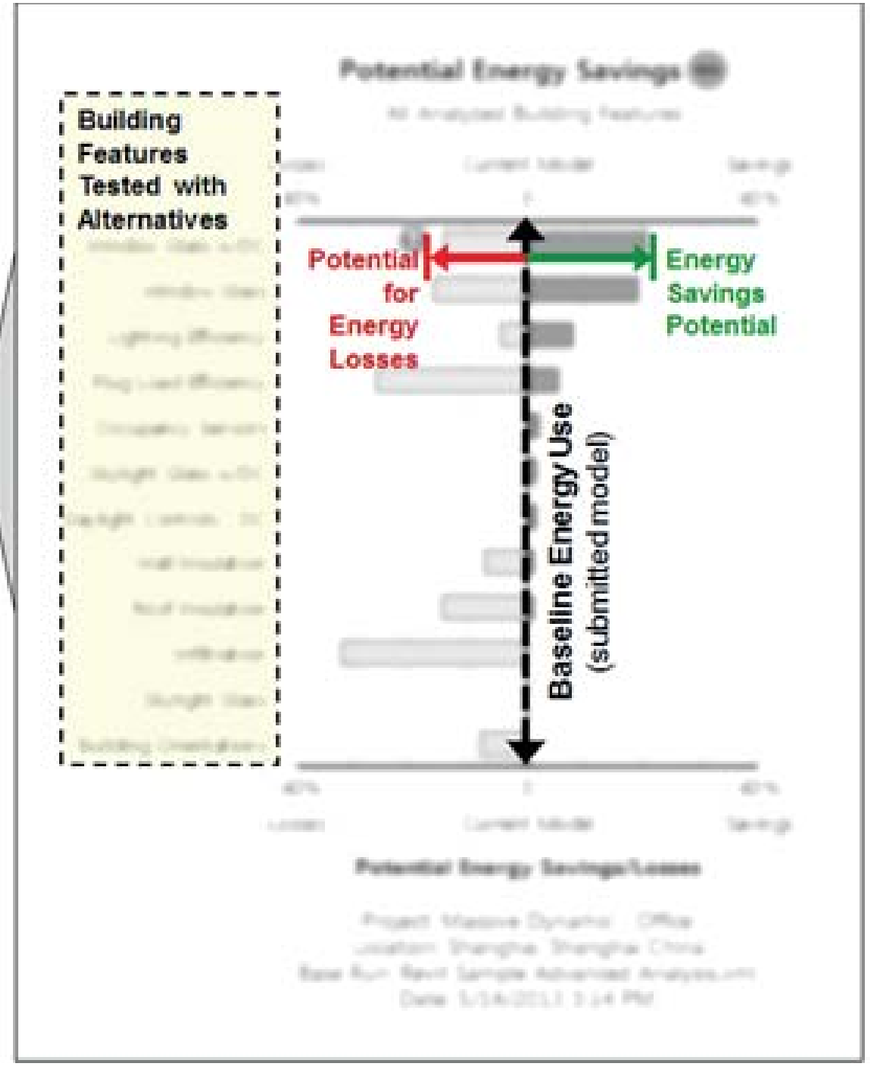
PARAMETRIC SIMULATIONS

BUILD-IN PARAMETRIC STUDY





Images: http://autodesk.typepad.com/.a/6a00e5536ab23988330191022dec7c970c-pi

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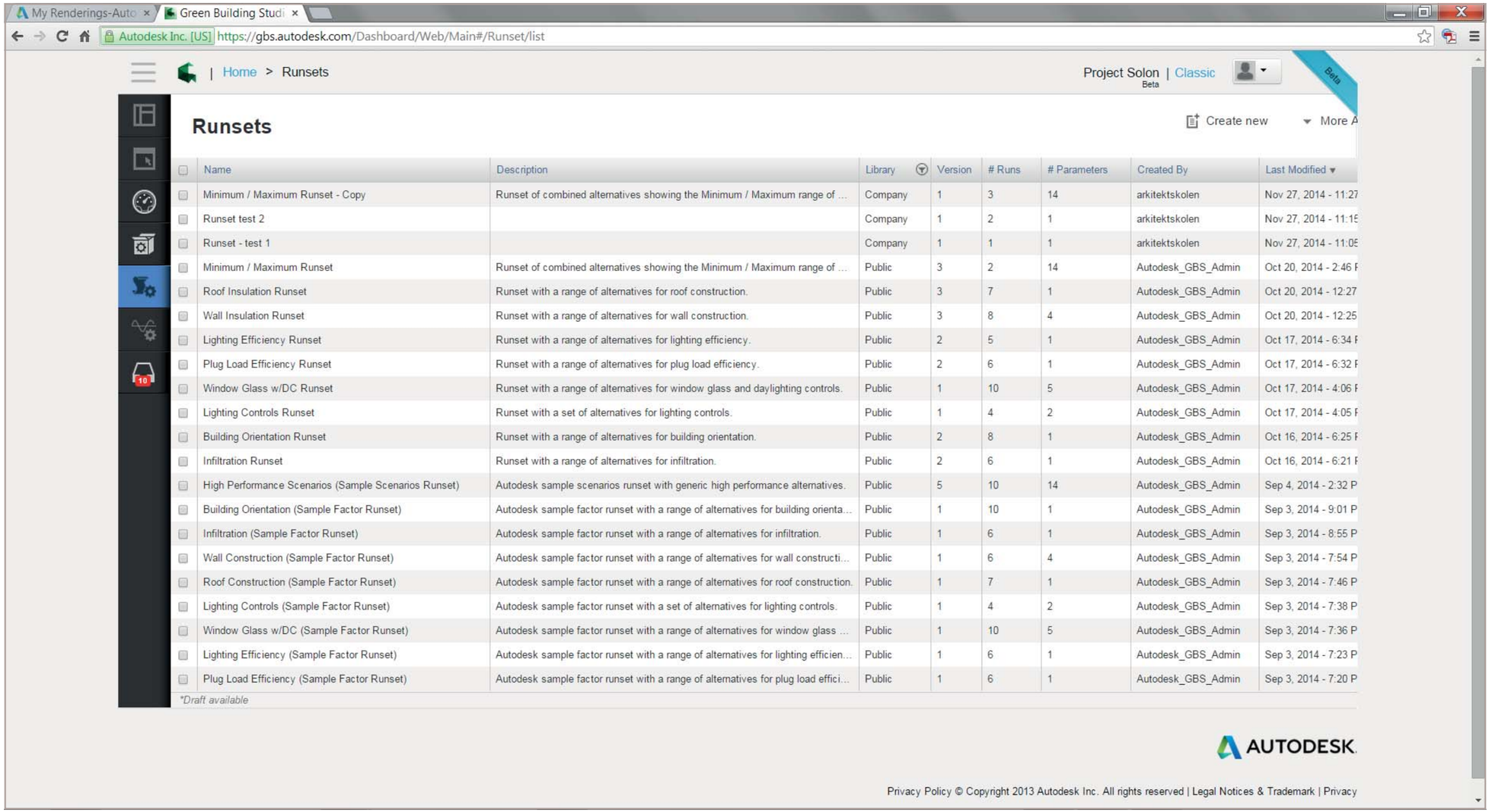
PARAMETRIC SIMULATIONS

PROJECT SOLON - CUSTOMIZED PARAMETRIC RUNSETS



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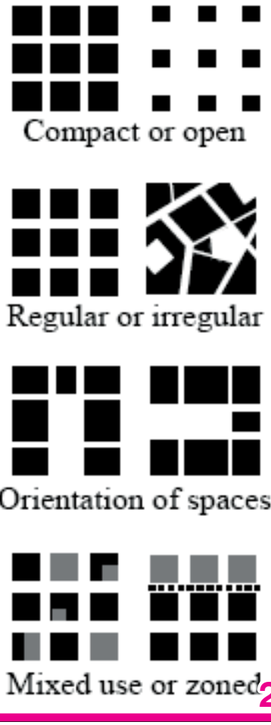
PARAMETRIC SIMULATIONS AND SCALE OF DESIGN

Creating optimized relations

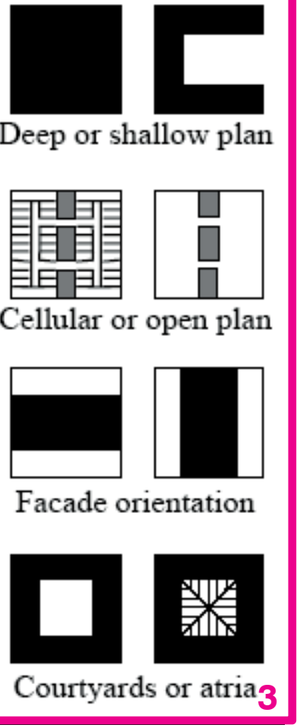
Input >
Objectives
Variables
Constraints

Urban planning



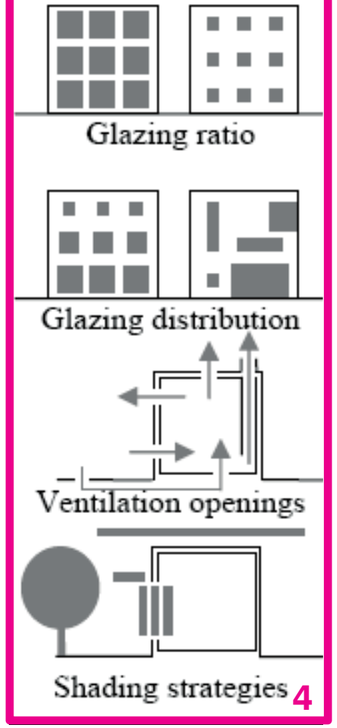
2

Building form



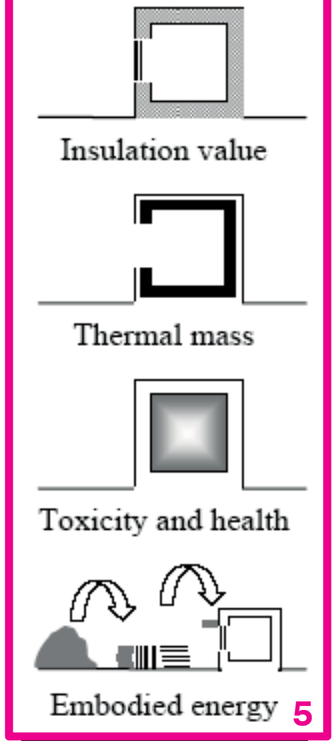
3

Façade design



4

Building fabric



5

Output >
Optimized
Design

at all scale of design !

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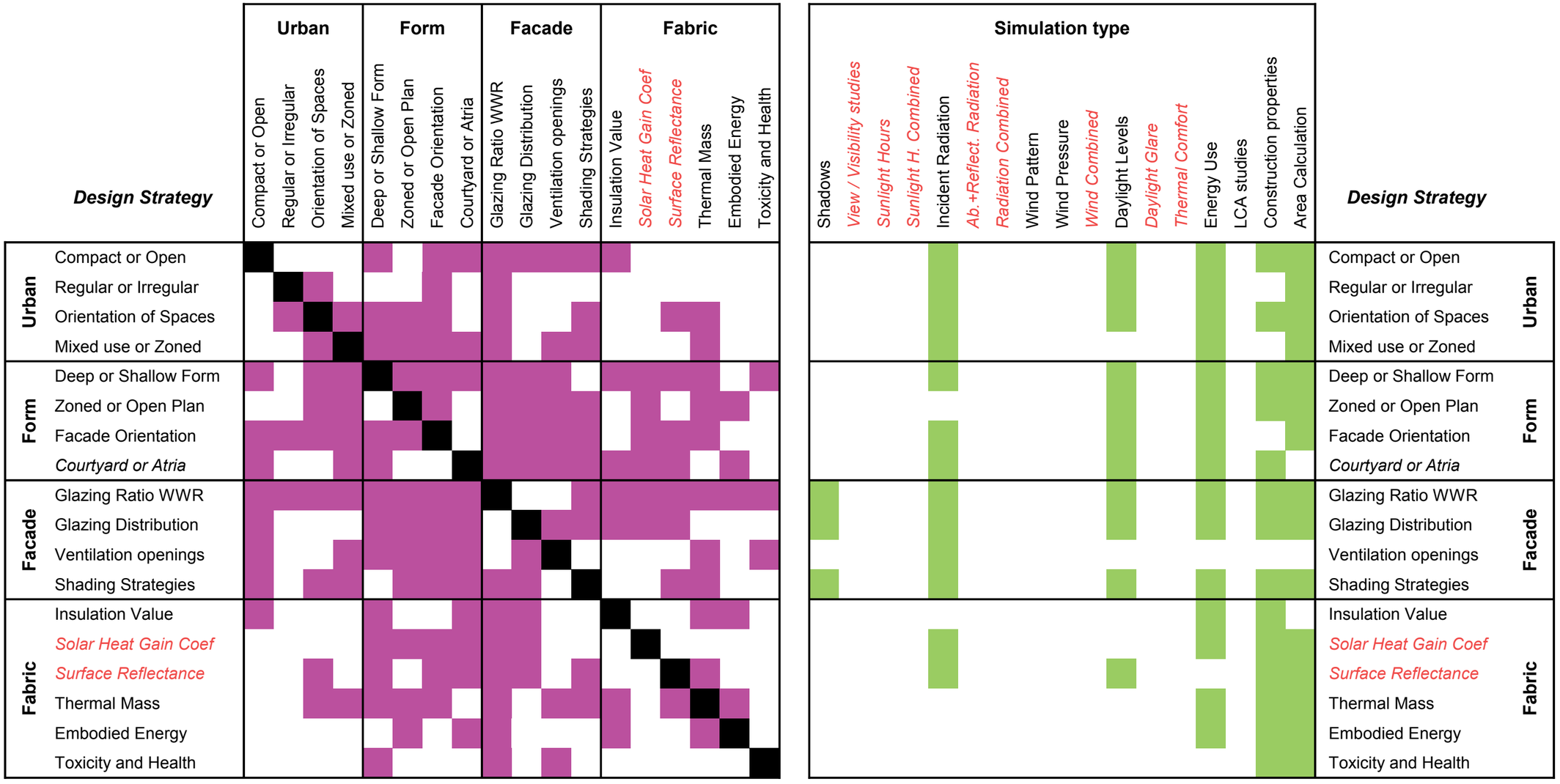
PARAMETRIC SIMULATIONS

THE MATRIX RELATED TO DYNAMO



Strategy in Italic is added or original edit

Simulation Type in Italic = no Autodesk tools

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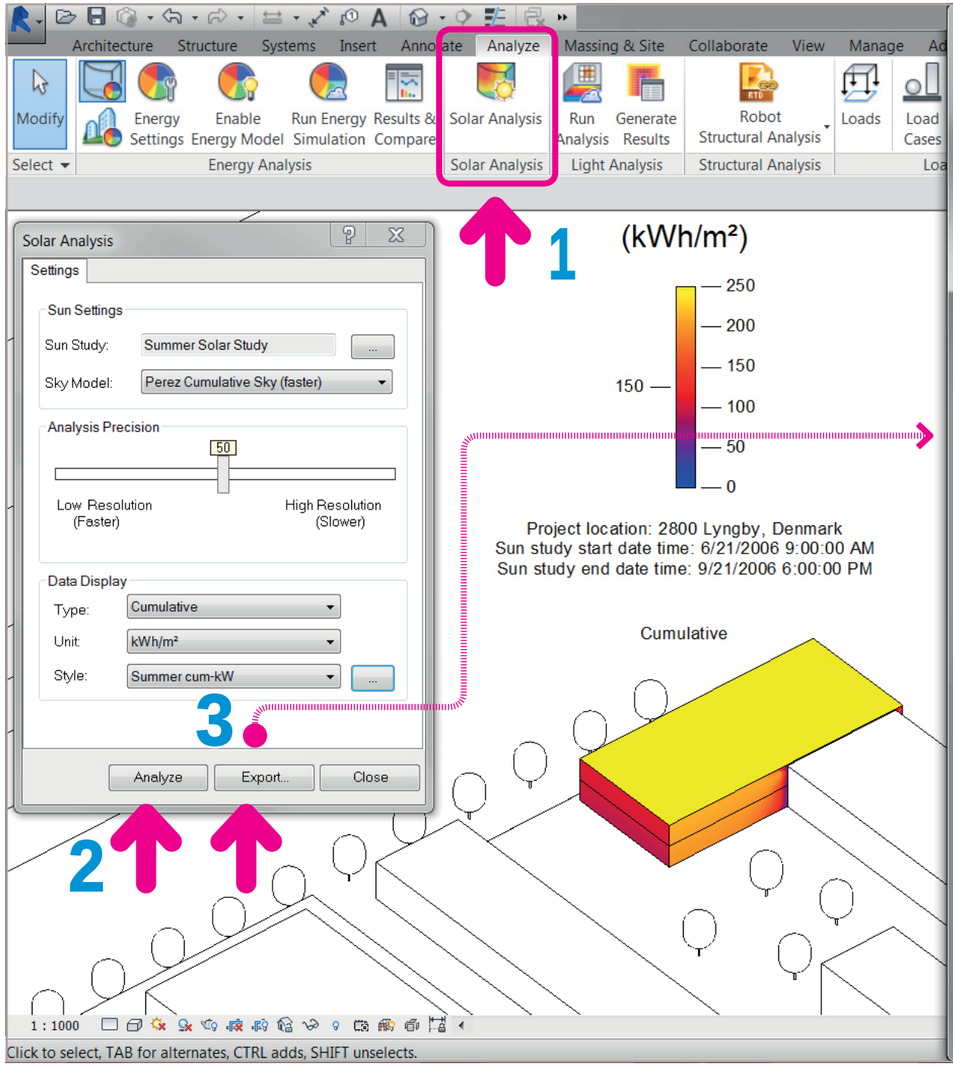
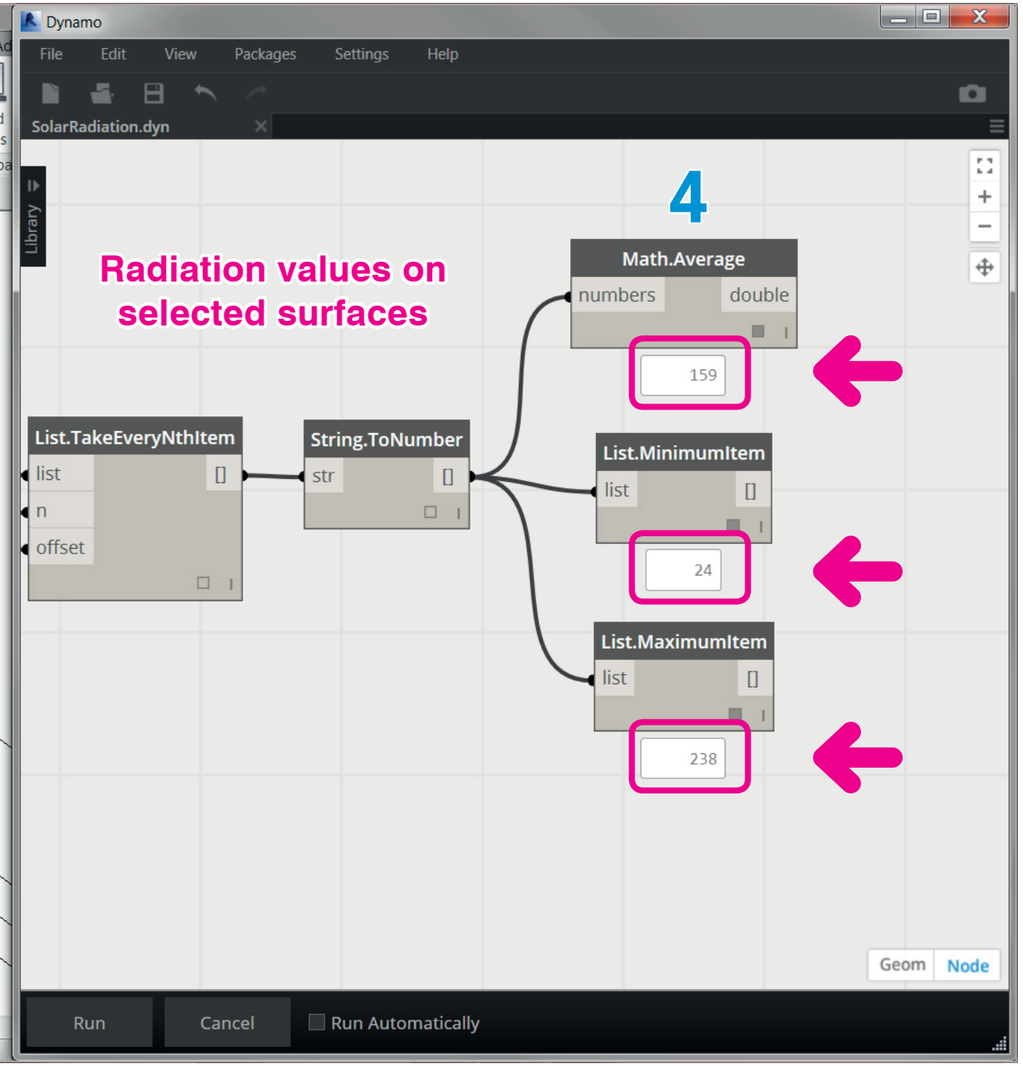
PARAMETRIC SIMULATIONS

GETTING RADIATION VALUES WITH DYNAMO









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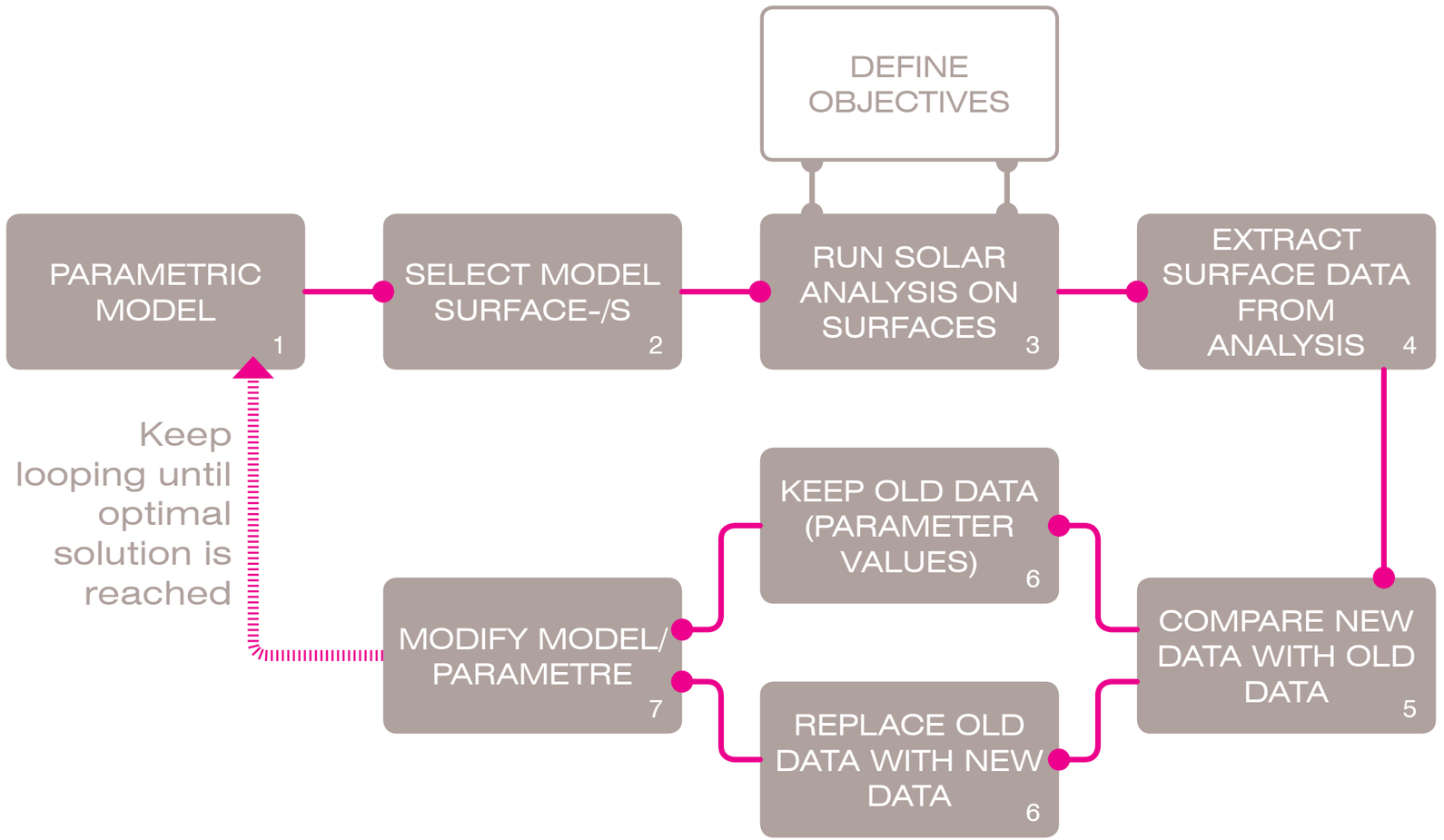
PARAMETRIC SIMULATIONS

THE CONCEPT OF THE SOLAR RADIATION OPTIMIZER WITH DYNAMO



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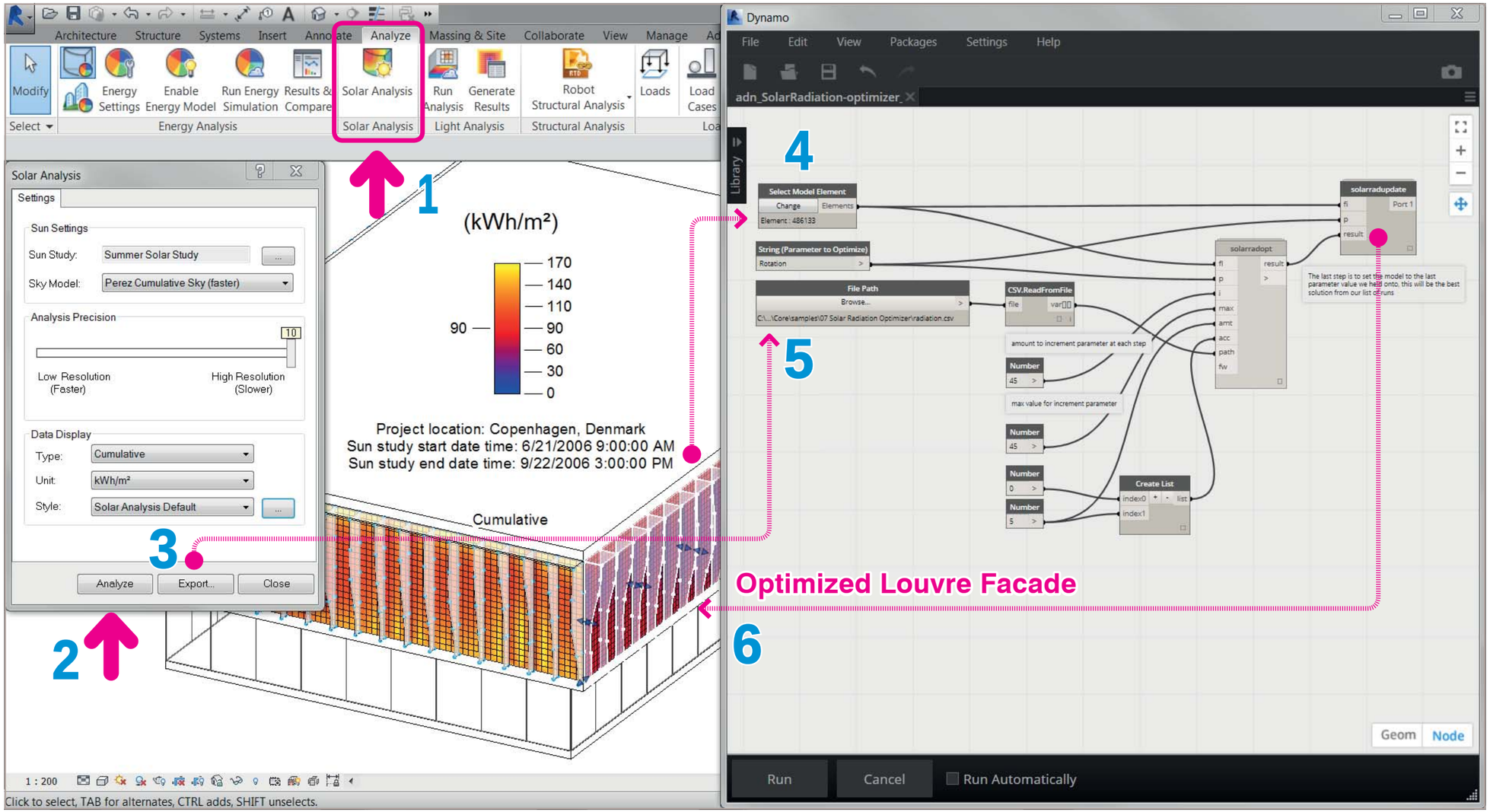
PARAMETRIC SIMULATIONS

OPTIMIZING LOUVRE FACADE WITH DYNAMO



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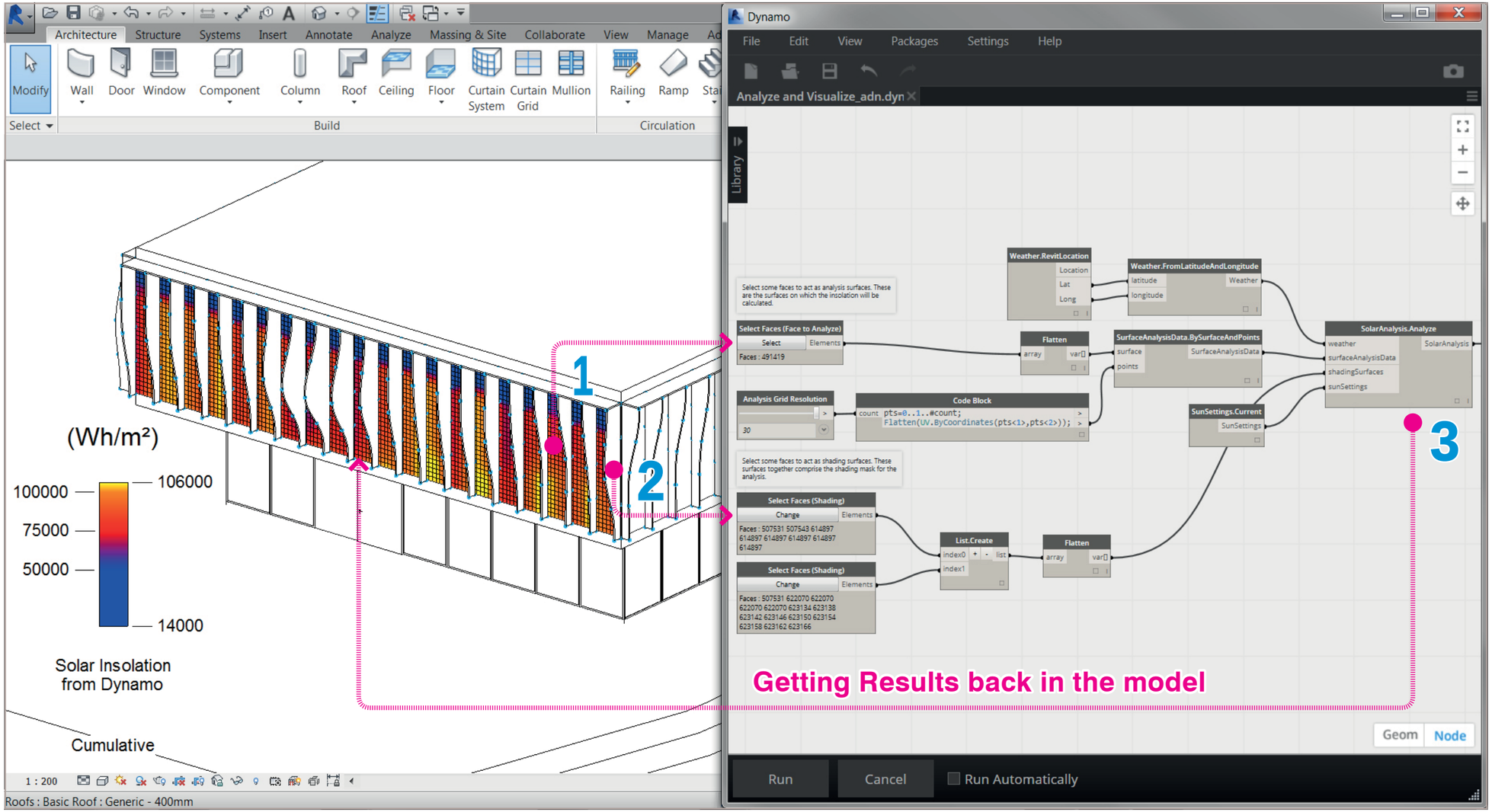
PARAMETRIC SIMULATIONS

OPTIMIZING LOUVRE FACADE WITH DYNAMO



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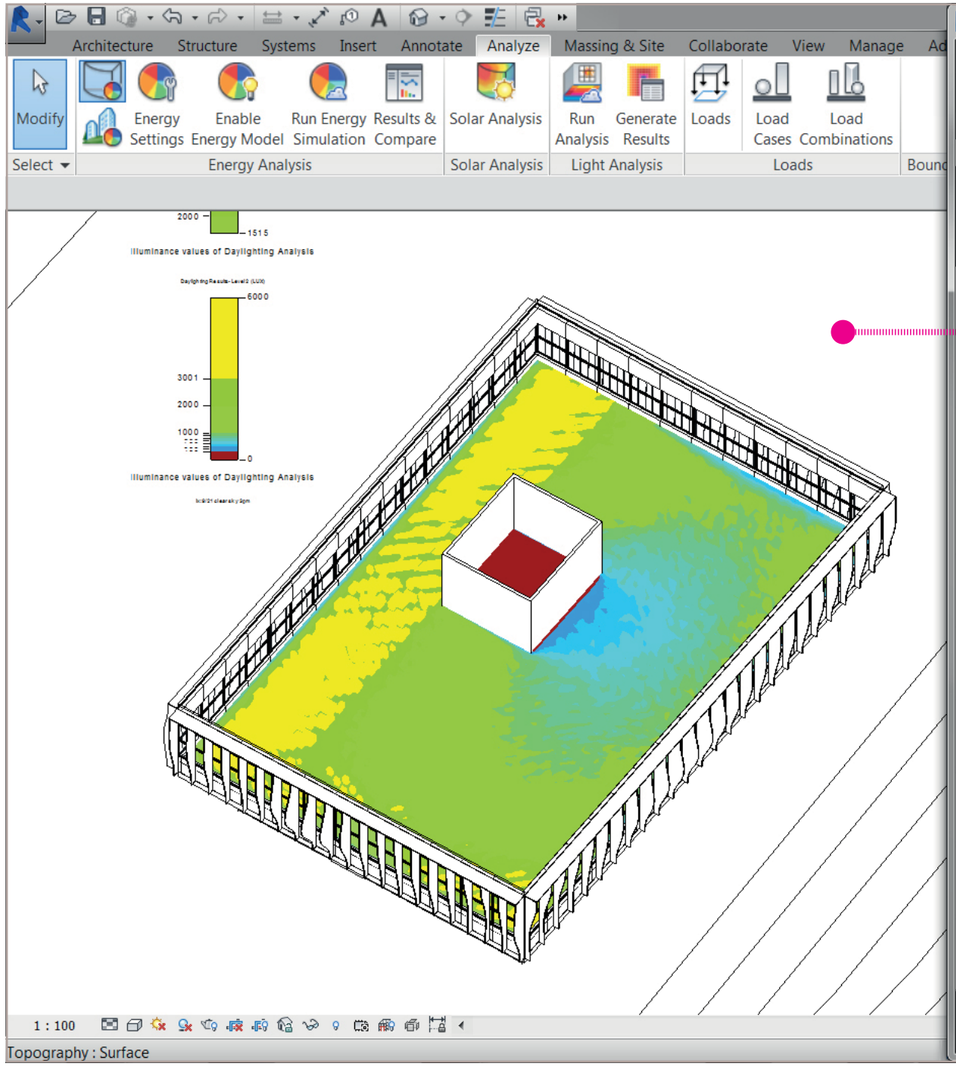
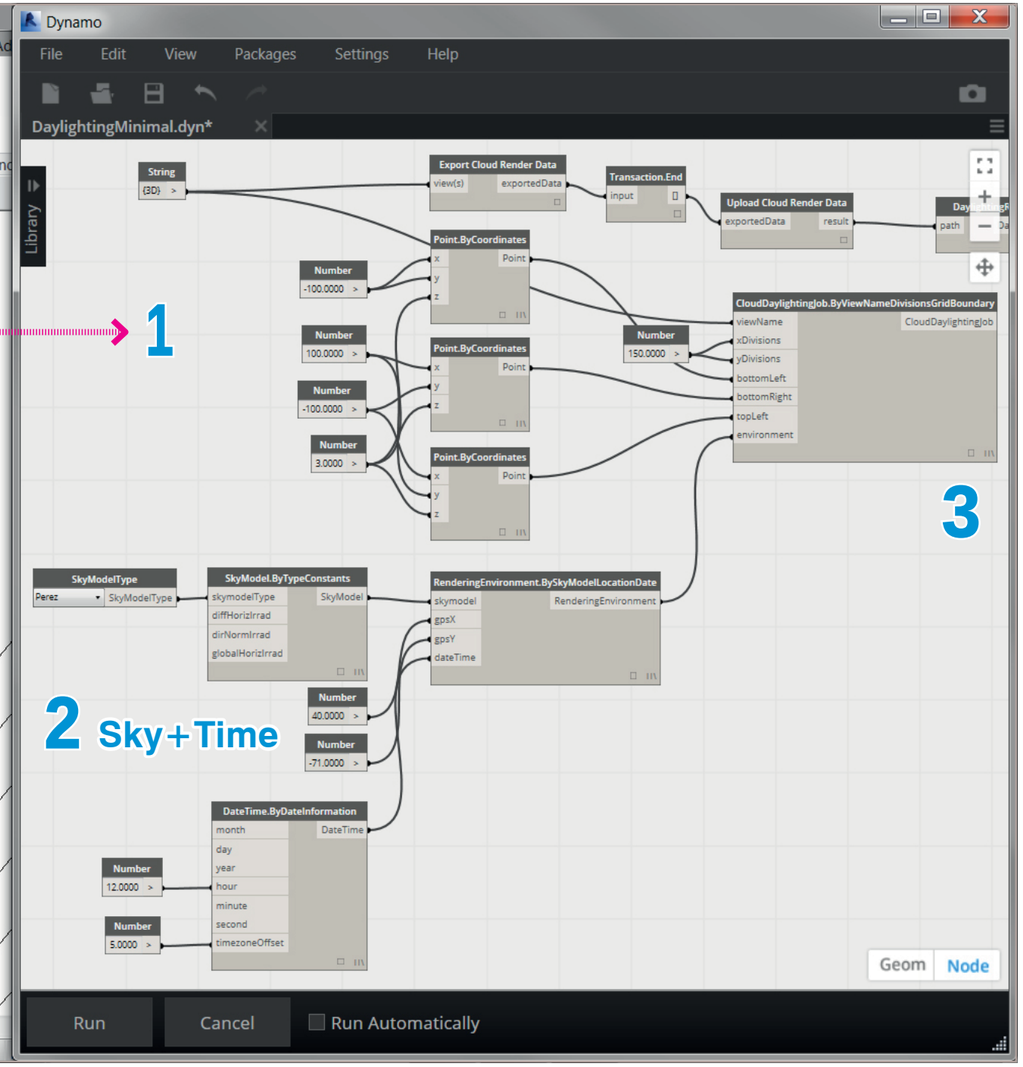
PARAMETRIC SIMULATIONS

DAYLIGHT SIMULATION AND RENDERING NODES





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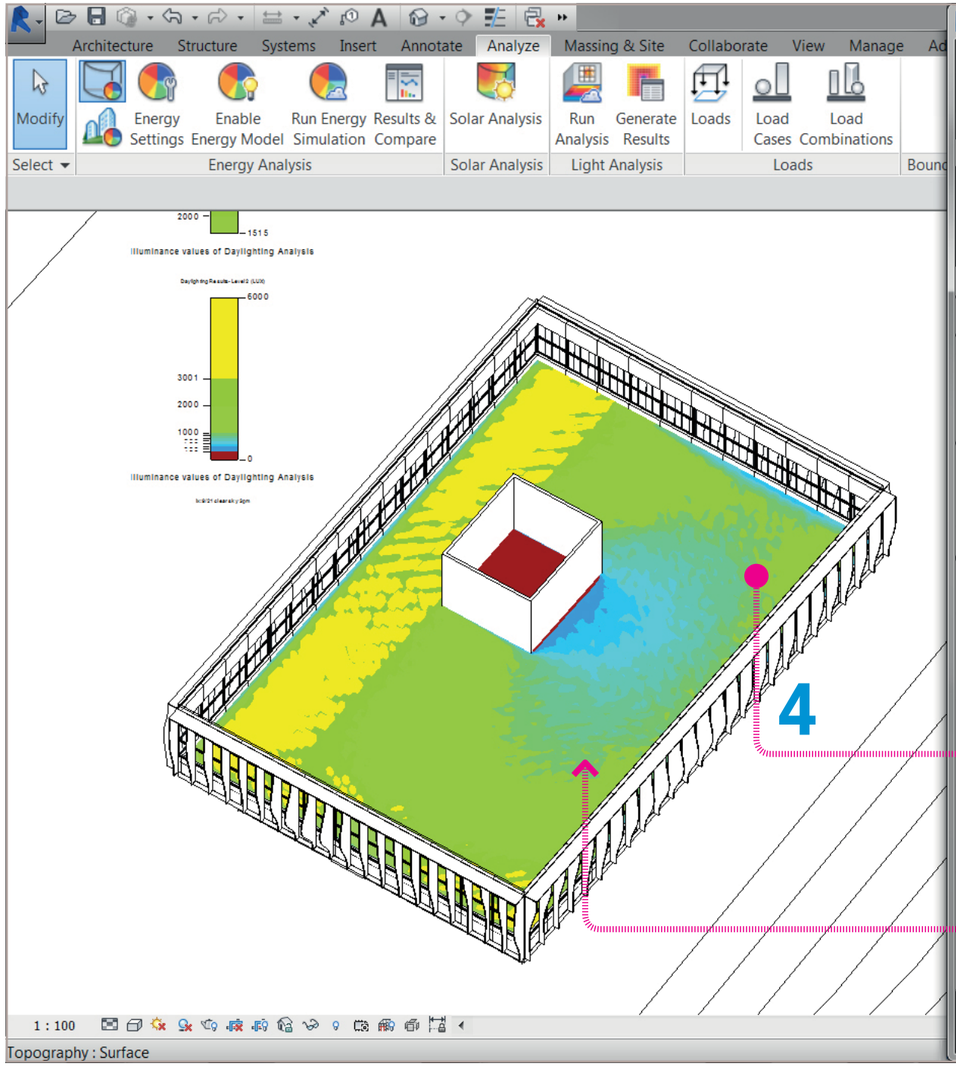
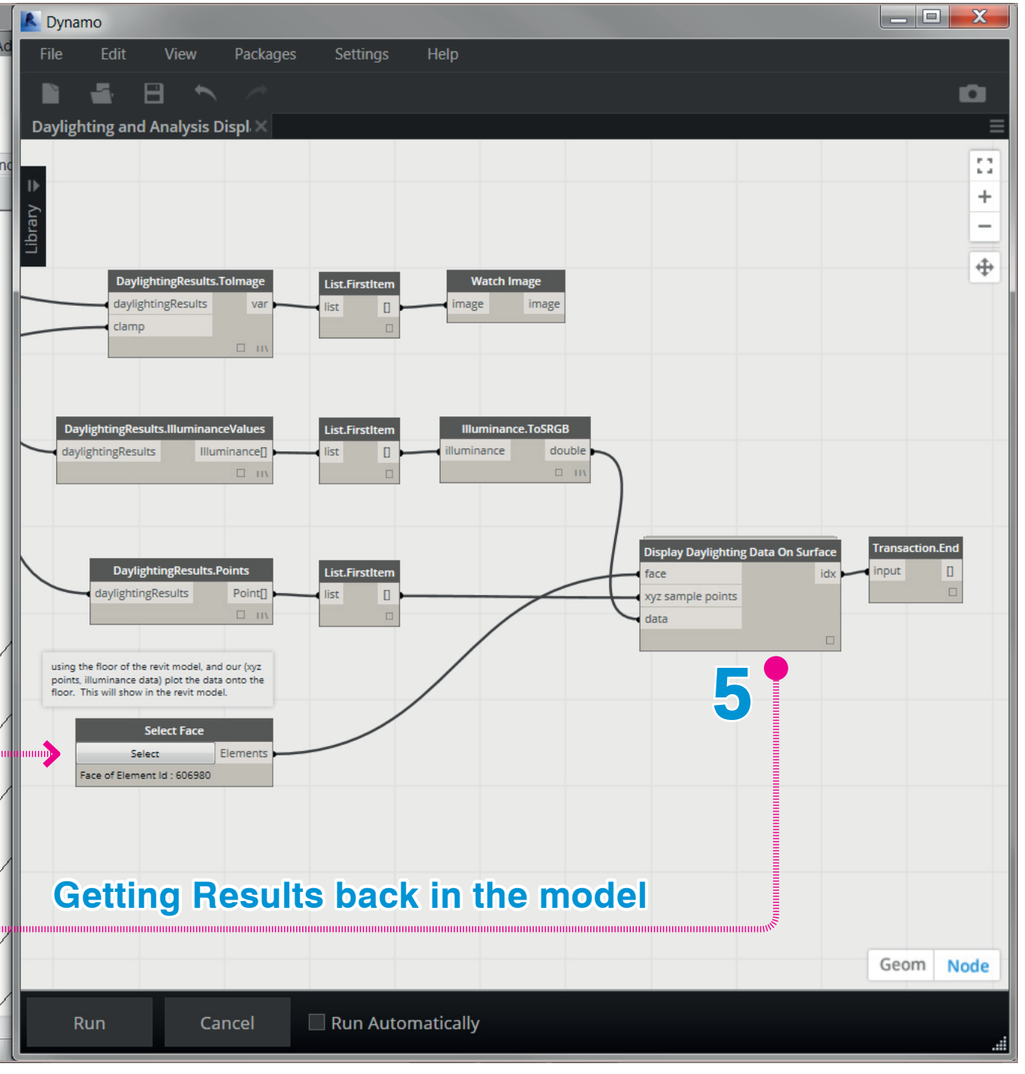
PARAMETRIC SIMULATIONS

DAYLIGHT SIMULATION AND RENDERING NODES





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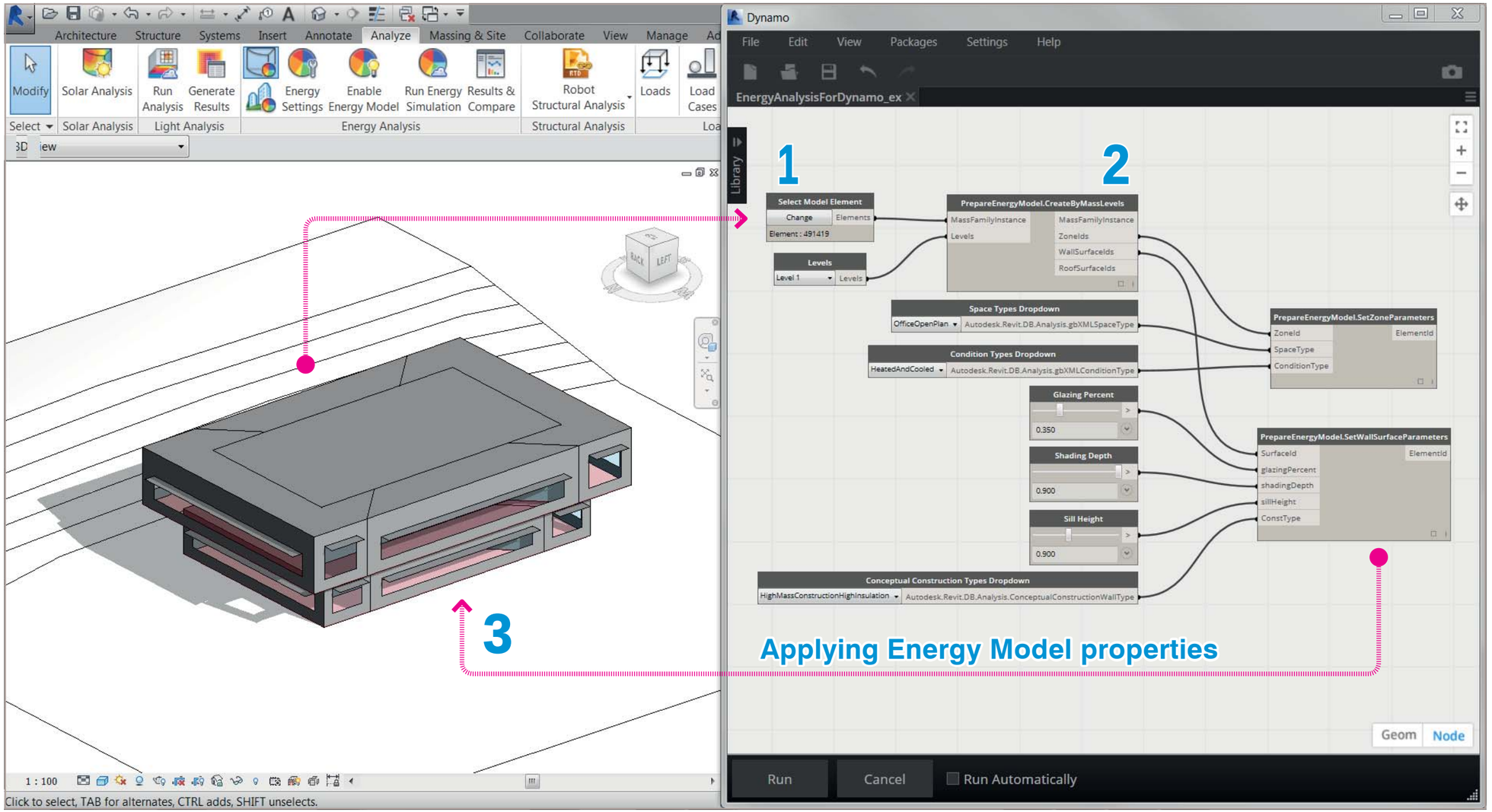
PARAMETRIC SIMULATIONS

PARAMETRIC ENERGY SIMULATION NODES



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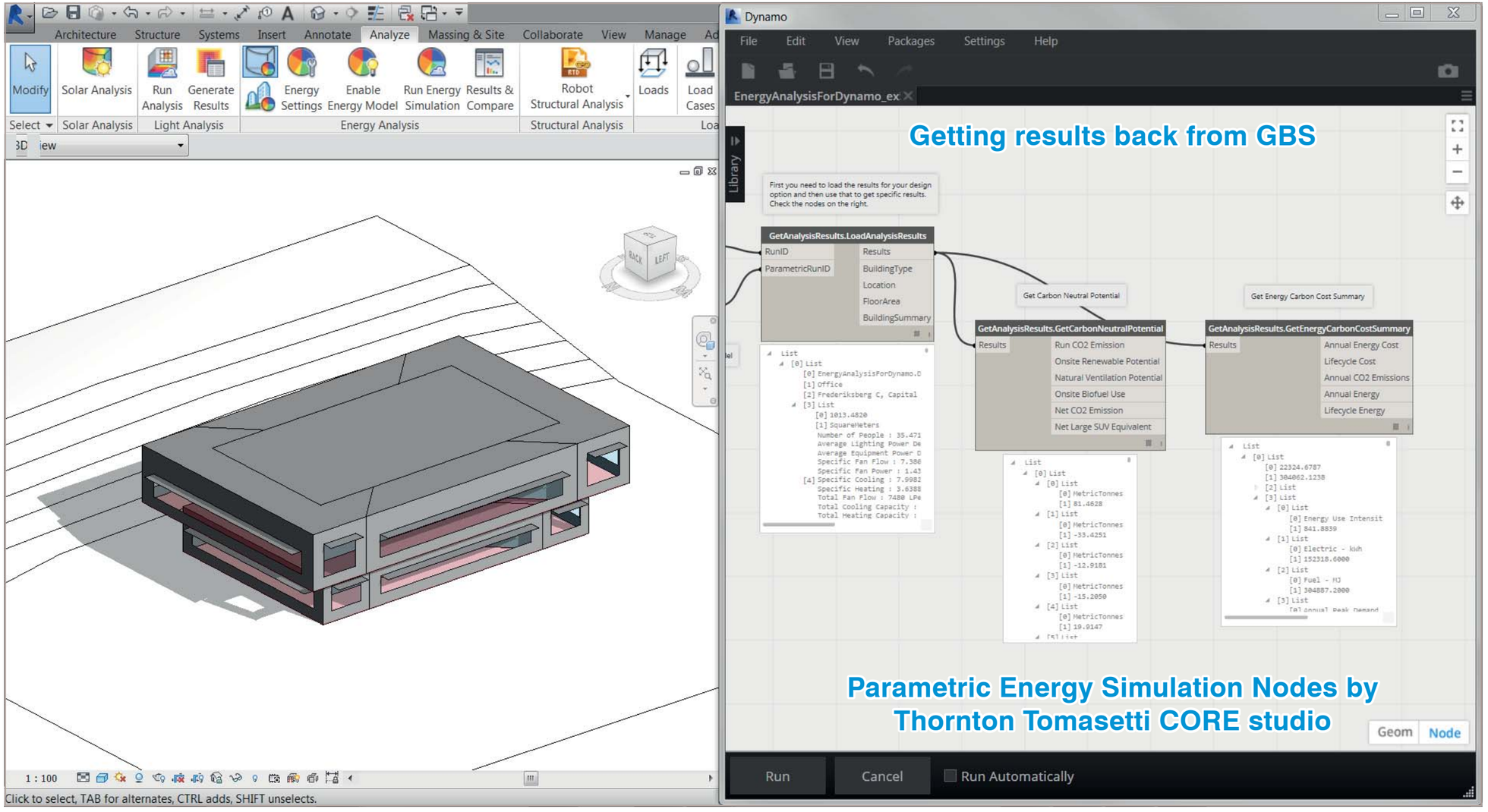
PARAMETRIC SIMULATIONS

PARAMETRIC ENERGY SIMULATION NODES



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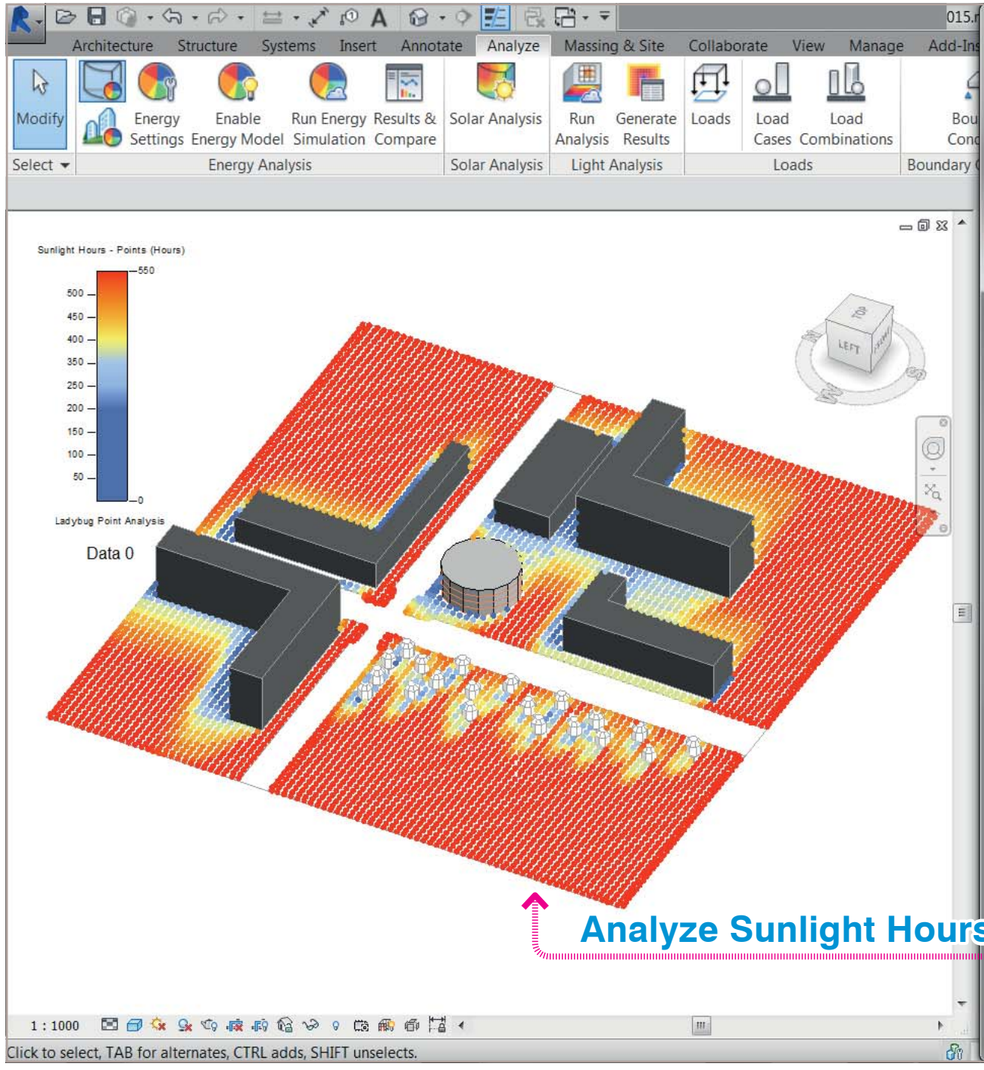
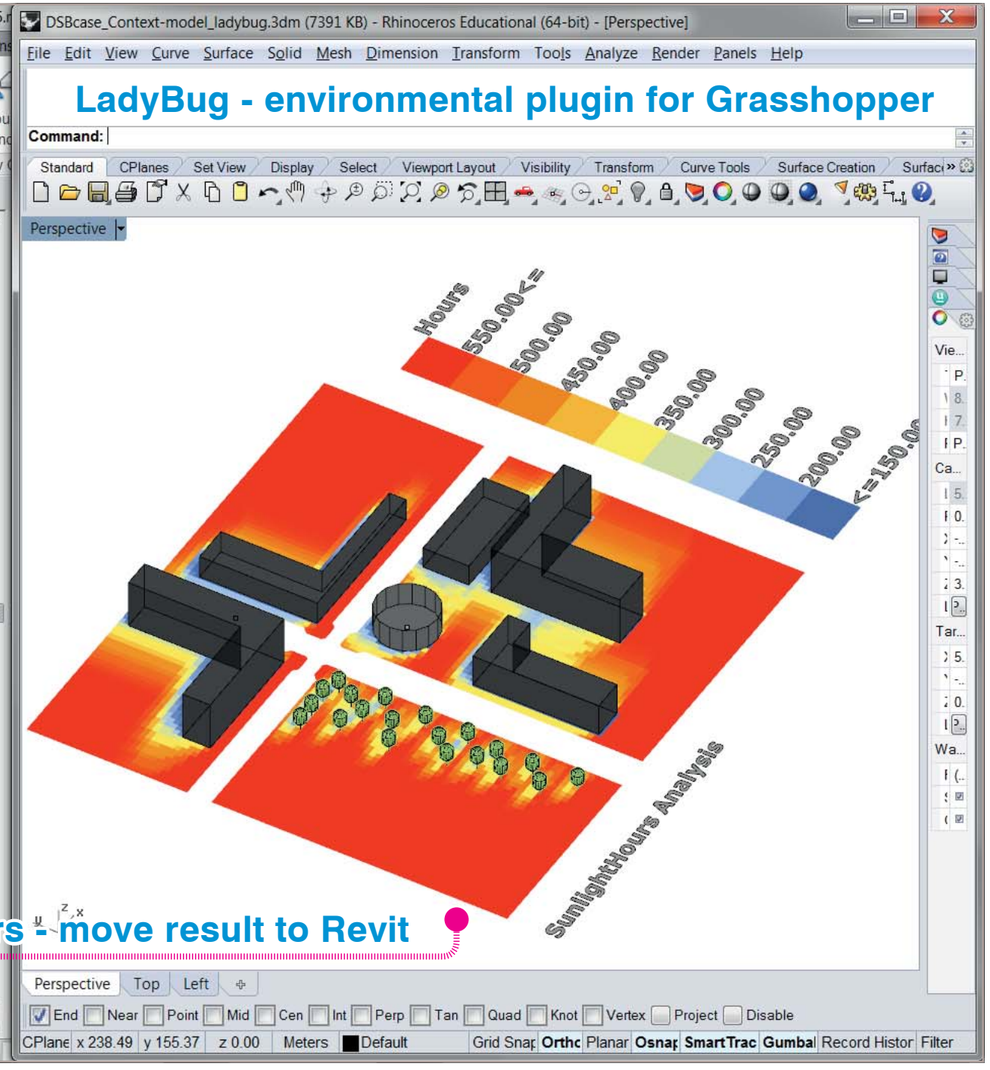
PARAMETRIC SIMULATIONS

MANTIS SHRIMP - VISUALIZING SIMULATION RESULTS





Analyze Sunlight Hours - move result to Revit

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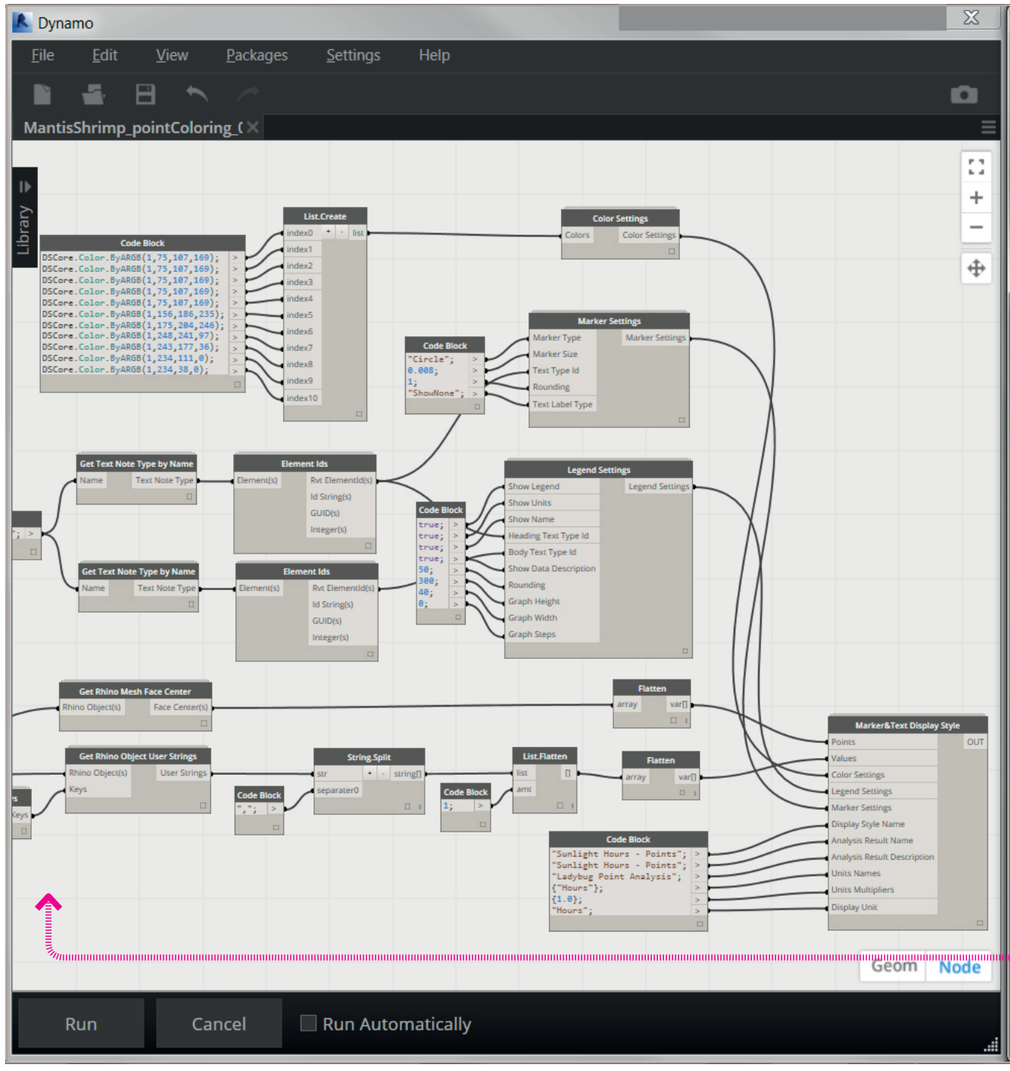
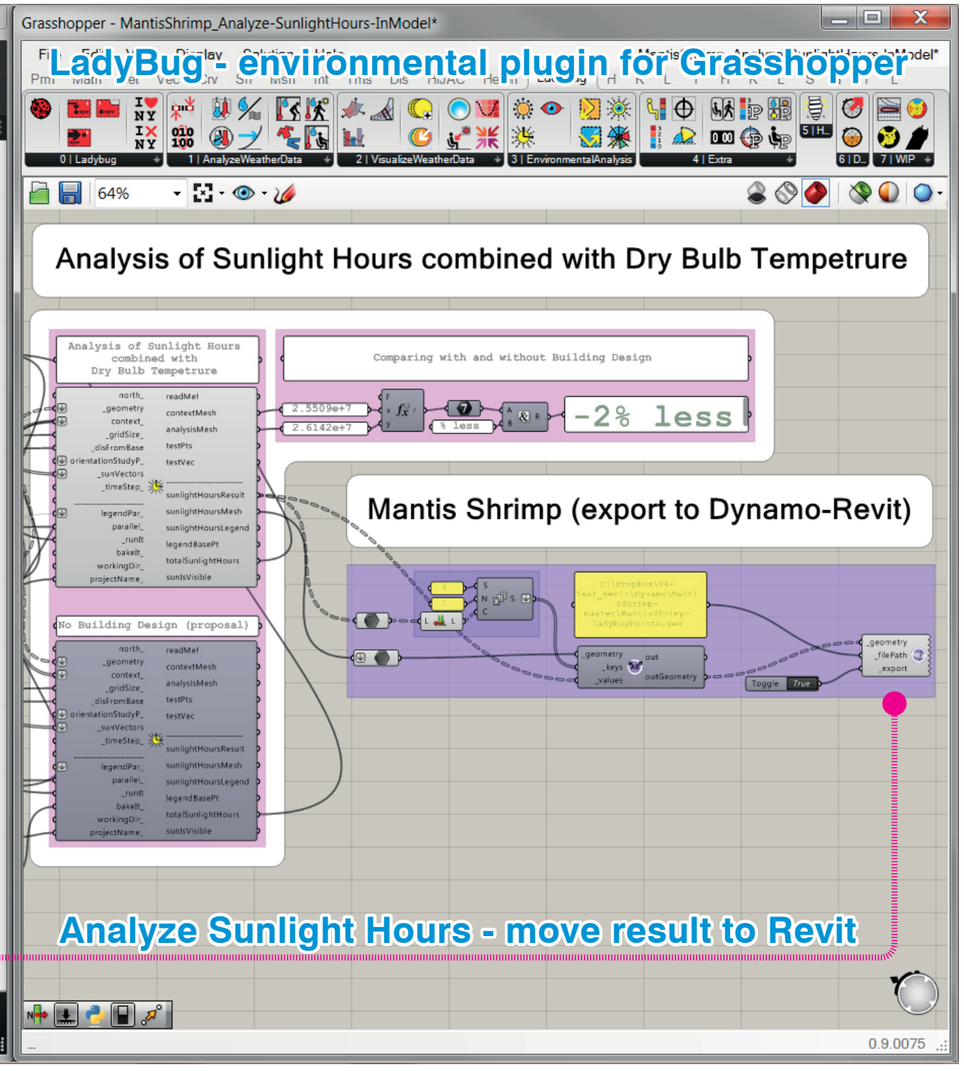
PARAMETRIC SIMULATIONS

MANTIS SHRIMP - VISUALIZING SIMULATION RESULTS





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[3.4]

Learning from PARAMETRIC POSSIBILITIES

Develop strong architectural Concepts

Translate Concept into a Parametric model

Parametric Models maximize Variation Studies

Parametric optimazing !

Image: http://www.eurekastreet.com.au/uploads/image/fionakatauskas/36885.jpg

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[4]

EFFICIENT PROCESS

Daniel Nielsen © architect maa + constructing architect © ark.daniel.nielsen@gmail.com

Pre-, Parallel and Post Analyses

Conceptual vs Contextual vs Reference Studies

The Analytical Design Process

Learning from Efficient Process

Are you too busy to improve...



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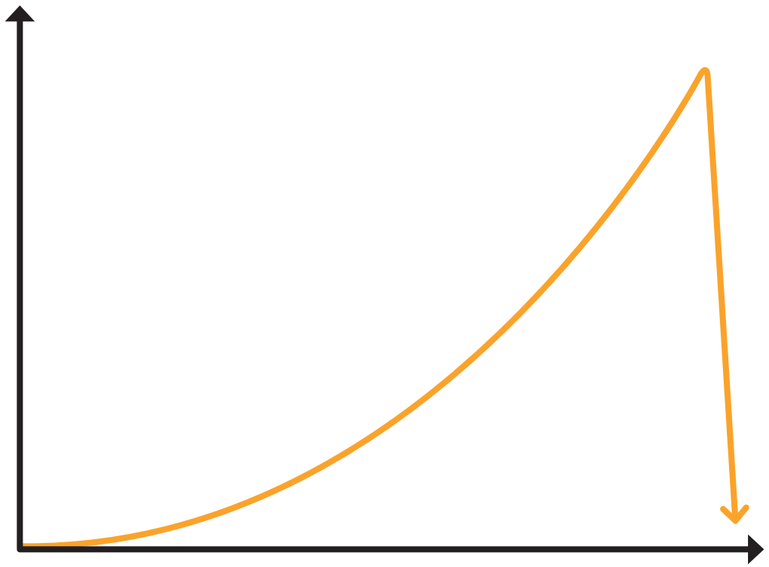
[4.1]

PRE-, PARALLEL AND POST ANALYSES

PRE-, PARALLEL AND POST ANALYSES

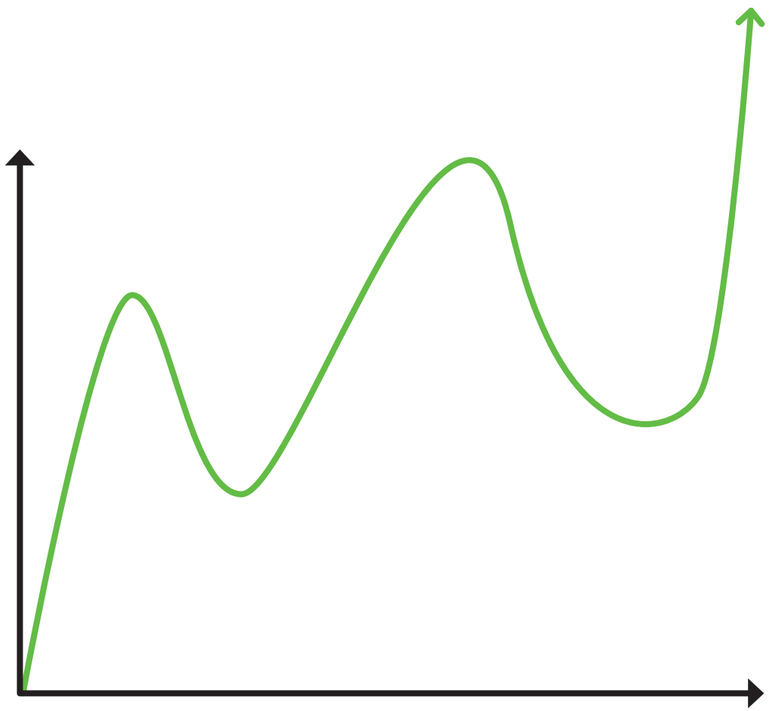
WORK LOAD AND STRESS LEVEL

PRE-ANALYSES



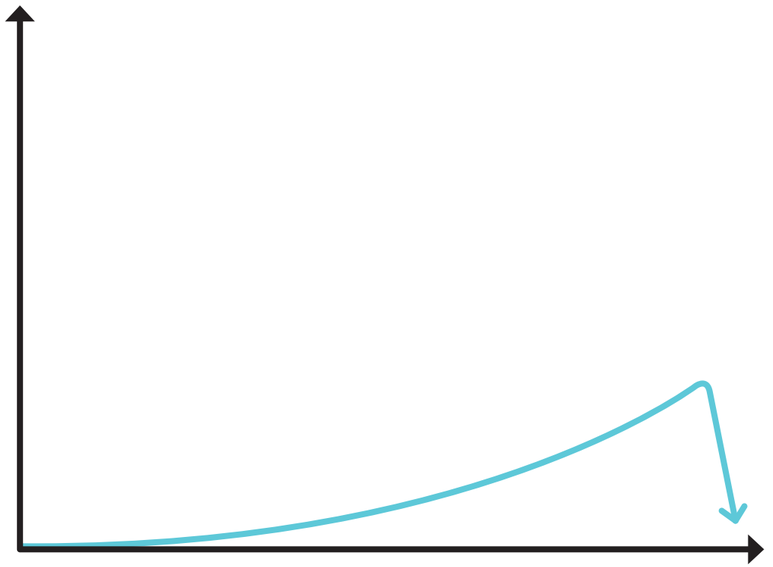
Easy to setup a
structured work-flow

PARALLEL ANALYSES



Nearly impossible to
have good work-flow

POST ANALYSES



Easier to setup a
structured work-flow

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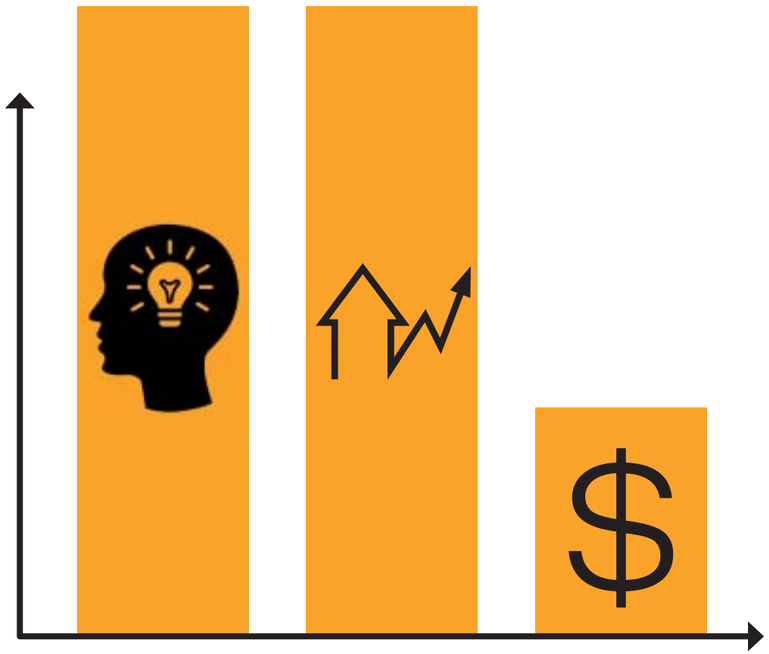
PRE-, PARALLEL AND POST ANALYSES

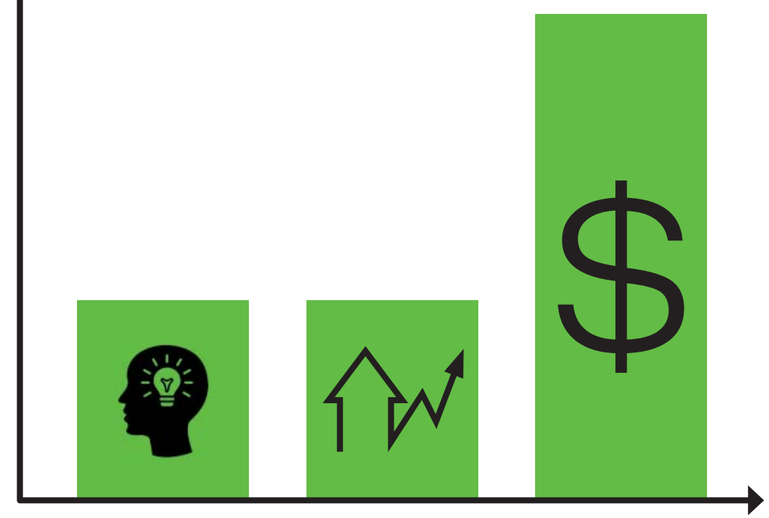
THE VALUE OF ANALYSES

PRE-ANALYSES



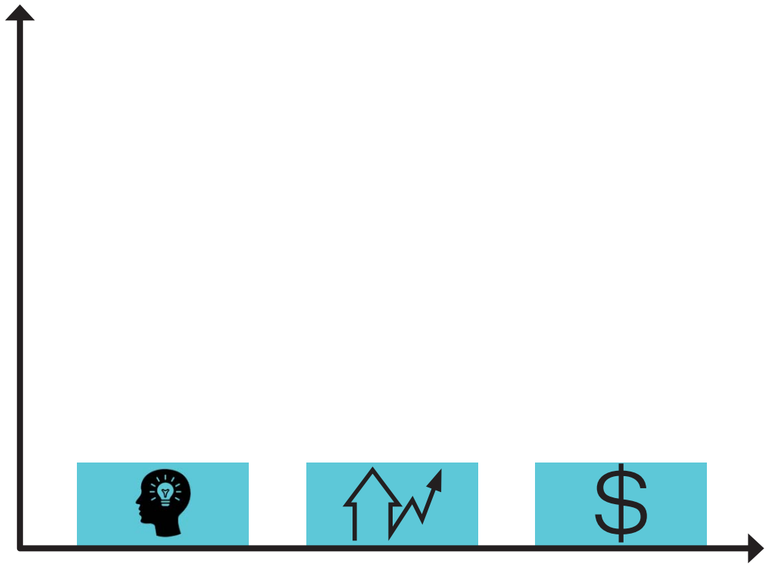
Greatest value potential

PARALLEL ANALYSES



It is possible but challenging!

POST ANALYSES



Only valuable if design fullfil the objectives

Creative Trigger

Project Value

Analysis Cost

http://www.vectorstock.com/composite/1098253/head-brain-vecotr-icons-set-vector.jpg and http://virtualresults.net/wp-content/uploads/2013/05/your-home-town-market-value-.jpg

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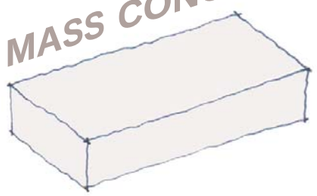
PRE-, PARALLEL AND POST ANALYSES

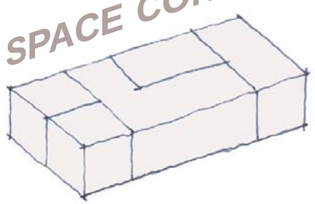
PROPOSED ANALYSES RELATED TO MODEL DETAIL LEVELS

PRE-ANALYSES

MASS CONCEPTS



SPACE CONCEPTS

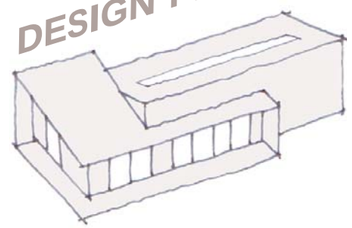


ROOM CONCEPTS



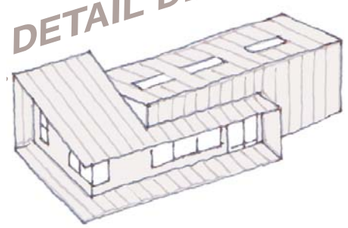
PARALLEL ANALYSES

DESIGN PROPOSAL



POST ANALYSES

DETAIL DESIGN



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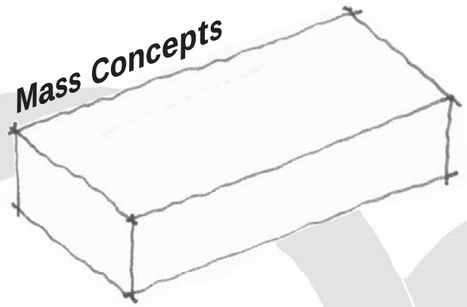
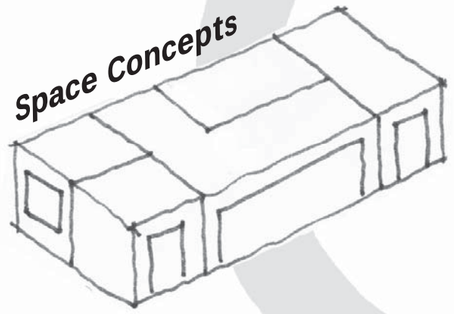
PRE-, PARALLEL AND POST ANALYSES

DESIGN WITH KNOWLEDGE !

EARLY INSIGHT AND UNDERSTANDING OF DESIGN OPTIONS



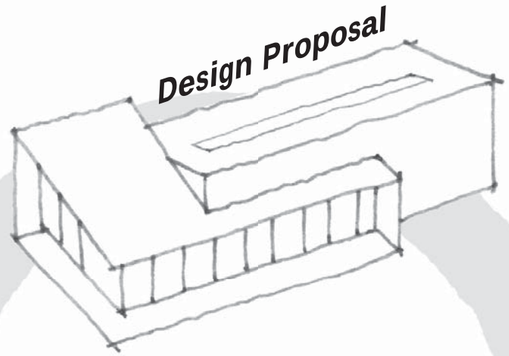


Conceptual energy and comfort analysis

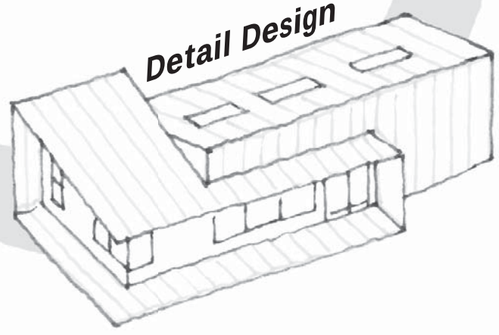


Design with knowledge

QUALIFIED DESIGN DECISIONS AND SOLUTIONS



Designing



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[4.2]

CONCEPTUAL vs CONTEXTUAL vs REFERENCE STUDIES

What is the difference between these Studies:

Conceptual Studies

Contextual Stubies

Reference Studies

? ! ?

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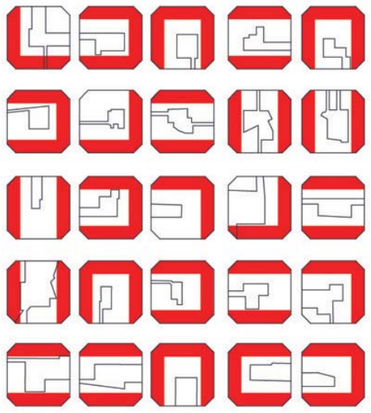
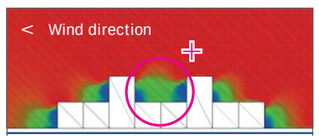
CONCEPTUAL VS CONTEXTUAL VS REFERENCE STUDIES

EXAMPLE OF CONCEPTUAL STUDIES

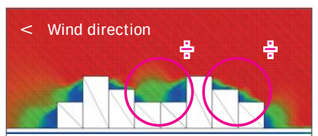
CONCEPTUAL URBAN STUDIES





Create more calm spaces i the middle section

VS

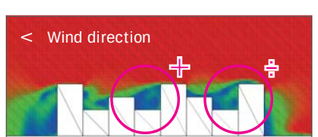


Create less calm spaces i the middle section
At right the wind bounce on the edge of the building block

VS

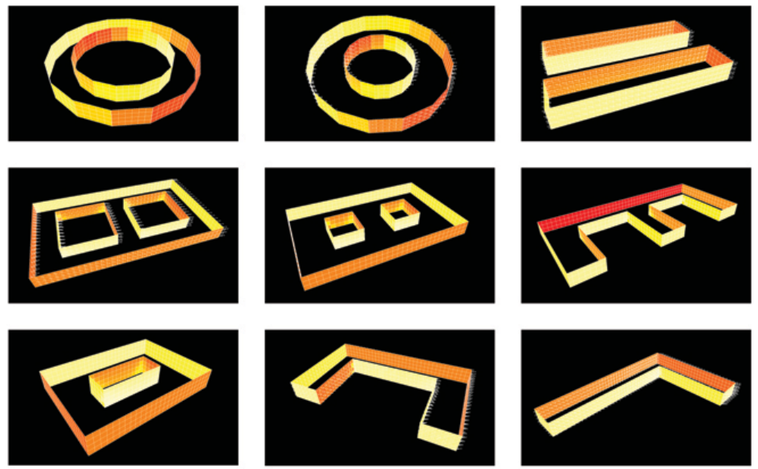


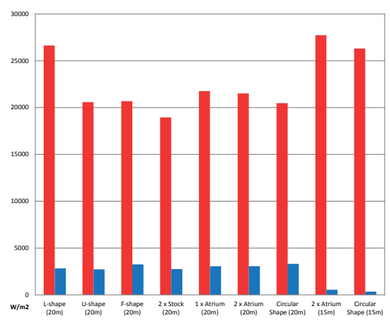
Create less calm spaces i the middle section

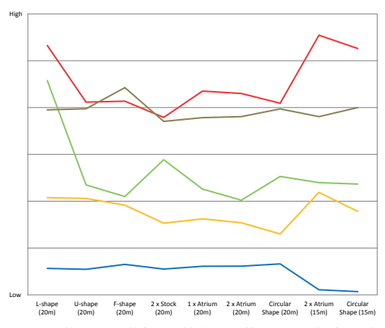


Create more calm spaces i the middle section
At right there could occur a risk of turbulence

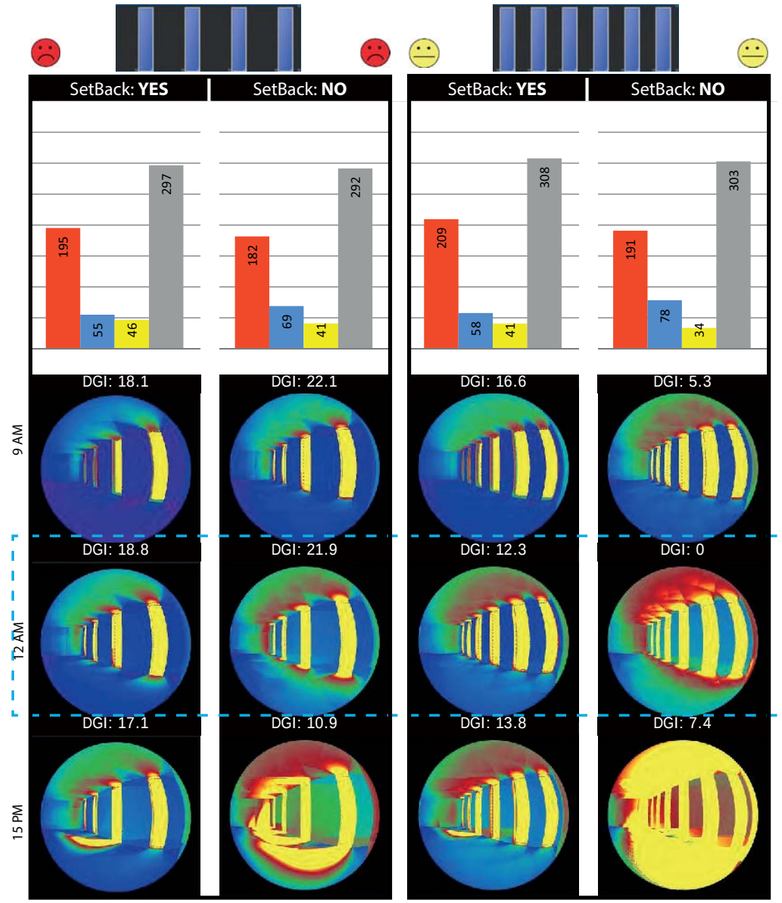
CONCEPTUAL BUILDING STUDIES







CONCEPTUAL ROOM-FACADE STUDIES



Project Pomini - In collaboration with e3Lab

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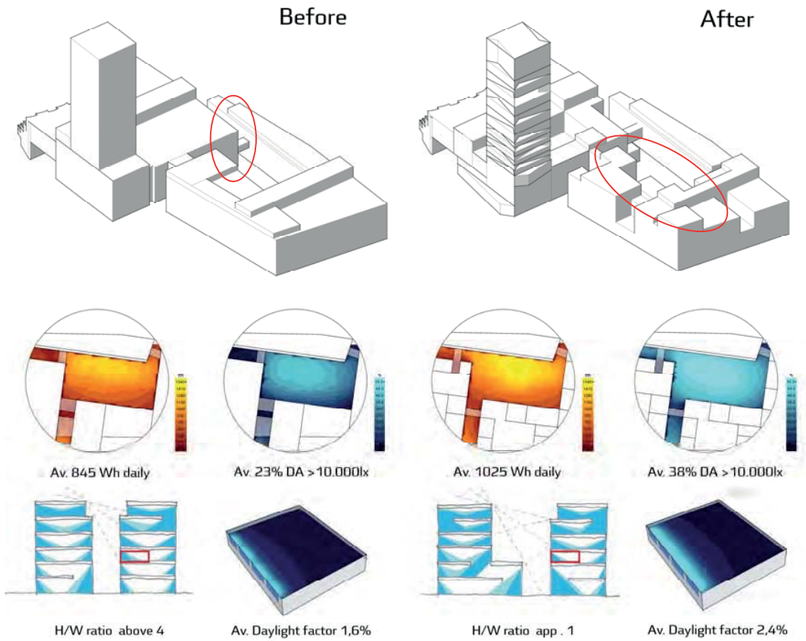
CONCEPTUAL VS CONTEXTUAL VS REFERENCE STUDIES

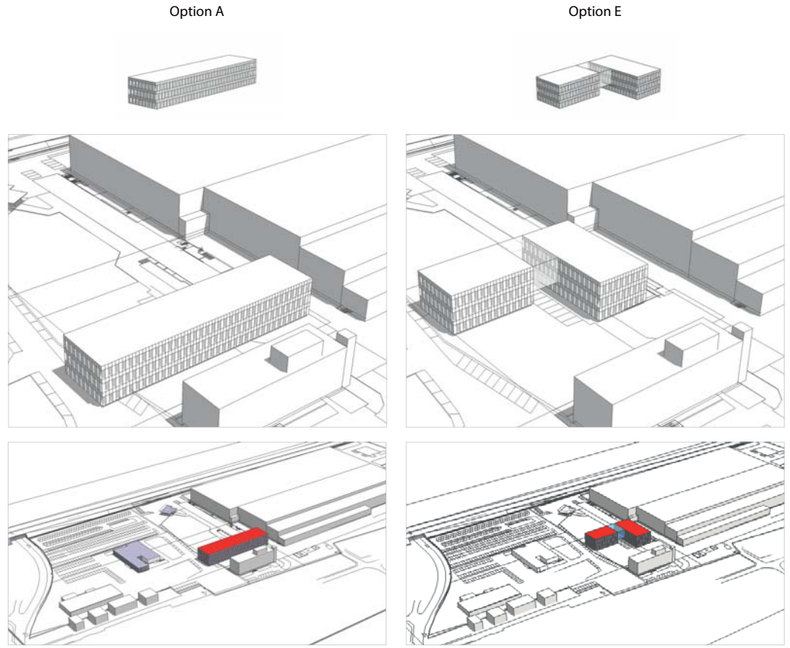
EXAMPLE OF CONTEXTUAL STUDIES

CONTEXTUAL URBAN STUDIES



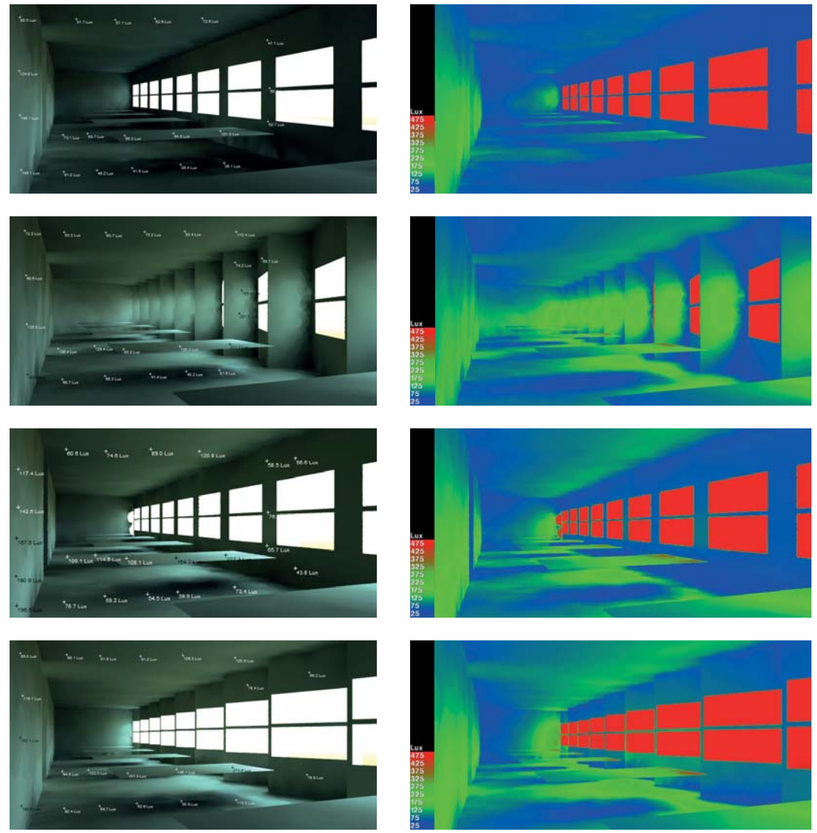
Sattrup, Peter Andreas and Beim, Anne (2012); Sustainability - Energy Optimization - Daylight and Solar Gains; Ph.D. thesis

CONTEXTUAL BUILDING STUDIES



Project Pomini - In collaboration with e3Lab

CONTEXTUAL ROOM-FACADE STUDIES



Project DSV - In collaboration with Gottlieb Paludan Architects

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CONCEPTUAL VS CONTEXTUAL VS REFERENCE STUDIES

EXAMPLE OF REFERENCE STUDIES









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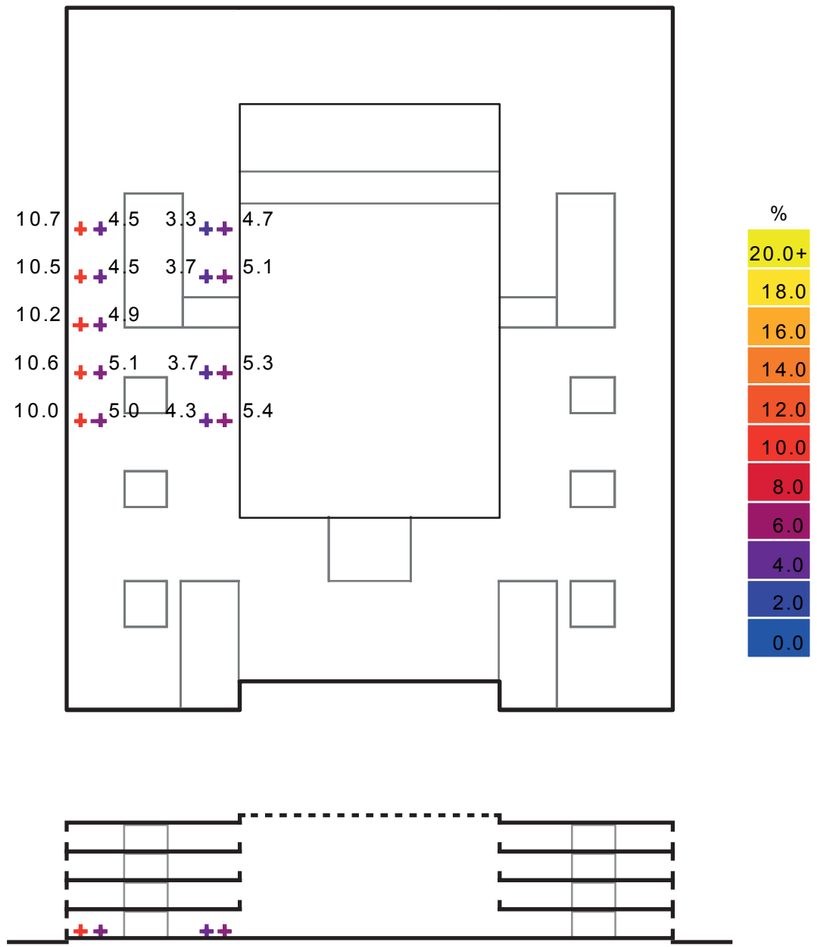
CONCEPTUAL VS CONTEXTUAL VS REFERENCE STUDIES

EXAMPLE OF REFERENCE STUDY - COMPARING DAYLIGHT LEVELS

Reference project
the NNE Domicil



Proposal
a 3 storey building with atrium



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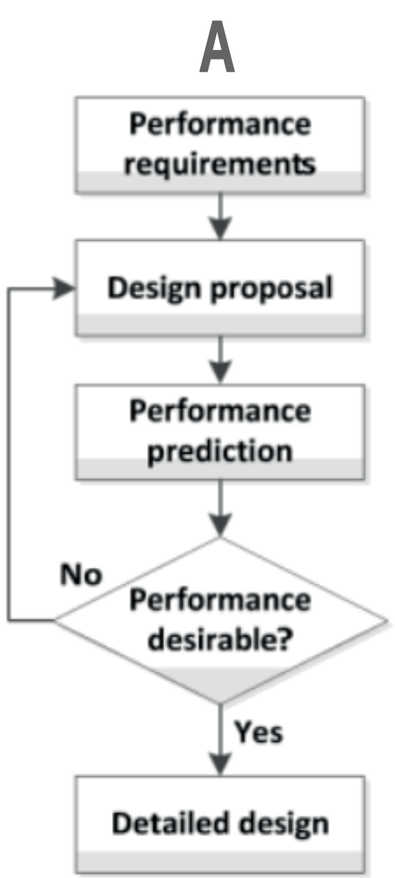
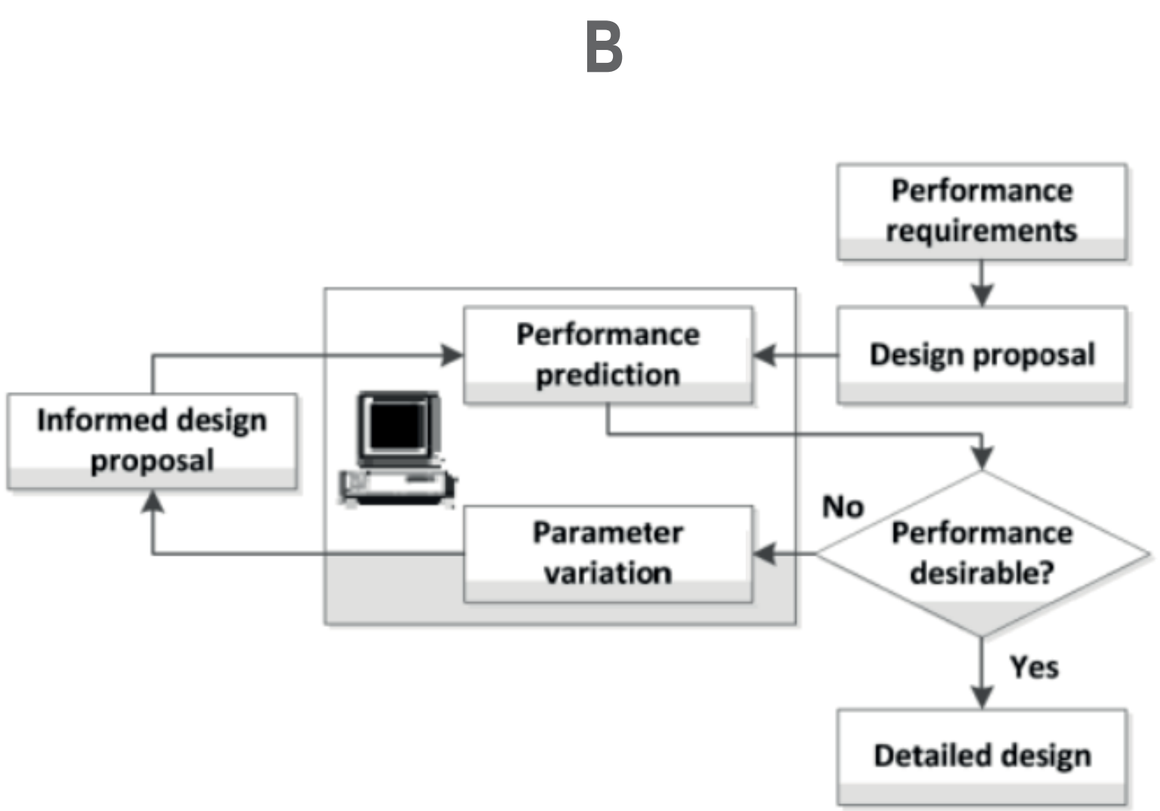
[4.3]

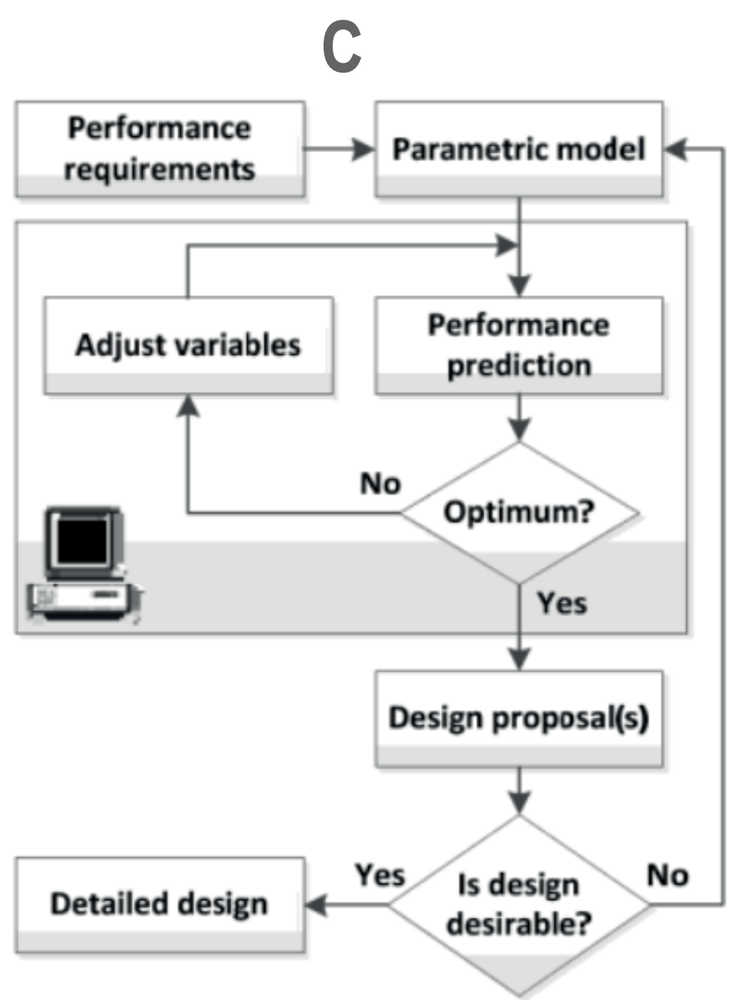
THE ANALYTICAL DESIGN PROCESS

THE ANALYTICAL DESIGN PROCESS

KNOWN DESIGN WORK-FLOW PROCESSES







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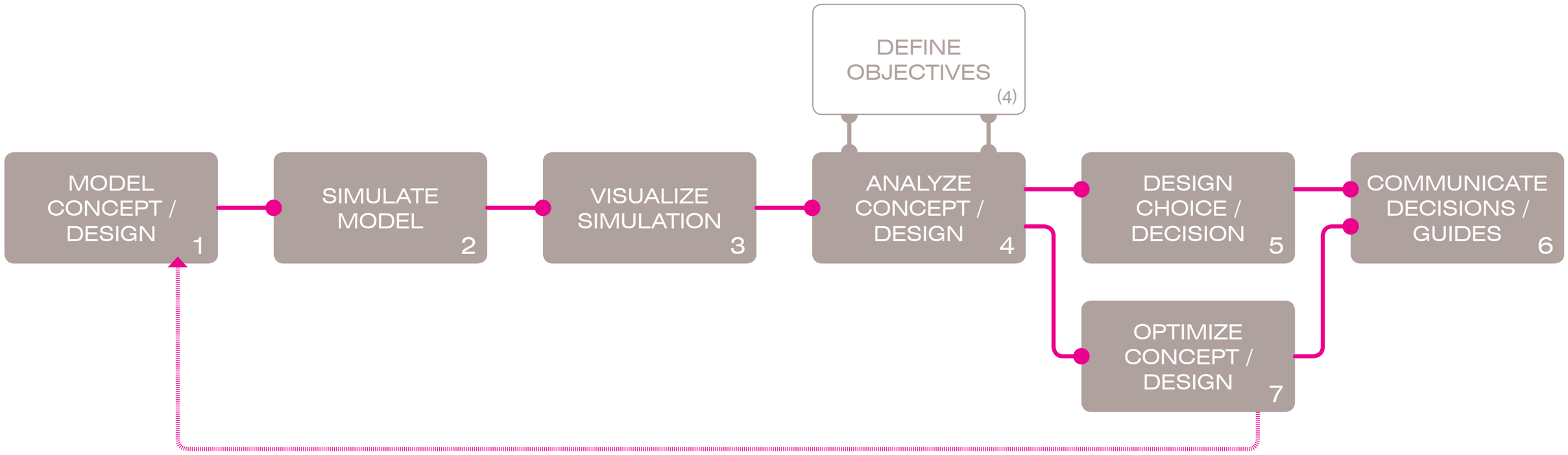
THE ANALYTICAL DESIGN PROCESS

THE “MANUALLY” WORK-FLOW



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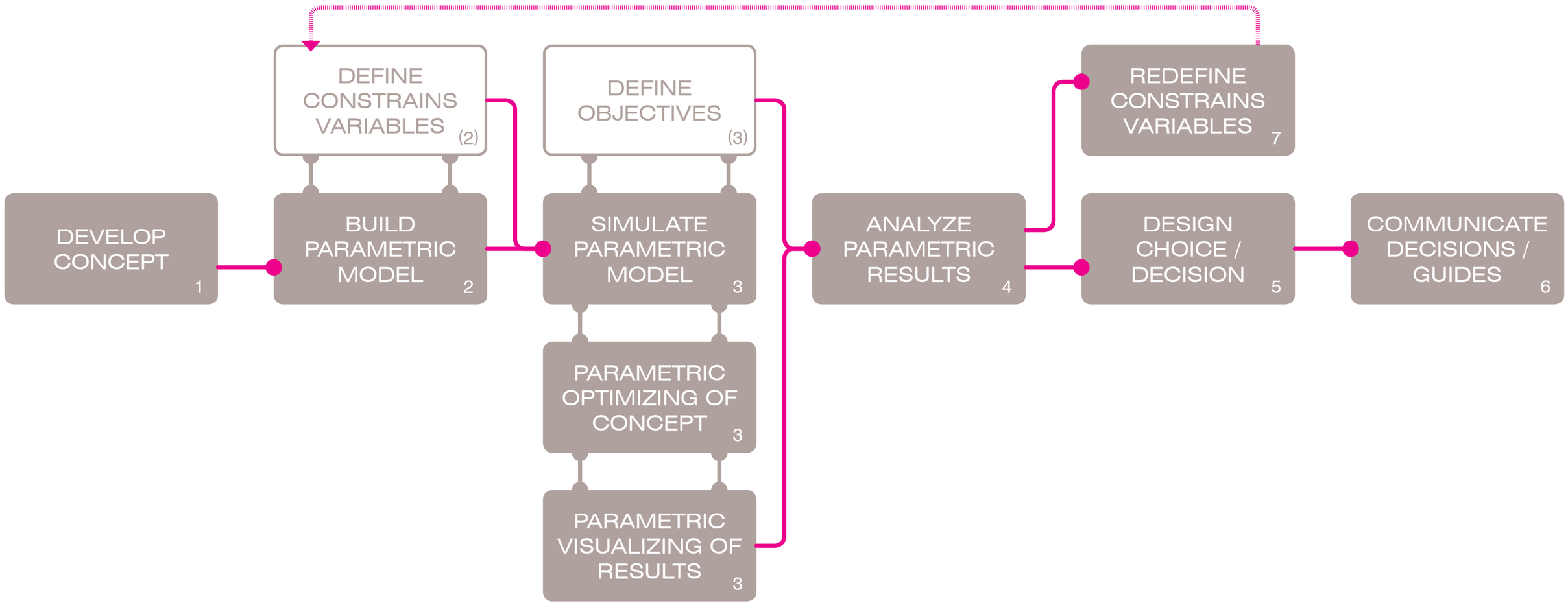
THE ANALYTICAL DESIGN PROCESS

PARAMETRIC INTEGRATED WORK-FLOW



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[3.4]

The summary of EFFICIENT PROCESSES

Importance of Visual Communication

The “BOX” analysis Method

Parametric Models and Simulations

Get Efficient

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