RESPONSIVE CITIES

Cognitive Design Computing

Gerhard Schmitt, Reinhard König, November 23, 2015

Smart Cities

1 GS: Introduction	2 GS: Urban Systems I	3 PJ: Urban Systems II	4 GS: Urban Systems III	5 GS: Urban Research	6 GS: Urban Science	7 GS: Complexity Science	8 GS: Urban Governance	9 GS: Responsive Cities	10 GS: Final Critique
Principles of Information Architecture and Urban Simulation	Smart Cities	Methods and Tools for Urban Design	Stocks and Flows in Urban Systems	A Conversation: Measurements in the City	A Conversation: Citizen Design Science	Cities as Complex Systems	Participatory Design and Management	Cognitive Design Computing	Presentation of Results from 3 Courses
Exercise 1: Examples of Smart Cities			Exercise 2: Data Collection and Specification			Exercise 3: Energy and Mobility Data			Certificates

The story so far:

- 23.11.2015 Cognitive Design Computing - interface between human and evidence based design
- 16.11.2015 Urban Governance - specific to each city and determines its development
- 9.11.2015 Seeing cities as complex systems helps to understand and predict urban growth
- 2.11.2015 Citizen Design Science closes the gap between science and city development
- 26.10.2015 Metrics of Smart Cities are basic instruments of urban research
- 12.10.2015 Stocks and Flows are fundamental concepts for understanding urban dynamics
- 5.10.2015 Methods and Tools for Urban Design can support the creative design process
- 28.9.2015 From smart houses to smart cities – emerging criteria for smart cities as urban systems
- 21.9.2015 Cities are complex systems. Ideally, they are sustainable, resilient, livable, smart, and finally responsive – from production machines to human habitat

Content

- Cognitive Design Computing
- Prof. Dr. Reinhard König: Cognitive Design Computing in the Future Cities Laboratory Responsive Cities scenario
- An Example: Cooler Calmer Singapore
- Conclusions

Cognitive Design Computing

Cognitive computing extends the application of IT into data- and information-rich dynamic situations: situations that humans face daily. An example is IBM's Watson computing initiative and the associated programmes. A computational device as an opponent in a game of chess or Jeopardy was the beginning (Kelly and Hamm, 2013). Extending this capability to other areas of daily life will be increasingly easy.

Cognitive computing began as a concept in the late 1950s, and built on results of artificial intelligence. When it became clear that it is not enough to recreate certain functions that the brain is supposed to have, researchers tried to include cognitive capabilities into the system to inform the decision-making. By doing so, they also brought the functioning of artificial cognitive systems closer to the way the human brain was considered to work. The limitations of artificial intelligence that became obvious in the 1970s and 1980s lead to a more quiet development, which was invigorated by advances in cognitive science in the 1990s. In addition, the massive advances in the speed of computation in the decades since the definition of artificial intelligence gave a boost to cognitive computing and make the results more comprehensive today.

Architecture provided excellent application areas for artificial intelligence and for cognitive computing from the very beginning. Yet the relative and absolute small numbers of researchers in architecture made the advances appear less than they actually were. Architectural applications of artificial intelligence methods and techniques were introduced into design education as early as the 1970s and 1980s in the United States and later in Europe. Architecture is an interesting application area, because it requires the combination of structured input that can be produced with rule-based systems, as well as past experiences and expectations of the future. This mix of requirements is almost identical with the computational tools available at present: structured input and requirements, as defined by all kinds of regulations; historical data and information, needed as the basis for future design decisions; and user requirements that come in radically different shapes and forms and representations to define the future city or the improvement of the existing city.

Urban design is an even more interesting application area of cognitive computing, as the amount of structured information and rules is relatively small compared to architecture, yet the amount of decisions to be derived from citizen input, transportation needs, and external requirements is much higher than in individual buildings. This asks for a better collection and mining of all opinions, proposals, requests that can be represented as data.

Cognitive design computing will be the combination of the above: from architectural design, it takes the very efficient abstraction methods and the deep knowledge about materials, climates, and the human use of the habitat going back several thousand years. From urban design, it takes the necessity to provide for large numbers of people that do not necessarily live in the urban system, but which rely on its infrastructure and its cognitive systems. Essential in both cases is, that with the advent of big data and the possibility to mine these big data for patterns and individual preferences, the urban design computing system will become more and more powerful.

Big Data Informed Urban Design

Background and Research Context

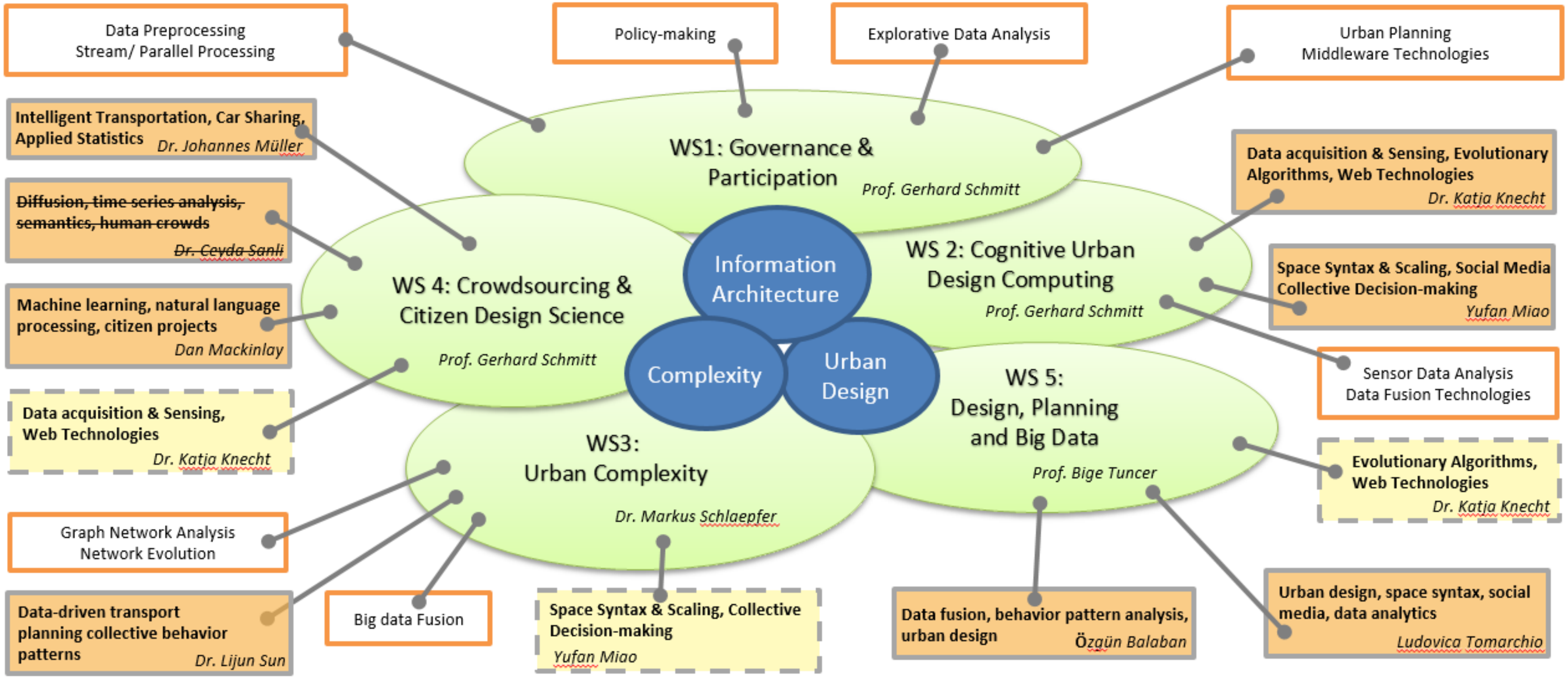
ETH zürich

iA Chair of Information Architecture

(SEC) SINGAPORE-ETH CENTRE 新加坡－ETH 研究中心

(FCL) FUTURE CITIES LABORATORY 未来城市实验室

Workstreams



Workstream 2: Cognitive Computing for Urban Design

Problem Statement:

Many computational planning tools still dependent highly on human beings for cognition processing. Cognitive Urban Planning enhances the current design process by mainly integrating the human cognition process into the urban design.

Methodology:

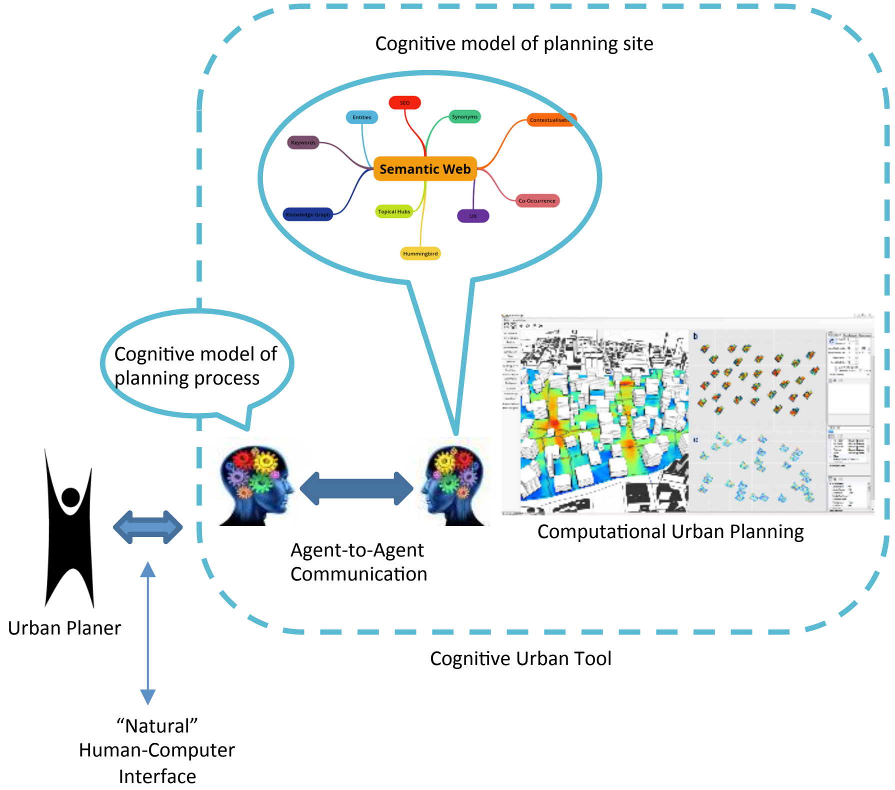
- Cognitive decision making pipeline including reasoning, planning and selecting.
- Semantic annotation of urban graph models to reflect cognitive planning knowledge (e.g. convex space crawler for OpenStreetMaps).
- Verification through user studies.

Expected Results:

- New generation of urban planning tools that support more natural user interactions and strongly automate non-design tasks.

Links:

- WS 5: Big Data and Urban Planning.
- Cooler Calmer Singapore/ Scenario 1 HDMC



Source: ETH Zürich, 2014

Cognitive Design Computing

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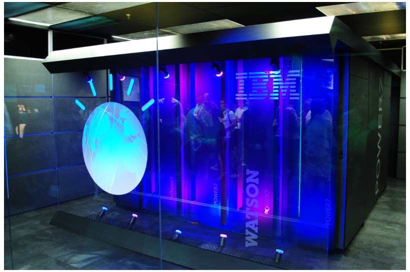
Cognitive Computing in Design

23.11.2015

Jun.-Prof. Dr. Reinhard König
reinhard.koenig@arch.ethz.ch

Cognitive Computing

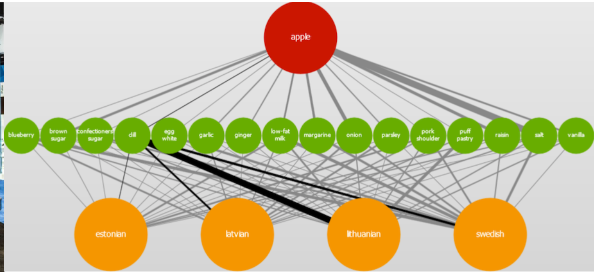
May 11, 1997: Machine Beats Man in Tournament-Level Chess Match



In 2011, Watson competed on Jeopardy! against former winners Brad Rutter and Ken Jennings. Watson received the first place prize of $1 million.

Computational Creativity

2014: IBM's Watson Sparks Culinary Creativity with Cognitive Cooking



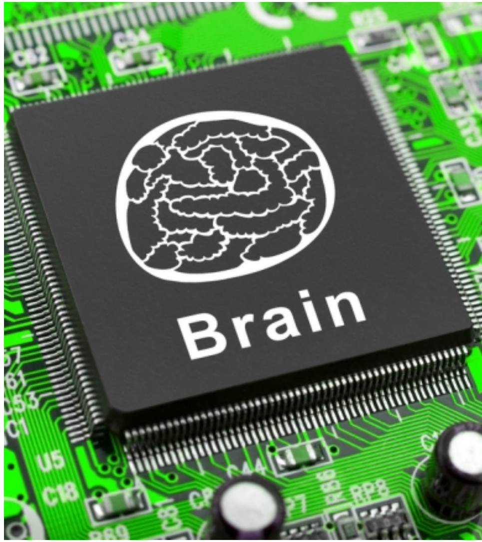
Florian Pinel's Baltic Apple Pie model.

Cognitive Computing in Design?

The central idea is an artificial intelligence,
which supports the planner in his work.

Cognitive computing makes a new class of problems computable.

- It addresses **complex situations** that are characterized by ambiguity and uncertainty.
- In these dynamic, information-rich, and shifting situations, **data tends to change frequently**, and it is often conflicting.
- The **goals of users evolve** as they learn more and redefine their objectives.
- To respond to the fluid nature of users' understanding of their problems, the cognitive computing system **offers a synthesis** not just of information sources but of influences, contexts, and insights.
- To do this, systems often need to weigh conflicting evidence and suggest an answer that is **"best" rather than "right"**.

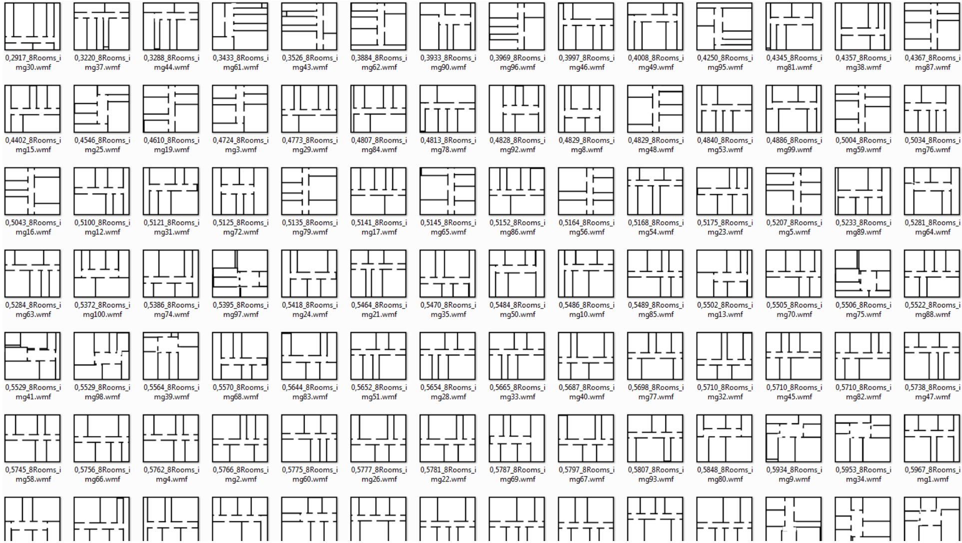


http://en.wikipedia.org/wiki/Cognitive_computing

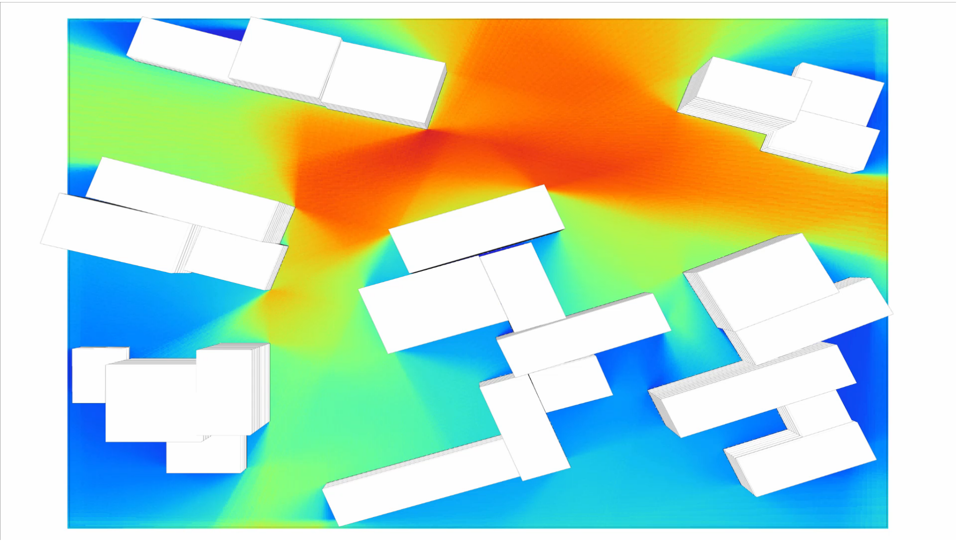
Design Space Exploration

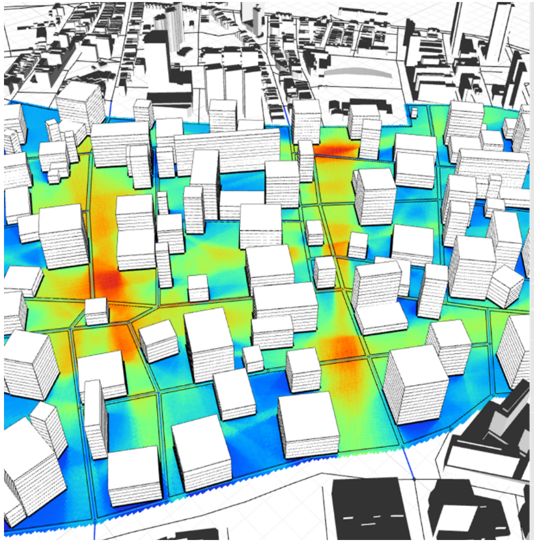
http://www.adpic.de/data/picture/detail/Bergsteiger_erreicht_Gipfel_13946.jpg

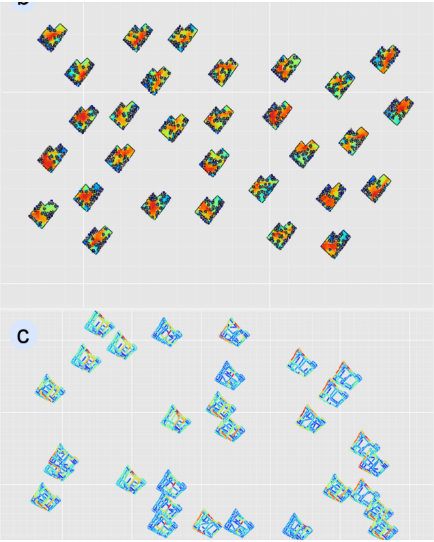
Design Synthesis
for Floorplans



Design Synthesis for Urban Design

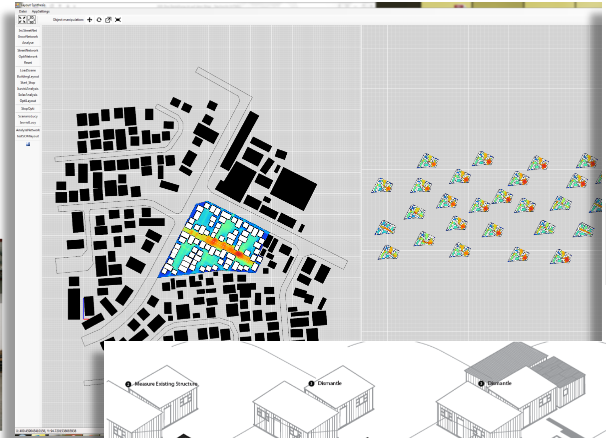


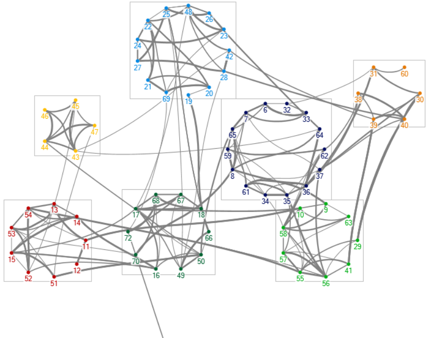




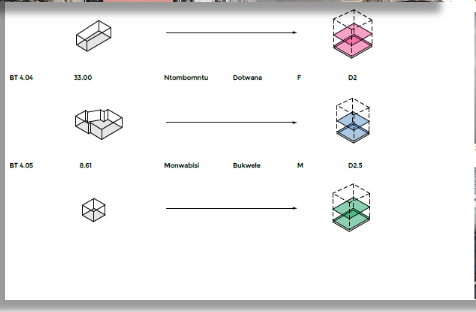
Empower Shack

Project in Cape Town with the Urban Think Thank, ETH Zurich





1



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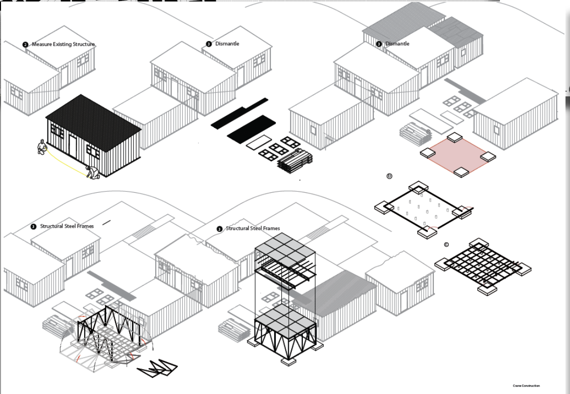
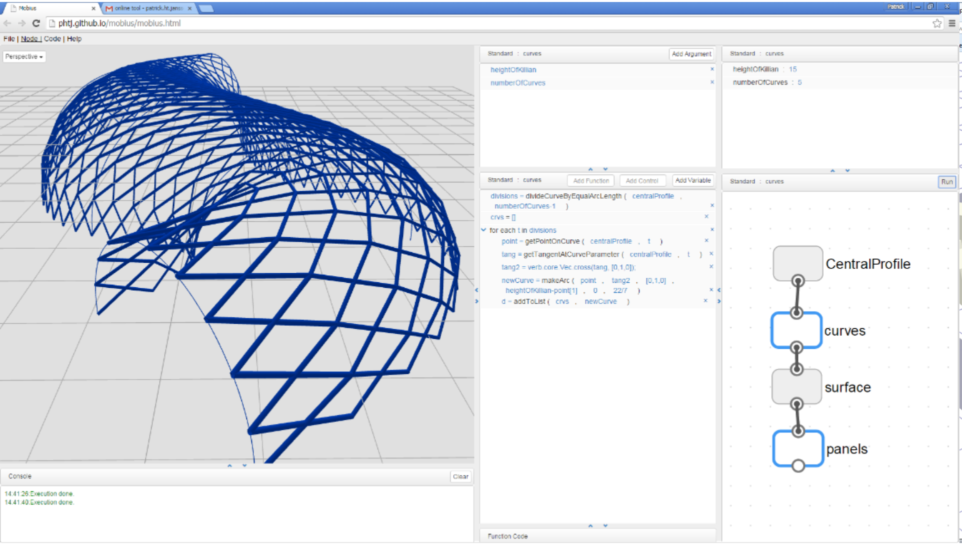
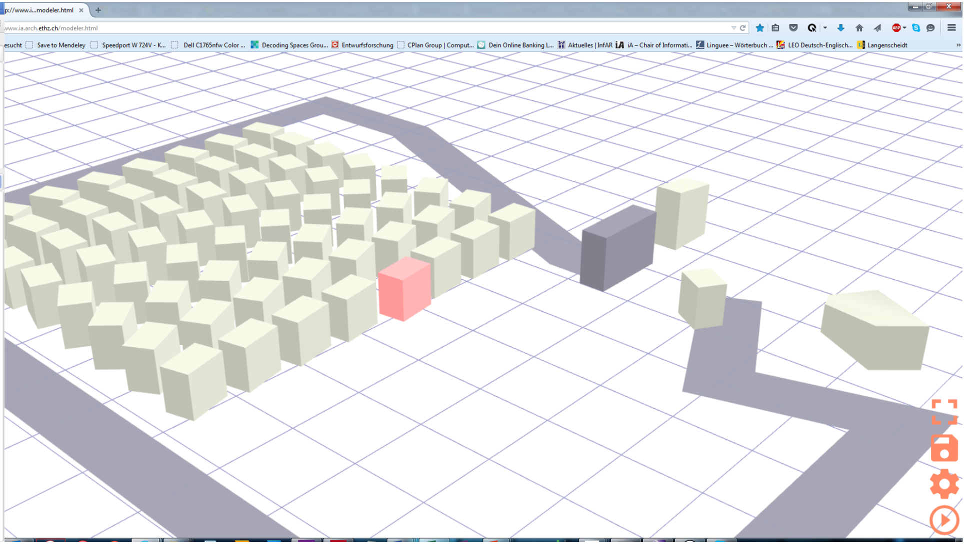


Online Tools

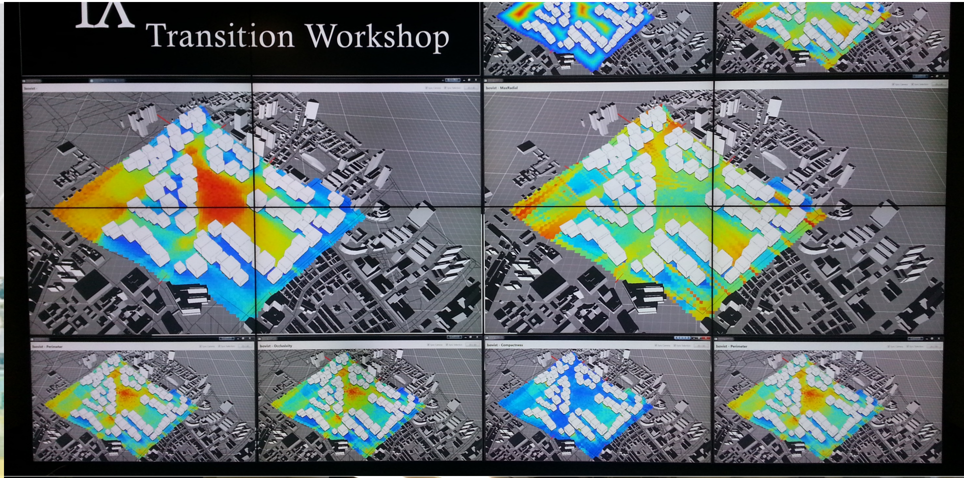


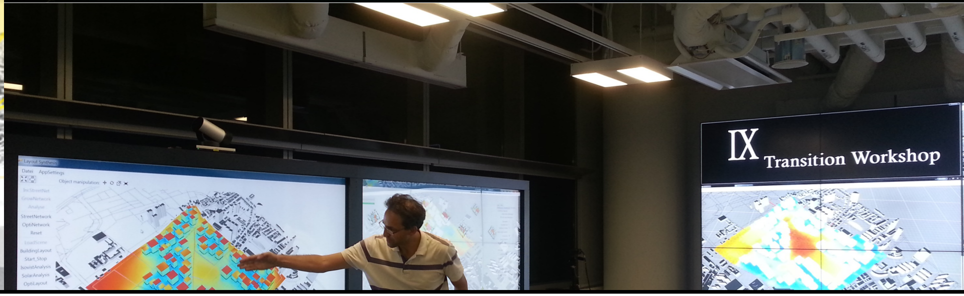
Prof. Patrick Janssen, NUS



Artem Chirkin, ETH

Planning-Environments





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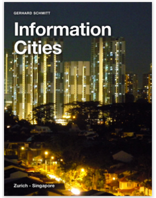
HS 2015 - Exercise 3:
Complexity in Urban Systems: Energy and Mobility

FROM ANALYSIS TO DESIGN FOR LIVEABILITY



In the second exercise, you have listed features which decrease livability in the city, along with preliminary recommendations for improvement. Yet solving one urban problem often creates others. Therefore, the challenge is to evaluate how your recommendations can be implemented without negative side effects on other stocks and flows. The focus of this exercise is on Energy and Mobility, however you can also select the stock and flow of your focus from exercise 2, or a new stock and flow you would now like to explore. The conceptual design exercise consists of three parts:

Part 1: Re-visit the iBook "Information Cities". Again, choose one city, and this time, focus on *one* stock & flow. If you use the case from exercise 2, refine it. If you choose to examine a new city and/or stock & flow, go through the same steps to identify one area to be *improved* and state which stock & flow it is *associated* with.

Part 2: For the stock & flow that you choose to focus on, make a *sketch* to show all other interdependent urban stocks & flows. Highlight your *insights* in writing or drawing.

Part 3: Based on your suggested *improvement* identified in Part 1, and the *interdependent* stocks and flows outlined in Part 2, estimate the *side effects* of your improvement on other inter-dependent stocks and flows using available data sources. The objective is to *minimize* the negative side effects on the overall quality of the city by re-adjusting your original recommendation in a *feedback process*. In case you do not have the appropriate *data*, list the data sources you would need to make this process successful. Use a combination of sketches, charts, tables and/or descriptions to express your idea.

A theoretical example: you increase the flow and stock of finances in a city which might increase the stock and flow of private cars (increasing traffic jams and decreasing air quality). You try to counter this effect by increasing mixed use, attracting cleantech industry and increasing public transportation and walkability through attractive architecture.

As before, include all references and sources. Send until 12:00 November 26, 2015 to griego@arch.ethz.ch. Save your assignment as LastName_FirstName_Exercise2.ppt.

COOLER CALMER SINGAPORE

Dr. sc. Matthias Berger

Mod. IX

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

(SEC) SINGAPORE-ETH CENTRE 新加坡－ETH 研究中心

(FCL) FUTURE CITIES LABORATORY 未来城市实验室

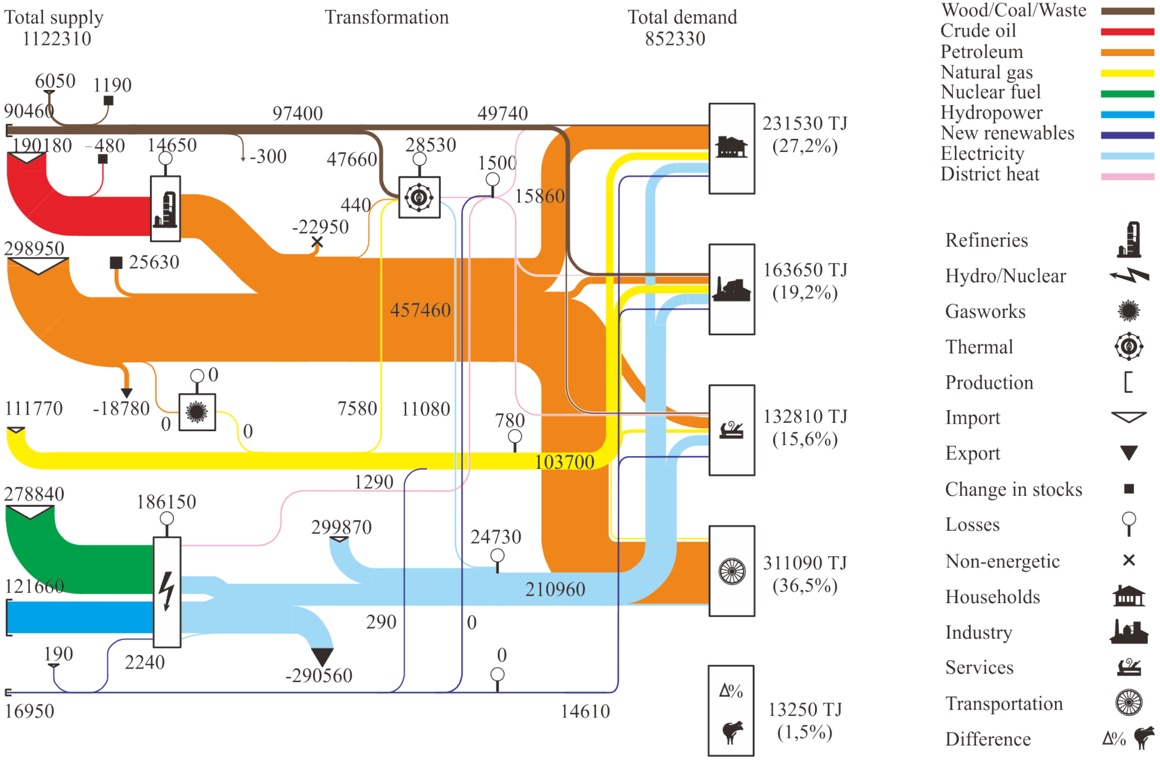
$$dE = \delta Q + \delta W$$

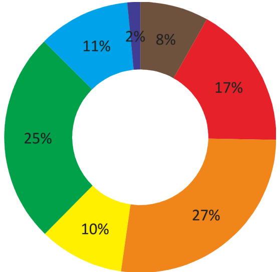
Burning energy results into ambient heat.


Work results as well into ambient heat.
$dE = \delta Q + \delta W$
VIOLET

Energy flows in TJ for Switzerland

Population	8’014’000
Energy dem.	852’330 TJ
Area	41’285 km^2
Density	194/ km^2
GDP(PPP)	340 bil. US$





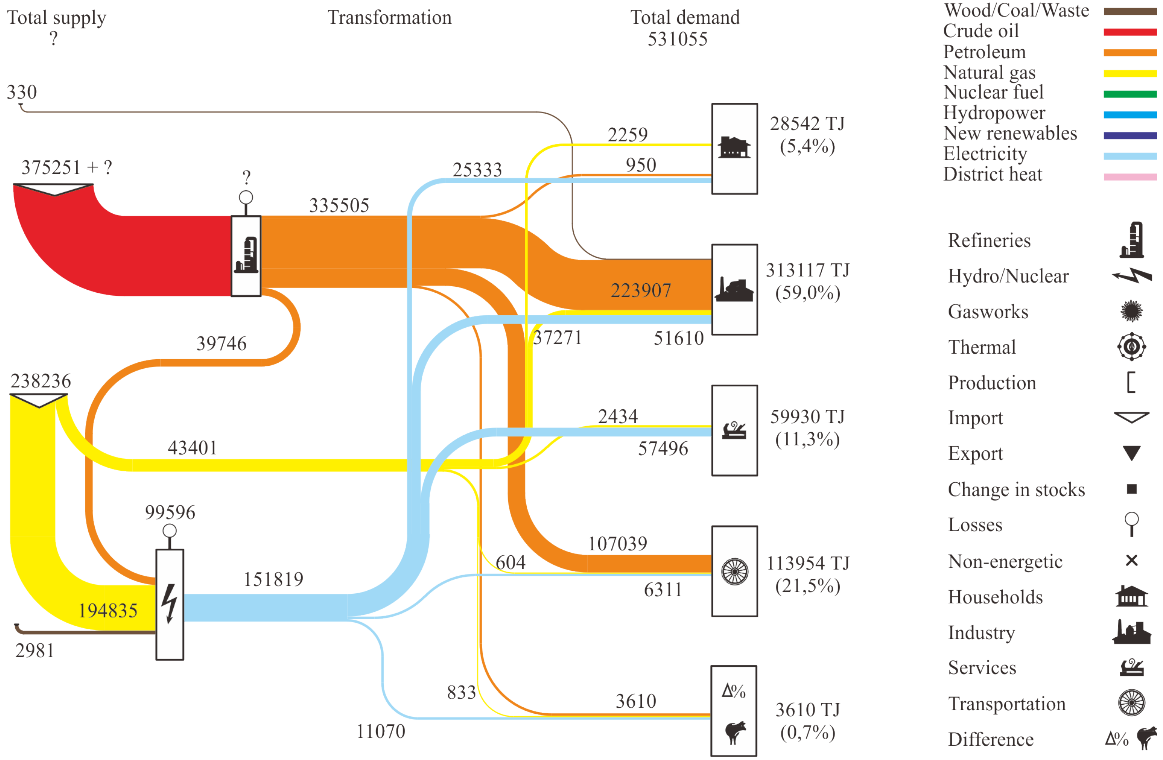
Total Primary Energy Supply (TPES)

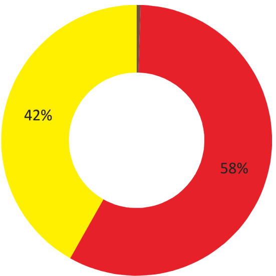
$$dE = \delta Q + \delta W$$
$$= [J]$$

Image courtesy of Swiss Federal Office of Energy.

Energy flows in TJ for Singapore

Population	5'312'400
Energy dem.	531'055 TJ
Area	712.4 km^2
Density	7126/ km^2
GDP(PPP)	315 bil. US$





Total Primary Energy Supply (TPES)

$$dE = \delta Q + \delta W$$
$$= [J]$$

Cooler Calmer Singapore – Facts

Contribution to Heat Flux in Singapore

- Industry (60%)
- Transportation (22%)
- Buildings (17%)

- The existing Urban Planning model

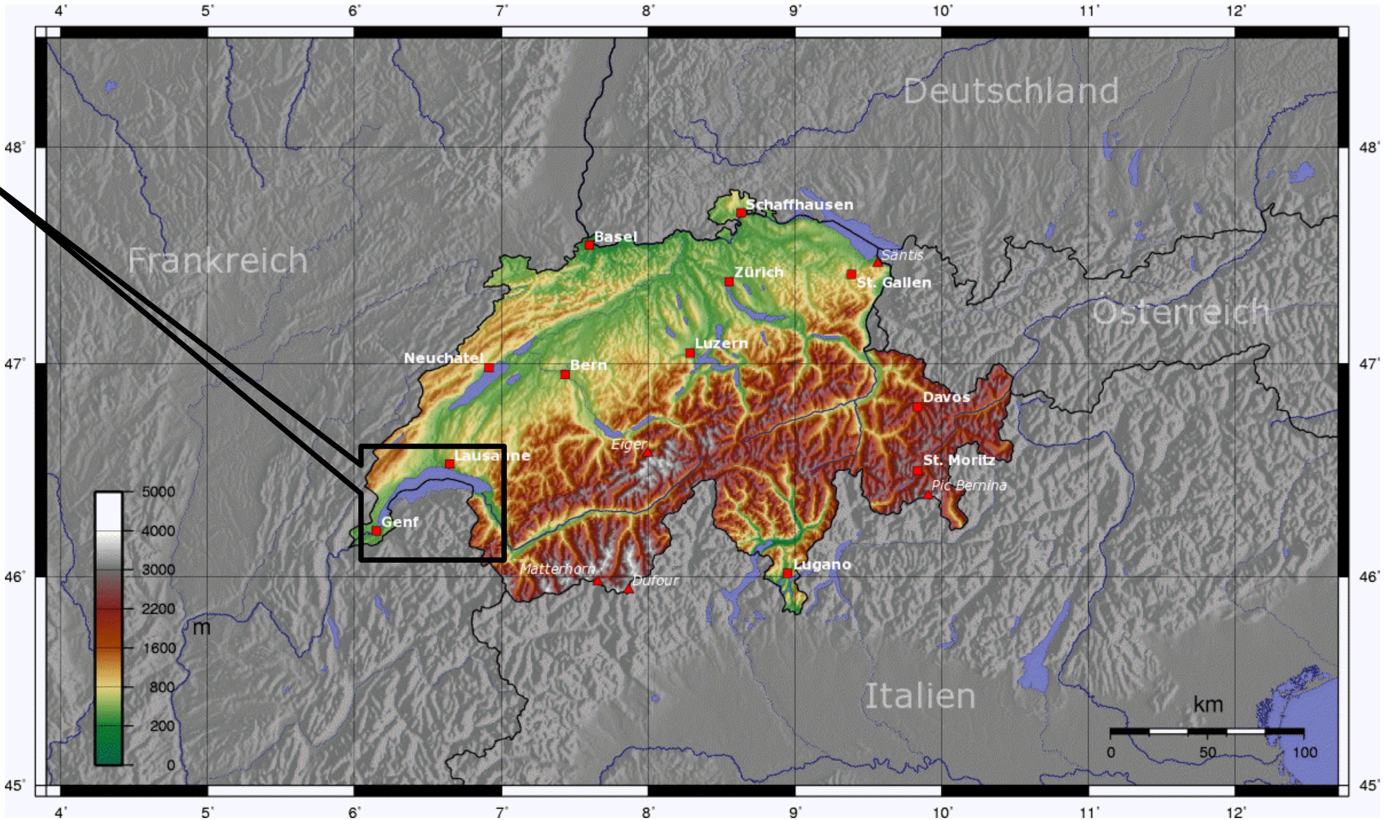
Singapore: 715 km2
Mean temperature: 27° C

Lake Geneva: 580 km2
Mean temperature: 11° C

Singapore energy demand:
531000 TJ

Swiss Energy demand:
852000 TJ

Imagine: 2/3 of Swiss energy supply to be released on Lake Geneva



Cooler Calmer Singapore

Energy Demand	531‘000 TJ
– Industry	313‘000 TJ
– Transport	114‘000 TJ
– Buildings	89‘000 TJ
• Commercial	60‘000 TJ
• Housing	29‘000 TJ
Electricity gen.	99‘000 TJ

UHI (Scenario)	5.3° C
– Industry	3.1° C
– Transportation	1.4° C
– Buildings	0.9° C
• Commercial	0.6° C
• Housing	0.3° C
Effect (Scenario)	0.9° C

CCS Buildings

Energy Demand	531‘000 TJ
– Industry	313‘000 TJ
– Transport	114‘000 TJ
– Buildings	89‘000 TJ
• Commercial	60‘000 TJ
• Housing	29‘000 TJ
Electricity gen.	99‘000 TJ

UHI (Scenario)	5.3° C
– Industry	3.1° C
– Transportation	1.4° C
– Buildings	0.9° C
• Commercial	0.6° C
• Housing	0.3° C
Effect (Scenario)	0.9° C

CCS - Transportation

Energy Demand	531‘000 TJ
– Industry	313‘000 TJ
– Transport	114‘000 TJ
– Buildings	89‘000 TJ
• Commercial	60‘000 TJ
• Housing	29‘000 TJ
Electricity gen.	99‘000 TJ

UHI (Scenario)	5.3° C
– Industry	3.1° C
– Transportation	1.4° C
– Buildings	0.9° C
• Commercial	0.6° C
• Housing	0.3° C
Effect (Scenario)	0.9° C

CCS Electricity Generation

Energy Demand	531‘000 TJ
– Industry	313‘000 TJ
– Transport	114‘000 TJ
– Buildings	89‘000 TJ
• Commercial	60‘000 TJ
• Housing	29‘000 TJ
Electricity gen.	99‘000 TJ

UHI (Scenario)	5.3° C
– Industry	3.1° C
– Transportation	1.4° C
– Buildings	0.9° C
• Commercial	0.6° C
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Effect (Scenario)	0.9° C

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Development and Conflict

- Geometry driven planning
- Sequential planning
- Functional planning
- Urban Science
- Complexity Science informed design
- Big Data informed design

Design

↓

Analysis
(Design 2.0?)

Urban Science, Complexity, Big Data

- Urban Science
- Land use plannnig, generative design
- Complexity Science informed design
- Stocks and flows, quantum city
- Big Data informed urban design
- Citizen design science, cognitive design computing

Positivism

Crowdsourcing

Conclusions

- Cognitive computing began as a concept in the late 1950s, and built on results previously known as artificial intelligence.
- Architecture provided excellent application areas of artificial intelligence and of cognitive computing from the very beginning.
- Urban design is an even more interesting application area of cognitive computing, as the amount of structured information and rules is relatively small compared to architecture, yet the amount of decisions to be derived from citizen input, transportation needs, and external requirements is much higher than in individual buildings.
- Cognitive design computing will be the combination of the above: from architectural design, it takes the abstraction methods and the deep knowledge about materials, climates, and the human use of the habitat

Next Monday 14:00-18:00 here, Apéro 18:00. Thank you!