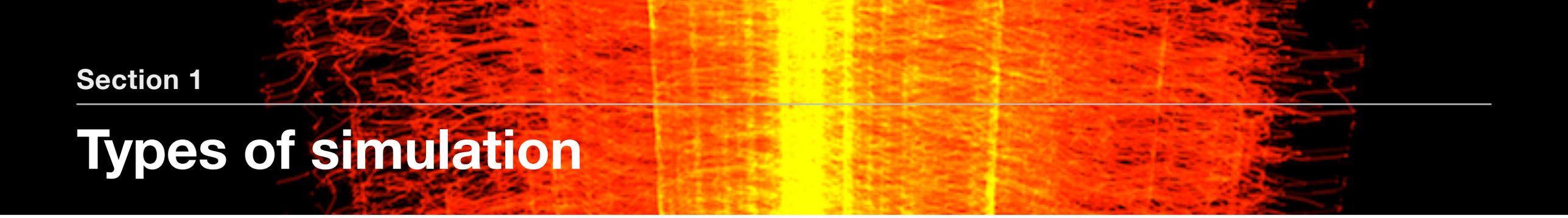


Section 1

Types of simulation

SIMULATION

Simulation in Architecture, urban design, and territorial planning is evolving rapidly. In Architecture, it is often used synonymously with visualization. In more technical terms, it includes energy use simulation of buildings, evacuation simulation, or interactive exploration of a virtual model of a building. The factor time, which is important in simulation, becomes more apparent on the urban scale: simulation of transportation and mobility, of land value changes, of densification, or any other changes over time. On the territorial scale, simulation is used to depict the growth of city networks, migration of people, or flows of material and information across continents.

Students study Architecture or urban design to design buildings and cities. Design is at the centre of their attention. They devote most of their time in education to design. Technology, information technology and other technical fields may appear as unwelcome constraints to the freedom of design. Thus, design and **simulation** are in constant competition. They compete for the student‘s attention and time, but in the end, design wins. Who wants a building that performs well on quantifiable criteria but is ugly or has no appeal, except for being efficient with regard to low-dimensional criteria?

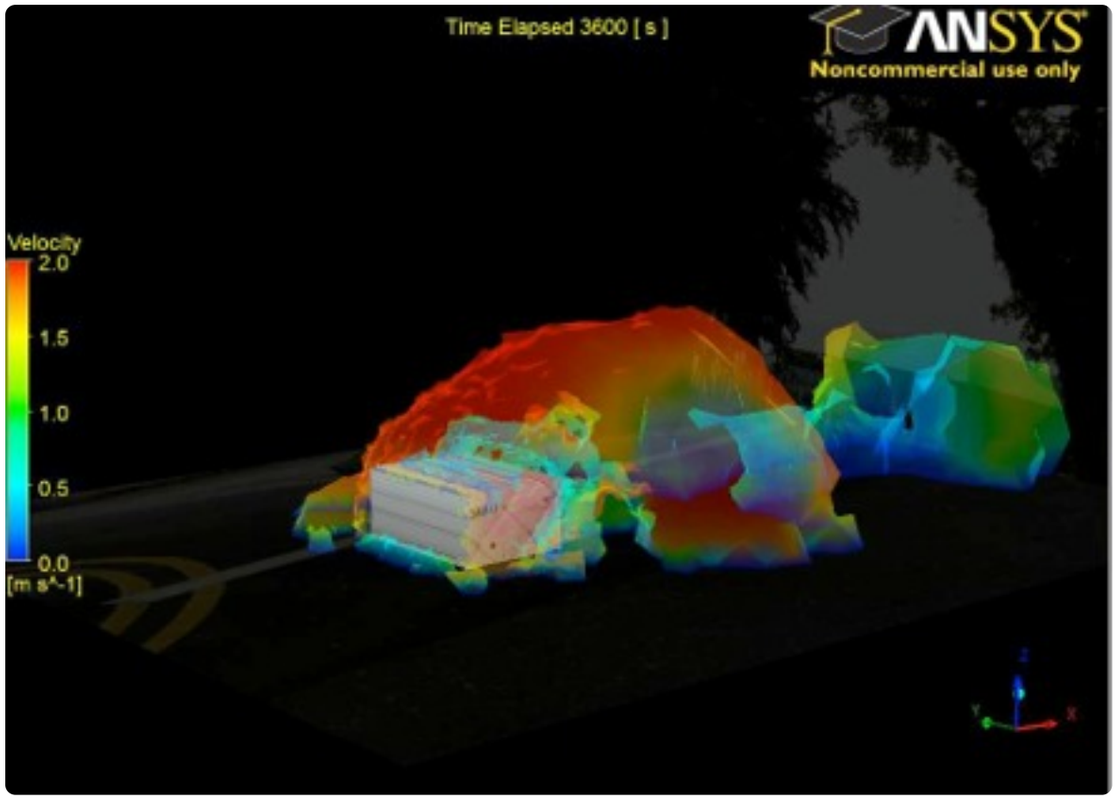
In the practice of building single buildings or complete cities, especially in the design and decision making phase, institutional clients require simulation more often than private clients, mostly because they are investing in high-tech buildings with significant maintenance cost. For this purpose, simulation seems to make sense. Sometimes during this phase, simulation is used to confirm wishes or anticipated results, which can be questionable.

In the construction and maintenance phase of a building or part of a city, simulation becomes more popular, perhaps because there are less undefined parameters to observe and the accuracy and reliability of the simulation result increases. In this phase, the role of the architect is reduced compared to the early phases. Yet these phases in the life cycle of buildings and cities are of high interest, as they have produced highly valuable data and information.

Building simulation - wind

Simulation is only possible to form phenomena that we are able to quantify and to understand. The same is true for building simulation. Examples could be the wind flows around the exterior of the building, the air movement inside the building, or the stream of occupants entering or exiting buildings. It could also show the flow of energy and temperature, light and sound inside the building.

Gallery 8.1 Building simulation



Papadopoulou, M. and Vernier, D. 2011. *Simulation of wind velocity surrounding the Future Cities Laboratory.* [BubbleZero experimental installation].

Building simulation – energy

The projected use of energy of a building was one of the first quantities to be simulated. Early simulation programs go back to the 1960s. The University of California at Berkeley and the Lawrence Berkeley Laboratory were eminent research locations that developed computer programs such as **DOE-2** which are still the basis for todays energy simulation programs, such as **Ecotect**.

Building visualisation

The visualisation of 3D models of planned buildings is often called building simulation. As the parameter time is often missing in these visualisations, it is not entirely correct to label them as simulation. However, virtual walks through and around these buildings could be accepted as visual simulation of future designs. This will change soon, with the dynamic aspects of architectural design gaining importance rapidly.

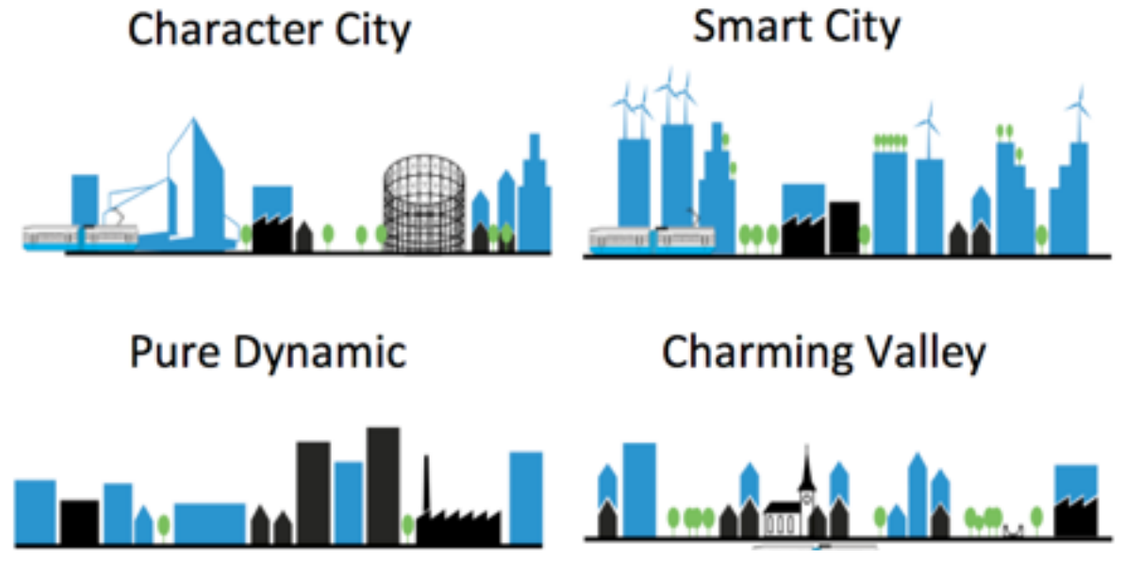
Gallery 8.2 Building visualisation

Halatsch, J. 2010. *Procedural model of a street in Masdar, the planned carbon-free city in Abu Dhabi.* [Simulation-visualization].

Urban simulation - patterns

Urban patterns are the physical expression of specific settlement characteristics. They differ widely throughout the world, determined by climate, culture, history and purpose of the city. They can be decided and designed top-down, or they can develop and change over time according to the forces that shape the city. The reason for looking at urban patterns is often a situation that has become difficult, like for example the growth or decline of population, changes of the settlement's economic base and connections, or transportation issues.

Gallery 8.3 Urban simulation - patterns

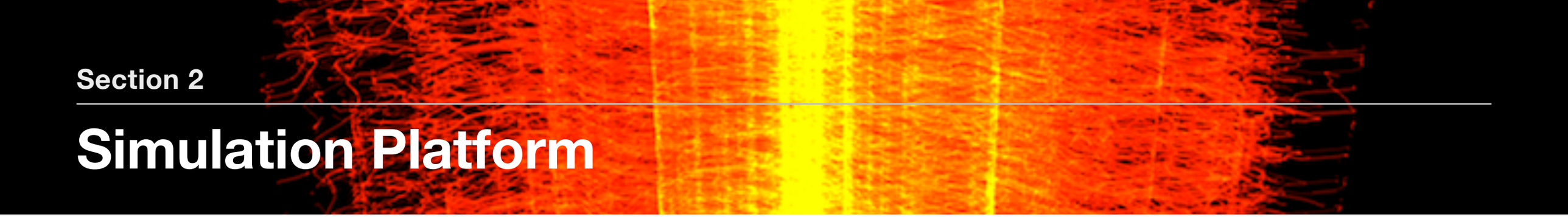


Kunze, A. 2012. *The 4 scenaria for the SUPat project in the area North of Zurich, in the Limmattal.* [Urban simulation].

The conscious research for a sustainable future for urban patterns is relatively new, and in this sector Information Architecture and simulation can play a major role. The Swiss National Science Foundation, SNSF, launched a special program on New Urban Quality in 2009. One of the winning projects focuses on Sustainable Urban Patterns - **SUPat**: “SUPat scenarios describe four perspectives focusing on design, technological, economical and ecological aspects of urban development in the Limmattal region.

The scenario “City with Character” presents the Limmattal as a valley with a strong identity, created by a clear sequence of centres and a good mix of land use and architecture. In the scenario “Smart City”, the valley positions itself as a cleantech pioneer; it boasts the highest possible energy efficiency, a high density of services and an optimum modal-split-infrastructure design.

The scenario “Pure Dynamics” presents a concept without a joint regional development plan. The valley is shaped by a vaguely defined mix of industrial areas, housing developments, green sites and transport infrastructures with no character of their own. The scenario “Charming Valley” presents the valley as a human ecological system with a strong mix of concentrated developments (informed by modern small-town values) along with a productive and resource-rich agriculture. The research project defines new urban quality as the interaction between human behaviour and the built and non-built environment. The needs and objectives of the population are linked to urban structures (e.g. sufficient open spaces) and their functions (e.g. recreation)”.



Section 2

Simulation Platform

DEFINITION

“As citizens, we want to enjoy and contribute to the life of the city. As architects, designers, and planners, we want to understand the city and propose exciting choices considering effects and side effects. In the past, architects and designers could project their visions into the future and hope that citizens would support the design results by adaptation. The growing knowledge of components and their interaction, the increasing wealth of data generated by the city and the rapid progress of computational instruments and computational power have opened new possibilities for the design and management of the city. We call the combination and deployment of this knowledge, information, data and computation *simulation*. To support the urban design process with this activity, we need a *Simulation Platform*.” (Schmitt, Gerhard, Module Leader Reflections, mid-term evaluation report, Future Cities Laboratory, Singapore – ETH Centre, May 2013)

Simulation of the city: scenarios

Sometimes, there is the opportunity to design a new city or to redesign an existing city, because unusual situations have made it possible. If such an opportunity arose, why would simulation be important? And why would one need a simulation platform to put together all aspects of the planned city?

Simply put, the simulation platform allows to collect, store, assemble, process, and visualise all information that is available or can be gathered about a city. Take, for example, the situation of Yangon, the largest city in Myanmar, at the beginning of 2013. Major political changes lead to the expectation that the city will develop into a mega city in the coming decades. It is obvious to the decision-makers and to the external observers, that the city cannot just continue to grow as it did in the past. Major strategic decisions are necessary, but must be based on sound evidence. In other words, city planners, citizens, and stakeholders need to know what the result of their decisions will be.

This is the point where the Simulation Platform becomes an indispensable instrument. It will be able to display the historic stock and the infrastructure of the existing city, and it will be able to depict the results and the side-effects of each decision taken with regard to the placement of housing, industry, mixed-use areas, or subways. It will show the carbon footprint of the city, its value creation and prosperity. The Simulation Platform cannot predict, but show scenarios.

The Simulation Platform

Simulation, as we see it, describes integrated future urban scenarios based on the most up-to-date knowledge, information and data. Simulation includes scales within space, time, economic, ecologic and social dimensions. It allows the incorporation of new real-time data from crowdsourcing, and it creates opportunities to move from limited top-down specific and exclusive models towards pre-specific and inclusive models.

The body of knowledge in urban design and planning accumulated over the last centuries is immense and too large to be remembered by a single person or by a team. Not using this knowledge because of naivete would be irresponsible. Design using integrated simulation is therefore becoming essential.

The Simulation Platform increasingly helps to identify and quantify the components of a city, their functions and their connections. For the first time in history, it is possible to directly and interactively visualise stocks and flows of people, energy, water, finances and information in Singapore, a city of more than 5 million people. For this, the Simulation Platform accesses Big Data, explores the role of individual data and discrete populations versus statistics on the urban level, and searches for innovative models of the city. While progress is incremental in each field, researchers in the Simulation Platform continue to question the role and the future of the underlying models and abstractions. At the same time, they are able to support other research modules in the Future Cities Laboratory with the newest hardware, software and data interpretation strategies, thereby keeping the Simulation Platform's modelling capabilities at the forefront of the global state-of-the-art.

Advanced urban design and modelling environment: the Value Lab Asia

Members of the Simulation Platform conceived, designed, and implemented the Value Lab Asia, a physical visualisation,

Gallery 8.4 Value Lab Asia

Aschwanden, G. 2010. *Simulation of the Value Lab 2.* [Photograph].

simulation and interaction space in the CREATE campus. With more than 35 million pixels it offered South East Asia's highest resolution display and interactive touch panels for urban planning.

It is by now a major asset of the Future Cities Laboratory. The Value Lab Asia supports more than 80% of all external and internal presentations at the Future Cities Laboratory and is at the same time a visual programming environment for researchers. The Value Lab Asia has set the standard for interactive urban planning environments and constitutes a role model for Australia (Perth) and Switzerland (Value Lab Zurich). The Value Lab Asia is open to Singaporean educational and research institutions as well as to government agencies. It is also the platform for presentations to industry and the host to the Digital Art Weeks in Singapore.

Teaching and Massive Open Online Courses

The Value Lab Asia has developed into a successful teaching environment with weekly courses between the Value Lab Zurich and Singapore. Classes are interactive and students from Singapore and Zurich participate from both locations. The unique visualisation and sound system of the Value Lab Asia creates an immersive classroom atmosphere, where the participants from Zurich appear in 1:1 scale on the large display in Singapore. The sharing of presentations, drawings, videos, and other media functions seamlessly. The Value Lab Asia is the test bed platform for the emerging Massive Open Online Courses on Future Cities, prepared by the faculty of the Future Cities Laboratory.

Computing and visualising stocks and flows

The Simulation Platform successfully enables visualisation of urban stocks and flows. It displays historic maps of Singapore in high resolution, showing impressively the change of material stock. It allows research into the change of land use over time with associated physical transformations of areas.

Visualisation of stocks and flows of material also illustrates the increase of the land size of Singapore since 1965. This extensive dynamics in stocks and flows of material is unique worldwide. Also unique is the rapid flow of material within the city by reusing the material from demolished buildings for new structures, with the result of increased density. Innovative algorithms by Simulation Platform researchers can automatically detect this physical change over time by comparing satellite images and other sources.

The Simulation Platform is capable of visualising the energy stocks and flows of Singapore or any other city, as far as official data are available. In this case, it is able to break down the energy stocks and flows to the individual building level. The resulting map of the island of Singapore provides an impressive differentiation between areas of comparably low energy consumption, such as housing and office areas, and the highly industrialised areas around Jurong and the airport. The energy

intensity indicates origins of the heat island effect. The Simulation Platform is also able to depict the emerging electricity grid of Ethiopia. Planners, decision makers and observers interactively model and manipulate existing and new energy sources on the large touch screens of the Value Lab, attaining a previously unreached level of interaction and precision.

In cooperation with the transportation and mobility specialists of the Future Cities Laboratory, the Simulation Platform simulates the stocks and flows of people, cars and buses in the street network of the entire island of Singapore. Theoretically, every Singaporean can be modelled and displayed as an individual agent. The location and movement of these agents can be displayed on the high-resolution screen in the Value Lab Asia that provides a qualitative jump of analytic capacity over individual screens that can only display a fraction of the information.

A unique feature of the Value Lab Asia Large Display is the realistic visualisation of mobility in the city. On the urban design scale, programs developed by Simulation Platform researchers show the individual movement of people walking through parts of the city. The programs help designers to recognise what people will see, how they make their navigation choices and which parts of the urban area will be most populated. A different programme developed by Simulation Platform researchers visualises the incredibly diverse streams of passengers in Singapore MRT stations at different times of the day. A further interactive visualisation demonstrates whether or not citizens can reach certain destinations in Singapore, in a given time, using public transportation only.

The computational fluid dynamics work of the Simulation Platform produces promising results in defining the best locations to gain the most information with the minimum number of sensors. It generates better knowledge of airflow around buildings in Singapore, which can lead to better design and refurbishment of buildings by increasing the effectiveness of natural ventilation. The use of sensors can also improve the accuracy of other simulations, such as those for temperature. The practical benefits of intelligent sensed cities include more reliably reaching important design goals, such as sustainability, under increasingly changing environmental conditions.

Finally, the architectural effects of urban planning, depicted by three-dimensional visualisations of buildings, are further refined by the use of the procedural modelling tool CityEngine. The CityEngine software has been enhanced by members of the ETH team to rapidly display geometry originating from design decisions, including energy-related information and the effects of design decisions on embodied CO2 or CO2 produced by the heating or cooling of buildings.

Collecting, storing, mining: Big Data

The Simulation Platform has accumulated the most impressive dataset of historic, current and emerging data about Singapore. This dataset is available to all researchers of the Future Cities Laboratory, as well as to outside parties. The Simulation Platform thus enables the collection, the storage and the mining of the ever-increasing amount of data about the city. The structure of the database is generalizable, while the content is specific for each city. The Simulation Platform is set up to receive and then take advantage of the major onslaught of Big Data, generated by thousands and soon by millions of sensors and smartphones in use and shared by citizens. It uniquely connects this data to a GIS model of the city.

In this context, it is important to build up trust and to take full advantage of the data that citizens are willing to share. For this purpose, the Simulation Platform offers a safe and attractive environment for depositing and extracting data. The data is then formed and visualised in advanced ways. Big Data visualisation has become one of the major assets of the Future Cities Laboratory, not only for the researchers, but also for the stakeholders of Singapore and for any other city that chooses to employ this concept.

UAV: Dimensions of Singapore and Jakarta

There is no 3D publicly accessible model of all buildings and topologies of Singapore for civil use. The Simulation Platform closes this gap and proposes several innovations on the way. Firstly, the difficulty to achieve high altitude flyover rights in Singapore led to the acquisition of a small and versatile Unmanned Aerial Vehicle (UAV) platform that can take high-resolution images from predefined positions at low altitudes. By flying the UAV at 120 meters above ground, Simulation Platform researchers took more than 800 aerial photographs of the campus of the National University of Singapore, thus acquiring the basis for a full three-dimensional reconstruction. Nevertheless, the extensive tree cover on the ground of the NUS campus obstructed the aerial view of the natural topography and to the facades of most of the buildings. This led to the necessity for ground-based Lidar data acquisition by a Mobile Mapping System, mounted on a car. The combination of the point clouds with image analysis techniques, resulting from both data acquisition methods to arrive at a precise three-dimensional and texture model of the buildings, is a major innovation. The combination of satellite image based 3D reconstruction and point clouds acquired from ground-based Lidar led to precise models of the Rochor area which are now the basis for integrated design studios between ETH, and the Singapore University of Technology and Design, SUTD. In Jakarta, finally, the use of fixed wing UAVs led to crucial point cloud models of Ciliwung River settlements, which can now be transformed into 3D models, and be used as the necessary basis for new designs for the purpose of flood mitigation in the area.

Cooler calmer Singapore

The knowledge accumulated in the Future Cities Laboratory and in the Simulation Platform has led to the recognition of the interdependencies between climate, urban design, energy demand in the city, the heat island effect, the intensity of downpours and flooding in Singapore, population density, and the planned increase of the populace to possibly 6.9 million in 2030 from 5.3 million in 2013. The question is: will it be possible to decrease or at least keep the average temperature stable in the coming years, decrease the noise level, reduce the intensity of downpours, and at the same time increase the population density and guarantee or even improve the liveability of the city? Simulation is the only possibility to generate, evaluate and propose realistic answers to such questions, which are crucial for the future of Singapore. As a consequence, the interest in this topic is high among the population, as well as among city planners and decision-makers. In this case, the Simulation Platform could become a key instrument to improve the quality of life, not only in Singapore, but also in many other emerging tropical cities.

The first step is to collect and confirm relevant data, either from the database of the Simulation Platform, or from any other research institute in the CREATE campus. This collective effort is unique worldwide and has not been tested before, thus the potential for innovation is high. The advanced research institutes from TU Munich and MIT contribute to the Simulation Platform with data and information to make the most realistic assessment about the future of cities. Data are climatic, geographic, energy related, urban design related, geometric, political, economic, and health-related.

The results of the simulation are open-ended. First estimations suggest interesting and far-reaching consequences. For example, Singapore could become the first country in the world that would completely switch to non-fossil individual transportation and thus reduce the heat and noise output. Singapore could also become the first country to function with non-fossil and non-nuclear electricity generated in neighbouring countries with high efficiency photovoltaic and energy storage areas. Singapore could finally become the first country that reverses man-made health and commercial risks such as air pollution and flooding. Singapore could also become the first country in the world to export this knowledge to other countries and emerging cities.

At present, the Simulation Platform is the only instrument that allows the realistic observation, implementation, and long term monitoring of such far-reaching plans. As such, the Simulation Platform would move from an academic, fundamental research driven instrument, into the reality of planning, implementation and monitoring. Implementation and monitoring are necessary subsequent steps for the Simulation Platform, because they will guarantee a constant flow of data and information to verify or

falsify assumptions, models, abstractions, and proposals derived from the results of simulations.

Alternative City Models: Quantum City

The basic research group at FCL is dealing with a known problem: more data and more computing power will not solve the old questions regarding cities, because each level of more analytical accuracy is increasing the computation costs exponentially. Therefore, we need new questions to cope with the extraordinary political, economical and cultural dynamics which are explicitly demonstrated by the rise of social media today. The basic research group therefore follows the concept of pre-specific modelling as a next level in computer aided design and decision-making. In case of urban development, the concept of a **Quantum City** was developed. The basic technical question is how to establish a coexistence of citizens within infinite data streams. To get a better understanding, a principle implementation could be developed which illustrates technological questions deriving from these concepts. Pre-specific modelling is not only of theoretical interest, but it also has direct practical implications: A prototype of pre-specific modelling on urban topologies was demonstrated, which illustrates that the costs for setting up city models can be reduced by at least the factor of 100. With a second prototype which focussed on topographies we were able to show that it is possible to generate online datasets with minimal costs that can substitute expensive simulations for most of the questions today. The next step in this line of new tools for modelling will be on text analysis of websites, blogs and news feeds as a source to map abstract parameters, like for example cultural identities, moods, political and economical activity or even city styles. In summary, pre-specific modelling promises, apparently paradoxically, to run a city beyond it‘s optimum.

Dissemination

The Value Lab Asia has developed into a strong instrument of dissemination. On average, more than 200 weekly internal researchers and external visitors make use of the unique modelling and visualisation capacities of this laboratory. There are now more than 65,000 specific entries under “Value Lab” on the Internet, referring to the ETH Value Labs in Zurich and Singapore. Students from the National University of Singapore, from the Nanyang Technological University, and from six different Singapore based primary and secondary schools have interacted with information displayed on the touch panels and on the large display, or they have also seen the UAV in action. They spread this experience to their classmates and parents, and this results in follow-ups.

In Asia and beyond, the Simulation Platform is also becoming known for its quality as an interactive teaching environment. Every semester, students from ETH Zurich as well as from other universities, registered as guest students at ETH Zurich, and participate in the interactive seminars on information architecture

and information cities. These courses are increasingly used to disseminate results from all research modules of the Future Cities Laboratory.

Dissemination of results from the stocks and flows research also works through presentations to high-level government delegations from Singapore, Switzerland, Germany and other countries. These presentations result in follow-up visits and research proposals. The Cooler Calmer Singapore project, for example, originates in part from feedback by Singaporeans visiting the Value Lab Asia and seeing representations of the stocks and flows of energy in the city.

The reputation of the Value Lab Asia as an interactive digital library of the most complete geographic and historical data about Singapore is increasing. It has led to the plan to make available data to researchers in the entire CREATE campus and beyond under the title “Data Alliance”.

One of the most prominent modes of dissemination of the results originates from the flights with the UAV across the NUS campus and the follow-up reconstruction of many of the buildings in high detail. This has led to a follow-up project with NEA which aims to detect small water puddles in difficult situations, in order to eliminate the breeding grounds of insects that spread Dengue fever. With its very high accurate Digital Terrain Model, the Simulation Platform also supports the work of a NUS hydrology group, which maintains a hydrology test field on campus.

Regarding alternative city models, such as quantum city, there are several recorded lectures available, as well as papers on conferences and an upcoming summarizing book at Springer in Vienna.

Synergies

Strong synergies have emerged with the research module on transportation and mobility. This module provides data and the MatSim simulation programme, and the Simulation Platform provides the know-how to visualise and interpret the results. The use of the visualisation environment of the Value Lab Asia has led to new qualitative findings regarding transportation processes for two reasons. At first, the size of the large high-resolution display allows the discovery of integrative aspects that cannot be seen on smaller displays while the interactivity of the touch panel displays is the best environment for exploring time-based and dynamic simulation results.

Strong synergies also exist with the Rochor+ project. In this case, three-dimensional information, necessary for the analysis of different building types, was attained by 3D reconstruction from satellite images as well as from point clouds created by Lidar data acquired from the street level. Other synergies include the development of programs that directly and interactively depict what people would see by walking on the streets of Rochor. This program is agent-based and computationally innovative, while at the same time very practical and user friendly.

The Jakarta+ project benefits from the collaboration with the Simulation Platform. In this case, it is the reconstruction of 3D building roofs and flooding prone topography derived from point clouds that were generated by flyovers of a model helicopter, UAV, by the Geomatics group in cooperation with the landscape ecology research module.

Synergies with ETH Zurich and Singapore Agencies are strong. With the Urban Redevelopment Authority URA, a first talent exchange has been agreed on. It means that one person from the Simulation Platform will be directly working with a URA planning group. With the National Environment Agency NEA, a first joint project on detection of Dengue breeding grounds has been completed.

The potential for synergies based on the direct and striking first results of pre-specific modelling is large. Yet it is necessary to integrate them into the mostly applied research context at FCL. This is especially the case in the design studios and the research on simulations, climate and economy. The basic research group, therefore, decided to slow down the conceptional and technological development and concentrate more on the mediation of the theory and technology of pre-specificity into the urban disciplinary discourses, by writing the book “A Quantum City”.

Impact

Simulation Platform members advanced the knowledge on that field with publications on technical innovation, visualization and user interfaces, design research, and city models. Technical innovation papers focus on reality-based reconstruction (Gruen 2013; Huang et al. 2013; Müller Arisona et al. 2013; Qin et al. 2012) and on the future role of sensors in the city (Vernay et al. 2013; Papadopoulou et al. 2013). Visualization, simulation, interaction, as well as data acquisition and management publications (Zhong et al. 2012; Wei et al. 2013; Aschwanden et al 2012; Shin et al. 2012; Dai et al. 2012; Wang 2013) will have impact on the emerging Big Data analysis field. Design research publications integrate technical and design aspects (Schmitt 2013; Schmitt 2013a). City models publications range from urban heat island topics (Berger 2012) to alternative models (Miro 2013, Moosavi 2013). Two book publications cover the fields of engineering informatics (Raphael and Smith, 2013) and digital urban modelling and simulation (Müller Arisona et al 2012) broadly.

The work of the Future Cities Laboratory and Simulation Platform members was featured prominently in the 2012 Annual Report of the ETH Domain and of the ETH Zurich, as well as in the Bank Vontobel’s client magazine “blue” and the Swiss design journal “Hochparterre”.

The Value Lab Asia is a physical, built statement on the future urban design and planning environment (System Integrations Asia 2013). The fact that it is being copied by other countries is a strong sign for its impact. Researchers of the Simulation Platform have used the Value Lab Asia as a base for laboratory work and communication, and have spoken through it in front of large audiences in conferences in Asia, Oceania, the Americas, Europe and Africa. The Value Lab Asia also hosted part of the Digital Art Weeks festival in Singapore from May 6 to May 19, 2013 and displayed patterns between art, architecture, planning, and computer science, nurturing a culture of sustainability.

Researchers from the Simulation Platform were active as experts in the globally leading Smartgeometry Workshop at The Bartlett / UCL, London, from 15-20 April 2013, where they contributed algorithms and interactive tutorials, along with published articles.

For Singapore, visualising the heat island effect by depicting the energy use of the island has a high impact, because it was not visualised before. The same is true for the visualisation of Singapore work locations derived from the transportation and mobility studies, which partially explains certain traffic conditions.

The interactive multi-touch Singapore connectivity application also has a high impact on all visitors, as it depicts the large differences between locations in Singapore with regard to accessibility by public transportation. More specifically, after pointing to the area of their choice, visitors immediately understand which areas in Singapore are advantaged in terms of public transportation and which are not.

The emerging Cooler Calmer Singapore Project has already drawn the attention of decision-makers and researchers in Singapore and beyond. The project shows that context specific topics can lead to scientific contributions beyond the place of application. The preparation of the Cooler Calmer Singapore Project involves stakeholders and opinion leaders from several agencies and universities. Building on the extensive knowledge accumulated in the Future Cities Laboratory, this project is becoming a strong attractor for Singaporean and foreign talents willing to look across the boundaries of their disciplines.

The Quantum city model as basic research field will unfold its impact in the future. It questions the fundamentals of the applied research projects and is obviously disturbing their well-adjusted pragmatics. In the long term, however, this kind of thinking will gain momentum. In theory, these questions exist for more than 120 years, but in information technology this way of thinking became explicit with Google and the social media since 2000. So now applications in economy can be expected soon.

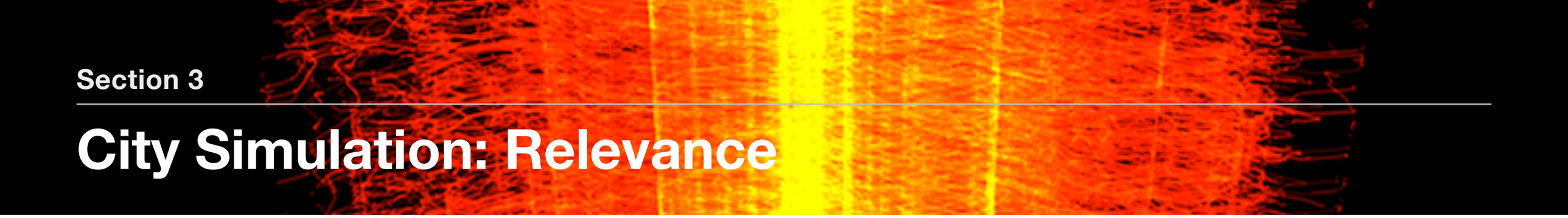
Benefit

The Simulation Platform is on its way to become an interactive companion for decision-makers, urban planners, academics, as well as for the general public. The multitude of programs developed for the Simulation Platform cover an increasing area of

interest for the analysis and planning of new cities as for the renewal of existing cities. They allow the integration of large amounts of data and crowdsourcing with traditional top-down decision-making tools.

The Simulation Platform provides a planning and simulation environment, and therefore allows for alternative views and explorations of the urban planning process. Pre-specific modelling promises a way out of the global conditions described prominently by Rem Koolhaas as the generic city and junk space. It has enormous economic impacts and will nevertheless keep the cultural differentiation. But it will take time to change the mind-set of politicians, stakeholders, researches and institutions. On the other hand, and this is probably the most interesting, the citizens of the future cities will change faster, as we see with internet and social media.

In the long run, the Simulation Platform will be an important contributor to the resolution of the conflict between too much pragmatism and too much theory. Equipped with the interactive software and hardware arsenal it is developing, the Simulation Platform will be a major benefit for society. Distributed in a Massive Open Online Platform for teaching, the Simulation Platform will become an important instrument for dissemination of art, engineering, design and planning knowledge on a global scale.



Section 3

City Simulation: Relevance

HOW IS CITY SIMULATION RELEVANT?

City Simulation always existed - in the designer‘s mind, in the builder‘s mind, and in the mind of the people governing a city. Now we have more powerful methods and instruments to externalise these visions, using combinations of science and visualisation:

1. **Make the invisible visible: we know results of processes both from experience and observations, but we cannot directly visualize it - this is where simulation helps.**
2. **Design future scenarios: We have ideas about a future building, urban, or territorial design, but it seems too complex to explain or draw it - this is when simulation helps to design realistic future scenarios.**
3. **Test future scenarios: We have come up with or received a proposal for future urban design, but we are not sure if this will work or have the desired effects - this is when urban simulation is needed to test the assumptions and visualize the results of the design over time.**

Simulation is a powerful method to structure our thoughts and to put things into order. In spite of the advent of big data and seemingly arbitrary decisions, city simulation grows in relevance over time.

Testing future performance scenarios is a good example: it is possible to simulate the energy consumption and CO2 production of a city, based on assumptions or goals by the decision-makers. The more factors and the more precise descriptions of the future situation the simulation can take into account, the closer the actual performance will resemble the simulation. This, in turn, gives the confidence to improve the simulation model and to test other, possibly more complex design scenarios with the simulation.

Simulation is also relevant on a shorter time horizon and in a reduced complexity scenario. In this case, we can use simulation to predict a desired reality in the future. If one can guarantee that most of the simulation‘s assumptions can be kept, the future reality will be close to the result of the simulation. We have used this approach in the design and simulation of the ETH Hönggerberg Science City campus, resulting in quite a close match between prediction and reality. Finally, using simulation to make the invisible visible works at every level, especially at the building and the urban design level to demonstrate the stocks and flows working in a building, or in a city. This is necessary to better understand the city.