



raum simlab

simlab
arranging imagination

ISBN 978-3-902707-37-6

simlab

arranging imagination



“What we see depends as much on our goals and expectations as it does on the light that enters our eyes”

Citation: Matthew Ward, Georges G. Grinstein, Daniel Keim. Interactive Data Visualization: Foundations, Techniques and Applications. A K Peters, 2010
Picture: Thomas Kaufmann (URBEM) analyses electrical grids via the „URBEM – visualisation“





Prof. Dr. Johannes Fröhlich
Vice Rector for Research and Innovation, TU Wien

Technische Universität Wien seeks to forge collaborations in academic study and research at all levels, promoting such projects in the context of its profile-raising activities with the aim of further developing cooperation both inside and outside the university, i.e. between the faculties, with other research institutions, with business and the public sector. A particular focus is on building international networks of academics and researchers. With its research projects on energy-conscious urban and regional development and development of digital analysis methods for spatial planning and architecture, the simlab, with its VR (Virtual Reality) simulation environment, pursues an interdisciplinary approach in line with the research foci of TU Wien and is concerned with scientific, economic and societal issues that are of local and global importance for the future.

Simlab served as the platform for the integration of scientific findings from the doctoral college URBEM (Urban Energy and Mobility System, 2013–2016) . With Vienna as an example, a prototype of a virtual city was developed – and validated using real data. The central result is the prototype of an interdisciplinary decision-making support tool which can be used for detailed planning as well as higher-level urban planning scenarios. Julia Forster, the new head of simlab and a member of URBEM, was awarded with this year's prestigious TU Wien Ressel Prize for her PhD. URBEM was also the trigger for a number of additional research projects involving cross-faculty cooperation (e.g. "Blackout", "Virtual Airport City").

The simlab at TU Wien is not only a cross-faculty simulation laboratory for visualization, simulation and modelling in (inter)national research projects; it also provides a platform for making complex issues and subject matter accessible to a wider audience – precisely in keeping with our mission statement, „Technology for People“.

Prof. Dr. Michael Getzner
Head of Department of Spatial Planning, TU Wien



The Spatial Simulation Lab, an interdisciplinary research centre at the Department of Spatial Planning plays an important role in research and teaching in the fields of simulation and modeling of spatial developments and communicating plans to a broad audience. Many new and diverse findings can be derived from the representation of spaces in 3D, especially regarding the perception of urban spaces, and the assessment and evaluation of different urban and regional development projects.

Not only does the lab serve the interests of research it also offers new perspectives for presenting and conveying spaces as well as spatial relationships to both specialist audiences and laypeople alike. Though incredibly simple on the surface, complex mathematical models and an array of different technologies are hidden in the background.

The technical equipment is one aspect of the lab. However, a large part of its success is due to the departmental staff that has brought our lab to international standards enabling it to perform on the international stage. The manifold successes in the past are complemented by recent advances such as the crucial participation in the URBEM project resulting in the award-winning dissertation by Julia Forster, or the ongoing research on cities as virtual airports, and energy infrastructures.

For the Department of Spatial Planning, the existence of the lab is both a distinction and an essential future perspective which is imperative for us to preserve and, it goes without saying, expand further. On behalf of the Department of Spatial Planning I would above all like to thank Andreas Voigt and Julia Forster for the design and development of our spatial simulation lab and for their untiring commitment.



Prof. Dr. Thomas Bednar
Institute of Building Construction and Technology, TU Wien

Complex energy and mobility system like cities with all their buildings and infrastructure need a powerful 3D visualisation environment if scenarios for future developments are analysed by stakeholders. The simlab as the host for such a Virtual Reality is therefore a key part of multidisciplinary research on international level. The doctoral school URBEM which is formed by six faculties already benefited a lot from the possibilities. Stakeholders which together can use a Virtual City will find the necessary measures much easier towards liveable, supply secure and sustainable cities.



Dipl.-Ing.ⁱⁿ Dr.ⁱⁿ Sanela Pansinger
Joanneum Research LIFE

Implementing gestalt sustainability forms the basis for 3D visualisations that enable future functional and design aspects of space to come to life and to enable the flow between content and form beyond functional necessities, respectively. By respecting gestalt sustainability in 3D visualisations space is activated long-term and thus resource-conserving, energy saving, climate-friendly and finally (if you like) efficient.

Consequently, the main aim of applying gestalt sustainability in 3D visualisations is scale and time spanning preservation of the essential characteristics that convey meaning to the special structures.

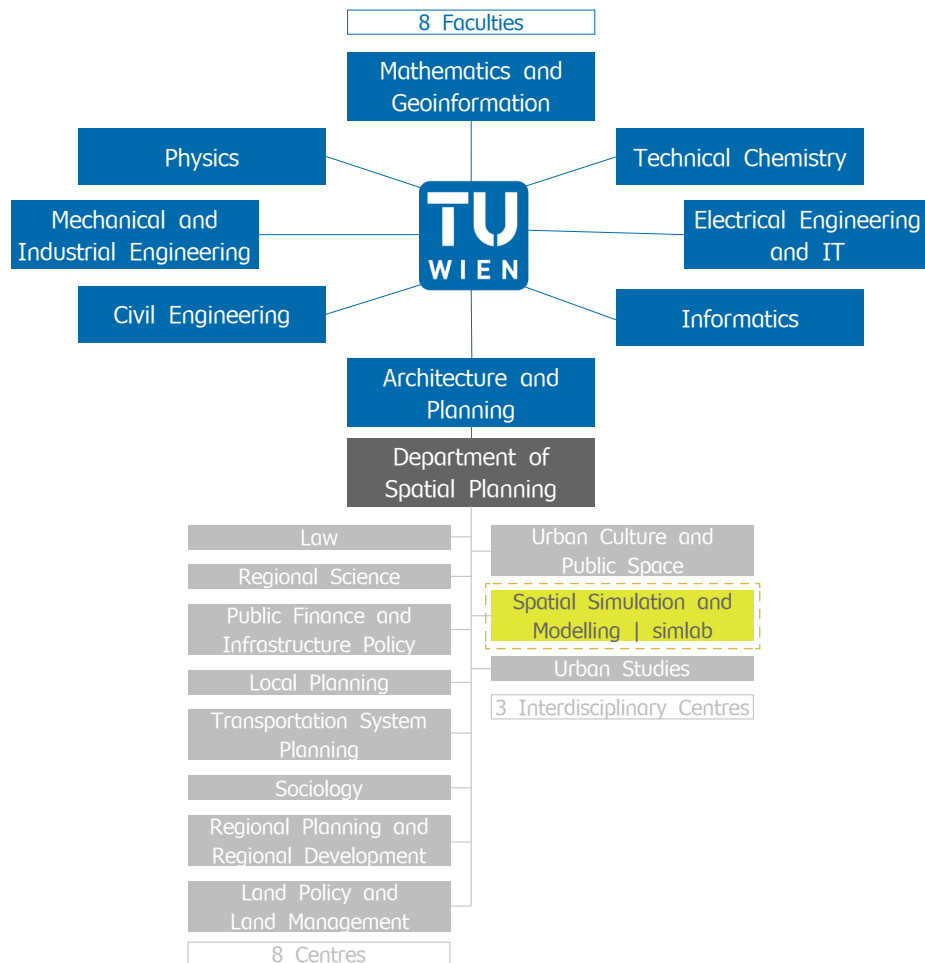
Prof. Dr. Andreas Voigt
Head of Centre for Local Planning, TU Wien



Dipl.-Ing.ⁱⁿ Dr.ⁱⁿ Julia Forster
Head of simlab, TU Wien

The team at the Interdisciplinary Centre for Spatial Simulation and Modelling conduct research into visual analytics, visualization of spatial data using state-of-the-art graphic technologies, and the integration of the latter into urban planning and decision-making processes.

The core of the centre is the Spatial Simulation Lab (simlab), which is equipped with digital tools to support urban planning and decision-making. Virtual reality (VR) technologies allow multiscale, 3D stereoscopic, interactive real-time processing of spatial data. Strategic overviews of spatial problems can thus be obtained, various scenarios and potential solutions tested, interventions and their effects investigated and interactions identified. Interdisciplinary visualizations of spatial systems can thus be produced, enabling individual and above all team-based elaboration of whole-system overviews which allow interrelated effects and causal relationships to be studied in context. Interdisciplinary research projects at the simlab focus inter alia on strategic inward development of settlement systems and spatial energy planning, resilience of spatial structures and infrastructures, and sustainable design of urban spaces.



Vienna International Airport	Wiener Stadtwerke
Austrian Armed Forces	Joanneum Research Life
High-Performance Computing Center Stuttgart	Energie Steiermark AG
Project partners	

ETH Zurich	University of Stuttgart
STU Slovak University of Technology in Bratislava	Danube University Krems
BME Budapest University of Technology and Economics	
University of Oulu	TUM Technical University of Munich
Partner universities	

Research



In order to analyse a space and its characteristics, spatial planning makes use of various methods of reconnaissance and investigation. On-site inspections and field surveys are carried out to explore the space and obtain a multi-sensory perception of it. These explorations provide the basis for further analyses and are extremely well suited for generating an understanding of the challenges and problems specific to the space.

The findings and results thus obtained can be analysed in greater detail using analogue mapping, sketches and visualizations and supplemented by additional descriptive and numeric data. CAD and geo-information systems can also be used for digital storage of this analogue data. In this way, data and findings can not only be stored long term but also passed on to others and used elsewhere.

The urban space simulation lab (simlab) develops digital planning environments (visual analytics) as a visual support tool for use in complex planning tasks.

Requirements and government policy goals concerning sustainable conservation of resources are giving rise to the development of new supply, infrastructure and waste disposal technologies (mobility, buildings, thermal and electrical energy, waste water, etc.). As a result, settlement development structures are becoming increasingly interdisciplinary and the associated planning processes increasingly complex. Geo-located and geo-locatable data provide an important basic tool to support planners in analysing an existing settlement system, extrapolating future developments and assessing the effects of planning measures. These fundamental data are generated by the built and planned environment and the actors within it.

In order to make use of these fundamental data as a support tool for all parties involved in planning and the associated decision-making processes, the simlab focuses on two essential areas. The first is GIS and CAD-based spatial analysis to elaborate a quantitative and qualitative basis for planning discussions. In order to process the results for use by stakeholders in planning processes and superimpose findings from various other disciplines, a further focus is on spatial visualization of data. The use of interactive systems for spatial visualization allows multiscale, interdisciplinary presentation of the underlying data. At the simlab, information can be presented to planning stakeholders in 2D and 3D. The lab environment provides a parallel stereoscopic view of the scenarios for up to 15 process participants. The simlab thus provides digital support for planning processes and a visual tool that facilitates communication in projects requiring interdisciplinary planning.





Technical equipment

Three multi-touch monitors allow simultaneous visualization of the effects of different planning scenarios or developments over various time horizons, and/or simultaneous viewing of pictorial, numeric and spatial information. A rear-projection wall allows simultaneous viewing of spatial visualizations in 2D and 3D for up to 15 people. The lab also has a virtual reality connection for stereoscopic presentation of the planning datasets. As well as 2D and 3D projectors, it is also equipped with an HTC VIVE multimedia headset that allows users to interact in the virtual reality space. The associated software has been specially adapted for planning visualizations and is subject to continuous further development. Naturally, the SimLab is also equipped with all the necessary software to produce CAD and GIS-based urban models and visualize the latter in virtual interactive environments as a planning support tool.



The ongoing projects in which the simlab is involved (the doctoral college „Urban Energy and Mobility System“, URBEM, „Virtual Airport City“, „Blackout“ and „SmartAIRea“, inter alia) are all characterized by interdisciplinary collaboration – both across faculties at TU Wien as well as with project partners from other research institutions, business and the public sector.

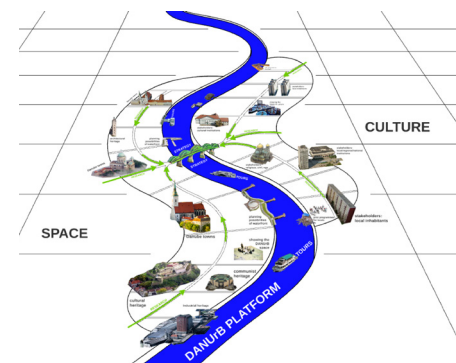
Projects



'DANuRB | DANube Urban Brand'

DANuRB was launched in January 2017 as part of the INTERREG Danube Transnational Programme and involves 39 partners from 7 countries bordering the Danube, including universities, research institutions, NGOs, tourism enterprises and local and regional authorities. The aim of the project is to develop innovative, sustainable cultural and tourism strategies to generate valuable economic and social impetus for the Danube region and preserve its cultural heritage. The principal task of TU Vienna is to present suitable spatial & regional planning and research methods and show how these can be implemented in practice. A key factor here is the potential transferability of these planning processes and potential solutions to other regions on the Danube. The results are structured, processed and stored in digital form in a GIS database to ensure knowledge transfer and facilitate further use of the findings.

For further details please visit:
<http://www.interreg-danube.eu/danurb>



'SmartAIRea'

As a road/rail/air transport hub, Graz Airport and its surroundings offer an ideal opportunity to embed thematic principles of sustainable development such as building and spatial organisation, conservation of resources, sustainable energy supply, quality of life, noise reduction, economic balance and good governance into the planning process and test them out for the first time for potential further application in other projects. The airport environment is thus transformed into a transparent, interconnected, controllable and resilient location – the so-called SmartAIRea, where the key emphasis is on sustainable design and a space planned around people and their needs. Modelling and simulation are essential tools for the planning of a resilient location of this kind, providing a basis for communication that allows all the necessary stakeholders to be brought together around one table. For this research project both an analogue and a digital model were developed at the SimLab (see images).

For further info please visit:
smartairea.project.tuwien.ac.at



TECHNISCHE
UNIVERSITÄT
WIEN



'Wiener Hofburg 3D Quellenspeicher'

In collaboration with the Department of Art History of the Institute of History of Art and Musicology at the Austrian Academy of Sciences (ÖAW), the Architecture Collection at the Albertina and the ÖAW's Austrian Center for Digital Humanities, the SimLab is developing an interactive 3D model of Vienna's Hofburg Palace from the mediaeval period to modern times as a dynamic visualization tool for use in humanities and technological research. The project is intended as a contribution to the development of the digital humanities, using state-of-the-art technologies to visualize research findings in the field of art history, process them for use in future research projects and make them available for the long term through open access publication.

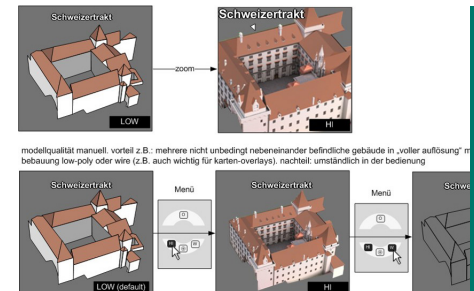
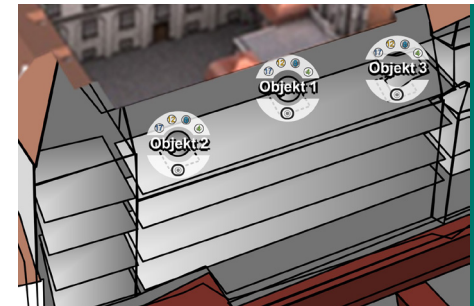
For further info please visit:
<https://www.oew.ac.at/stipendien-foerderungen/foerderprogramme/godigital/>



TECHNISCHE
UNIVERSITÄT
WIEN



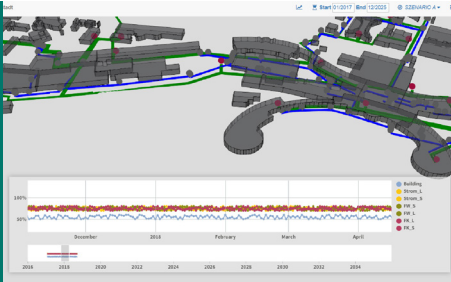
ALBERTINA



'Virtuelle Flughafenstadt – Flughafen Wien Schwechat'

In order to optimize the energy consumption of the Vienna Airport, a simulation model is being created that will transform Vienna Airport into a virtual model city. Vienna Airport comprises around 100 properties in which 20,000 people work in hotels, offices, shops, terminals, logistics companies and many other areas. The power consumption is comparable to the consumption of the city of Klagenfurt. The insights gained from the simulations of the virtual airport city serve as a strategic basis for decision-making. The goal is to sustainably reduce energy consumption and improve the CO₂-balance as well as to avoid planning mistakes that would only become noticeable in real operation. The virtual visualization model is developed in the simlab.

For further info please visit:
https://www.tuwien.ac.at/aktuelles/news_detail/article/124830/

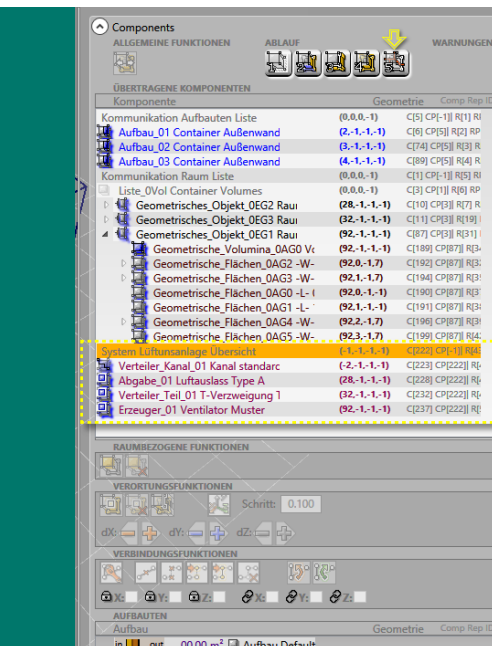
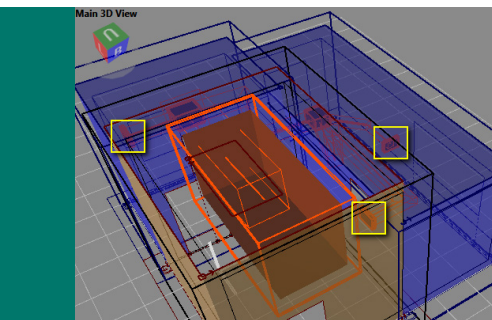


'Blackout durch Cyberangriffe'

Military experts and IT specialists are pooling their know-how with academic researchers from Vienna University of Technology to improve preparedness for a blackout scenario. Under the auspices of TU Vienna's doctoral college URBEM (Urban Energy and Mobility System), ten PhD students collaboratively developed the prototype of a virtual city to address urban issues from an economic, technological, social and ecological perspective. This model is to be transferred to the situation centres of the Austrian Federal Armed Forces and optimized using input and expertise from the participants in the doctoral college. The resilience of IT systems will be surveyed, analysed and evaluated in order to safeguard the management capability in the situation centres of the Federal Ministry of Defence and the four major Armed Forces commands in the event of a blackout scenario.

For further info please visit:
<http://www.bundesheer.at/cms/artikel.php?ID=8943>





'SIMULTAN'

The research project SIMULTAN addresses questions about the city of the future with a view to planning sustainable, liveable cities of tomorrow. The goal is to produce a workable tool, in the form of software to support the planning and decision-making process, which will allow experts from various disciplines to jointly design, optimise, build and operate building complexes. The City of Vienna serves as a case study, providing a concrete space in which to develop the methodology and concrete data with which to validate the models. The simlab platform allows highly complex processes to be translated into visual form for the respective experts. This supports and facilitates communication among the participants in planning and decision-making processes. Developing various planning scenarios, modelling them in combination with big data from the various urban energy systems and visualizing the results allows interventions in complex networks to be tested in terms of their impact on the overall system before being implemented in practice.

For further info please visit:



TECHNISCHE
UNIVERSITÄT
WIEN



WIENER
STADTWERKE



WIEN
ENERGIE



Schöberl & Pöll GmbH
BAUPHYSIK UND FORSCHUNG



WIENER
NETZE

'URBEM'

Launched in 2013, the doctoral college URBEM (Urban Energy and Mobility System) is an interdisciplinary collaboration between TU Vienna and Vienna's public utilities operator Wiener Stadtwerke. The college comprises the PhD research projects of nine postgraduate students, co-supervised by professors from six faculties of TU Vienna and experts from Wiener Stadtwerke and its subsidiaries. Taking Vienna as an example and adopting a holistic, interdisciplinary approach, URBEM has researched and developed an interactive environment to analyse scenarios for a future „sustainable, liveable, affordable city with a secure energy supply“. A key factor is the combination of economic and sociological research methods with technical analysis of buildings, thermal and electricity supply infrastructure and mobility systems. Visualization and distributed computing allow user-friendly operation of the prototype and presentation of the results.

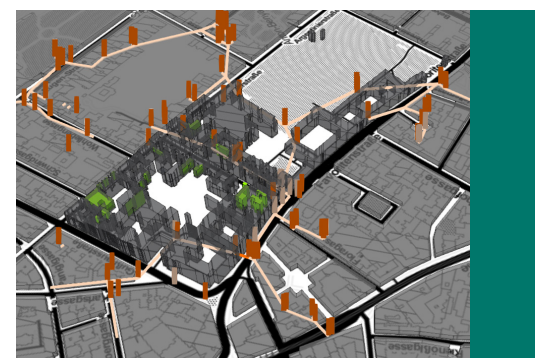
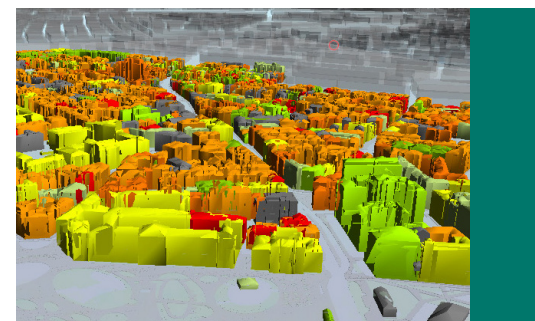
For further info please visit:
<http://urbem.tuwien.ac.at>



TECHNISCHE
UNIVERSITÄT
WIEN



WIENER
STADTWERKE



Teaching



international and interdisciplinary student workshop, Krems 2017

The simlab can also be integrated into teaching in a multitude of different ways. Students can use the lab equipment and technologies when presenting project or seminar work, as well as for academic research projects such as dissertations and PhD theses.

The following modules from the curriculum of the Master's Programme in Spatial Planning are taught in cooperation with the simlab:

- Master's degree project (e.g. DANuRB | Danube Urban Brand)
- Methods and Techniques in Spatial Planning
- Spatial Information Systems in the Planning Process
- Web-based Geo-information in the Planning Process
- Spatial Planning Support Systems and Simulation
- Spatial Process Modelling, Simulation and Visualization

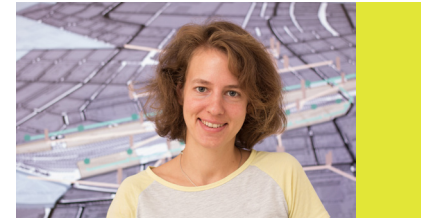
Team



Andreas Voigt, head of centre and director of the research team, studied Spatial Planning at TU Vienna, where he was awarded a doctorate with distinction („sub auspiciis praesidentis“) and was subsequently appointed Associate Professor of Local Planning. His research and teaching activities focus on sustainable urban and regional development and spatial simulation and its theoretical foundations.



Julia Forster, head of simlab, is an architect concerned with strategic visualization of energy and mobility data in settlement areas as a tool to support planning and decision-making. She completed her PhD under the auspices of the URBEM doctoral college and was awarded with the TU Wien Ressel Prize 2017 for her PhD.



Julia Pechhacker, project researcher, is a spatial planner. Her master's dissertation chiefly deals with the development of the Danube region with a focus on visual representation of analytical results and planning tasks using geographical information systems (GIS).





Tiina Maria Hotakainen, researcher,
is a PhD student at TU Wien and the University of Oulu in Finland whose research focuses on areas in transformation. In her work at the SimLab she is analysing the extent to which digital and analogue art and culture installations can be used to support planning processes.



Isabella Schuster, project researcher,
is a spatial planner with professional experience in infrastructure planning and visualization for municipal customers. She is doing a PhD in spatial planning and is currently attending the International Doctoral College – Spatial Research Lab. Her main research focus lies on the interdisciplinarity of spatial development and entangling planning affairs.



Stefan Bindreiter, project researcher,
is a trained software developer with years of professional practice in various software development companies. Currently, he is master student of spatial planning and in his diploma thesis he will focus on spatial analysis along the local railway network of Upper Austria.

Doris Mayer, office and administration,
always keeps her eye on the big picture. Doris is in charge of the organisational, administrative and financial side of the simlab and also schedules the lab time for the various projects.



Birger Schacht, IT system manager,
takes care of the lab's hardware, software and network environment and is the contact for all technical matters.



Visiting professors, guests and partners

*in alphabetical order

We'd like to thank the following for their collaboration with the simlab:

Thomas Bednar | Technische Universität Wien

Rupert Fritzenwallner | Österreichisches Bundesheer

Christian Hanus | Donau Universität Krems

Balint Kadar | Budapest University of Technology and Economics

Joachim Kieferle | Hochschule RheinMain

Kurt Königshofer | Joanneum Research LIFE

Richard Kurdiovsky | Österreichische Akademie der Wissenschaften

Günther Ofner | Flughafen Wien AG

Sanela Pansinger | Joanneum Research LIFE

Franz Prettenthaler | Joanneum Research LIFE

Rudolf Scheuvsen | Technische Universität Wien

Bernd Scholl | ETH Zürich

Walter Schönwandt | Universität Stuttgart

Ilse Stockinger | Wiener Stadtwerke Holding AG

Arpad Szabo | Budapest University of Technology and Economics

Uwe Wössner | High Performance Computing Center Stuttgart (HLRS)

Gabriel Wurzer | Technische Universität Wien

Claudia Yamu | University of Groningen





“The artist's imagination is a world of potentialities that no work will succeed in realizing”

Citation: Italo Calvino. Six Memos for the Next Millenium. Harvard University Press, 1988
Picture: Julia Forster analyzes building structure via virtual reality technology

Impress

simlab

Interdisciplinary Centre for Spatial Simulation and Modelling

Department of Spatial Planning

TU Wien

Augasse 2–6 | A–1090 Wien

<http://simlab.tuwien.ac.at>

Editors & Authors

Julia Forster

Julia Pechhacker

Andreas Voigt

printed in November 2017

Images by:

Julia Forster: p. 2/3, 16, 17, 20, 21, 22, 25, 28, 34/35, 29, 30, 31

Julia Pechhacker: cover picture, p. 4, 10/11, 15, 18, 22

Stefan Bindreiter: p. 9, 33

TU Wien: p. 6, 7, 24, 25

Department für Bauen und Umwelt | Donau–Universität Krems: p. 12, 26

Bundesheer/Mickla Anton; Bundesheer/Tschemernjak; Bundesheer/Alfred Miesenböck: p. 23

Thomas Bednar: p. 8

Sanela Pansinger: p. 8

Fabian Dembski: p. 19

DANURB, BME: p. 19

ISBN 978–3–902707–37–6