Det Kongelige Danske Kunstakademis Skoler
for Arkitektur, Design og Konservering

# MULTI SCALAR MODELLING SEMINAR

*CITA* CENTRE FOR INFORMATION TECHNOLOGY AND ARCHITECTURE

31. MAY 2013

# AIM

Advancements in architecture - particularly the emergence of engineered materials and the associated challenge of specifying material locally to meet global performance requirements - are posing new multi-scalar questions for the design and simulation process. Traditionally, architecture's tools for modeling and representation have considered only single scales: we now need to better understand how simulations can link generative computational models, structural analysis and material specifications to geometric and performative design goals, at the scales of structure, element and material.

Our aim for this seminar is gain a deeper understanding of the practices and considerations that underlie multiscale modeling. Recognising that knowledge about multiscale methods is distributed across multiple fields, and also developed around distinct practices, the seminar seeks to share approaches and perspectives, to discover areas of overlap, and to gain useful insights from the disciplines around us. By bringing together perspectives from architecture, economics, ergonomics, physics, materials science and coastal engineering, the seminar provides a space for knowledge transfer between disciplines, and to foster interdisciplinary thinking about the application of multi scale methods within design practice.

# VENUE

KADK
Philip de Langes Alle 10
Skolerådssalen

# AGENDA

9.30 Introduction to seminar and participants
The perspective from CITA's design practice
Paul Nicholas & Martin Tamke
CITA, DK

10.15 Eric Winsberg
University of South Florida, USA

11.00 Coffee

11.20 Jos Stam
Autodesk, CA

12.05 Questions and discussion 1

12.30 Lunch
KADK Canteen

13.30 Daniel Büning
UdK, DE

14.15 Azam Khan
Autodesk, CA

15.00 Coffee

15.20 Thorbjørn Knudsen & Massimo Warglien
University of Southern Denmark, DK

16.05 Jan Mulder & Wiebe de Boer
Deltares, NL

16.50 Questions and discussion 2

17.30 End of Seminar

# SPEAKERS

## ERIC WINSBERG

Eric Winsberg is a philosopher of science working at the University of South Florida. He's held visiting fellowships at Northwestern University, the Center for Interdisciplinary Research (ZiF), at the University of Bielefeld, the Institute for Advanced Study at The University of Durham, the University of California, and The University of Munich. His principle research interests are in the philosophy of science and the philosophy of physics, especially in the foundations, methodology and epistemology of computer simulations, the foundations of climate modeling, and in the foundations of statistical mechanics and the arrow of time. He has published about twenty articles on these topics in such places as Philosophy of Science, The Journal of Philosophy, Synthese, Studies in History and Philosophy of Modern Physics, Philosophy Compass, and Science in Context. His book, Science in the Age of Computer Simulation, explores the limits and possibilities of this new scientific practice.

Multiscale Modeling in Physics (and Philosophy)
In this talk I will present an account of the role of concurrent multiscale modeling methods in the simulation of physical systems. I will try to give a brief overview of some of the topics in philosophy of science in which these methods raise interesting issues. I will talk about the relations that hold hold between different levels of description, the possibility of building models of inconsistent systems, and the role of fictions in science.

# JOS STAM

Jos Stam was born in the Netherlands and educated in Geneva, Switzerland, where he received dual Bachelor degrees in computer science and pure mathematics. In 1989, Stam moved to Toronto where he completed his Masters and Ph.D. degrees in computer science. After that he pursued postdoctoral studies as a ERCIM fellow at INRIA in France and at VTT in Finland. In 1997 Stam joined the Alias Seattle office as a researcher and stayed there until 2003 to relocate to Alias' main office in Toronto. Stam is now employed with Autodesk as a Senior Research Scientist as part of Autodesk's acquisition of Alias in 2006. Stam's research spans several areas of computer graphics: natural phenomena, physics-based simulation, rendering and surface modeling, especially subdivision surfaces. He has published papers in all of these areas in journals and at conferences, most notably at the annual SIGGRAPH conference. In 2005 Stam was awarded one of the most prestigeous awards in computer graphics: the SIGGRAPH Computer Graphics Achievement Award. Stam also won two Technical Achievement Awards from the Academy of Motion Picture Arts and Sciences: in 2005 for his work on Subdivision Surfaces and in 2007 for his work on fluid dynamics. He was also featured in a January 2008 Wired magazine article.

The theme of this talk is the emergence of complex behavior through simple local physical interactions. The material is based on the "Nucleus" solver that is used in our MAYA computer animation software. Nucleus resolves deformations and interactions between different elements such as cloth, hair, particles, etc. We handle two way interactions in a unified manner. Collisions handling between elements is crucial. We will present the basic building blocks known as constraints that will generate complex behavior through their interactions. In the talk we will present many examples from Computer Graphics. The solver however can also be used in the context of shape design in Architecture. Also recently we have been using Nucleus at the nano-scale level to create self-assembling structures.

# DANIEL BÜNING

Daniel Buening is an Architect and currently a Ph.D. Candidate at the University of the Arts Berlin at the Department for Experimental and Digital Design of Prof. Dr. Norbert Palz.
Daniel received a Masters Degree in Architecture (with Distinction) from MSA Muenster School of Architecture, and spent a year in the M-Arch Program at PRATT Institute in Brooklyn, NY. The work of Daniel was distinguished with many scholarships (e.g Fulbright Comission, Studienstiftung des deutschen Volkes, MEXT (Ministry of Education, Culture, Sports, Science and Technology in Japan) and Friedrich-Ebert Stiftung and awards (e.g Anerkennung Föderpreis des deutschen Stahlbaus 2008 and the Bauwelt Lesestipendium).

Design Workows for the Additive Fabrication of Heterogenous Building Elements.
The lecture outlines a digital workow for the design, simulation and fabrication of large scale additive manufactured building components with three dimensionally graded heterogenous inner structure. The experimental design method is bifurcated into two categories, one that globally denes the overall geometric hull and the other one, which locally alternates the internal conguration of its structural core. The iterative form finding method of topology optimization is utilized to create the ttest shape and at the same time produces structural information that is contained as a data set and stored as cell results. These three-dimensional matrices are utilized to form space lling nodal networks that are spatially constrained. The so created cellular conguration serves as an internal substructure which stands in a direct parametric controllable relationship to its informing hull shape. In the proposed digital process the informed and calibrated 3D-Model stands in a 1:1 relationship to its subsequent additive fabricated counter piece of large scale. The insertion of a tight interdependency between Form, Performance and Matter points to an enhanced sustainable and environment friendly manufacturing cycle.

# AZAM KHAN

Azam Khan is the Head of the Environment & Ergonomics Research Group at Autodesk Research. Starting in the field of Human-Computer Interaction, Azam focused on advanced 3D camera navigation interaction techniques, large displays, visualization, and pen-based interaction. More recently, Azam has been exploring modeling and simulation including physics-based generative design, air flow and occupant flow in an architectural context, and simulation visualization and validation based on sensor-networks. In 2009, Azam founded and chaired SimAUD, the Symposium on Simulation for Architecture and Urban Design to foster cross-pollination between the simulation research and the architecture research communities. Azam is also the Principal Investigator of the Parametric Human project and, in 2010, Azam became a founding member of the International Society of Human Simulation

Toward a Systematic Multiscale approach for the Parametric Human Project. Inherently multiscale simulation systems are unlikely to exist. The practice used in climate modeling, electronics and engineering, and in the modeling of biological systems, shows how models designed for various scales of time or space may be coupled. However, implementing these couplings may be quite difficult as models will typically have incompatible parameters and variables. To help ensure that models within multiscale systems can be used properly, controlled methods of reduction are needed, or a common unreduced model is needed to support the meaningful comparison of incompatible reductions. We present approaches being considered and used in the Parametric Human Project.

# THORBJØRN KNUDSEN

Thorbjørn Knudsen is professor of organization design at the University of Southern Denmark (SDU) where he is heading the Strategic Organization Design Unit and co-director of the Danish Institute for Advanced Study (DIAS). He has been working on evolutionary and adaptive processes in organizations and the way organization design can shape these processes.

# MASSIMO WARGLIEN

Massimo Warglien is a professor at the Department of Management at Ca' Foscari University and is currently at the DIAS at SDU. He has been working on learning in games, organization theory, and models of conceptual spaces and linguistic interaction. He is interested in the close dialogue between experiments and models.

Architecture of Adaptive Organizations: A Multi-level perspective. Work on the design of social organizations has mostly conceived organizations in reified and static terms – much like the naïve perception of a design for a building. On the other hand, approaches that model the dynamics of organizations have typically ignored their architecture, e.g. the way incentive or communication is structured. There is a need for a rigorous multi-level theory where behavior and structure is adapted in response to the changing demands of a dynamic environment. We see organizational adaptation as processes of learning that occur at multiple nested levels, both within a given organizational architecture and more fundamentally involving changes in the architecture itself. We are interested in exploring how computational and experimental methods and possibly new approaches from other fields can be used to address this problem.

# JAN MULDER

Dr. Jan P.M. Mulder graduated in physical geography at Utrecht University, did his PhD in forest hydrology at Groningen University, and has three years of research experience in groundwater hydrology working at TNO, and 27 years of research experience in coastal - and estuarine morphodynamics and in coastal zone management working at Rijkswaterstaat RIKZ. Since 2008 he is employed at Deltares.He has been involved in several projects integrating results from field experiments and empirical and numerical modelling, integrating results from physical (hydrodynamic and morphodynamic) and ecological disciplines and translating research results into coastal zone management concepts. He has contributed to several coastal policy documents in the Netherlands, plays an active role within the present Delta programme and has participated in "Research-by-Design" workshops of the Atelier Kustkwaliteit. He takes special interest in the communication between science and management.

# WIEBE DE BOER

Wiebe de Boer studied Civil Engineering & Management at the University of Twente. After his Master degree in Water Engineering & Management, he worked as a junior researcher in coastal engineering at the University of Twente. Since 2010 he is a coastal engineer at Deltares, a research institute in the fields of water, subsurface and infrastructure. His main interests are coastal morphodynamics, hydroinformatics and tool development for rapid assessments and stakeholder communication.

The protection and development of economical, ecological and recreational user functions require dedicated coastal safety and maintenance strategies. Designing these strategies asks for a cross-scale approach in terms of spatial extent and time horizon, taking account of scale differences between the physical-ecological, the socio-economic and the political system and between different policy levels. Large-scale considerations – e.g. at a national policy level, with spatial scales of tens to hundreds of kilometers and time scales of decades to a century – often dictate boundary conditions for coastal design on the small (local) scale – e.g. at local government levels, with spatial scales of a few kilometers and time scales of years. This can be seen as a 'top-down' process. However, as coastal interventions often have impacts way beyond the time and spatial scales at which they are implemented, local adjustments to the design may have considerable 'bottom-up' consequences for the larger scale. Therefore, designing coastal safety and maintenance strategies requires a cross scale, co-design approach involving stakeholders at different levels.

To facilitate exchange of knowledge and information and a continuous cross-scale (top-down and bottom up) verification of the initial objectives, simple model tools are indispensable. The process of cross-scale, coastal co-design will be illustrated by a case study of the Sand Motor, a mega-scale beach nourishment (20 million m3 of sand) recently implemented in the Netherlands. The characteristics of the co-design tool that originated from this process, will be briefly elaborated.

# SEMINAR QUESTIONS

We have invited speakers from research areas that have distinctly different concerns, but which share the need to consider, model and simulate at multiple scales. These fields include economics, physics, philosophy, architecture, coastal engineering, material design and ergonomics. To support an interdisciplinary discussion about how the challenge of multiscale modelling meets the challenge of design, the seminar asks:

- Where does the model get its knowledge from, and what kind(s) of knowledge does it embed?

- How is intent located - in the coupling between scales, within scale-bound models, or in the behaviour of agents within models?

- How do multi-scalar design models distinguish themselves from multi-scalar models?