

**Developments in
Design & Decision Support Systems
in Architecture and Urban Planning**

Edited by

Jos P. van Leeuwen

and

Harry J.P. Timmermans

*Eindhoven University of Technology
Department of Architecture, Building, and Planning
Eindhoven, The Netherlands*

CIP-DATA, KONINKLIJKE BIBLIOTHEEK, DEN HAAG

ISBN 90-6814-155-4

Cover design by Jos van Leeuwen.
Front image adapted from the original, courtesy of Masahiro Murakami et al.
Back image adapted from page 292, courtesy of Jan Hensen.

Copyright © 2004 by the authors

Eindhoven University of Technology
Department of Architecture, Building, and Planning
Urban Planning Group / Design Systems Group
www.ddss.arch.tue.nl

Printed in The Netherlands.

TABLE OF CONTENTS

Preface	ix
International Scientific Committee	x
Introduction	xi
On the Extended Use of Citations in CAAD – Making the network between related publications visible <i>Tomo Cerovsek and Bob Martens</i>	1
Models for Urban Planning	
Urban Planning as Project Management - A limited rationality model <i>Fabrizio Fantini, Ugo Schiavoni, Barbara Barboni</i>	21
A Spatial Decision Support System for Provision and Monitoring of Urban Green Space <i>Claudia Pelizaro, T.A. Arentze, and H.J.P. Timmermans</i>	33
Environment – Urban Interface within Urban Growth <i>Maurício Polidori and Romulo Krafta</i>	49
Applying Genetic Algorithms to Establish Disaster Decision Support System for Flooding Evacuation Path of Hsichih Area in Taiwan <i>Kuo-Chung Wen and Wei-Lung Chen</i>	63
The Project Planning of Urban Decongestion - A contingent valuation methodology of making scenarios <i>Lucia Tangari, Michele Ottomanelli, and Domenico Sassanelli</i>	77
Activity Modelling and Agent Technology	
Multi-Agents Generating Alternative Plans in Local Land-Use Planning – Specifying their reasoning and interaction <i>Dick Saarloos, Theo Arentze, Aloys Borgers, and Harry Timmermans</i>	95

Pedestrian Behaviour Modelling – An application to retail movements using a genetic algorithms <i>Kay Kitazawa and Michael Batty</i>	111
Data Requirements for the Amanda Model System <i>Jan Dijkstra, Harry Timmermans, and Bauke de Vries</i>	127
User Behaviour Modelling – Applied in the context of space utilisation <i>V. Tabak, B. de Vries, and J. Dijkstra</i>	141
Space is the Machine, with a Ghost Inside – Agents and space in an urban model <i>Romulo Krafta</i>	157
Representation and Visualisation of Knowledge	
InnotiveBrowser – A real-time digital content display software using VR technology <i>Ahmad Rafi, Tran Hoai Nam, Kim Jin Woo, and Wai Lau</i>	177
Visual Knowledge Transfer between Planners and Business Decision Makers – A framework for knowledge visualization <i>Remo Burkhard</i>	193
Re-Using Re-Design Knowledge – Towards tool support for tacit knowledge exchange <i>Jonas Lindekens and Ann Heylighen</i>	209
Dynamic Linkages between Ideas and Cases – Toward a computational approach for supporting idea association during brainstorming <i>Ih-Cheng Lai</i>	225
Collaborative Design	
Interoperable Co-Design Supporting System – A distributed hybrid agent approach <i>Sheng-Cheng Shih</i>	241

<i>Table of Contents</i>	vii
Collocated, Multi-Disciplinary, Collaborative Designspace – An overview <i>N. Deshpande, B. de Vries, and J.P. van Leeuwen</i>	253
Towards a Multi Agent System for the Support of Collaborative Design – Assembling a toolbox for the creation of a proof of concept <i>Jakob Beetz, Jos van Leeuwen and Bauke de Vries</i>	269
Building Performance	
Adapting Epidemiological Methodologies to the Prediction of Health Effects of Built Environment Interventions <i>Johanna E.M.H. van Bronswijk, Ludovicus G.H. Koren, and Cor E.E. Pernot</i>	283
Towards More Effective Use of Building Performance Simulation in Design <i>Jan L.M. Hensen</i>	291
Author Index	307

PREFACE

As editors of this volume we would like to express our gratitude to the contributing authors who have delivered these highly relevant and inspiring chapters and to the international scientific committee for their help in the review and editing. Special thanks go to our colleagues Mandy van de Sande, Marlyn Aretz, and Leo van Veghel, who were great in organising the conference and took care of everything that made it a pleasant and comfortable event.

Eindhoven, July 2004

Jos van Leeuwen and Harry Timmermans
Conference Chairs

INTERNATIONAL SCIENTIFIC COMMITTEE

Alan Bridges, UK
Aleksander Asanowicz, PL
Aloys Borgers, NL
Anders Ekholm, SE
Andy Brown, UK
Anthony Yeh, HK
Ardeshir Mahdavi, AT
Atsuyuki Okabe, JP
Bauke de Vries, NL
Bob Martens, AT
Dirk Donath, DE
Frances Brazier, NL
Gilles Halin, FR
Guillermo Vásquez de Velasco, USA
Hannu Penttila, FI
Henri Achten, NL
Jin-Yeu Tsou, HK
Joachim Kieferle, DE
Johan Verbeke, BE
John Stillwell, UK
José Duarte, PT
José Kós, BR
Kees Dorst, NL
Luca Caneparo, IT
Mark Clayton, USA
Mark Gross, USA
Michael Batty, UK
Milton Tan, SG
Mitsuo Morozumi, JP
Nancy Cheng, USA
Omer Akin, USA
Philip Steadman, UK
Pierre Leclercq, BE
Ray Wyatt, AU
Richard Klosterman, USA
Rivka Oxman, IL
Robert Woodbury, CA
Sevil Sariyildiz, NL
Sheng-Fen Chien, TW
Stefania Bandini, IT
Tay-Sheng Jeng, TW
Theo Arentze, NL
Thomas Kvan, HK
Wassim Jabi, USA

INTRODUCTION

The International Conference on Design & Decision Support Systems in Architecture and Urban Planning is organised bi-annually by the Eindhoven University of Technology. This volume contains a selection of papers from the seventh conference that was held at De Ruwenberg Castle in Sint-Michielsgestel, The Netherlands, from 2 to 5 July, 2004.

Traditionally, the DDSS conferences aim to be a platform for both starting and experienced researchers who focus on the development and application of computer support in the areas of urban planning and architectural design. This results in an interesting mix of well-established research projects and first explorations. It also leads to a very valuable cross-over of theories, methods, and technologies for support systems in the two different areas, architecture and urban planning. This volume contains twenty papers from this year's conference. Another twenty-two papers are collected in a book that was published by Kluwer under the title "Recent Advances in Design & Decision Support Systems in Architecture and Urban Planning." In comparison to that book, the present volume had a considerably shorter production time, which allowed the authors to include late-breaking research results as well as ongoing work in their contributions.

The chapters in this volume are organised into 5 sections. The first section contains five chapters on models for urban planning. The second section is about agent technology for modelling human activities and decision support for land-use planning. The section on representation and visualisation of knowledge contains two chapters on improved utilisation of visual aspects of knowledge and two chapters with a focus on case-based reasoning. Section four, on collaborative design includes three chapters on computer support for both distant and near collaborative design processes. In the final section, the focus is on the performance of the built environment, both in retrospect and in design stages.

The following paragraphs provide an overview of these five sections. However, the first chapter in this book presents the results of an analysis of the research area in the CAAD community. Cerovsek and Martens discuss the usage of the Cumulative Index of CAAD (CUMINCAD) as a digital library of scientific publications in this area. The system applies graph theory for the analysis of citations to determine the impact of particular publications.

Models for Urban Planning

Five chapters in this book reflect the continued work in urban planning to develop models and tools that can be of assistance in the various stages of an urban planning project: scenario generation, impact assessment and evaluation. Fantini et al. suggest a linear programming model for the generation of scenarios. Their approach also makes budget allocation decisions transparent. Operations research methods are used to identify the best project. The approach is illustrated in the context of the Socio-Economic Plan for the Mountain Community of Sabina, Italy.

Three chapters describe the development of tools that are especially relevant for impact assessment: Pelizaro et al. developed a decision support system for the planning, design and maintenance of urban parks. A set of model allow the prediction of the impact of planning scenarios and design options on the use of parks and related performance criteria. Unique to this decision support system is the use of an activity-based model of the use of greenspace. To assess urban growth, Polidori and Krafta describe an approach, integrating a potential model with graph theory, cellular automata and geographical information systems. Interesting, urban and environmental aspects, and expansion and densification are treated simultaneously, which makes their approach different from similar approaches. Likewise, Wen and Chen apply genetic algorithms for choosing the best flood evacuation path. The approach is illustrated for Shiji, Taiwan.

As for evaluation, multicriteria evaluation methods have been popular in urban planning for a long time. Tangari et al. suggest and apply a contingent valuation methodology, which has been widely applied in environment economics but which is less known in urban planning. The approach is positioned in the context of the problem of determining an optimal solution to urban congestion, politically acceptable to the user. The approach is illustrated with respect to an integrated transport system in Bari, Italy.

Activity Modelling and Agent Technology

Recently, in addition to the traditional interest in the supply side, an increasing number of studies has looked at spatial behaviour, where individuals are treated as agents. This trend is also reflected in the papers submitted to this conference. Saarloos et al. propose a multi-agent system, covering actually both the supply and demand side. Their MASQUE system is meant for generating local land use plans, but does include sub-models of behaviour. Based on a set of beliefs, individual agents try to achieve goal states. In order to do so, certain claims are made with respect to particular cells, reflecting strategic behaviour. Interaction protocols are developed to

model the actual land assignment process. Kitazawa and Batty present progress in the development and application of agent-based simulation of pedestrian movement. Their paper is specifically concerned with route choice behaviour. They argue that the shortest route algorithm is too simplistic to describe pedestrian movement. Genetic algorithms are used within a utility-maximizing framework to generate alternative routes, which are compared with actual trajectories of shoppers. The Amanda system under development by Dijkstra et al. is similar in goals but differs in terms of the mechanisms that drive the simulation. Dijkstra et al. describe some specific data needs and data collection issues that need to be solved in order to operationalise Amanda. In particular, they discuss how observation and direct interviewing techniques may be used to estimate the parameters of functions that drive activity-scheduling and shopping behaviour of pedestrians.

Concepts about activity spaces and agent-based simulation are not restricted to large-scale urban environments. Tabak et al. show that agent technology and activity modelling are powerful concepts and tools for simulating space utilisation as well. They suggest using Petri nets to formalise the process. Finally in this section, Krafta presents a creative development of agent technology for the simulation of urban morphology and urban growth. In his model, he distinguishes between space production and space consumption. In an interplay between these two 'circuits', agents display activities for maximisation of profit on the one hand and maximisation of utility and investment on the other.

Representation and Visualisation of Knowledge

The work by Rafi et al. acknowledges the importance of efficiency in searching and browsing multi-media content. In a collaboration project between university and software industry, they have developed and applied enhanced technology for displaying and searching multi-media archives. This technology has improved and accelerated display capabilities and offers a number of advanced tools for authoring, navigating, and interlinking content. As such it is used to enable students at staff at their university to discover and re-use visual materials.

Burkhard introduces a framework for the visualisation of knowledge to support knowledge transfer. In three different perspectives on knowledge transfer, this framework distinguishes various types of knowledge, different recipients of knowledge, and visualisation types. It offers a three dimensional interface for combined access to these perspectives, which helps to select the most optimal method of visualising knowledge in a particular context.

Lindekens and Heylighen aim to make building re-design knowledge available for students and practising architects, so that they benefit from these rich resources of both procedural and content knowledge. For this purpose, analysed re-design processes have been described in different lines of thought and design strategies that show various aspects of the designer's considerations. These re-design cases are then utilised in a case base that is indexed on the basis of dimension, scale, abstraction level, and chronology of the designs.

Another approach to make knowledge in case bases accessible is discussed in the chapter by Lai. This work addresses the value of links between various cases, the associations between ideas. The so-called Dynamic Idea-Maps is a tool that provides a mechanism for idea association through symbolic representation and linking of ideas and design precedents. The case-based reasoning mechanism provides various strategies for retrieval and adaptation of ideas from the design cases.

Collaborative Design

Collaborative design is an old but still actual research topic where very diverse approaches are developed to provide support in complex design projects, on the one hand by facilitating distant communication and information sharing, and on the other hand by stimulating the synergy in multi-disciplinary design teams.

The Interoperable Co-Design system proposed by Shih is a combination of a web-based communication service, providing tools for group activities, and an agent messaging service that supports role-playing and design process management.

The research of Deshpande et al. concentrates not on distant collaboration but rather on collocated collaboration. Their contribution offers an extensive review of the state-of-the-art of computer mediation for face-to-face collaboration in design teams. This research area is mapped in a landscape of design theory, knowledge manage, cognitive psychology, sociology, and computer science. He proposes an augmented collaboration design space that supports the design dialogue and the informal argumentative process between the designers and systems.

Focusing on the representation and re-usage of design and engineering knowledge, Beetz et al. propose a multi-agent approach to provide personalised design support. The proposed system integrates legacy applications by examination of interface activities with a protocol for agent-based communication and exchange of design knowledge.

Building Performance

The performance of buildings has a strong impact on the performance and well-being of their users. With respect to the influence of the built environment on the health of people, van Bronswijk et al. discuss the relation between changes in constructions or building services and the effects on the users' health. The results of this research provide knowledge for product innovation and open the possibility to model health in relation to built environments.

In the final chapter of this book, Hensen argues that building performance simulation can help to reduce environmental pollution and increase comfort levels in building, by taking into account the dynamic interactions of buildings and service systems. He discusses the work in the Center for Buildings & Systems on quality assurance and interoperability issues of simulation software. The ultimate goal is to increase the uptake of simulation software during design stages in order to achieve design optimisation.