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Energy modeling or simulation is the practice of using computerized simulation programs to model the energy and environmental performance of an entire building or the systems within a building. Researchers concur that architects should use the energy simulation programs as a potential design decision support tool, especially in the early design stages, where the time and budgetary constraints often preclude the objective performance feedback from engineers and energy simulation experts who regularly perform energy simulation and where such objective performance feedback can have substantial influence on the overall energy and environmental performance of the final building. However, user surveys assessing simulation uptake by architects have shown that energy simulation is rarely employed by architects in practice. A literature review of these surveys indicated design process related, software related, and user related issues responsible for their limited uptake. Of these, very limited research is focused on the user related issues: enhancing the level of understanding of energy simulation of architects and the ways to facilitate this understanding. The research presented in this thesis proposes the formulation of a simulation tool independent guide to address the user related issue and gives an overview of the topics to be included in this guide. The topics chosen were based on the analysis of the author's experience of a performed test design and the issues identified through literature review of the user surveys. The topics discussed for inclusion in the guide are: an introduction to simulation; defining the simulation scope; selection of energy simulation programs; defining simulation model and performing simulation; quality assurance and program validation; and data analysis and interpretation. Of these, 'defining the simulation scope' was perceived as one of the important topics influencing the modeling and simulation strategy and the selection of energy simulation programs and hence, was further analyzed. A simulation tool independent framework is proposed and developed to facilitate the formulation of the simulation scope. The framework is a visual representation of the inter-relationship between the design inquiries in the early design stage, simulation tasks and the related performance parameters to be simulated by energy simulation programs for deriving decision support for the design inquiries.

When used appropriately, building performance simulation has the potential to reduce the environmental impact of the built environment, to improve indoor quality and productivity, as well as to facilitate future innovation and technological progress in construction. Since publication of the first edition of Building Performance Simulation for Design and Operation, the discussion has shifted from a focus on software features to a new agenda, which centres on the effectiveness of building performance simulation in building life cycle processes. This new edition provides a unique and comprehensive overview of building performance simulation for the complete building life cycle from conception to demolition, and from a single building to district level. It contains new chapters on building information modelling, occupant behaviour modelling, urban physics modelling, urban building energy modelling and renewable energy systems modelling. This new edition keeps the same chapter structure throughout including learning objectives, chapter summaries and assignments. Moreover, the book: • Provides unique insights into the techniques of building performance modelling and simulation and their application to performance-based design and operation of buildings and the systems which service them. • Provides readers with the essential concepts of computational support of performance-based design and operation. • Provides examples of how to use building simulation techniques for practical design, management and operation, their limitations and future direction. It is primarily intended for building and systems designers and operators, and postgraduate architectural, environmental or mechanical engineering students.

Fundamentals of Building Performance Simulation pares the theory and practice of a multi-disciplinary field to the essentials for classroom learning and real-world applications. Authored by a veteran educator and researcher, this textbook equips graduate students and emerging and established professionals in engineering and architecture to predict and optimize buildings' energy use. It employs an innovative pedagogical approach, introducing new concepts and skills through previously mastered ones and deepening understanding of familiar themes by means of new material. Covering topics from indoor airflow to the effects of the weather, the book's 19 chapters empower learners to: Understand the models and assumptions underlying popular BPS tools Compare models, simulations, and modelling tools and make appropriate selections Recognize the effects of modelling choices and input data on simulation predictions And more. Each subject is introduced without reference to particular modelling tools, while practice problems at the end of each chapter provide hands-on experience with the tools of the reader's choice. Curated reading lists orient beginners in a vast, cross-disciplinary literature, and the critical thinking skills stressed throughout prepare them to make contri-

butions of their own. Fundamentals of Building Performance Simulation provides a much-needed resource for new and aspiring members of the building science community.
Meet the challenge of integrating Building Information Modeling and sustainability with this in-depth guide, which pairs these two revolutionary movements to create environmentally friendly design through a streamlined process. Written by an award-winning team that has gone beyond theory to lead the implementation of Green BIM projects, this comprehensive reference features practical strategies, techniques, and real-world expertise so that you can create sustainable BIM projects, no matter what their scale.

Energy saving in buildings through cost and energy-intensive measures, such as the application of additional building materials and technologies, is only possible with a great consumption of resources and CO2 emissions for their production. For low energy buildings, the investment costs, including user costs and governmental subsidies, are generally high, and construction is not always economically viable in consideration of the national capital in the present economic conditions of most countries. For these reasons, it is first of all necessary to apply cost and resource-efficient measures to save energy in buildings and then make use of additional cost and energy-intensive measures by improving the thermal envelope, the HVAC system or by installing energy generating systems. One of the most cost effective and ecological methods of energy saving in buildings is the reduction of energy requirements through climate responsive architecture. Due to the fact that energy saving through the optimization of architecture is not only cost-neutral, resource-efficient and carbon-neutral but also has a very high energy-saving potential, the first and most important strategy to save energy should be an optimized and climate responsive design. Energy saving through optimized architectural design is economically and ecologically sustainable. The development of building simulation science in the last decades has made it easier to study the energy performance of buildings. Tools have made it possible to predict the complex behavior of buildings regarding the climate. Except for the comparison of different building typologies to find the most efficient, there are no other methods to achieve energy savings through the architectural design, which can be applied by a variety of building types and climates. Therefore, in order to encourage the optimization of architectural design, it is necessary to improve these methods which represent strategies to significantly reduce the energy demand of buildings. Architectural Energy Efficiency is a parametric method which separately studies the effects of various energy-related architectural factors on the energy demand of buildings by using dynamic energy simulations to find the, from an energy efficiency point of view, optimum value for each of these. The architectural factors include orientation, building elongation, building form, opening ratio in different orientations, sun shading, natural ventilation etc. The research process that led to the formulation of the Architectural Energy Efficiency method is based on a series of simulations carried out by a dynamic simulation software tool (DesignBuilder) to calculate the energy demands of a building with different variants for a single architectural feature. The aim of the simulations is to find an optimum set of energy-related variables that result in the best and most efficient energy performance for a specific building type and climate. This method of efficiency illustrates the effects different architectural features have on the various energy demands of buildings. The criteria are derived from the application of this method for a specific building occupation and climate, and can be applied in the design process of buildings, which leads to improvements of the energy performance and a reduction of resource consumption. As the architectural design affects the heating and cooling as well as the lighting energy demands of buildings, the optimum value of each factor must be based on these three aspects. The heating, cooling and lighting energy demands of buildings all behave very differently. Therefore, these three energy demands together (i. e. the sum of heating, cooling and lighting energy) must also be applied as a criterion to study the building energy performance and find the optimum value for each architectural feature. The criteria for selecting the best variant can not only be based on the total energy demand, but should also consider the primary energy demand, the CO2 emissions, energy costs (for heating, cooling and lighting), life cycle costs, etc. The application of these findings to the architectural design of buildings minimizes the energy demand, the CO2 emissions and energy costs of the building, does not, however, affect the initial building costs. The advantages of energy saving through optimizing the architectural design are not only the improvement of the building’s energy performance, but also the fact that the energy saving is cost and resource-efficient. This means that the energy demand of a building will decrease without increasing the investment costs of the building and without consuming any resources and energy for the production of additional building materials. The cost and resource efficiency contributes towards the economic and ecological sustainability of a building during the full life cycle.
Since the appearance of the first edition of 'Energy Simulation in Building Design', the use of computer-based appraisal tools to solve energy design problems within buildings has grown rapidly. A leading figure in this field, Professor Joseph Clarke has updated his book throughout to reflect these latest developments. The book now includes material on combined thermal/lighting and CFD simulation, advanced glazings, indoor air quality and photovoltaic components. This thorough revision means that the book remains the key text on simulation for architects, building engineering consultants and students of building engineering and environmental design of buildings. The book's purpose is to help architects, mechanical & environmental engineers and energy & facility managers to understand and apply the emerging computer methods for options appraisal at the individual building, estate, city, region and national levels. This is achieved by interspersing theoretical derivations relating to simulation within an evolving description of the built environment as a complex system. The premise is that the effective application of any simulation tool requires a thorough understanding of the domain it addresses.
Providing a complete and in-depth overview of the available knowledge in the area of low energy and low carbon architecture. The scope of this edited book includes several important topics ranging from chapters giving a broad view of the progressing models in ecologically responsible environments to other chapters focussing on recent advances in de
This book of Proceedings presents the latest thinking and research in the rapidly evolving world of architecture and sustainable development through 255 selected papers by authors coming from over 60 countries.

This paper describes the Energy Design Plugin, a new software plugin that aims to integrate simulation as a tool during the earliest phases of the design process. The plugin couples the EnergyPlus whole-building simulation engine to the Google SketchUp[Trademark] drawing program. Leveraging the powerful SketchUp application programming interface, we developed a plugin that extends the

capabilities of SketchUp to allow EnergyPlus building models to be developed in 3-D while taking advantage of all of the native SketchUp capabilities, including intuitive tools, different rendering modes, and realistic shading. The model geometry can be saved to create an EnergyPlus input file. Existing input files can be opened, edited in the SketchUp environment, and saved again. Already well-established as a popular tool among architects and designers, SketchUp offers a familiar, easy--to-use interface that, when coupled with the plugin, could make building energy simulation more accessible for architects, designers, and students during the design process.

The four-volume set LNCS 8012, 8013, 8014 and 8015 constitutes the proceedings of the Second International Conference on Design, User Experience, and Usability, DUXU 2013, held as part of the 15th International Conference on Human-Computer Interaction, HCII 2013, held in Las Vegas, USA in July 2013, jointly with 12 other thematically similar conferences. The total of 1666 papers and 303 posters presented at the HCII 2013 conferences was carefully reviewed and selected from 5210 submissions. These papers address the latest research and development efforts and highlight the human aspects of design and use of computing systems. The papers accepted for presentation thoroughly cover the entire field of Human-Computer Interaction, addressing major advances in knowledge and effective use of computers in a variety of application areas. The total of 282 contributions included in the DUXU proceedings were carefully reviewed and selected for inclusion in this four-volume set. The 83 papers included in this volume are organized in the following topical sections: DUXU in business and the enterprise, designing for the Web experience; product design; information and knowledge design and visualisation; and mobile applications and services.

Building energy design is currently going through a period of major changes. One key factor of this is the adoption of net-zero energy as a long term goal for new buildings in most developed countries. To achieve this goal a lot of research is needed to accumulate knowledge and to utilize it in practical applications. In this book, accomplished international experts present advanced modeling techniques as well as in-depth case studies in order to aid designers in optimally using simulation tools for net-zero energy building design. The strategies and technologies discussed in this book are, however, also applicable for the design of energy-plus buildings. This book was facilitated by International Energy Agency's Solar Heating and Cooling (SHC) Programs and the Energy in Buildings and Communities (EBC) Programs through the joint SHC Task 40/EBC Annex 52: Towards Net Zero Energy Solar Buildings R&D collaboration. After presenting the fundamental concepts, design strategies, and technologies required to achieve net-zero energy in buildings, the book discusses different design processes and tools to support the design of net-zero energy buildings (NZEBs). A substantial chapter reports on four diverse NZEBs that have been operating for at least two years. These case studies are extremely high quality because they all have high resolution measured data and the authors were intimately involved in all of them from conception to operating. By comparing the projections made using the respective design tools with the actual performance data, successful (and unsuccessful) design techniques and processes, design and simulation tools, and technologies are identified. Written by both academics and practitioners (building designers) and by North Americans as well as Europeans, this book provides a very broad perspective. It includes a detailed description of design processes and a list of appropriate tools for each design phase, plus methods for parametric analysis and mathematical optimization. It is a guideline for building designers that draws from both the profound theoretical background and the vast practical experience of the authors.

Energy Modeling in Architectural Design demonstrates how design elements can lead to energy savings, to help you reduce the energy footprint of your buildings. In addition to identifying climate opportunities, you'll also learn fundamental passive design elements for software-agnostic energy modeling of your projects from conception. Using parametric models and testing each element during design will lead you to create beautiful and high-performance buildings. Illustrated with more than 100 color images, this book also includes a pattern guide for high-performance buildings, discusses energy and daylighting optimization, and has a glossary for easy reference.

"Any architect doing small or medium scaled projects who is alsovested in sustainable design but is not yet doing BIM will enjoythis book's overall focus."-Architosh.com This work is the leading guide to architectural design within abuilding information modeling (BIM) workflow, giving thepractitioner a clear procedure when designing climate-loaddominated buildings. The book incorporates new information relatedto BIM, integrated practice, and sustainable design, as wellinformation on how designers can incorporate the latesttechnological tools. Each chapter addresses specific topics, suchas natural ventilation for cooling, passive solar heating,rainwater harvesting and building hydrology, optimizing materialuse and reducing construction waste, and collaborating withconsultants or other building professionals such as engineers andenergy modelers.

The integration of quantitative building energy performance simulation with qualitative architecture representational 3D data can facilitate performance-based decision making in the early phase of building design process. However, there are some problems that delay decision making until the late stages of design.Many interrelated parameters can affect building energy performance. Unlike design options conventionally created based on offered values of ASHRAE 90.1 or NECB, design alternatives with lower energy consumption can be suggested through the configuration of various parameters. A systematic strategy is needed to support performance-based quantitative evaluation. Due to the complexity of integration of interrelated energy simulation parameters with qualitative architecture representations, this approach is not being adequately accomplished in current architecture/energy-performance practices. There is a lack of an effective integrated workflow between architects and engineers to simultaneously represent visual qualitative 3D data related to quantitative energy performance-based data of each design alternative.In addition, exchanging data between the architectural model and the energy model in large-scale evaluations is a time-consuming and error-prone process. Collaborative platforms are not sufficiently being used in current practices to facilitate geometric and physical data-sharing through a single environment. In this regard, there is no clear integrated design workflow between architectural needs and engineering needs.The objective of this research is to propose a workflow to facilitate decision-making at the early design phase by automatically generating the quantitative energy performance data and qualitative visual representations of each design alternative, in order that architects and engineers can collaborate within a common platform of communication. This proposed workflow will be implemented through the utilization of a case study, within the collaborative platform of Building Information Modeling (BIM).Numbers of 1296 quantitative energy-performance results and their related qualitative 3D designs have been generated automatically through the BIM platform. These results support architects and engineers with a variety of 2best performance-based design solutions,3 while involving them simultaneously in

the design process from the early phase without needing to perform the error-prone and time-consuming process of energy model data re-entry.

This book is a guide to a sustainable design process that moves from theory, to site and energy use, to building systems, and finally to evaluation and case studies, so you can integrate design and technology for effective sustainable building. Kuppaswamy Iyengar shows you how to get it right the first time, use free energy systems, and utilise technologies that minimize fossil fuel use. Each chapter has a sustainable design overview, technical details and strategies marked by clear sections, a summary, and further resources. Heavily illustrated with charts, tables, drawings, photographs, and case studies, the book shows technologies and concepts integrated into cohesive project types, from small and large office spaces to single and multiuse residences, hospitals, schools, restaurants, and warehouses to demonstrate implementing your designs to meet clients' needs now and for the future. Includes an overview of alternate assessment and evaluation systems such as BREEAM, CASBEE, GBTool, Green Globes alongside LEED, ECOTECT, energy 10, HEED and eQuest simulation programs. The guide reveals the importance of the building envelope—walls, superstructure, insulation, windows, floors, roofs, and building materials—on the environmental impact of a building, and has a section on site systems examining site selection, landscape design, thermal impact, and building placement.

Paves the path for the adoption and effective implementation of BIM by design firms, emphasizing the design opportunities that this workflow affords This book expands on BIM (Building Information Modeling), showing its applicability to a range of design-oriented projects. It emphasizes the full impact that a data modeling tool has on design processes, systems, and the high level of collaboration required across the design team. It also explains the quantitative analysis opportunities that BIM affords for sustainable design and for balancing competing design agendas, while highlighting the benefits BIM offers to designing in 3D for construction. The book concludes with a deep look at the possible future of BIM and digitally-enhanced design. Through clear explanation of the processes involved and compelling case studies of design-oriented projects presented with full-color illustrations, BIM for Design Firms: Data Rich Architecture at Small and Medium Scales proves that the power of BIM is far more than an improved documentation and sharing environment. It offers chapters that discuss a broad range of digital design, including problems with BIM, how readers can leverage BIM workflows for complex projects, the way BIM is taught, and more. Helps architects in small and medium design studios realize the cost and efficiency benefits of using BIM Demonstrates how the use of BIM is as relevant and beneficial for a range of projects, from small buildings to large and complex commercial developments Highlights the quantitative analysis opportunities of data-rich BIM models across design disciplines for climate responsiveness, design exploration, visualization, documentation, and error detection Includes full-color case studies of small to medium projects, so that examples are applicable to a range of practice types Features projects by Arca Architects, ARX Protugal Arquitectos, Bearth & Deplazes, Durbach Block Jaggers, Flansburgh Architects, and LEVER Architecture BIM for Design Firms is an excellent book for architects in small and medium-sized studios (including design departments within large firms) as well as for architecture students.

When designing a building, the architect has typically relied on the input of outside experts to determine the performance of building systems. When done properly this collaboration can yield highly effective designs, but typically this reliance has left the architect outside of the loop on performance based decisions and impeded the development of innovative solutions. With the availability of powerful building simulation tools, designers can have direct access to building performance attributes and use them to qualify the environmental impact of design-decisions. With knowledge of fundamental principles in building performance and computer modeling, a designer can effectively harness the power of these tools from the beginning of the design process. While this does not eliminate the need for expert opinion, it allows the designer to further develop and have more control over the solution through collaboration. By working effectively in this digital design environment, the practice of architecture can meet its responsibility to reduce the impact of buildings on the physical environment. To test this statement, a brief overview of the integration of analysis tools in two projects that represent the current state of the art for digital performance simulation describes the need for multiple tools to achieve effective results. Based on this experience, a study was done to explore the capabilities of four representative simulation tools to support a design process that is entirely digital. The software evaluated was Energy-10, eQUEST, Sketch-Up with Demeter (a recently released plug-in for energy analysis) and ECOTECT. These tools were chosen because they have been targeted toward architects and claim to be easy to use. The results of this investigation were used to determine an appropriate tool set to develop a design for submission to the Leading Edge Competition, chosen because one of the requirements is that entrants perform energy analyses on their schemes to show how design decisions led to improved performance, making it a good vehicle to explore the process of designing in a simulation environment.

Computing the Environment presents practical workflows and guidance for designers to get feedback on their design using digital design tools on environmental performance. Starting with an extensive state-of-the-art survey of what top international offices are currently using in their design projects, this book presents detailed descriptions of the tools, algorithms, and workflows used and discusses the theories that underlie these methods. Project examples from Transsolar Klimaengineering, Buro Happold´s SMART Group, Behnish Behnisch Architects, Thomas Herzog, Autodesk Research are contextualized with quotes and references to key thinkers in this field such as Eric Winsberg, Andrew Marsh, Michelle Addington and Ali Malkawi.

Discover BIM: A better way to build better buildings Building Information Modeling (BIM) offers a novel approach to design, construction, and facility management in which a digital representation of the building product and process is used to facilitate the exchange and interoperability of information in digital format. BIM is beginning to change the way buildings look, the way they function, and the ways in which they are designed and built. The BIM Handbook, Third Edition provides an in-depth understanding of BIM technologies, the business and organizational issues associated with its implementation, and the profound advantages that effective use of BIM can provide to all members of a project team. Updates to this edition include: Information on the ways in which professionals should use BIM to gain maximum value New topics such as collaborative working, national and major construction clients, BIM standards and guides A discussion on how various professional roles have expanded through the widespread use and the new avenues of BIM practices and services A wealth of new case studies that clearly illustrate exactly how BIM is applied in a wide variety of conditions Painting a colorful and thorough picture of the state of the art in building information modeling, the

BIM Handbook, Third Edition guides readers to successful implementations, helping them to avoid needless frustration and costs and take full advantage of this paradigm-shifting approach to construct better buildings that consume fewer materials and require less time, labor, and capital resources.

Building design processes are dynamic and complex. The context of a building pro- ject is manifold and depends on the cultural context, climatic conditions and personal design preferences. Many stakeholders may be involved in deciding between a large space of possible designs defined by a set of influential design parameters. Building performance simulation is the state-of-the-art way to provide estimates of the energy and environmental performance of various design alternatives. However, setting up a simulation model can be labour intensive and evaluating it can be com- putationally costly. As a consequence, building simulations often occur towards the end of the design process instead of being an active component in design processes. This observation and the growing availability of machine learning algorithms as an aid to exploring analytical problems has lead to the development of surrogate mo- dels. The idea of surrogate models is to learn from a high-fidelity counterpart, here a building simulation model, by emulating the simulation outputs given the simula- tion inputs. The key advantage is their computational efficiency. They can produce performance estimates for hundreds of thousands of building designs within seconds. This has great potential to innovate the field. Instead of only being able to assess a few specific designs, entire regions of the design space can be explored, or instan- taneous feedback on the sustainability of building can be given to architects during design sessions. This PhD thesis aims to advance the young field of building energy simulation surrogate models. It contributes by: (a) deriving Bayesian surrogate models that are aware of their uncertainties and can warn of large approximation errors; (b) deriving surrogate models that can process large weather data (≈150'000 inputs) and estimate the associated impact on building performance; (c) calibrating a simulation model via fast iterations of surrogate models, and (d) benchmarking the use of surrogate-based calibration against other approaches.

Computing the Environment presents practical workflows and guidance for designers to get feedback on their design using digital design tools on environmental performance. Starting with an extensive state-of-the-art survey of what top international offices are currently using in their design projects, this book presents detailed descriptions of the tools, algorithms, and workflows used and discusses the theories that underlie these methods. Project examples from Transsolar Klimaengineering, Buro Happold´s SMART Group, Behnish Behnisch Architects, Thomas Herzog, Autodesk Research are contextualized with quotes and references to key thinkers in this field such as Eric Winsberg, Andrew Marsh, Michelle Addington and Ali Malkawi.

Explores and brings together the existent body of knowledge on building performance analysis Building performance is an important yet surprisingly complex concept. This book presents a comprehensive and systematic overview of the subject. It provides a working definition of building performance, and an in-depth discussion of the role building performance plays throughout the building life cycle. The book also explores the perspectives of various stakeholders, the functions of buildings, performance requirements, performance quantification (both predicted and measured), criteria for success, and the challenges of using performance analysis in practice. Building Performance Analysis starts by introducing the subject of building performance: its key terms, definitions, history, and challenges. It then develops a theoretical foundation for the subject, explores the complexity of performance assessment, and the way that performance analysis impacts on actual buildings. In doing so, it attempts to answer the following questions: What is building performance? How can building performance be measured and analyzed? How does the analysis of building performance guide the improvement of buildings? And what can the building domain learn from the way performance is handled in other disciplines? Assembles the current body of knowledge on building performance analysis in one unique resource Offers deep insights into the complexity of using building performance analysis throughout the entire building life cycle, including design, operation and management Contributes an emergent theory of building performance and its analysis Building Performance Analysis will appeal to the building science community, both from industry and academia. It specifically targets advanced students in architectural engineering, building services design, building performance simulation and similar fields who hold an interest in ensuring that buildings meet the needs of their stakeholders.

In addition to the application of fundamental principles that lead to a structured method for zero carbon design of buildings, this considerably expanded second edition includes new advanced topics on multi-objective optimisation; reverse modelling; reduction of the simulation performance gap; predictive control; nature-inspired emergent simulation leading to sketches that become ‘alive’; and an alternative economics for achieving the sustainability paradigm. The book features student design work from a Master’s programme run by the author, and their design speculation for a human settlement on Mars. Tasks for simple simulation experiments are available for the majority of topics, providing the material for classroom exercise and giving the reader an easy introduction into the field. Extended new case studies of zero carbon buildings are featured in the book, including schemes from Japan, China, Germany, Denmark and the UK, and provide the reader with an enhanced design toolbox to stimulate their own design thinking.

This research is meant to facilitate a wider use of energy simulation in urban and schematic building design. The major contribution is the development and validation of software algorithms that can manage, automatically produce and execute building energy models for urban and schematic design. Modeling approaches for building performance simulation engines such as EnergyPlus and TRNSYS have been developed. The first approach introduces an algorithm that automatically converts arbitrary building massing models into multi-zone thermal models following the ASHRAE 90.1 Appendix G prescribed perimeter and core discretization schema. This method yields geometrically resolved multizone models and provides a streamlined workflow for single and multi-building energy evaluation. The second approach dissects an urban massing model that may consist of hundreds of buildings with various architectural programs into a discrete number of "typical room" energy models. It is shown that for standard interior partitions and fully conditioned spaces the method yields results that are comparable to conventional perimeter and core simulations in terms of accuracy as well as temporal and spatial resolution at a fraction of the calculation time. This speed-up facilitates interactive urban level design evaluations. The third approach explores the energetic consequences of using a zoning methodology that goes beyond generic perimeter and core subdivisions. Based on a review and categorization of real floor plan designs it is shown that key characteristics of interior subdivisions have a decisive effect on building energy use and present a largely untapped opportunity for

architects to reduce building energy use in schematic design. Each approach is documented and simulation results are compared against conventional modeling workflows for a realworld urban case study. As a proof of concept, the mentioned methods have been implemented as plug-ins for the widely used CAD modeling software Rhinoceros3d (Rhino) and its parametric scripting environment Grasshopper.

Leading architectural firms are now using in-house design simulation to help make more sustainable design decisions. Taking advantage of these new tools requires understanding of what can be done with simulation, how to do it, and how to interpret the results. This software-agnostic book, which is intended for you to use as a professional architect, shows you how to reduce the energy use of all buildings using simulation for shading, daylighting, airflow, and energy modeling. Written by a practicing architect who specializes in design simulation, the book includes 30 case studies of net-zero buildings, as well as of projects with less lofty goals, to demonstrate how energy simulation has helped designers make early decisions. Within each case study, author Kjell Anderson mentions the software used, how the simulation was set up, and how the project team used the simulation to make design decisions. Chapters and case studies are written so that you learn general concepts without being tied to particular software. Each chapter builds on the theory from previous chapters, includes a summary of concept-level hand calculations (if applicable), and gives comprehensive explanations with graphic examples. Additional topics include simulation basics, comfort, climate analysis, a discussion on how simulation is integrated into some firms, and an overview of some popular design simulation software.

With the increasing interest in energy efficient building design, whole building energy simulation programs are increasingly employed in the design process to help architects and engineers determine which design alternatives save energy and are cost effective. DOE-2 is one of the most popular programs used by the building energy simulation community. eQUEST is a powerful graphic user interface for the DOE-2 engine. EnergyPlus is the newest generation simulation program under development by the U.S. Department of Energy which adds new modeling features beyond the DOE-2's capability. The new modeling capabilities of EnergyPlus make it possible to model new and complex building technologies which cannot be modeled by other whole building energy simulation programs. On the other hand, EnergyPlus models, especially with a large number of zones, run much slower than those of eQUEST. Both eQUEST and EnergyPlus offer their own set of advantages and disadvantages. The choice of which building simulation program should be used might vary in each case. The purpose of this thesis is to investigate the potential of both the programs to do the whole building energy analysis and compare the results with the actual building energy performance. For this purpose the energy simulation of a fully functional building is done in eQUEST and EnergyPlus and the results were compared with utility data of the building to identify the degree of closeness with which simulation results match with the actual heat and energy flows in building. It was observed in this study that eQUEST is easy to use and quick in producing results that would especially help in the taking critical decisions during the design phase. On the other hand EnergyPlus aids in modeling complex systems, producing more accurate results, but consumes more time. The choice of simulation program might change depending on the usability and applicability of the program to our need in different phases of a building's lifecycle. Therefore, it makes sense if a common front end is designed for both these simulation programs thereby allowing the user to select either the DOE-2.2 engine or the EnergyPlus engine based upon the need in each particular case.

This textbook teaches the fundamentals of building energy modeling and analysis using open source example applications built with the US DOE's OpenStudio modeling platform and EnergyPlus simulation engine. Designed by researchers at US National Laboratories to support a new generation of high performance buildings, EnergyPlus and OpenStudio are revolutionizing how building energy modeling is taught in universities and applied by professional architects and engineers around the world. The authors, all researchers at National Renewable Energy Laboratory and members of the OpenStudio software development team, present modeling concepts using open source software that may be generally applied using a variety of software tools commonly used by design professionals. The book also discusses modeling process automation in the context of OpenStudio Measures—small self-contained scripts that can transform energy models and their data—to save time and effort. They illustrate key concepts through a sophisticated example problem that evolves in complexity throughout the book. The text also examines advanced topics including daylighting, parametric analysis, uncertainty analysis, design optimization, and model calibration. Building Energy Modeling with OpenStudio teaches students to become sophisticated modelers rather than simply proficient software users. It supports undergraduate and graduate building energy courses in Architecture, and in Mechanical, Civil, Architectural, and Sustainability Engineering.

The second edition of Building Energy Simulation includes studies of various components and systems of buildings and their effect on energy consumption, with the help of DesignBuilderTM, a front-end for the EnergyPlus simulation engine, supported by examples and exercises. The book employs a "learning by doing" methodology. It explains simulation-input parameters and how-to-do analysis of the simulation output, in the process explaining building physics and energy simulation. Divided into three sections, it covers the fundamentals of energy simulation followed by advanced topics in energy simulation and simulation for compliance with building codes and detailed case studies for comprehensive building energy simulation. Features: Focuses on learning building energy simulation while being interactive through examples and exercises. Explains the building physics and the science behind the energy performance of buildings. Encourages an integrated design approach by explaining the interactions between various building systems and their effect on energy performance of building. Discusses a how-to model for building energy code compliance including three projects to practice whole building simulation. Provides hands-on training of building energy simulation tools: DesignBuilderTM and EnergyPlus. Includes practical projects problems, appendices and CAD files in the e-resources section. Building Energy Simulation is intended for students and researchers in building energy courses, energy simulation professionals, and architects.

Technological evolutions have changed the field of architecture exponentially, leading to more stable and energy-efficient building structures. Architects and engineers must be prepared to further enhance their knowledge in the field in order to effectively meet new and advancing standards. Architecture and Design: Breakthroughs in Research and Practice is an authoritative resource for the latest research on the application of new technologies and digital tools that revolutionize the work of architects globally, aiding in architectural design, planning, implementation, and restoration. Highlighting a range of pertinent topics such as design anthropology, digital preservation, and 3D modeling,

this publication is an ideal reference source for researchers, scholars, IT professionals, engineers, architects, contractors, and academicians seeking current research on the development and creation of architectural design.

Architectural practices worldwide have to deal with increasingly complex design requirements. How do practices acquire the ability to do so? The Changing Shape of Practice provides a handbook of examples for practices that wish to integrate more research into their work and a reference book for students that seek to prepare themselves for the changing shape of practice in architecture. It addresses the increasing integration of research undertaken in architectural practices of different sizes ranging from small to very large practices from the UK, USA, Europe and Asia. The book is organized according to the size of the practices which is significant in that it addresses the different structures and resourcing requirements that are enabled by specific practice sizes, as this determines and constrains the type, scope and modes of research available to a given practice. The practices covered include: Woods Bagot Perkins + Will White AECOM UN Studio Shop Architects PLP Architecture Kieran Timberlake 3XN ONL AZPML Thomas Herzog + Partners Herreros Arquitectos Spacescape OCEAN Design Research Association By taking stock of the current shape of practice, the book provides essential information for professional architects who are integrating research into their practice.

This thesis investigates the use of building performance simulation tools as a method of informing the design decision of Net Zero Energy Buildings (NZEBs).

Simulation tools, when applied early in the design process, can considerably reduce the energy demand of newly constructed buildings. For a simulation tool to assist with design, it must be easy to use, provide feedback quickly, and allow rapid comparisons. Most existing tools do not meet these needs, usually because they were intended for modeling finalized building designs. Often there is no user interface, and it can take hours or days to prepare, run, and interpret results. Such tools are too sophisticated for design purposes. In this document the MIT Design Advisor is presented as a simple and rapid building energy simulation tool, developed specifically for architects and building designers. Conceptual building designs can be modeled quickly and without formal training. Results are interpreted graphically and displayed to the user in a simple user interface. Side-by-side comparisons of building designs can be made, allowing users to quickly learn which building components have the biggest impact on energy consumption (heating, cooling, and lighting), indoor daylight levels, and thermal comfort. User-specified building parameters are used together with local weather data to predict monthly and annual energy use. The heat transfer model used to make the energy predictions is explained in detail in this thesis. Calculation methods are given and validated. Agreement with existing models is quite good. The MIT Design Advisor is available at http://designadvisor.mit.edu.

This book results from a Special Issue related to the latest progress in the thermodynamics of machines systems and processes since the premonitory work of Carnot. Carnot invented his famous cycle and generalized the efficiency concept for thermo-mechanical engines. Since that time, research progressed from the equilibrium approach to the irreversible situation that represents the general case. This book illustrates the present state-of-the-art advances after one or two centuries of consideration regarding applications and fundamental aspects. The research is moving fast in the direction of economic and environmental aspects. This will probably continue during the coming years. This book mainly highlights the recent focus on the maximum power of engines, as well as the corresponding first law efficiency upper bounds.

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