Design Optimization Of Wind Turbine Blades For Reduction

The book presents a state-of-the-art in environmental aerodynamics and the structural design of wind energy support structures, particularly from a modern computational perspective. Examples include real-life applications dealing with pollutant dispersion in the building environment, pedestrian-level winds, comfort levels, relevant legislation and remedial measures. Design methodologies for wind energy structures include reliability assessment and code frameworks.

Within the last 20 years, wind turbines have reached matured and the growing worldwide wind energy market will allow further improvements. In the recent decades, the numbers of research papers that have applied optimization techniques in the attempt to obtain an optimal design have increased. The main target of manufacturers has been to minimize the cost of energy of wind turbines in order to compete with fossil-fuel sources. Therefore, it has been argued that it is more stimulating to evaluate the wind turbine design as an optimization problem consisting of more than one objective. Using multi-objective optimization algorithms, the designers are able to identify a trade-off curve called Pareto front that reveals the weaknesses, anomalies and rewards of certain targets. In this chapter, we present the fundamental principles of multi-objective optimization in wind turbine design and solve a classic multi-objective wind turbine optimization problem using a genetic algorithm.

Floating offshore wind turbines have the potential to become a significant source of affordable renewable energy. However, their strong interactions with both wind- and wave-induced forces raise a number of technical challenges in both modelling and design. This thesis takes aim at some of those challenges. One of the most uncertain modelling areas is the mooring line dynamics, for which quasi-static models that neglect hydrodynamic forces and mooring line inertia are commonly used. The consequences of using these quasi-static mooring line models as opposed to physically-realistic dynamic mooring line models was studied through a suite of comparison tests performed on three floating turbine designs using test cases incorporating both steady and stochastic wind and wave conditions. To perform this comparison, a dynamic finite-element mooring line model was coupled to the floating wind turbine simulator FAST. The results of the comparison study indicate the need for higher-fidelity dynamic mooring models for all but the most stable support structure configurations. Industry consensus on an optimal floating wind turbine configuration is inhibited by the complex support structure design problem; it is difficult to parameterize the full range of design options and intuitive tools for navigating the design space are lacking. The notion of an alternative, "hydrodynamics-based" optimization approach, which would abstract details of the platform geometry and deal instead with hydrodynamic performance coefficients, was proposed as a way to obtain a more extensive and intuitive exploration of the design space. A basis function approach, which represents the design space by linearly combining the hydrodynamic performance coefficients of a diverse set of basis platform geometries, was developed as the most straightforward means to that end. Candidate designs were evaluated in the frequency domain using linearized coefficients for the wind turbine, platform, and mooring system dynamics, with the platform hydrodynamic coefficients calculated according to linear hydrodynamic theory. Results obtained for two mooring systems demonstrate that the approach captures the basic nature of the design space, but further investigation revealed limitations on the physical interpretability of linearly-combined basis platform coefficients. A different approach was then taken for exploring the design space: a genetic algorithm-based optimization framework. Using a nine-variable support structure parameterization, this framework is able to span a greater extent of the design space than previous approaches in the literature. With a frequency-domain dynamics model that includes linearized viscous drag forces on the structure and linearized mooring forces, it provides a good treatment of the important physical considerations while still being computationally efficient. The genetic algorithm optimization approach provides a unique ability to visualize the design space. Application of the framework to a hypothetical scenario demonstrates the framework's effectiveness and identifies multiple local optima in the design space -- some of conventional configurations and others more unusual ... .

This work focuses on designing a blade of 45 meters in length that produces a power of 1.6 MW. The design of the blade was done using the Blade Element Momentum theory and the Prandtl's tip loss factor was used. The aerodynamic loads and differential power at are tabulated and plotted. The finite element method for analysis of the blade is used. As the chord lengths vary decreasingly along the blade radii in order to use the simple beam theory the breath and height of the blade is considered as a function of the chord length, hence the analysis is done assuming the blade to be a tapered hollow beam. The first few natural frequencies in the axial and transverse direction and mode shapes are calculated and plotted. In order to reduce the weight of the blade designed and increase the power two sets of optimization was done. The design variables are the chord lengths, with objective function as power mass constraints was used. The other optimization was using the mass as objective function and power as the constraint. The chord distribution results are plotted and discussed.

This dissertation, "Design Optimization of a Micro Wind Turbine Using Computational Fluid Dynamics" by Yun, Deng, ??, was obtained from The University of Hong Kong (Pokfulam, Hong Kong) and is being sold pursuant to Creative Commons: Attribution 3.0 Hong Kong License. The content of this dissertation has not been altered in any way. We have altered the formatting in order to facilitate the ease of printing and reading of the dissertation. All rights not granted by the above license are retained by the author. DOI: 10.5353/th_b4098770 Subjects: Wind turbines - Design and construction Computational fluid dynamics

Renewable energies constitute excellent solutions to both the increase of energy consumption and environment problems. Among these energies, wind energy is very interesting. Wind energy is the subject of advanced research. In the development of wind turbine, the design of its different structures is very important. It will ensure: the robustness of the system, the energy efficiency, the optimal cost and the high reliability. The use of advanced control technology and new technology products allows bringing the wind energy conversion system in its optimal operating mode. Different strategies of control can be applied on generators, systems relating to blades, etc. in order to extract maximal power from the wind. The goal of this book is to present recent works on design, control and applications in wind energy conversion systems.

Uncertainties play a dominant role in the design and optimization of structures and infrastructures. In optimum design of structural systems due to variations of the material, manufacturing variations, variations of the external loads and modelling uncertainty, the parameters of a structure, a structural system and its environment are not given, fixed coefficients, but random variables with a certain probability distribution. The increasing necessity to solve complex problems in Structural Optimization, Structural Reliability and Probabilistic Mechanics, requires the development of new ideas, innovative methods and numerical tools for providing accurate numerical solutions in affordable computing times. This book presents the latest findings on structural optimization considering uncertainties. It contains selected contributions dealing with the use of probabilistic methods for the optimal design of different types of structures and various considerations of uncertainties. The first part is focused on reliability-based design optimization and the second part on robust design optimization. Comprising twenty-one, self-contained chapters by prominent authors in the field, it forms a complete collection of state-of-the-art theoretical advances and applications in the fields of structural optimization, structural reliability, and probabilistic computational mechanics. It is recommended to researchers, engineers, and students in civil, mechanical, naval and aerospace engineering and to professionals working on complicated costs-effective design problems.

Wind turbines are one of the most promising renewable energy technologies, and this motivates fertile research activity about developments in power optimization. This topic covers a wide range of aspects, from the research on aerodynamics and control design to the industrial applications about on-site wind turbine performance control and monitoring. This Special Issue collects seven research papers about several innovative aspects of the multi-faceted topic of wind turbine power optimization technology. The seven research papers deal respectively with the aerodynamic optimization of wind turbine blades through Gurney flaps; optimization of blade design for large offshore wind turbines; control design optimization of large wind turbines through the analysis of the competing objectives of energy yield maximization and fatigue loads minimization; design optimization of a tension leg platform for floating wind turbines; innovative methods for the assessment of wind turbine optimization technologies operating on site; optimization of multiple wake interactions modeling through the introduction of a mixing coefficient in the energy balance method; and optimization of the dynamic stall control of vertical-axis wind turbines through plasma actuators. This Special Issue presents remarkable research activities in the timely subject of wind turbine power optimization technology, covering various aspects. The collection is believed to be beneficial to readers and contribute to the wind power industry.

This book reviews the status quo and visions for the future in the wind energy industry in China and around the globe, focusing on its roles in optimizing energy structure, alleviating environmental pollution, and coping with climate change. Providing a blueprint of wind power development till 2050, it suggests a series of further measures in the context of policies, regulations, laws, and marketing in order to overcome the existing bottlenecks. Moreover, it proposes a number of potential innovative technologies related to IT+ and advanced manufacturing, including integrated & distributed power and micro-grid systems, multi-energy complement, green and intelligent manufacturing, reliability design, blade design, manufacturing and maintenance, drive drain systems, and offshore wind farms. This book offers researchers and engineers insights into sustainable development in the wind power industry.

This book contains state-of-the-art contributions in the field of evolutionary and deterministic methods for design, optimization and control in engineering and sciences. Specialists have written each of the 34 chapters as extended versions of selected papers presented at the International Conference on Evolutionary and Deterministic Methods for Design, Optimization and Control with Applications to Industrial and Societal Problems (EUROGEN 2013). The conference was one of the Thematic Conferences of the European Community on Computational Methods in Applied Sciences (ECCOMAS). Topics treated in the various chapters are classified in the following sections: theoretical and numerical methods and tools for optimization (theoretical methods and tools; numerical methods and tools) and engineering design and societal applications (turbo machinery; structures, materials and civil engineering; aeronautics and astronautics; societal applications; electrical and electronics applications), focused particularly on intelligent systems for multidisciplinary design optimization (mdo) problems based on multi-hybridized software, adjoint-based and one-shot methods, uncertainty quantification and optimization, multidisciplinary design optimization, applications of game theory to industrial optimization problems, applications in structural and civil engineering optimum design and surrogate models based optimization methods in aerodynamic design.

Design Optimization of Fluid Machinery: Applying Computational Fluid Dynamics and Numerical Optimization Drawing on extensive research and experience, this timely reference brings together numerical optimization methods for fluid machinery and its key industrial applications. It logically lays out the context required to understand computational fluid dynamics by introducing the basics of fluid mechanics, fluid machines and their components. Readers are then introduced to single and multi-objective optimization methods, automated optimization, surrogate models, and evolutionary algorithms. Finally, design approaches and applications in the areas of pumps, turbines, compressors, and other fluid machinery systems are clearly explained, with special emphasis on renewable energy systems. Written by an international team of leading experts in the field Brings together optimization methods using computational fluid dynamics for fluid machinery in one handy reference Features industrially important applications, with key sections on renewable energy systems Design Optimization of Fluid Machinery is an essential guide for graduate students, researchers, engineers working in fluid machinery and its optimization methods. It is a comprehensive reference text for advanced students in mechanical engineering and related fields of fluid dynamics and aerospace engineering.

?????????,?????????????????,??????????????????????????????

The area of wind energy is a rapidly evolving field and an intensive research and development has taken place in the last few years. Therefore, this book aims to provide an up-to-date comprehensive overview of the current status in the field to the research community. The research works presented in this book are divided into three main groups. The first group deals with the different types and design of the wind mills aiming for efficient, reliable and cost effective solutions. The second group deals with works tackling the use of different types of generators for wind energy. The third group is focusing on improvement in the area of control. Each chapter of the book offers detailed information on the related area of its research with the main objectives of the works carried out as well as providing a comprehensive list of references which should provide a rich platform of research to the field.

This work seeks to add a new approach to optimize a wind turbine blade's performance by implementing a design with a variation in the chord, twist and the use of 3 different airfoils for the maximization of the Annual Energy Production. A baseline design of the blade starts with a replica of the Phase VI blade utilized in a NASA-Ames experiment and a MatLab script utilizes the Blade Element Momentum Theory (BEM) for the aerodynamic analysis. The optimization is performed by utilizing the SQP method for Local Search with the Phase VI baseline design as a starting point in the algorithm. Results show a 23% improvement in energy production by using this method.

Shape optimization is widely used in the design of wind turbine blades. In this dissertation, a numerical optimization method called Genetic Algorithm (GA) is applied to address the shape optimization of wind turbine airfoils and blades. In recent years, the airfoil sections with blunt trailing edge (called flatback airfoils) have been proposed for the inboard regions of large wind-turbine blades because they provide several structural and aerodynamic performance advantages. The FX, DU and NACA 64 series airfoils are

thick airfoils widely used for wind turbine blade application. They have several advantages in meeting the intrinsic requirements for wind turbines in terms of design point, off-design capabilities and structural properties. This research employ both single- and multi-objective genetic algorithms (SOGA and MOGA) for shape optimization of Flatback, FX, DU and NACA 64 series airfoils to achieve maximum lift and/or maximum lift to drag ratio. The commercially available software FLUENT is employed for calculation of the flow field using the Reynolds-Averaged Navier-Stokes (RANS) equations in conjunction with a two-equation Shear Stress Transport (SST) turbulence model and a three equation k-kl-[omega] turbulence model. The optimization methodology is validated by an optimization study of subsonic and transonic airfoils (NACA0012 and RAE 2822 airfoils). All the optimization results have demonstrated that the GA technique can be employed efficiently and accurately to produce globally optimal airfoils with excellent aerodynamic properties using a desired objective value (minimum Cd and/or maximum Cl /Cd). It is also shown that the multi-objective genetic algorithm based optimization can generate superior airfoils compared to those obtained by using the single objective genetic algorithm. The applications of thick airfoils are extended to the assessment of wind turbine performance. It is well established that the power generated by a Horizontal-Axis Wind Turbine (HAWT) is a function of the number of blades B, the tip speed ratio [lambda] (blade tip speed/wind free stream velocity) and the lift to drag ratio (Cl /Cd) of the airfoil sections of the blade. The airfoil sections used in HAWT are generally thick airfoils such as the S, DU, FX, Flat-back and NACA 6-series of airfoils. These airfoils vary in (Cl /Cd) for a given B and [lambda], and therefore the power generated by HAWT for different blade airfoil sections will vary. Another goal of this study is to evaluate the effect of different airfoil sections on HAWT performance using the Blade Element Momentum (BEM) theory. In this dissertation, we employ DU 91-W2-250, FX 66-S196-V1, NACA 64421, and Flat-back series of airfoils (FB-3500-0050, FB-3500-0875, and FB-3500-1750) and compare their performance with S809 airfoil used in NREL Phase II and III wind turbines; the lift and drag coefficient data for these airfoils sections are available. The output power of the turbine is calculated using these airfoil section blades for a given B and [lambda] and is compared with the original NREL Phase II and Phase III turbines using S809 airfoil section. It is shown that by a suitable choice of airfoil section of HAWT blade, the power generated by the turbine can be significantly increased. Parametric studies are also conducted by varying the turbine diameter. In addition, a simplified dynamic inflow model is integrated into the BEM theory. It is shown that the improved BEM theory has superior performance in capturing the instantaneous behavior of wind turbines due to the existence of wind turbine wake or temporal variations in wind velocity. The dissertation also considers the Wind Farm layout optimization problem using a genetic algorithm. Both the Horizontal -Axis Wind Turbines (HAWT) and Vertical-Axis Wind Turbines (VAWT) are considered. The goal of the optimization problem is to optimally position the turbines within the wind farm such that the wake effects are minimized and the power production is maximized. The reasonably accurate modeling of the turbine wake is critical in determination of the optimal layout of the turbines and the power generated. For HAWT, two wake models are considered; both are found to give similar answers. For VAWT, a very simple wake model is employed. Finally, some preliminary investigation of shape optimization of 3D wind turbine blades at low Reynolds numbers is conducted. The optimization employs a 3D straight untapered wind turbine blade with cross section of NACA 0012 airfoils as the geometry of baseline blade. The optimization objective is to achieve maximum Cl /Cd as well as maximum Cl. The multi-objective genetic algorithm is employed together with the commercially available software FLUENT for calculation of the flow field using the Reynolds-Averaged Navier-Stokes (RANS) equations in conjunction with a one-equation Sparlart-Allmaras turbulence model. The results show excellent performance of the optimized wind turbine blade and indicate the feasibility of optimization on real wind turbine blades with more complex shapes in the future.
The objectives of this study are (1) to develop an accurate and efficient fatigue analysis procedure that can be used in reliability analysis and reliability-based design optimization (RBDO) of composite wind turbine blades; (2) to develop a wind load uncertainty model that provides realistic uncertain wind load for the reliability analysis and the RBDO process; and (3) to obtain an optimal composite wind turbine blade that satisfies target reliability for durability under the uncertain wind load. The current research effort involves: (1) developing an aerodynamic analysis method that can effectively calculate detailed wind pressure on the blade surface for stress analysis; (2) developing a fatigue failure criterion that can cope with non-proportional multi-axial stress states in composite wind turbine blades; (3) developing a wind load uncertainty model that represents realistic uncertain wind load for fatigue reliability of wind turbine systems; (4) applying the wind load uncertainty model into a composite wind turbine blade and obtaining an RBDO optimum design that satisfies a target probability of failure for a lifespan of 20 years under wind load uncertainty. In blade fatigue analysis, resultant aerodynamic forces are usually applied at the aerodynamic centers of the airfoils of a blade to calculate stress/strain. However, in reality the wind pressures are applied on the blade surface. A wind turbine blade is often treated as a typical beam-like structure for which fatigue life calculations are limited in the edge-wise and/or flap-wise direction(s). Using the beam-like structure, existing fatigue analysis methods for composite wind turbine blades cannot cope with the non-proportional multi-axial stress states that are endured by wind turbine blades during operation.

Research into advanced wind turbine design has shown that load alleviation strategies like bend-twist coupled blades and coned rotors could reduce costs. However these strategies are based on nonlinear aero-structural dynamics providing additional benefits to components beyond the blades. These innovations will require Multi-disciplinary Design Optimization (MDO) to realize the full benefits.This research expands the MDO capabilities of Horizontal Axis Wind Turbines. The early research explored the numerical stability properties of Blade Element Momentum (BEM) models. Then developed a provincial scale wind farm siting models to help engineers determine the optimal design parameters. The main focus of this research was to incorporate advanced analysis tools into an aero-elastic optimization framework. To adequately explore advanced designs with optimization, a new set of medium fidelity analysis tools is required. These tools need to resolve more of the physics than conventional tools like (BEM) models and linear beams, while being faster than high fidelity techniques like grid based computational fluid dynamics and shell and brick based finite element models.

Structural topology optimization is a mathematical approach developed to perform design optimization with the purpose of reducing the material usage, while maximizing structural performance, in accordance to specific design constraints. The principles behind this technique have been around for many decades, but recent advancements in the processing power of computers have allowed for the solving of complex problems, such as the optimization of tall wind turbine towers, bridges, and the bracing systems in skyscrapers. There are two approaches commonly used in structural topology optimization: discrete and continuum. This thesis uses continuum topology optimization, which involves adjusting the distribution of a porous elastic solid material to extremize the design objective(s) and to satisfy constraints. The material porosity is the design variable that is adjusted during the optimization process. The design domain is broken down into a system of continuum degenerated finite elements, which are used for both structural analysis and to create a mesh representation of the structural system, just as pixels make up a picture. Solid elements are modeled as having no porosity, while void spaces have total porosity. As the optimization process occurs, the shape of the boundaries, and the number and size of internal holes are altered in order to best meet the design objective(s) and constraint(s). The purpose of performing continuum structural topology optimization of structural elements is to obtain promising concepts which provide a basis upon which to begin the design process. The steps taken in this thesis to optimize the wind turbine tower are: 1. Create a solid model of the tower domain 2. Define the material properties 3. Determine the equivalent static design wind forces using the extreme loading conditions outlined in IEC 61400 4. Formulate the optimization problem by specifying the objective and constraint functions. 5. Solve the optimization problem and interpret the results. This study on continuum topology optimization on the tower shell, indicates even with a significant reduction in material from the original design space, the structure is capable of meeting the design criteria. The results indicate that opening void spaces in the shell of the tower and creating an open lattice shape may be an effective method to reduce the volume of wind turbine towers, as it has in other applications. This concurs with the stated goal of my research, which is to show that topology optimization has the potential to be used in a multitude of practical applications in order to increase efficiency, and reduce cost of the production of wind power.

This book presents numerical and experimental research in the field of wind energy exploitation in urban environments. It comprises a selection of the best papers from the international colloquium “Research and Innovation on Wind Energy Exploitation in Urban Environment” (TUrbWind), held in Riva del Garda, Italy in September 2018. The book includes contributions from different research fields in urban wind resources, wind energy conversion systems, and urban integration, mainly focusing on the following topics: · turbine concepts for urban and sub-urban environment; · measuring and modelling wind resource; · rotor aerodynamics, wakes and noise; · design, loads, and supporting structures; · novel shapes and materials; · building concepts for wind energy exploitation; · planning approaches for wind exploitation in urban areas. It is a valuable resource for researchers and practitioners interested in the integration of wind energy systems and turbines in urban areas.

Offshore floating wind turbine technology is growing rapidly and has the potential to become one of the main sources of affordable renewable energy. However, this technology is still immature owing in part to complications from the integrated design of wind turbines and floating platforms, aero-hydro-servo-elastic responses, grid integrations, and offshore wind resource assessments. This research focuses on developing methodologies to investigate the technical and economic feasibility of a wide range of floating offshore wind turbine support structures. To achieve this goal, interdisciplinary interactions among hydrodynamics, aerodynamics, structure and control subject to constraints on stresses/loads, displacements/rotations, and costs need to be considered. Therefore, a multidisciplinary design optimization approach for minimum levelized cost of energy executed using parameterization schemes for floating support structures as well as a frequency domain dynamic model for the entire coupled system. This approach was based on a tractable framework and models (i.e. not too computationally expensive) to explore the design space, but retaining required fidelity/accuracy. In this dissertation, a new frequency domain approach for a coupled wind turbine, floating platform, and mooring system was developed using a unique combination of the validated numerical tools FAST and WAMIT. Irregular wave and turbulent wind loads were incorporated using wave and wind power spectral densities, JONSWAP and Kaimal. The system submodels are coupled to yield a simple frequency domain model of the system with a flexible moored support structure. Although the model framework has the capability of incorporating tower and blade structural DOF, these components were considered as rigid bodies for further simplicity here. A collective blade pitch controller was also defined for the frequency domain dynamic model to increase the platform restoring moments. To validate the proposed framework, predicted wind turbine, floating platform and mooring system responses to the turbulent wind and irregular wave loads were compared with the FAST time domain model. By incorporating the design parameterization scheme and the frequency domain modeling the overall system responses of tension leg platforms, spar buoy platforms, and semisubmersibles to combined turbulent wind and irregular wave loads were determined. To calculate the system costs, a set of cost scaling tools for an offshore wind turbine was used to estimate the levelized cost of energy. Evaluation and comparison of different classes of floating platforms was performed using a Kriging-Bat optimization method to find the minimum levelized cost of energy of a 5 MW NREL offshore wind turbine across standard operational environmental conditions. To show the potential of the method, three baseline platforms including the OC3-Hywind spar buoy, the MIT/NREL TLP, and the OC4-DeepCwind semisubmersible were compared with the results of design optimization. Results for the tension leg and spar buoy case studies showed 5.2% and 3.1% decrease in the levelized cost of energy of the optimal design candidates in comparison to the MIT/NREL TLP and the OC3-Hywind respectively. Optimization results for the semisubmersible case study indicated that the levelized cost of energy decreased by 1.5% for the optimal design in comparison to the OC4-DeepCwind.

Modern and larger horizontal-axis wind turbines with power capacity reaching 15 MW and rotors of more than 235-meter diameter are under continuous development for the merit of minimizing the unit cost of energy production (total annual cost/annual energy produced). Such valuable advances in this competitive source of clean energy have made numerous research contributions in developing wind industry technologies worldwide. This book provides important information on the optimum design of wind energy conversion systems (WECS) with a comprehensive and self-contained handling of design fundamentals of wind turbines. Section I deals with optimal production of energy, multi-disciplinary optimization of wind turbines, aerodynamic and structural dynamic optimization and aeroelasticity of the rotating blades. Section II considers operational monitoring, reliability and optimal control of wind turbine components.

"Development of a multidisciplinary design optimization (MDO) of a large scale hybrid composite wind turbine blade is performed. Multiple objectives are considered in the MDO process to maximize annual energy production and lifetime profit, minimize weight and power production rate. A wind turbine blade is divided into regions and the layup sequences for each region are considered as deign variables. The scale of wind turbine blade is also considered to find the optimum size of a wind turbine blade. Applied loads due to extreme wind conditions for rotor rotation and rotor stop condition are considered for finite element analysis (FEA) to evaluate the structural strength."--Leaf iv.

Design Optimization of Wind Energy Conversion Systems with ApplicationsSpecial Issues on Design Optimization of Wind Turbine Structures

Wind Turbine Airfoils and Blades introduces new ideas in the design of wind turbine airfoils and blades based on functional integral theory and the finite element method, accompanied by results from wind tunnel testing. The authors also discuss the optimization of wind turbine blades as well as results from aerodynamic analysis. This book is suitable for researchers and engineers in aeronautics and can be used as a textbook for graduate students.

A rigorous yet accessible graduate textbook covering both fundamental and advanced optimization theory and algorithms.

"Innovation in Wind Turbine Design covers the basics of design and the reasons behind design choices, as well as the methodology for evaluating innovative systems and components, always referencing a state of the art system for comparison. Thus the reader is able to understand current technology and the reasoning behind progress to date, before assessing where it can go in the future. It discusses the basics, as well as how to apply existing engineering knowledge to further technology.Innovation in Wind Turbine Design is divided into three main sections: introduction, design background and technology evaluation. Section 1 reviews the evolution of modern wind technology and establishes the basis for evaluating standard and innovative designs. Section 2 reviews the optimization of rotor design, discusses wind energy conversion systems, drive trains, scaling issues and offshore wind turbines, and concludes with an overview of technology trends with a glimpse of possible future technology. Section 3 comprises a global view of the multitude of design options for wind turbine systems, the basis for comparative valuation and evaluation methodology, cost of energy assessment and includes a number of innovative examples, some from working experiences for commercial clients. Draws upon the author's 30 years industry experience to synergize the separate fields of engineering innovation and wind technology into one practical reference text Enables both creative and analytical thinking as well as engineering insight that is invaluable in the early stages of parametric studies Includes innovative examples from working experiences for commercial clients Includes previously unpublished or little disseminated theory, including the author's recent research solving a problem generalizing Betz' theory to account for the behavior of rotors in ducts or non-uniform flow regions"--

Special Issues on Design Optimization of Wind Turbine Structures.