Multidisciplinary Design Optimization Methods For Electrical Machines And Drive Systems Power Systems

The volume includes papers from the WSCMO conference in Braunschweig 2017 presenting research of all aspects of the optimal design of structures as well as multidisciplinary design optimization where the involved disciplines deal with the analysis of solids, fluids or other field problems. Also presented are practical applications of optimization methods and the corresponding software development in all branches of technology.

Spotlighting the field of Multidisciplinary Design Optimization (MDO), this book illustrates and implements state-of-the-art methodologies within the complex process of aerospace system design under uncertainties. The book provides approaches to integrating a multitude of components and constraints with the ultimate goal of reducing design cycles. Insights on a vast assortment of problems are provided, including discipline modeling, sensitivity analysis, uncertainty propagation, reliability analysis, and global multidisciplinary optimization. The extensive range of topics covered include areas of current open research. This Work is destined to become a fundamental reference for aerospace systems engineers, researchers, as well as for practitioners and engineers working in areas of optimization and uncertainty. Part I is largely comprised of fundamentals. Part II presents methodologies for single discipline problems with a review of existing uncertainty propagation, reliability analysis, and optimization techniques. Part III is dedicated to the uncertainty-based MDO and related issues. Part IV deals with three MDO related issues: the multifidelity, the multi-objective optimization and the mixed continuous/discrete optimization and Part V is devoted to test cases for aerospace vehicle design.

Advances in Structural Optimization presents the techniques for a wide set of applications, ranging from the problems of size and shape optimization (historically the first to be studied) to topology and material optimization. Structural models are considered that use both discrete and finite elements. Structural materials can be classical or new. Emerging methods are also addressed, such as automatic differentiation, intelligent structures optimization, integration of structural optimization in concurrent engineering environments, and multidisciplinary optimization. For researchers and designers in industries such as aerospace, automotive, mechanical, civil, nuclear, naval and offshore. A reference book for advanced undergraduate or graduate courses on structural optimization and optimum design.

This book contains the edited version of lectures and selected papers presented at the NATO ADVANCED STUDY INSTITUTE ON COMPUTER AIDED OPTIMAL DESIGN: Structural and Mechanical Systems, held in Tr6ia, Portugal, 29th June to 11th July 1986, and organized by CEMUL -Center of Mechanics and Materials of the Technical University of Lisbon. The Institute was attended by 120 participants from 21 countries, including leading scientists and engineers from universities, research institutions and industry, and Ph.D. students. Some participants presented invited and contributed papers during the Institute and almost all participated actively in discussions on scientific aspects during the Institute. The Advanced Study Institute provided a forum for interaction among eminent scientists and engineers from different schools of thought and young reseachers. The Institute addressed the foundations and current state of the art of essential techniques related to computer aided optimal design of structural and mechanical systems, namely: Vari ational and Finite Element Methods in Optimal Design, Numerical Optimization Techniques, Design Sensitivity Analysis, Shape Optimal Design, Adaptive Finite Element Methods in Shape Optimization, CAD Technology, Software Development Techniques, Integrated Computer Aided Design and Knowledge Based Systems. Special topics of growing importance were also pre sented.

This book provides in-depth coverage of the latest research and development activities concerning innovative wind energy technologies intended to replace fossil fuels on an economical basis. A characteristic feature of the various conversion concepts discussed is the use of tethered flying devices to substantially reduce the material consumption per installed unit and to access wind energy at higher altitudes, where the wind is more consistent. The introductory chapter describes the emergence and economic dimension of airborne wind energy. Focusing on “Fundamentals, Modeling & Simulation”, Part I includes six contributions that describe quasi-steady as well as dynamic models and simulations of airborne wind energy systems or individual components. Shifting the spotlight to “Control, Optimization & Flight State Measurement”, Part II combines one chapter on measurement techniques with five chapters on control of kite and ground stations, and two chapters on optimization. Part III on “Concept Design & Analysis” includes three chapters that present and analyze novel harvesting concepts as well as two chapters on system component design. Part IV, which centers on “Implemented Concepts”, presents five chapters on established system concepts and one chapter about a subsystem for automatic launching and landing of kites. In closing, Part V focuses with four chapters on “Technology Deployment” related to market and financing strategies, as well as on regulation and the environment. The book builds on the success of the first volume “Airborne Wind Energy” (Springer, 2013), and offers a self-contained reference guide for researchers, scientists, professionals and students. The respective chapters were contributed by a broad variety of authors: academics, practicing engineers and inventors, all of whom are experts in their respective fields.

MULTIDESCIPLINARY design optimization (MDO) has developed in theory andpractice during the last three decades with the aim of optimizing complexproducts as well as cutting costs and product development time. Despite thisdevelopment, the implementation of such a method in industry is still a challenge andmany complex products suffer time and cost overruns. Employing higher fidelity models (HFMs) in conceptual design, one of the early and most important phases in the design process, can play an important role in increasing the knowledge base regarding the concept under evaluation. However, design space in the presence of HFMs could significantly be expanded. MDO has proven to be an important tool for searching the design space and finding optimal solutions. This leads to a reduction in

the number of design iterations later in the design process, with wiser and more robust decisions made early in the design process to rely on. In complex products, different systems from a multitude of engineering disciplines have to work tightly together. This stresses the importance of evolving various domain experts in the design process to improve the design from diverse engineering perspectives. Involving more engineers in the design process early on raises the challenges of collaboration, known to be an important barrier to MDO implementation in industry. Another barrier is the unavailability and lack of MDO experts in industry; those who understand the MDO process and know the implementation tasks involved. In an endeavor to address the mentioned implementation challenges, a novel collaborative multidisciplinary design optimization (CMDO) framework is defined in order to be applied in the conceptual design phase. CMDO provides a platform where many engineers team up to increase the likelihood of more accurate decisions being taken early on. The structured way to define the engineering responsibilities and tasks involved in MDO helps to facilitate the implementation process. It will be further elaborated that educating active engineers with MDO knowledge is an expensive and time-consuming process for industries. Therefore, a guideline for CMDO implementation in conceptual design is proposed in this thesis that can be easily followed by design engineers with limited prior knowledge in MDO. The performance of the framework is evaluated in a number of case studies, including applications such as aircraft design and the design of a tidal water power plant, and by engineers in industry and student groups in academia.

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

This book provides a comprehensive introduction to the mathematical and algorithmic methods for the Multidisciplinary Design Optimization (MDO) of complex mechanical systems such as aircraft or car engines. We have focused on the presentation of strategies efficiently and economically managing the different levels of complexity in coupled disciplines (e.g. structure, fluid, thermal, acoustics, etc.), ranging from Reduced Order Models (ROM) to full-scale Finite Element (FE) or Finite Volume (FV) simulations. Particular focus is given to the uncertainty quantification and its impact on the robustness of the optimal designs. A large collection of examples from academia, software editing and industry should also help the reader to develop a practical insight on MDO methods.

Multidisciplinary Design Optimization supported by Knowledge Based Engineering supports engineers confronting this daunting and new design paradigm. It describes methodology for conducting a system design in a systematic and rigorous manner that supports human creativity to optimize the design objective(s) subject to constraints and uncertainties. The material presented builds on decades of experience in Multidisciplinary Design Optimization (MDO) methods, progress in concurrent computing, and Knowledge Based Engineering (KBE) tools. Key features: Comprehensively covers MDO and is the only book to directly link this with KBE methods Provides a pathway through basic optimization methods to MDO methods Directly links design optimization methods to the massively concurrent computing technology Emphasizes real world engineering design practice in the application of optimization methods Multidisciplinary Design Optimization supported by Knowledge Based Engineering is a one-stop-shop guide to the state-of-the-art tools in the MDO and KBE disciplines for systems design engineers and managers. Graduate or post-graduate students can use it to support their design courses, and researchers or developers of computer-aided design methods will find it useful as a wide-ranging reference.

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.

This volume contains select papers presented during the 2nd National Conference on Multidisciplinary Analysis and Optimization. It discusses new developments at the core of optimization methods and its application in multiple applications. The papers showcase fundamental problems and applications which include domains such as aerospace, automotive and industrial sectors. The variety of topics and diversity of insights presented in the general field of optimization and its use in design for different applications will be of interest to researchers in academia or industry.

This book investigates Reliability-based Multidisciplinary Design Optimization (RBMDO) theory and its application in the design of deep manned submersibles (DMSs). Multidisciplinary Design Optimization (MDO) is an effective design method for large engineering systems like aircraft, warships, and satellites, which require designers and engineers from various disciplines to cooperate with each other. MDO can be used to handle the conflicts that arise between these disciplines, and focuses on the optimal design of the system as a whole. However, it can also push designs to the brink of failure. In order to keep the system balanced, Reliability-based Design (RBD) must be incorporated into MDO. Consequently, new algorithms and methods have to be developed for RBMDO theory. This book provides an essential overview of MDO, RBD, and RBMDO and subsequently introduces key algorithms and methods by means of case analyses. In closing, it introduces readers to the design of DMSs and applies RBMDO methods to the design of the manned hull and the general concept design. The book is intended for all students and researchers who are interested in system design theory, and

for engineers working on large, complex engineering systems.

Multidisciplinary design optimization (MDO) has recently emerged as a field of research and practice that brings together many previously disjointed disciplines and tools of engineering and mathematics. MDO can be described as a technology, environment, or methodology for the design of complex, coupled engineering systems, such as aircraft, automobiles, and other mechanisms, the behavior of which is determined by interacting subsystems.

Multidisciplinary Design Optimization supported by Knowledge Based Engineering provides a comprehensive guide to the use of Multidisciplinary Design Optimization (MDO) in the modern design environment. The combination of MDO and Knowledge Based Engineering (KBE), two rapidly developing technologies, can help to improve the robustness of the conceptual design process and these technologies and some examples of their application are the subject of this book. Multidisciplinary Design Optimization supported by Knowledge Based Engineering is divided into 4 parts, covering fundamental concepts, system details, MDO/KBE in real-world environments, and examples of MDO/KBE real-world applications. The aim of the book is to support an engineer confronting a complex engineering design problem requiring the application of MDO methods and technology.

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.

Although the overall appearance of modern airliners has not changed a lot since the introduction of jetliners in the 1950s, their safety, efficiency and environmental friendliness have improved considerably. Main contributors to this have been gas turbine engine technology, advanced materials, computational aerodynamics, advanced structural analysis and on-board systems. Since aircraft design became a highly multidisciplinary activity, the development of multidisciplinary optimization (MDO) has become a popular new discipline. Despite this, the application of MDO during the conceptual design phase is not yet widespread. Advanced Aircraft Design: Conceptual Design, Analysis and Optimization of Subsonic Civil Airplanes presents a quasi-analytical optimization approach based on a concise set of sizing equations. Objectives are aerodynamic efficiency, mission fuel, empty weight and maximum takeoff weight. Independent design variables studied include design cruise altitude, wing area and span and thrust or power loading. Principal features of integrated concepts such as the blended wing and body and highly non-planar wings are also covered. The quasi-analytical approach enables designers to compare the results of high-fidelity MDO optimization with lower-fidelity methods which need far less computational effort. Another advantage to this approach is that it can provide answers to “what if” questions rapidly and with little computational cost. Key features: Presents a new fundamental vision on conceptual airplane design optimization Provides an overview of advanced technologies for propulsion and reducing aerodynamic drag Offers insight into the derivation of design sensitivity information Emphasizes design based on first principles Considers pros and cons of innovative configurations Reconsiders optimum cruise performance at transonic Mach numbers Advanced Aircraft Design: Conceptual Design, Analysis and Optimization of Subsonic Civil Airplanes advances understanding of the initial optimization of civil airplanes and is a must-have reference for aerospace engineering students, applied researchers, aircraft design engineers and analysts.

A comprehensive introduction to optimization with a focus on practical algorithms for the design of engineering systems. This book offers a comprehensive introduction to optimization with a focus on practical algorithms. The book approaches optimization from an engineering perspective, where the objective is to design a system that optimizes a set of metrics subject to constraints. Readers will learn about computational approaches for a range of challenges, including searching high-dimensional spaces, handling problems where there are multiple competing objectives, and accommodating uncertainty in the metrics. Figures, examples, and exercises convey the intuition behind the mathematical approaches. The text provides concrete implementations in the Julia programming language. Topics covered include derivatives and their generalization to multiple dimensions; local descent and first- and second-order methods that inform local descent; stochastic methods, which introduce randomness into the optimization process; linear constrained optimization, when both the objective function and the constraints are linear; surrogate models, probabilistic surrogate models, and using probabilistic surrogate models to guide optimization; optimization under uncertainty; uncertainty propagation; expression optimization; and multidisciplinary design optimization. Appendixes offer an introduction to the Julia language, test functions for evaluating algorithm performance, and mathematical concepts used in the derivation and analysis of the optimization methods discussed in the text. The book can be used by advanced undergraduates and graduate students in mathematics, statistics, computer science, any engineering field, (including electrical engineering and aerospace engineering), and operations research, and as a reference for professionals.

This volume provides an up-to-date overview of major advances, emerging trends, and projected industrial applications in the field of multidisciplinary optimization. It concentrates on the current status of the field, exposes commonalities, innovative, promising, and speculative methods. This book provides a view of today’s multidisciplinary optimization environment through a balenced theoretical and practical treatment. The contributors are the foremost authorities in each area of specialisation.

Over the last years, Unmanned Aerial Vehicles (UAVs) have gradually become a more efficient alternative to manned aircraft, and at present, they are being deployed in a broad spectrum of both military as well as civilian missions. This has led to an unprecedented market expansion with new challenges for the aeronautical industry, and as a result, it has created a need to implement the latest design tools in order to achieve faster idea-to-market times and higher product performance. As a complex engineering product, UAVs are comprised of numerous sub-systems with intricate synergies and hidden dependencies. To this end, Multidisciplinary Design Optimization (MDO) is a method that can identify systems with better performance through the concurrent consideration of several engineering disciplines under a common framework. Nevertheless, there are still many limitations in MDO, and to this date, some of the most critical gaps can be found in the disciplinary modeling, in the analysis capabilities, and in the organizational integration of the method. As an aeronautical product, UAVs are also expected to work together with other systems and to perform in various operating environments. In this respect, System of Systems (SoS) models enable the exploration of design interactions in various missions, and hence, they allow decision makers to identify capabilities that are beyond those of each individual system. As expected, this significantly more complex formulation raises new challenges regarding the decomposition of the problem, while at the same time, it sets further requirements in terms of analyses and mission simulation. In this light, this thesis focuses on the design optimization of UAVs by enhancing the current MDO capabilities and by exploring the use of SoS models. Two literature reviews serve as the basis for identifying the gaps and trends in the field, and in

turn, five case studies try to address them by proposing a set of expansions. On the whole, the problem is approached from a technical as well as an organizational point of view, and thus, this research aims to propose solutions that can lead to better performance and that are also meaningful to the Product Development Process (PDP). Having established the above foundation, this work delves firstly into MDO, and more specifically, it presents a framework that has been enhanced with further system models and analysis capabilities, efficient computing solutions, and data visualization tools. At a secondary level, this work addresses the topic of SoS, and in particular, it presents a multi-level decomposition strategy, multi-fidelity disciplinary models, and a mission simulation module. Overall, this thesis presents quantitative data which aim to illustrate the benefits of design optimization on the performance of UAVs, and it concludes with a qualitative assessment of the effects that the proposed methods and tools can have on both the PDP and the organization.

The NASA Langley Multidisciplinary Design Optimization (MDO) method evaluation study seeks to arrive at a set of guidelines for using promising MDO methods by accumulating and analyzing computational data for such methods. The data are collected by conducting a series of reproducible experiments. This report documents all computational experiments conducted in Phase I of the study. This report is a companion to the paper titled Initial Results of an MDO Method Evaluation Study by N. M. Alexandrov and S. Kodiyalam (AIAA-98-4884). Kodiyalam, Srinivas Langley Research Center...

Choose the Correct Solution Method for Your Optimization ProblemOptimization: Algorithms and Applications presents a variety of solution techniques for optimization problems, emphasizing concepts rather than rigorous mathematical details and proofs. The book covers both gradient and stochastic methods as solution techniques for unconstrained and co

This book sheds light on the large-scale engineering systems that shape and guide our everyday lives. It does this by bringing together the latest research and practice defining the emerging field of Complex Engineered Systems. Understanding, designing, building and controlling such complex systems is going to be a central challenge for engineers in the coming decades. This book is a step toward addressing that challenge.

Many complex aeronautical design problems can be formulated with efficient multi-objective evolutionary optimization methods and game strategies. This book describes the role of advanced innovative evolution tools in the solution, or the set of solutions of single or multi disciplinary optimization. These tools use the concept of multi-population, asynchronous parallelization and hierarchical topology which allows different models including precise, intermediate and approximate models with each node belonging to the different hierarchical layer handled by a different Evolutionary Algorithm. The efficiency of evolutionary algorithms for both single and multi-objective optimization problems are significantly improved by the coupling of EAs with games and in particular by a new dynamic methodology named “Hybridized Nash-Pareto games”. Multi objective Optimization techniques and robust design problems taking into account uncertainties are introduced and explained in detail. Several applications dealing with civil aircraft and UAV, UCAV systems are implemented numerically and discussed. Applications of increasing optimization complexity are presented as well as two hands-on test cases problems. These examples focus on aeronautical applications and will be useful to the practitioner in the laboratory or in industrial design environments. The evolutionary methods coupled with games presented in this volume can be applied to other areas including surface and marine transport, structures, biomedical engineering, renewable energy and environmental problems. This book will be of interest to students, young scientists and engineers involved in the field of multi physics optimization.

This book presents various computationally efficient component- and system-level design optimization methods for advanced electrical machines and drive systems. Readers will discover novel design optimization concepts developed by the authors and other researchers in the last decade, including application-oriented, multi-disciplinary, multi-objective, multi-level, deterministic, and robust design optimization methods. A multi-disciplinary analysis includes various aspects of materials, electromagnetics, thermotics, mechanics, power electronics, applied mathematics, manufacturing technology, and quality control and management. This book will benefit both researchers and engineers in the field of motor and drive design and manufacturing, thus enabling the effective development of the high-quality production of innovative, high-performance drive systems for challenging applications, such as green energy systems and electric vehicles.

“Collaborative Product and Service Life Cycle Management for a Sustainable World” gathers together papers from the 15th ISPE International Conference on Concurrent Engineering (CE2008), to stimulate the new thinking that is so crucial to our sustained productivity enhancement and quality of life. It is already evident in this new century that the desire for sustainable development is increasingly driving the market to reach for new and innovative solutions that more effectively utilize the resources we have inherited from previous generations; with the obvious responsibility to future generations. Human productivity and progress can be positively engineered and managed in harmony with the provision and needs of our natural environment. One century on from the industrial revolution, this is now the time of the sustainable revolution; requiring holistic technological, process and people integrated solutions to sustained socio-economic enhancement.

Multidisciplinary Design Optimization is a rapidly growing field of study. It falls under the umbrella of engineering and focuses on solving design related problems with the help of optimization methods. The techniques are also helpful and useful in other fields like automobile design, electronics, computers, etc. This book aims to elaborately discuss the various problem solving techniques under the broader category of design optimization like gradient based methods, population based methods and gradient free methods, etc. As this field is emerging at a rapid pace, the contents of this book will help the readers understand the modern concepts and applications of the subject. From theories to research to practical applications, case studies related to all contemporary topics of relevance to the field of multidisciplinary design optimization have been included in this book.

Multidisciplinary design optimization (MDO) can be used in computer aided engineering (CAE) to efficiently improve and balance performance of automotive structures. However, large-scale MDO is not yet generally integrated within automotive product development due to several challenges, of which excessive computing times is the most important one. In this thesis, a metamodel-based MDO process that fits normal company organizations and CAE-based development processes is presented. The introduction of global metamodels offers means to increase computational efficiency and distribute work without implementing complicated multi-level MDO methods. The presented MDO process is proven to be efficient for thickness optimization studies with the objective to minimize mass. It can also be used for spot weld optimization if the models are prepared correctly. A comparison of different methods reveals that topology optimization, which requires less model preparation and computational effort, is an alternative if load cases involving simulations of linear systems are judged to be of major importance. A technical challenge when performing metamodel-based design optimization is lack of accuracy for metamodels representing complex responses including discontinuities, which are common in for example crashworthiness applications. The decision boundary from a support vector machine (SVM) can be used to identify the border between different types of deformation behaviour. In this thesis, this information is used to improve the accuracy of feedforward neural network metamodels. Three different approaches are tested; to split the design space and fit separate metamodels for the different regions, to add estimated guiding samples to the fitting set along the boundary

before a global metamodel is fitted, and to use a special SVM-based sequential sampling method. Substantial improvements in accuracy are observed, and it is found that implementing SVM-based sequential sampling and estimated guiding samples can result in successful optimization studies for cases where more conventional methods fail.

This book contains thirty-five 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 2017). This was one of the Thematic Conferences of the European Community on Computational Methods in Applied Sciences (ECCOMAS). Topics treated in the various chapters reflect the state of the art in theoretical and numerical methods and tools for optimization, and engineering design and societal applications. The volume focuses 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.

A new MDO method, BLISS, and two different variants of the method, BLISS/RS and BLISS/S, have been implemented using iSIGHT's scripting language and evaluated in this report on multidisciplinary problems. All of these methods are based on decomposing a modular system optimization system into several subtasks optimization, that may be executed concurrently, and the system optimization that coordinates the subtasks optimization. The BLISS method and its variants are well suited for exploiting the concurrent processing capabilities in a multiprocessor machine. Several steps, including the local sensitivity analysis, local optimization, response surfaces construction and updates are all ideally suited for concurrent processing. Needless to mention, such algorithms that can effectively exploit the concurrent processing capabilities of the compute servers will be a key requirement for solving large-scale industrial design problems, such as the automotive vehicle problem detailed in Section 3.4.Kodiyalam, Srinivas and Yuan, Charles and Sobieski, Jaroslaw (Technical Monitor)Goddard Space Flight Center; Langley Research CenterMULTIDISCIPLINARY DESIGN OPTIMIZATION; CONCURRENT PROCESSING; DESIGN ANALYSIS; SYSTEMS ENGINEERING; PARALLEL PROCESSING (COMPUTERS); MULTIPROCESSING (COMPUTERS); ALGORITHMS; SYSTEMS ANALYSIS

"We present a novel multi-model management method for numerical design optimization. The goal is to determine whether any of the analysis models associated with lower computational cost (that are typically expected to have inferior predictive capability relative to models associated with higher computational cost) can be used in certain areas of the design space as the latter is being explored during the optimization process. The framework quantifies and utilizes relative errors among available models regardless of their expected fidelity to enhance the predictive capability of inexpensive models and reduce the use of expensive ones. We implement our strategy by means of a trust-region management framework that utilizes the mesh adaptive direct search derivative-free optimization algorithm. We first present the methodology for single-disciplinary design optimization problems and demonstrate it using a cantilevered flexible beam example. Results show significant reduction in the computational cost of the optimization process. We also investigate the scalability of the proposed method using an airfoil shape optimization problem.We then proceed to extend our method to solve multidisciplinary design optimization problems with particular emphasis on strongly-coupled fluid-structure interaction. We illustrate that interactions can have a significant impact on multi-model management as models that could have been selected in a single-disciplinary analysis environment can be inadequate in a multidisciplinary analysis context. We implement our method for two multidisciplinary design optimization architectures: the monolithic multidisciplinary feasible formulation (also known as all-at-once) and a penalty-based distributed interdisciplinary feasible formulation.Finally, we extend the method to allow the consideration of time-dependent multidisciplinary design optimization problems. The algorithms are modified to automate the search for adequate modeling parameters during the time-dependent multidisciplinary analysis. We demonstrate the proposed time-invariant and time-dependent multidisciplinary design optimization methods by means of three problems: a flexible plate fluid-structure interaction problem, a flexible beam fluid-structure interaction problem, and a transonic fan flow problem. Results show that both methods are accurate and efficient and result in significant cost savings, especially in the presence of strongly-coupled disciplines"--

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