

Article

Multidiscipline Design Optimization for Large-Scale Complex Nonlinear Dynamic System Based on Weak Coupling Interfaces

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Abstract: For high-tech manufacturing industries, developing large-scale complex nonlinear dynamic systems must be taken as one of the basic works, formulating problems to be solved, steering system design in a more preferable direction, and making correct strategic decisions. By using effective tools of big data mining, Dynamic Design Methodology was proposed to establish a technical platform for Multidiscipline Design Optimization such as High-Speed Rolling Stock, including three key technologies: analysis graph of full-vehicle stability properties and variation patterns, improved transaction strategy of flexible body to MBS interface, seamless collaboration with weldline fatigue damage assessments through correct Modal Stress Recovery. By applying the above methodology, a self-adaptive improved solution was formulated with optimal parameter configuration, which is one of the more favorable options for higher-speed bogies. While within a velocity (140–200) km/h at $\lambda_c < 0.10$, car body instability's influence on ride comfort can be easily improved by using a semi-active vibration reduction technique between inter-vehicles through outer windshields. Comprehensive evaluations show that only under rational conditions of wheel-rail matching, i.e., $0.10 \geq \lambda_{cr} > \lambda_{crmin}$ and $\lambda_{crmax} = (0.03–0.06)$, can this low-cost solution achieve the three goals of low track concavity, optimal route planning, and investment benefit maximization. So, rail vehicle experts are necessary to collaborate and innovate intensively with passenger transportation and steel rail ones. Specifically, by adopting rail grinding treatment, occurrence probability is controlled at 85% and 5% for track concavity of (0.03–0.10) and (0.25–0.35). By optimizing routing planning, operating across dedicated lines of different speed grades can achieve self-cleaning of central hollow tread wear over time. According to the inherent rigid-flex coupling relationship, geometric nonlinearities of worn wheel-rail contact should be avoided as much as possible for HSR practices. Only under weak coupling interfaces in the floor frame can the structural integrity of an aluminum alloy car body be ensured.

Keywords: large-scale complex nonlinear dynamic system; multidiscipline design optimization; weak coupling interface; rigid-flex coupling simulation technique; modal stress recovery

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1. Introduction

As for high-tech manufacturing industries such as HSRS (High Speed Rail Stock), the dynamic design methodology should be actively recommended and introduced to better develop the corresponding large-scale complex nonlinear dynamic systems. Furthermore, by applying efficient tools such as PODA (Proper Orthogonal Decomposition Approach) or MMRT (Modal Modification Responding Technique), weak coupling interfaces are necessary to be constructed between different disciplines, by which the large-scale MDO (Multidiscipline Design Optimization) technical platform can be established, steering the system design in a more preferable direction.

Multidiscipline Design Optimization Solutions Manual

Rachel S Tattersall



Multidiscipline Design Optimization Solutions Manual:

Multidisciplinary Design Optimization and Its Application in Deep Manned Submersible Design Binbin

Pan, Weicheng Cui, 2020-08-28 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 Lessons Learned During Solutions of Multidisciplinary Design Optimization Problems

, 2000 Multiphysics Modelling and Simulation for Systems Design and Monitoring Mohamed Haddar, Mohamed Slim Abbes, Jean-Yves Choley, Taoufik Boukharouba, Tamer Elnady, Andrei Kanaev, Mounir Ben Amar, Fakher Chaari, 2015-01-03 This book reports on the state of the art in the field of multiphysics systems It consists of accurately reviewed contributions to the MMSSD 2014 conference which was held from December 17 to 19 2004 in Hammamet Tunisia The different chapters covering new theories methods and a number of case studies provide readers with an up to date picture of multiphysics modeling and simulation They highlight the role played by high performance computing and newly available software in promoting the study of multiphysics coupling effects and show how these technologies can be practically implemented to bring about significant improvements in the field of design control and monitoring of machines In addition to providing a detailed description of the methods and their applications the book also identifies new research issues challenges and opportunities thus providing researchers and practitioners with both technical information to support their daily work and a new source of inspiration for their future research **A Cascade Optimization Strategy for Solution of Difficult**

Multidisciplinary Design Problems, 1996 A research project to comparatively evaluate 10 nonlinear optimization algorithms was recently completed A conclusion was that no single optimizer could successfully solve all 40 problems in the test bed even though most optimizers successfully solved at least one third of the problems We realized that improved search directions and step lengths available in the 10 optimizers compared were not likely to alleviate the convergence difficulties For the solution of those difficult problems we have devised an alternative approach called cascade optimization strategy The cascade strategy uses several optimizers one followed by another in a specified sequence to solve a problem A pseudorandom

scheme perturbs design variables between the optimizers The cascade strategy has been tested successfully in the design of supersonic and subsonic aircraft configurations and air breathing engines for high speed civil transport applications These problems could not be successfully solved by an individual optimizer The cascade optimization strategy however generated feasible optimum solutions for both aircraft and engine problems This paper presents the cascade strategy and solutions to a number of these problems

Analytic Methods for Design Practice Gyung-Jin Park,2007-05-31 In the competitive world of modern engineering rigorous and definite design methodologies are needed However many parts of engineering design are performed in either an ad hoc manner or based on the intuition of the engineer This is the first book to look at both stages of the design process conceptual design and detailed design and detail design methodologies for every step of the design process The following analytic design methodologies are introduced and their usefulness is explored with many mathematical and practical examples Axiomatic design Optimization Design of experiments Robust design Structural optimization Dynamic response optimization and Multidisciplinary optimization Case studies show how practical design problems can be solved with analytic design methods Students will find this book an excellent introduction to the subject The book s practical focus will interest practising engineers as a practical handbook of design

A General-Purpose Optimization Engine for Multi-Disciplinary Design Applications Surya N. Patnaik,1996

Advances in Multidisciplinary Design, Analysis and Optimization Deepak Sharma,Sachin Singh Gautam,Tapan K. Mankodi,Ujjwal K. Saha,2025-05-22 This book contains select papers presented during the 6th National Conference on Multidisciplinary Analysis and Optimization The book focuses on design and analysis as applicable to optimization of engineering systems in aerospace mechanical automotive manufacturing biomedical and other domains The book includes papers on the topics such as metamodeling or surrogate modeling systems design and optimization optimization and additive manufacturing mixed integer and linear programming multiscale and multiphysics problems among others The book can be a valuable reference for researchers and professionals interested in the field of optimization and its use in design for different applications

Scientific and Technical Aerospace Reports ,1994 **Performance Trend of Different Algorithms for Structural Design Optimization** Surya N. Patnaik,1996 **Bi-Level Integrated System Synthesis (BLISS)** Jaroslaw Sobieszczanski-Sobieski,1998 **Optimization of Air-Breathing Engine Concept** Surya N. Patnaik,1996 *Proceedings of the ... ASME Design Engineering Technical Conferences* ,2005 **Advances in Design Automation, 1994: Robust design applications. Decomposition and design optimization. Optimization tools and applications** ,1994

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The Aeronautical Journal ,1999 **AIAA Journal** American Institute of Aeronautics and Astronautics,2008

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