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Multidisciplinary Design, Analysis, and Optimization Tool Development Using a Genetic Algorithm Feb 26 2022 Multidisciplinary design, analysis, and optimization using a genetic algorithm is being developed at the National Aeronautics and Space Administration Dryden Flight Research
Center (Edwards, California) to automate analysis and design process by leveraging existing tools to enable true multidisciplinary optimization in the preliminary design stage of subsonic, transonic, supersonic, and hypersonic aircraft. This is a promising technology, but faces many challenges in large-scale, real-world application. This report describes current approaches, recent results, and challenges for multidisciplinary design, analysis, and optimization as demonstrated by experience with the Ikhana fire pod design. Pak, Chan-gi and Li, Wesley Armstrong Flight Research Center NASA/TM-2009-214645, H-2921, DFRC-911

Recent Experiences in Multidisciplinary Analysis and Optimization, Part 2 Jun 20 2021

Progress Towards a Multidisciplinary Analysis and Optimisation Capability for Air Vehicle Design Apr 30 2022

Multidisciplinary Design Optimization in Computational Mechanics Jul 22 2021 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.

Advances in Structural Optimization Dec 03 2019 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.

Non-Deterministic Metamodeling for Multidisciplinary Design Optimization of Aircraft Systems Under Uncertainty Apr 06 2020 To make coupled multi-physics-informed design decisions, multidisciplinary analysis, design optimization and uncertainty quantification must be present to accurately represent the full system under investigation. Unfortunately, all of these processes are computationally demanding, requiring a large number of system evaluations with identified uncertain variables, and iterative system evaluations with respect to the design variables of interest. Surrogate or metamodels are used to alleviate the computational burden in both these design exploration activities by trading accuracy with efficiency. The primary objective of this dissertation is to develop a flexible surrogate modeling technique capable of quantifying the uncertainty of multidisciplinary systems in an iterative and efficient procedure. In this work, the Non-Deterministic Kriging (NDK) method is derived. This surrogate model represents a flexible approach for approximating epistemic and aleatory uncertainty. To achieve an iterative and efficient computational framework additional tasks were established: (1) characterize and develop a unified stochastic process incorporating incomplete and mixed uncertainty data; (2) develop a novel adaptive sampling method that effectively and efficiently updates the NDK model to enable a global multidisciplinary design optimization technique under uncertainty; (3) derive analytic sensitivities to achieve non-deterministic sensitivities with respect to the design variables; (4)
propose an efficient reliability-based design optimization framework for multidisciplinary systems using NDK to reduce the design space.

**Advances in Multidisciplinary Analysis and Optimization** Aug 03 2022 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.

**A Multidisciplinary Approach to Mixer-Ejector Analysis and Design** Feb 03 2020 The design of an engine for a civil supersonic aircraft presents a difficult multidisciplinary problem to propulsion system engineers. There are numerous competing requirements for the engine, such as to be efficient during cruise while yet quiet enough at takeoff to meet airport noise regulations. The use of mixer-ejector nozzles presents one possible solution to this challenge. However, designing a mixer-ejector which will successfully address both of these concerns is a difficult proposition. Presented in this paper is an integrated multidisciplinary approach to the analysis and design of these systems. A process that uses several low-fidelity tools to evaluate both the performance and acoustics of mixer-ejectors nozzles is described. This process is further expanded to include system-level modeling of engines and aircraft to determine the effects on mission performance and noise near airports. The overall process is developed in the OpenMDAO framework currently being developed by NASA. From the developed process, sample results are given for a notional mixer-ejector design, thereby demonstrating the capabilities of the method.
Financial Analysis in Multidisciplinary Design Optimization

Nov 13 2020

MDO is moving beyond the small group of NASA and Aerospace companies and is increasingly being adopted by organizations around the world. With MDO, we can optimize across multiple disciplines and find the ideal design which maximizes benefit to the company and society. Given the complexity of working with multiple disciplines and stakeholders, it is important to have a single metric which teams and organizations can use to choose the best design. Since financial metrics play a dominant role in the decision-making process, we can use them to choose the best design for the company. In the thesis, we created a framework for doing financial analysis in MDO. We applied the framework to the baseplate, a component used within the excavator pump, and optimized across three different disciplines of cost, natural frequency and temperature to find the baseplate design with the highest sales potential. We focused on sales as it is the most important financial metric for the product, but a similar framework can be used for maximizing profit, NPV, IRR or any other financial metric. We used two approaches for finding the best design for the company. In the first approach, we found designs which minimized cost and temperature, while increasing the natural frequency. We then converted the cost and temperature data into sales and chose the design with most sales. In the second approach, we only set one objective of maximizing sales and chose the design with the highest sales. In both the approaches we were able to significantly increase sales. We would recommend approach 1 as we get higher sales with the method, and because of limitations within the optimization software OptiSLang in regards to implementing approach 2. Approach 2 might become the better option in the coming years as MDO software, including OptiSLang, is in the early stage and might significantly improve. Approach 2 also has the advantage of MDO teams only setting one objective, helping establish consistency and uniformity in MDO implementation. We believe MDO has a lot of potential. Similar to CAD, it is an
extremely powerful tool. Some of the challenges to successful implementation were: computational resources, high quality and reliable financial data and early stage MDO software. Organizations which implement MDO will create better products which maximize savings and financial benefit.

Evaluation of Methods for Multidisciplinary Design Optimization (MDO) Sep 11 2020 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 Center MULTIDISCIPLINARY DESIGN OPTIMIZATION; CONCURRENT PROCESSING; DESIGN ANALYSIS; SYSTEMS ENGINEERING; PARALLEL PROCESSING (COMPUTERS); MULTIPROCESSING (COMPUTERS); ALGORITHMS; SYSTEMS ANALYSIS

Multidisciplinary Optimization in Aircraft Design Using Analysis Technology Models Jun 08 2020

Digital Transformation of Multidisciplinary Design Firms Apr 18 2021 This book analyzes the process-oriented and organizational changes related to the digital transformation of multidisciplinary
design firms. Based on this it proposes a systematic analysis-based methodology for change management, which consists of two distinct, but complementary components: a framework and a set of analysis methods. It particularly focuses on the relationship between the new paradigms, perspectives, and context of change related to digital transformation. The proposed framework combines these three elements in order to identify and address areas of investigation concerning process-oriented and organizational changes in the context of digital transformation, and also quantitatively and qualitatively assesses these changes in practice. This book offers the first comprehensive review of change management and digital practice, and includes case studies to enhance readers’ understanding of change management in the context of the digitalization. As such it is of interest to both industry practitioners and researchers.

MIDAS Aug 23 2021

Modeling and Management of Epistemic Uncertainty for Multidisciplinary System Analysis and Design Feb 14 2021

Multidisciplinary Design Optimization Supported by Knowledge Based Engineering Mar 06 2020

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.

**Multidisciplinary Design Optimization** Oct 05 2022

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.

**Design Engineering Journey** Aug 30 2019

This book provides an introductory treatment of the design methodology for undergraduate students in multiple disciplines. It introduces the principles of design, and discusses design tools and techniques from traditional and multidisciplinary perspectives and comprehensively explores the design engineering process. Innovation, creativity, design thinking, collaboration, communication, problem solving, and technical skills are increasingly being identified as key skills for practicing engineers in tackling today's complex design problems. Design Engineering Journey addresses the need for a design textbook that teaches these skills. It presents a broad multidisciplinary perspective to design that encourages students to be innovative and open to new ideas and concepts while also drawing on traditional design methods and strategies. For example, students are provided with design solutions inspired by nature as well as the arts to nurture their creative problem solving skills. This book provides an overview from establishing need to ideation of
concepts and realization techniques and prototyping, presented in an engaging and visually appealing manner, incorporating multidisciplinary examples that aim to reinforce the student's evolving design knowledge. The technical level of this book is kept at an introductory level so that freshman and sophomore students should be able to understand and solve a variety of design problems and come up with innovative concepts, and realize them through prototype and testing. This book also can serve as a reference text for senior capstone design projects, and the readers will find that the examples and scenarios presented are representative of problems faced by professional designers in engineering.

**Multidisciplinary Design Optimization Methods for Electrical Machines and Drive Systems**

Jan 16 2021

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.

**Analysis and Optimization Using Numerical and Experimental Evaluation Methods for Multidisciplinary Design Problems**

Nov 01 2019

The Multidisciplinary Design Optimization (MDO) system is needed to reduce the developing time and production cost in most industries. The MDO is the new technology for optimization design, and considers solid mechanics, dynamics, kinematics,
vibration/noise control, and fluid mechanics, simultaneously. Higher product quality, less developing time and lower manufacturing cost will be achieved through a balanced and organic MDO method. In this paper, numerical stress analysis, optimization method, and experimental stress analysis will be conducted to accomplish: 1) production cost; 2) developing time; 3) quality improvement; and 4) service-rate drop. First, the coupled analysis using the finite element method will be performed to obtain the accurate data. Second, OPTISTRUCT, which is commercial optimization software, will be used for shape and size optimization analysis. Third, an experimental stress analysis system will be established to assist the optimization design and numerical analysis.

**Multidisciplinary Design Optimization: An Emerging New Engineering Discipline** Sep 04 2022
Study of Surrogate Models in Multidisciplinary Analysis and Design Jul 10 2020
**Recent Experiences in Multidisciplinary Analysis and Optimization, Part 1** Oct 01 2019
Systems Design and Engineering Jan 28 2022

As its name implies, the aim of Systems Design and Engineering: Facilitating Multidisciplinary Development Projects is to help systems engineers develop the skills and thought processes needed to successfully develop and implement engineered systems. Such expertise typically does not come through study but from action, hard work, and cooperation. To that end, the authors have chosen a "hands-on" approach for presenting material rather than concentrating on theory, as so often is the case in a classroom setting. This attractive and accessible text is a mix of theory and practical approach, illustrated with examples that have enough richness and variability to hold your attention. Models are presented for controlling the design, change, and engineering processes. Various aspects of systems engineering and methods providing the big picture at system level are discussed. In some ways, you can think of the book as a compact "starter’s kit" for systems engineers. Although the authors are recognized experts in academic settings, they attribute
much of their success in systems engineering to their own hands-on experiences and want to show you how to achieve that same level of expertise. Simply reading this book or any other book will not suffice for the learning process to become a systems engineer - no book will do that. However, by following the principles laid out in this book, you can develop the necessary skills and expertise to help you start an interesting, challenging, and rewarding career as a systems engineer.

**Physically-based, Real-time Visualization and Constraint Analysis in Multidisciplinary Design Optimization** Jan 04 2020

Aerospace System Analysis and Optimization in Uncertainty Sep 23 2021 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.

**Multidisciplinary Concurrent Design Optimization Via the Internet** May 20 2021 A methodology
is presented which uses commercial design and analysis software and the Internet to perform concurrent multidisciplinary optimization. The methodology provides a means to develop multidisciplinary designs without requiring that all software be accessible from the same local network. The procedures are amenable to design and development teams whose members, expertise and respective software are not geographically located together. This methodology facilitates multidisciplinary teams working concurrently on a design problem of common interest. Partition of design software to different machines allows each constituent software to be used on the machine that provides the most economy and efficiency. The methodology is demonstrated on the concurrent design of a spacecraft structure and attitude control system. Results are compared to those derived from performing the design with an autonomous FORTRAN program.

Woodard, Stanley E. and Kelkar, Atul G. and Koganti, Gopichand

Langley Research Center

MULTIDISCIPLINARY DESIGN OPTIMIZATION; INTERNETS; DESIGN ANALYSIS; APPLICATIONS PROGRAMS (COMPUTERS); COMPUTER AIDED DESIGN; FORTRAN; SPACECRAFT STRUCTURES; AUTONOMY; ATTITUDE CONTROL

A multidisciplinary approach to mixer-ejector analysis and design

May 27 2019

Finite Element Multidisciplinary Analysis

Jul 02 2022 Annotation This book fills a gap within the finite element literature by addressing the challenges and developments in multidisciplinary analysis. Current developments include disciplines of structural mechanics, heat transfer, fluid mechanics, controls engineering and propulsion technology, and their interaction as encountered in many practical problems in aeronautical, aerospace, and mechanical engineering, among others. These topics are reflected in the 15 chapter titles of the book. Numerical problems are provided to illustrate the applicability of the techniques. Exercises may be solved either manually or by using suitable computer
software. A version of the multidisciplinary analysis program STARS is available from the author. As a textbook, the book is useful at the senior undergraduate or graduate level. The practicing engineer will find it invaluable for solving full-scale practical problems.

**Sensitivity Analysis and Multidisciplinary Optimization for Aircraft Design: Recent Advances and Results** Oct 25 2021

**Evaluation of Methods for Multidisciplinary Design Optimization (MDO)** Jun 28 2019

**A Multidisciplinary Approach to Mixer-Ejector Analysis and Design** Aug 11 2020 The design of an engine for a civil supersonic aircraft presents a difficult multidisciplinary problem to propulsion system engineers. There are numerous competing requirements for the engine, such as to be efficient during cruise while yet quiet enough at takeoff to meet airport noise regulations. The use of mixer-ejector nozzles presents one possible solution to this challenge. However, designing a mixer-ejector which will successfully address both of these concerns is a difficult proposition. Presented in this paper is an integrated multidisciplinary approach to the analysis and design of these systems. A process that uses several low-fidelity tools to evaluate both the performance and acoustics of mixer-ejectors nozzles is described. This process is further expanded to include system-level modeling of engines and aircraft to determine the effects on mission performance and noise near airports. The overall process is developed in the OpenMDAO framework currently being developed by NASA. From the developed process, sample results are given for a notional mixer-ejector design, thereby demonstrating the capabilities of the method. Hendricks, Eric, S. and Seidel, Jonathan, A. Glenn Research Center WBS 984754.02.07.03.12.02

**Jiao yu za zhi suo yin** Dec 15 2020

**Modified Cascade Correlation Neural Network and Its Applications to Multidisciplinary Analysis**
Multidisciplinary Design and Analysis for Commercial Aircraft Dec 27 2021

Multidisciplinary design and analysis (MDA) has become the normal mode of operation within most aerospace companies, but the impact of these changes have largely not been reflected at many universities. On an effort to determine if the emergence of multidisciplinary design concepts should influence engineering curricula, NASA has asked several universities (Virginia Tech, Georgia Tech, Clemson, BYU, and Cal Poly) to investigate the practicality of introducing MDA concepts within their undergraduate curricula. A multidisciplinary team of faculty, students, and industry partners evaluated the aeronautical engineering curriculum at Cal Poly. A variety of ways were found to introduce MDA themes into the curriculum without adding courses or units to the existing program. Both analytic and educational tools for multidisciplinary design of aircraft have been developed and implemented. Cummings, Russell M. and Freeman, H. JoAnne Ames Research Center

The Component Packaging Problem Jul 30 2019

This report summarizes academic research which has resulted in an increased appreciation for multidisciplinary efforts among our students, colleagues and administrators. It has also generated a number of research ideas that emerged from the interaction between disciplines. Overall, 17 undergraduate students and 16 graduate students benefited directly from the NASA grant: an additional 11 graduate students were impacted and participated without financial support from NASA. The work resulted in 16 theses (with 7 to be completed in the near future), 67 papers or reports mostly published in 8 journals and/or presented at various conferences (a total of 83 papers, presentations and reports published based on NASA inspired or supported work). In addition, the faculty and students presented related work at many meetings, and continuing work has
been proposed to NSF, the Army, Industry and other state and federal institutions to continue efforts in the direction of multidisciplinary and recently multi-objective design and analysis. The specific problem addressed is component packing which was solved as a multi-objective problem using iterative genetic algorithms and decomposition. Further testing and refinement of the methodology developed is presently under investigation. Teaming issues research and classes resulted in the publication of a web site, (http://design.eng.clemson.edu/psych4991) which provides pointers and techniques to interested parties. Specific advantages of using iterative genetic algorithms, hurdles faced and resolved, and institutional difficulties associated with multi-discipline teaming are described in some detail. Fadel, Georges and Bridgewood, Michael and Figliola, Richard and Greenstein, Joel and Kostreva, Michael and Nowaczyk, Ronald and Stevenson, Steve Glenn Research Center NGT10008; NAG3-2046; RTOP 505-90-52

Multidisciplinary Design, Analysis, and Optimization Tool Development Using a Genetic Algorithm

Mar 30 2022 Multidisciplinary design, analysis, and optimization using a genetic algorithm is being developed at the National Aeronautics and Space Administration Dryden Flight Research Center (Edwards, California) to automate analysis and design process by leveraging existing tools to enable true multidisciplinary optimization in the preliminary design stage of subsonic, transonic, supersonic, and hypersonic aircraft. This is a promising technology, but faces many challenges in large-scale, real-world application. This report describes current approaches, recent results, and challenges for multidisciplinary design, analysis, and optimization as demonstrated by experience with the Ikhana fire pod design.

Engineering Design Optimization May 08 2020 Based on course-tested material, this rigorous yet accessible graduate textbook covers both fundamental and advanced optimization theory and
algorithms. It covers a wide range of numerical methods and topics, including both gradient-based and gradient-free algorithms, multidisciplinary design optimization, and uncertainty, with instruction on how to determine which algorithm should be used for a given application. It also provides an overview of models and how to prepare them for use with numerical optimization, including derivative computation. Over 400 high-quality visualizations and numerous examples facilitate understanding of the theory, and practical tips address common issues encountered in practical engineering design optimization and how to address them. Numerous end-of-chapter homework problems, progressing in difficulty, help put knowledge into practice. Accompanied online by a solutions manual for instructors and source code for problems, this is ideal for a one- or two-semester graduate course on optimization in aerospace, civil, mechanical, electrical, and chemical engineering departments.

**Advances in Multidisciplinary Analysis and Optimization** Oct 13 2020 This volume contains select papers presented during the 4th National Conference on Multidisciplinary Analysis and Optimization. It discusses new developments at the core of optimization methods and their 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.

**Collaborative Multidisciplinary Design Optimization for Conceptual Design of Complex Products** Mar 18 2021 MULTIDISCIPLINARY design optimization (MDO) has developed in theory and practice during the last three decades with the aim of optimizing complex products as well as cutting costs and product development time. Despite this development, the implementation of such a method in industry is still a challenge and many complex products suffer time and cost overruns. Employing higher fidelity
models (HFM) 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 HFM 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