Game Theory Bargaining And Auction Strategies Practical Examples From Internet Auctions To Investment Banking

Microeconomic Theory is based on lecture notes for a graduate course in microeconomic theory. It covers a broad range of topics, and to some extent the lecture structure is retained in the style of the book. The author provides a clear account of the main ideas in each area concisely, and in some depth of detail. The presentation is at an advanced level and provides succinct coverage of the material in a self contained discussion. Chapters are organized and written independently making it possible to read any chapter without having read earlier material. Each chaper is written on the presumption that the reader has some familiarity with the topics or issues under discussion but would value further discussion, or a second point of view . While much of the material is mainstream, a substantial portion is not available in existing textbooks. The book covers a range of topics appearing in advanced courses in microeconomic theory. Coverage includes such topics as decision theory, strategic and extensive form games, auctions, bargaining, information models, principal- agent problems, signalling and screening games, cooperative games and models of learning.

We live in a highly connected world with multiple self-interested agents interacting and myriad opportunities for conflict and cooperation. The goal of game theory is to understand these opportunities. This book presents a rigorous introduction to the mathematics of game theory without losing sight of the joy of the subject. This is done by focusing on theoretical highlights (e.g., at least six Nobel Prize winning results are developed from scratch) and by presenting exciting connections of game theory to other fields such as computer science (algorithmic game theory), economics (auctions and matching markets), social choice (voting theory), biology (signaling and evolutionary stability), and learning theory. Both classical topics, such as zero-sum games, and modern topics, such as sponsored search auctions, are covered. Along the way, beautiful mathematical tools used in game theory are introduced, including convexity, fixed-point theorems, and probabilistic arguments. The book is appropriate for a first course in game theory at either the undergraduate or graduate level, whether in mathematics, economics, computer science, or statistics. The importance of game-theoretic thinking transcends the academic setting—for every action we take, we must consider not only its direct effects, but also how it influences the incentives of others.

Managers are continually called on to make strategic decisions based on how someone else will act, and react, and this is exactly what game theory was invented to analyze. With the publication of John McMillan's 'Games, Strategies, and Managers, ' managers can now unlock the power of this bold way of thinking. The book strips away distracting details and provides insights into what is really going on in every negotiation and strategic decision.

This textbook is an introduction to game theory, which is the systematic analysis of decision-making in interactive settings. Game theory can be of great value to business managers. The ability to correctly anticipate countermove by rival firms in competitive and cooperative settings enables managers to make more effective marketing, advertising, pricing, and other business decisions to optimally achieve the firm’s objectives. Game theory does not always accurately predict how rivals will act in strategic situations, but does identify a decision maker’s best response to situations involving move and countermove. As Nobel Prize winner Thomas Shelling noted: “We may wish to understand how participants actually do conduct themselves in conflict situations; an understanding of the ‘correct’ play may give us a bench mark for the study of actual behavior.” The concise and axiomatic approach to the material presented in this textbook is easily accessible to students with a background in the principles of microeconomics and college mathematics. The selection and organizations of topics makes the textbook appropriate for use in a wide range of curricula by students with different backgrounds.

This textbook for master programs in economics offers a comprehensive overview of microeconomics. It employs a carefully graded approach where basic game theory concepts are already explained within the simpler decision framework. The unavoidable mathematical content is supplied when needed, not in an appendix. The book covers a lot of ground, from decision theory to game theory, from bargaining to auction theory, from household theory to oligopoly theory, and from the theory of general equilibrium to regulation theory. Additionally, cooperative game theory is introduced. This textbook has been recommended and developed for university courses in Germany, Austria and Switzerland.

Are all film stars linked to Kevin Bacon? Why do the stock markets rise and fall sharply on the strength of a vague rumour? How does gossip spread so quickly? Are we all related through six degrees of separation? There is a growing awareness of the complex networks that pervade modern society. We see them in the rapid growth of the Internet, the ease of global communication, the swift spread of news and information, and in the way epidemics and financial crises develop with startling speed and intensity. This introductory book on the new science of networks takes an interdisciplinary approach, using economics, sociology, computing, information science and applied mathematics to address fundamental questions about the links that connect us, and the ways that our decisions can have consequences for others.

An exciting new edition of the popular introduction to game theory and its applications The thoroughly expanded Second Edition presents a unique, hands-on approach to game theory. While most books on the subject are too abstract or too basic for mathematicians, Game Theory: An Introduction, Second Edition offers a blend of theory and applications, allowing readers to use theory and software to create and analyze real-world decision-making models. With a rigorous, yet accessible, treatment of mathematics, the book focuses on results that can be used to determine optimal game strategies. Game Theory: An Introduction, Second Edition demonstrates how to use modern software, such as MapleTM, Mathematica®, and Gambit, to create, analyze, and implement effective decision-making models. Coverage includes the main aspects of game theory including the fundamentals of two-person zero-sum games, cooperative games, and population games as well as a large number of examples from various fields, such as economics, transportation, warfare, asset distribution, political science, and biology. The Second Edition features: • A new chapter on extensive games, which greatly expands the implementation of available models • New sections on correlated equilibria and exact formulas for three-player cooperative games • Many updated topics including threats in bargaining games and evolutionary stable strategies • Solutions and methods used to solve all odd-numbered problems • A companion website containing the related Maple and Mathematica data sets and code A trusted and proven guide for students of mathematics and economics, Game Theory: An Introduction, Second Edition is also an excellent resource for researchers and practitioners in economics, finance, engineering, operations research, statistics, and computer science.

Used to explain complicated economic behavior for decades, game theory is quickly becoming a tool of choice for those serious about optimizing next generation wireless systems. Illustrating how game theory can effectively address a wide range of issues that until now remained unresolved, Game Theory for Wireless Communications and Networking provid

Games are everywhere: Drivers manoeuvring in heavy traffic are playing a driving game. Bargain hunters bidding on eBay are playing an auctioning game. A firm negotiating next year's wage is playing a bargaining game. The opposing candidates in an election are playing a political game. The supermarket's price for corn flakes is decided by playing an economic game. Game theory is about how to play such games in a rational way. Even when the players have not thought everything out in advance, game theory often works for the same reason that mindless animals sometimes end up behaving very cleverly: evolutionary forces eliminate irrational play because it is unfit. Game theory has seen

spectacular successes in evolutionary biology and economics, and is beginning to revolutionize other disciplines from psychology to political science. This Very Short Introduction introduces the fascinating world of game theory, showing how it can be understood without mathematical equations, and revealing that everything from how to play poker optimally to the sex ratio among bees can be understood by anyone willing to think seriously about the problem. ABOUT THE SERIES: The Very Short Introductions series from Oxford University Press contains hundreds of titles in almost every subject area. These pocket-sized books are the perfect way to get ahead in a new subject quickly. Our expert authors combine facts, analysis, perspective, new ideas, and enthusiasm to make interesting and challenging topics highly readable.

This book is intended as an introduction to game theory which goes beyond the field of application, economics, and which introduces the reader to as many different sides of game theory as possible within the limitations of an introduction. The main goal is to give an impression of the diversity of game theoretical models, while at the same time covering the standard topics. The book has an equal coverage of non-cooperative and cooperative games, and it covers several topics such as selecting Nash equilibria, non-transferable utility games, applications of game theory to logic, combinatorial and differential games.

Please note that the content of this book primarily consists of articles available from Wikipedia or other free sources online. Pages: 243. Chapters: Nash equilibrium, Prisoner's dilemma, Pareto efficiency, General equilibrium theory, Rock-paper-scissors, Evolutionarily stable strategy, Tragedy of the commons, The Evolution of Cooperation, Minimax, Bounded rationality, Tragedy of the anticommons, Free rider problem, Compromise, Collusion, Shapley value, Monty Hall problem, Zugzwang, Chicken, Cooperative game, Succinct game, Social dilemma, Mechanism design, Expected utility hypothesis, Ultimatum game, Extensive-form game, Fair division, Stackelberg competition, Social trap, Parrondo's paradox, Justice, Price of anarchy, Auction theory, Martingale, Signaling game, The Bottle Imp, Bayesian game, Common knowledge, Centipede game, Cournot competition, Best response, Inequity aversion, Braess's paradox, Solution concept, Bargaining problem, Coordination game, Dynamic inconsistency, Core, Game semantics, Prisoners and hats puzzle, Simulations and games in economics education, Glossary of game theory, Backward induction, Stable marriage problem, Normal-form game, Topological game, Metagaming, Continuous game, Smart market, Pursuit-evasion, Dictator game, Stable roommates problem, Strategic dominance, Banzhaf power index, Risk dominance, Superrationality, Traveler's dilemma, Vickrey-Clarke-Groves auction, Negotiation theory, Public goods game, Signalling, Chainstore paradox, Stochastic game, Fixed point, Expected value of sample information, Metagame analysis, Evolutionary game theory, Haven, Cheap talk, Grand coalition, Correlated equilibrium, Max Dominated Strategy, List of games in game theory, Social software, Keynesian beauty contest, Stag hunt, Generalized game theory, Sir Philip Sidney game, Competitive altruism, Rational ignorance, Repeated game, Contract theory, Trembling hand perfect equilibrium, Replicator equation, Bertrand competition, Battle of the...

This text bridges the gulf between theoretical economic principles of negotiation and auction theory and their multifaceted applications in actual practice. It is intended to be a supplement to the already existing literature, as a comprehensive collection of reports detailing experiences and results of very different negotiations and auctions.

Now in its second edition, this popular textbook on game theory is unrivalled in the breadth of its coverage, the thoroughness of technical explanations and the number of worked examples included. Covering non-cooperative and cooperative games, this introduction to game theory includes advanced chapters on auctions, games with incomplete information, games with vector payoffs, stable matchings and the bargaining set. This edition contains new material on stochastic games, rationalizability, and the continuity of the set of equilibrium points with respect to the data of the game. The material is presented clearly and every concept is illustrated with concrete examples from a range of disciplines. With numerous exercises, and the addition of a solution manual with this edition, the book is an extensive guide to game theory for undergraduate through graduate courses in economics, mathematics, computer science, engineering and life sciences, and will also serve as useful reference for researchers.

This book provides a critical, selective review of concepts from game theory and their applications in public policy, and further suggests some modifications for some of the models (chiefly in cooperative game theory) to improve their applicability to economics and public policy.

Bargaining in the Shadow of the Market — Selected Papers on Bilateral and Multilateral Bargaining consists of selected research in bargaining carried out by Kalyan Chatterjee by himself and with various co-authors. Chatterjee has been one of the earliest researchers to work on noncooperative bargaining theory and has contributed to bilateral bargaining with parties having private information as well as multilateral coalition formation models. Some of his work in each of these areas finds place here.The main theme of this collection of papers is the nature of negotiations when participants have alternatives to continue negotiating, either by beginning negotiations with a different partner or set of partners or by engaging in time-consuming search for such partners. Chapters in this book include: a noncooperative theory of coalitional bargaining and features a laboratory experiment relevant to this theory as well as an extension to political negotiations, search for alternative partners, the effect of markets and bargaining on incentives of players to invest in the partnership and related papers on incentive compatibility, arbitration and a dynamic model of negotiation. The book also includes a new introduction that puts these papers in the context of the broader literature in the field.

This text opens with the theory of 2-person zero-sum games, 2-person non-zero sum games, and n-person games, at a level between non-mathematical introductory books and technical mathematical game theory books. Includes introductory explanations of gaming and meta games. Includes numerous exercises anbd problems with solutions and over 30 illustrations. 1986 edition.

This book offers a self-sufficient treatment of a key tool, game theory and mechanism design, to model, analyze, and solve centralized as well as decentralized design problems involving

multiple autonomous agents that interact strategically in a rational and intelligent way. The contents of the book provide a sound foundation of game theory and mechanism design theory which clearly represent the “science” behind traditional as well as emerging economic applications for the society.The importance of the discipline of game theory has been recognized through numerous Nobel prizes in economic sciences being awarded to game theorists, including the 2005, 2007, and 2012 prizes. The book distills the marvelous contributions of these and other celebrated game theorists and presents it in a way that can be easily understood even by senior undergraduate students.A unique feature of the book is its detailed coverage of mechanism design which is the art of designing a game among strategic agents so that a social goal is realized in an equilibrium of the induced game. Another feature is a large number of illustrative examples that are representative of both classical and modern applications of game theory and mechanism design. The book also includes informative biographical sketches of game theory legends, and is specially customized to a general engineering audience.After a thorough reading of this book, readers would be able to apply game theory and mechanism design in a principled and mature way to solve relevant problems in computer science (esp, artificial intelligence/machine learning), computer engineering, operations research, industrial engineering and microeconomics.

This is a light-hearted introduction to game theory suitable for advanced undergraduate students or beginning graduate students. It answers three questions. What is game theory? How is game theory applied? Why is game theory right?

Playing for Real is a problem-based textbook on game theory that has been widely used at both the undergraduate and graduate levels. The Coursepack Edition contains only the material necessary for a course of ten two-hour lectures plus problem classes. It comes with a disc of teaching aids including the author's own lecture presentations and two series of weekly exercise sets with answers.

Gain some insight into the game of life... Game Theory means rigorous strategic thinking. It is based on the idea that everyone acts competitively and in his own best interest. With the help of mathematical models, it is possible to anticipate the actions of others in nearly all life's enterprises. This book includes down-to-earth examples and solutions, as well as charts and illustrations designed to help teach the concept. In The Complete Idiot's Guide® to Game Theory, Dr. Edward C. Rosenthal makes it easy to understand game theory with insights into: ? The history of the disciple made popular by John Nash, the mathematician dramatized in the film A Beautiful Mind ? The role of social behavior and psychology in this amazing discipline ? How important game theory has become in our society and why

The manufacturing industry is facing the challenges of shifting its operations from the traditional factory integration philosophy to a supply chain based e-factory philosophy, and of transforming the focus of companies from the local factory to global enterprise and business. Innovative Tools for Business Coalitions in B2B Applications presents a set of innovative methodologies that can be used to face all the issues that stem from the interaction of customers and suppliers in an e-marketplace environment. The first methodology discussed is multi-agent architecture and this forms the basis of a simulation environment developed in order to test the proposed models. The second concerns a bargaining model based on the negotiation mechanism and the third centers on production planning to support agents during the bargaining phase. The fourth is the possibility of a coalition between the suppliers and the authors offer a choice of two different approaches. One is the application of Nash equilibrium to select the members of a potential coalition of sellers, while the other is a centralized approach with a profit sharing mechanism based on the Shapley value. All the innovative approaches reported in Innovative Tools for Business Coalitions in B2B Applications have been statistically tested in different market conditions. The methodologies, approaches and results presented in Innovative Tools for Business Coalitions in B2B Applications will be of interest to PhD students, operations managers and supply chain management researchers who develop value-added services for an e-marketplace in a business-to-business environment.

This book provides a comprehensive introduction to modern auction theory and its important new applications. It is written by a leading economic theorist whose suggestions guided the creation of the new spectrum auction designs. Aimed at graduate students and professionals in economics, the book gives the most up-to-date treatments of both traditional theories of 'optimal auctions' and newer theories of multi-unit auctions and package auctions, and shows by example how these theories are used. The analysis explores the limitations of prominent older designs, such as the Vickrey auction design, and evaluates the practical responses to those limitations. It explores the tension between the traditional theory of auctions with a fixed set of bidders, in which the seller seeks to squeeze as much revenue as possible from the fixed set, and the theory of auctions with endogenous entry, in which bidder profits must be respected to encourage participation.

Written in a crisp and approachable style, Games and Information uses simple modeling techniques and straightforward explanations to provide students with an understanding of game theory and information economics. Written for introductory courses seeking a little rigor. The 4th edition brings the material fully up-to-date and includes new end-of-chapter problems and classroom projects, as well as a math appendix. Accompanied by a comprehensive website featuring solutions to problems and teaching notes.

In the last twenty-five years, game theory has been applied to a growing number of practical problems: from antitrust analysis to monetary policy; from the design of auction institutions to the structuring of incentives within firms; from patent races to dispute resolution. The purpose of Game Theory and Business Applications is to expand these applications of game theory into a broad and meaningful view of the way business decisions can be modelled and analyzed. The chapter contents embrace a wide variety of business functions - from accounting to finance, to operations, to strategy, and to organizational design. In addition, specific application areas include numerous kinds of market competition, bargaining, auctions and competitive bidding. All of these applications involve competitive decision settings, specifically situations where a number of economic agents in pursuit of their respective self-interests take actions that together affect all of their fortunes. In the language of game theory, players take actions consistent with the given `rules of the game,' and these joint actions determine final outcomes and payoffs. As this volume demonstrates, game theory provides a compelling guide for business strategy. The first section of this volume discusses game-theoretic applications in four functional areas of business: finance, accounting, operations management and information systems, and organization design. The second section considers competitive strategies in `imperfect' markets. Using cooperative and non-cooperative game-theoretic approaches, these four chapters consider various topics: spatial competition, signaling of product quality, trust and cooperation in ongoing

relationships, strategic behavior in bargaining, and the `balance of power' between the firm and its buyers and suppliers. The last section of the book deals in detail with auctions and competitive bidding institutions. The emphasis is on the contributions of game theory to both auction theory and practice. Topics considered include optimal auctions, bidder collusion, and the design of institutions for selling the radio spectrum and trading electrical power.

This comprehensive textbook introduces readers to the principal ideas and applications of game theory, in a style that combines rigor with accessibility. Steven Tadelis begins with a concise description of rational decision making, and goes on to discuss strategic and extensive form games with complete information, Bayesian games, and extensive form games with imperfect information. He covers a host of topics, including multistage and repeated games, bargaining theory, auctions, rent-seeking games, mechanism design, signaling games, reputation building, and information transmission games. Unlike other books on game theory, this one begins with the idea of rationality and explores its implications for multiperson decision problems through concepts like dominated strategies and rationalizability. Only then does it present the subject of Nash equilibrium and its derivatives. Game Theory is the ideal textbook for advanced undergraduate and beginning graduate students. Throughout, concepts and methods are explained using real-world examples backed by precise analytic material. The book features many important applications to economics and political science, as well as numerous exercises that focus on how to formalize informal situations and then analyze them. Introduces the core ideas and applications of game theory Covers static and dynamic games, with complete and incomplete information Features a variety of examples, applications, and exercises Topics include repeated games, bargaining, auctions, signaling, reputation, and information transmission Ideal for advanced undergraduate and beginning graduate students Complete solutions available to teachers and selected solutions available to students

The ability to understand and predict behavior in strategic situations, in which an individual’s success in making choices depends on the choices of others, has been the domain of game theory since the 1950s. Developing the theories at the heart of game theory has resulted in 8 Nobel Prizes and insights that researchers in many fields continue to develop. In Volume 4, top scholars synthesize and analyze mainstream scholarship on games and economic behavior, providing an updated account of developments in game theory since the 2002 publication of Volume 3, which only covers work through the mid 1990s. Focuses on innovation in games and economic behavior Presents coherent summaries of subjects in game theory Makes details about game theory accessible to scholars in fields outside economics Table of contents

Andrew Coleman provides an accessible introduction to the fundamentals of mathematical gaming and other major applications in social psychology, decision theory, economics, politics, evolutionary biology, philosophy, operational research and sociology.

This book introduces readers to basic game theory as a tool to deal with strategic decision problems, helping them to understand the complexity of such problems – to extract a solution, if possible – and to manage the complexity by revising the game if appropriate. The authors discuss basic decision situations modeled as Prisoners’ Dilemma, Chicken Game, and Stag Hunt Game, as well as concepts like the Nash equilibrium, Trembling Hand Perfectness, Rationalizable Strategies and the Theory of Moves to introduce game theoretic thinking. Further, the book presents pioneers of strategic thinking, e.g., Sun Tzu, Machiavelli, Adam Smith, and Goethe, and includes cases of conflict and cooperation to illustrate practical applications. Readers learn to apply game theory in business and in daily life – to manage their decision problems and to better understand the decision problems of others.

A fundamental introduction to modern game theory from amathematical viewpoint Game theory arises in almost every fact of human and inhumaninteraction since oftentimes during these communications objectivesare opposed or cooperation is viewed as an option. From economicsand finance to biology and computer science, researchers andpractitioners are often put in complex decision-making scenarios,whether they are interacting with each other or working withevolving technology and artificial intelligence. Acknowledging therole of mathematics in making logical and advantageous decisions,Game Theory: An Introduction uses modern software applications tocreate, analyze, and implement effective decision-makingmodels. While most books on modern game theory are either too abstractor too applied, this book provides a balanced treatment of thesubject that is both conceptual and hands-on. Game Theoryintroduces readers to the basic theories behind games and presentsreal-world examples from various fields of study such as economics,political science, military science, finance, biological science aswell as general game playing. A unique feature of this book is theuse of Maple to find the values and strategies of games, and inaddition, it aids in the implementation of algorithms for thesolution or visualization of game concepts. Maple is also utilizedto facilitate a visual learning environment of game theory and actsas the primary tool for the calculation of complex non-cooperativeand cooperative games. Important game theory topics are presented within the followingfive main areas of coverage: Two-person zero sum matrix games Nonzero sum games and the reduction to nonlinear programming Cooperative games, including discussion of both the Nucleolusconcept and the Shapley value Bargaining, including threat strategies Evolutionary stable strategies and population games Although some mathematical competence is assumed, appendices areprovided to act as a refresher of the basic concepts of linearalgebra, probability, and statistics. Exercises are included at theend of each section along with algorithms for the solution of thegames to help readers master the presented information. Also,explicit Maple and Mathematica® commands are included in thebook and are available as worksheets via the book's related Website. The use of this software allows readers to solve many moreadvanced and interesting games without spending time on the theoryof linear and nonlinear programming or performing other complexcalculations. With extensive examples illustrating game theory's wide range ofrelevance, this classroom-tested book is ideal for game theorycourses in mathematics, engineering, operations research, computerscience, and economics at the upper-undergraduate level. It is alsoan ideal companion for anyone who is interested in the applicationsof game theory.

This is the first volume of the Handbook of Game Theory with Economic Applications, to be followed by two additional volumes. Game Theory has developed greatly in the last decade, and today it is an essential tool in much of economic theory. The three volumes will cover the fundamental theoretical aspects, a wide range of applications to economics, several chapters on applications to political science, and individual chapters on relations with other disciplines. The topics covered in the present volume include chess-playing computers, an introduction to the non-cooperative theory, repeated games, bargaining theory, auctions, location, entry deterrence, patents, the cooperative theory and its applications, and the relation between Game Theory and ethics. For more information on the Handbooks in Economics series, please see our home page on http://www.elsevier.nl/locate/hes

The objective of the third edition of Game Theory: A Nontechnical Introduction to the Analysis of Strategy is to introduce the ideas of game theory in a way that is approachable, intuitive, and interdisciplinary. Relying on the Karplus Learning Cycle, the book is intended to teach by example. Noncooperative equilibrium concepts such as Nash equilibrium play the central role. In this third edition, increased stress is placed on the concept of rationalizable strategies, which has proven in teaching practice to assist students in making the bridge from intuitive to more formal concepts of noncooperative equilibrium. The Instructor Manual and PowerPoint Slides for the book are available upon request for all instructors who adopt this book as a course text. Please send your request to sales@wspc.com.

Business managers make decisions in an interactive strategic environment that resembles games. ‘Out-Think’ makes game theoretic concepts usable for strategic decision-makers and functional managers. The book exposes the reader to game theory concepts using examples not only from the domain of business, but also from the fields of professional sports, parlour games like chess, poker etc., and military

practices.
How to master the game of negotiation, from a groundbreaking game theorist. By focusing on the basics and introducing the most sophisticated negotiation techniques, Murnighan shows how game theory can be applied to negotiations, ranging from the most inconsequential to the vital.
Economists often look at markets as given, and try to make predictions about who will do what and what will happen in these markets. Market design, by contrast, does not take markets as given; instead, it combines insights from economic and game theory together with common sense and lessons learned from empirical work and experimental analysis to aid in the design and implementation of actual markets In recent years the field has grown dramatically, partially because of the successful wave of spectrum auctions in the US and in Europe, which have been designed by a number of prominent economists, and partially because of the increase use of the Internet as the platform over which markets are designed and run There is now a large number of applications and a growing theoretical literature. The Handbook of Market Design brings together the latest research from leading experts to provide a comprehensive description of applied market design over the last two decades In particular, it surveys matching markets: environments where there is a need to match large two-sided populations to one another, such as medical residents and hospitals, law clerks and judges, or patients and kidney donors It also examines a number of applications related to electronic markets, e-commerce, and the effect of the Internet on competition between exchanges.
Some of the finest and most recent research in economic and political design is presented. Among the authors are several prominent academics as well as many new and promising researchers. They investigate social choice and electoral systems, auctions, matching, bargaining, coalitional stability and efficiency, regulation, the design of rights, mechanisms, games, hierarchies and information. The book is bound to become a standard reference as a collection displaying where we are and where we are going in a broad spectrum of areas in economic design.