



“A model of popular economics.”  
—Tim Harford, *Financial Times*

A Game Theorist's  
Guide to Success in  
Business and Life



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# The Art *of* Strategy

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AVINASH K. DIXIT  
BARRY J. NALEBUFF

authors of the best-selling *Thinking Strategically*

*The*  
**Art**  
*of*  
**Strategy**

A GAME THEORIST'S  
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# *The Art of Strategy*

**A GAME THEORIST'S  
GUIDE TO SUCCESS  
IN BUSINESS & LIFE**

**Avinash K. Dixit**  
**Barry J. Nalebuff**



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*To all our students,  
from whom we have learned so much  
(especially Seth—BJN)*

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## Preface

WE DIDN'T SET out to write a new book. The plan was simply to revise our 1991 book, *Thinking Strategically*. But it didn't quite turn out that way.

One model for writing a revision comes from Borges's character Pierre Menard, who decides to rewrite Cervantes's *Don Quixote*. After great effort, Menard's revision ends up being word-for-word identical to the original. However, 300 years of history and literature have passed since *Quixote*, including *Quixote* itself. Although Menard's words are the same, his meaning is now entirely different.

Alas, our original text wasn't *Don Quixote*, and so the revision did require changing a few words. In fact, most of the book is entirely new. There are new applications, new developments in the theory, and a new perspective. So much is new that we decided a new title was called for as well. Although the words are new, our meaning remains the same. We intend to change the way you see the world, to help you think strategically by introducing the concepts and logic of game theory.

Like Menard, we have a new perspective. When we wrote *Thinking Strategically*, we were younger, and the zeitgeist was one of self-centered competition. We have since come to the full realization of the important part that cooperation plays in strategic situations, and how good strategy must appropriately mix competition and cooperation.\*

We started the original preface with: "Strategic thinking is the art of outdoing an adversary, knowing that the adversary is trying to do the same to you." To this we now add: It is also the art of finding ways to cooperate, even when others are motivated by self-interest, not benevolence. It is the art of convincing others, and even yourself, to do what you say. It is the art of

interpreting and revealing information. It is the art of putting yourself in others' shoes so as to predict and influence what they will do.

We like to think that *The Art of Strategy* includes this older, wiser perspective. But there is also continuity. Even though we offer more real-life stories, our purpose remains to help you develop your own ways of thinking about the strategic situations you will face; this is not an airport book offering “seven steps for sure strategic success.” The situations you face will be so diverse that you will succeed better by knowing some general principles and adapting them to the strategic games you are playing.

Businessmen and corporations must develop good competitive strategies to survive, and find cooperative opportunities to grow the pie. Politicians have to devise campaign strategies to get elected and legislative strategies to implement their visions. Football coaches plan strategies for players to execute on the field. Parents trying to elicit good behavior from children must become amateur strategists—the children are pros.

Good strategic thinking in such numerous diverse contexts remains an art. But its foundations consist of some simple basic principles—an emerging science of strategy, namely game theory. Our premise is that readers from a variety of backgrounds and occupations can become better strategists if they know these principles.

Some people question how we can apply logic and science to a world where people act irrationally. It turns out that there is often method to the madness. Indeed, some of the most exciting new insights have come from recent advances in behavioral game theory, which incorporates human psychology and biases into the mix and thus adds a social element to the theory. As a result, game theory now does a much better job dealing with people as they are, rather than as we might like them to be. We incorporate these insights into our discussions.

While game theory is a relatively young science—just over seventy years old—it has already provided many useful insights for practical strategists. But, like all sciences, it has become shrouded in jargon and mathematics. These are essential research tools, but they prevent all but the specialists from understanding the basic ideas. Our main motive for writing *Thinking Strategically* was the belief that game theory is too interesting and important to leave to the academic journals. The insights prove useful in many endeavors—business, politics, sports, and everyday social interactions. Thus

we translated the important insights back into English and replaced theoretical arguments with illustrative examples and case studies.

We are delighted to find our view becoming mainstream. Game theory courses are some of the most popular electives at Princeton and Yale, and most other schools where they are offered. Game theory permeates strategy courses in MBA programs, and a Google search for game theory produces more than 6 million pages. You'll find game theory in newspaper stories, op-eds, and public policy debates.

Of course, much of the credit for these developments belongs to others: to the Economics Nobel Prize Committee, which has awarded two prizes in game theory—in 1994, to John Harsanyi, John Nash, and Reinhard Selten and in 2005, to Robert Aumann and Thomas Schelling;<sup>\*</sup> to Sylvia Nasar, who wrote *A Beautiful Mind*, the best-selling biography of John Nash; to those who made the award-winning movie of the same name; and to all those who have written books popularizing the subject. We might even share a bit of the credit. Since publication, *Thinking Strategically* has sold 250,000 copies. It has been translated into numerous languages, and the Japanese and Hebrew translations have been best sellers.

We owe a special debt to Tom Schelling. His writings on nuclear strategies, particularly *The Strategy of Conflict* and *Arms and Influence*, are justly famous. In fact, Schelling pioneered a lot of game theory in the process of applying it to nuclear conflict. Michael Porter's *Competitive Strategy*, drawing on the lessons of game theory for business strategy, is equally important and influential. An annotated guide to the works of Schelling, Porter, and many others is provided in our Further Reading section.

In this book we do not confine the ideas to any particular context. Instead, we offer a wide range of illustrations for each basic principle. Thus readers from different backgrounds will all find something familiar here. They will also see how the same principles bear on strategies in less familiar circumstances; we hope this will give them a new perspective on many events in news as well as history. We also draw on the shared experience of our readers, with illustrations from, for example, literature, movies, and sports. Serious scientists may think this trivializes strategy, but we believe that familiar examples are an effective vehicle for conveying the important ideas.

The idea of writing a book at a more popular level than that of a course text came from Hal Varian, now at Google and the University of California, Berkeley. He also gave us many useful ideas and comments on earlier drafts. Drake McFeely at W. W. Norton was an excellent if exacting editor for *Thinking Strategically*. He made extraordinary efforts to fashion our academic writing into a lively text. Many readers of *Thinking Strategically* gave us encouragement, advice, and criticism, all of which have helped us when writing *The Art of Strategy*. At the grave risk of omitting some, we must mention ones to whom we owe special thanks. Our coauthors on other related and unrelated book projects, Ian Ayres, Adam Brandenburger, Robert Pindyck, David Reiley, and Susan Skeath, generously gave us much useful input. Others whose influence continues in this new book include David Austen-Smith, Alan Blinder, Peter Grant, Seth Masters, Benjamin Polak, Carl Shapiro, Terry Vaughn, and Robert Willig. Jack Repcheck at W. W. Norton has been a constantly supportive, understanding, and perceptive editor for *The Art of Strategy*. Our manuscript editors, Janet Byrne and Catherine Pichotta, were generous to our faults. Every time you don't find a mistake, you should thank them.

We owe special thanks to Andrew St. George, book critic for the *Financial Times*. In choosing *Thinking Strategically* as a book he enjoyed reading most in the year 1991, he said: "it is a trip to the gym for the reasoning facilities" (*FT Weekend*, December 7/8, 1991). This gave us the idea of labeling some intriguing challenges we pose to the readers in this edition "Trips to the Gym." Finally, John Morgan, of the University of California, Berkeley, gave us a powerful incentive with the threat, "If you don't write a revision, I will write a competing book." And after we saved him the trouble, he helped us out with many ideas and suggestions.

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October 2007

## INTRODUCTION

### **How Should People Behave in Society?**

OUR ANSWER DOES not deal with ethics or etiquette. Nor do we aim to compete with philosophers, preachers, or parents. Our theme, although less lofty, affects the lives of all of us just as much as do morality and manners. This book is about strategic behavior. All of us are strategists, whether we like it or not. It is better to be a good strategist than a bad one, and this book aims to help you improve your skills at discovering and using effective strategies.

Work, even social life, is a constant stream of decisions. What career to follow, how to manage a business, whom to marry, how to bring up children, and whether to run for president are just some examples of such fateful choices. The common element in these situations is that you do not act in a vacuum. Instead, you are surrounded by active decision makers whose choices interact with yours. This interaction has an important effect on your thinking and actions.

To illustrate the point, think of the difference between the decisions of a lumberjack and those of a general. When the lumber-jack decides how to chop wood, he does not expect the wood to fight back: his environment is neutral. But when the general tries to cut down the enemy's army, he must anticipate and overcome resistance to his plans. Like the general, you must recognize that your business rivals, prospective spouse, and even your children are strategic. Their aims often conflict with yours, but they may well coincide. Your own choice must allow for the conflict and utilize the

cooperation. This book aims to help you think strategically, and then translate these thoughts into action.

The branch of social science that studies strategic decision making is called game theory. The games in this theory range from chess to child rearing, from tennis to takeovers, and from advertising to arms control. As the Hungarian humorist George Mikes expressed it, “Many continentals think life is a game; the English think cricket is a game.” We think both are right.

Playing these games requires many different kinds of skills. Basic skills, such as shooting ability in basketball, knowledge of precedents in law, or a blank face in poker, are one kind; strategic thinking is another. Strategic thinking starts with your basic skills and considers how best to use them. Knowing the law, you must decide the strategy for defending your client. Knowing how well your football team can pass or run and how well the other team can defend against each choice, your decision as the coach is whether to pass or to run. Sometimes, as in the case of nuclear brinkmanship, strategic thinking also means knowing when not to play.

The science of game theory is far from being complete, and much of strategic thinking remains an art. Our ultimate aim is to make you better practitioners of that art, but this requires a good foundation in some elementary concepts and methods of the science. Therefore we mix the two approaches. Chapter 1 begins with examples of the art, showing how strategic issues arise in a variety of decisions. We point out some effective strategies, some less effective ones, and even some downright bad ones that were used by players in these real-life games. These examples begin to suggest a conceptual framework. In the next set of chapters, 2–4, we build this basis for the science using examples, each of which is designed to bring out one principle. Then we turn our attention to more specific concepts and strategies for dealing with particular situations—how to mix moves when any systematic action can be exploited by the other player, how to change a game to your advantage, and how to manipulate information in strategic interaction. Finally, we take up several broad classes of strategic situations—bargaining, auctions, voting, and the design of incentives—where you can see these principles and strategies in action.

Science and art, by their very nature, differ in that science can be learned in a systematic and logical way, whereas expertise in art has to be acquired by example, experience, and practice. Our exposition of the basic science

generates some principles and broad rules—for example, the idea and method of backward reasoning that is developed in chapter 2, and the concept of Nash equilibrium in chapter 4. On the other hand, the art of strategy, in all the varied situations where you may need it, requires you to do more work. Each such situation will have some unique features that you must take into account and combine with the general principles of the science. The only way to improve your skill at this art is the inductive way—by seeing how it has been done before in similar situations. That is exactly how we aim to improve your strategic IQ: by giving numerous examples, including a case study, in each chapter and in a collection of case studies in the final chapter.

The examples range from the familiar, trivial, or amusing—usually drawn from literature, sports, or movies—to the frightening—nuclear confrontation. The former are merely a nice and palatable vehicle for the game-theoretic ideas. As to the latter, at one point in time many readers would have thought the subject of nuclear war too horrible to permit rational analysis. But with the cold war now long over, we hope that the game-theoretic aspects of the arms race and the Cuban missile crisis can be examined for their strategic logic with some detachment from their emotional content.

The case studies are similar to ones you might come across in a business-school class. Each case sets out a particular set of circumstances and invites you to apply the principles discussed in that chapter to find the right strategy for that situation. Some cases are open-ended; but that is also a feature of life. At times there is no clearly correct solution, only imperfect ways to cope with the problem. A serious effort to think each case through before reading our discussion is a better way to understand the ideas than any amount of reading of the text alone. For more practice, the final chapter is a collection of cases, in roughly increasing order of difficulty.

By the end of the book, we hope that you will emerge a more effective manager, negotiator, athlete, politician, or parent. We warn you that some of the strategies that are good for achieving these goals may not earn you the love of your rivals. If you want to be fair, tell them about our book.

# Part I

### Ten Tales of Strategy

WE BEGIN WITH ten tales of strategy from different aspects of life and offer preliminary thoughts on how best to play. Many of you will have faced similar problems in everyday life and will have reached the correct solution after some thought or trial and error. For others, some of the answers may be surprising, but surprise is not the primary purpose of the examples. Our aim is to show that such situations are pervasive, that they amount to a coherent set of questions, and that methodical thinking about them is likely to be fruitful.

In later chapters, we develop these systems of thought into prescriptions for effective strategy. Think of these tales as a taste of dessert before the main course. They are designed to whet your appetite, not fill you up.

#### #1. PICK A NUMBER

Believe it or not, we are going to ask you to play a game against us. We've picked a number between 1 and 100, and your goal is to guess the number. If you guess correctly on the first try, we'll pay you \$100.

Actually, we aren't really going to pay you \$100. It would be rather costly for us, especially since we want to give you some help along the way. But, as you play the game, we'd like you to imagine that we really are going to give you money, and we'll play the same way.

The chance of getting the number right on the first shot is quite low, only one in a hundred. So to improve your chances, we'll give you five guesses,

and after each wrong guess, we'll also tell you if you are too high or too low. Of course, there's a bigger reward for getting the right answer quickly. If you guess correctly on the second try, you'll get \$80. On the third try, the payment is down to \$60, then \$40 for the fourth guess, and \$20 if you get the number on the fifth try. If it takes more than five guesses, the game is over and you get nothing.

Are you ready to play? We are, too. If you are wondering how to play a game with a book, it is a bit of a challenge, but not impossible. You can go to the [artofstrategy.info](http://artofstrategy.info) web site and play the game interactively. Or, we can anticipate how you might be playing the game and respond accordingly.

Is your first guess 50? That's the most common first guess and, alas for you, it's too high.

Might your second guess be 25? Following 50, that is what most folks do. Sorry, that's too low. The next step for many is 37. We're afraid that 37 is too low. What about 42? Too low, again.

Let's pause, take a step back, and analyze the situation. This is your fifth guess coming up and your last chance to take our money. You know the number is above 42 and less than 50. There are seven options: 43, 44, 45, 46, 47, 48, and 49. Which of those seven do you think it will be?

So far, you have been guessing in a way that divides the interval into two equal parts and picking the midpoint. This is the ideal strategy in a game where the number has been chosen at random.\* You are getting the most information possible from each guess and therefore will converge to the number as quickly as possible. Indeed, Microsoft CEO Steven Ballmer is said to have used this game as a job interview question. For Ballmer the correct answer was 50, 25, 37, 42, ... He was interested in seeing if the candidate approached the search problem in the most logical and efficient manner.

Our answer is a bit different. In Ballmer's problem, the number was picked at random, and so the engineer's strategy of "divide the set in two and conquer" was just right. Getting the most information from each guess minimizes the expected number of guesses and therefore leads you to get the most money. In our case, however, the number was *not* picked at random. Remember that we said that we were playing this game as if we actually had to pay you the money. Well, no one is reimbursing us for money that, hypothetically, we would have to pay you. And as much as we like you for