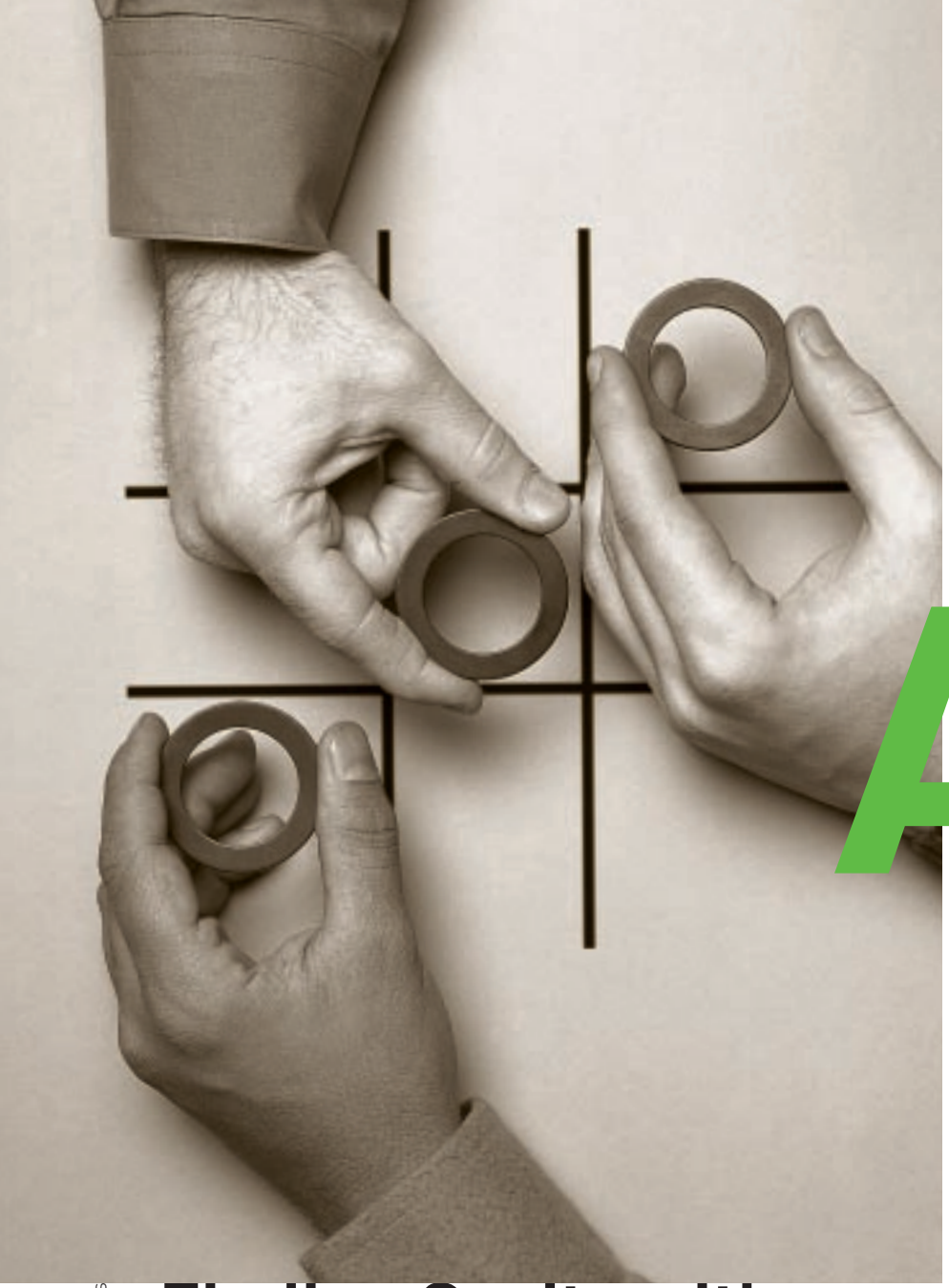

Photograph by Matthew Septimus

Finding Sanity with Game Theory

John Nash had a beautiful mind. These books showcase beautiful implications for companies.

Knowledge Review
by Scott Borg

A Beautiful Mind is a great tale of love and madness. But John Nash's biography engages us for another reason: He developed game theory.

Why should game theory be of interest to anyone other than theorists? For executives, game theory matters because we live and do business in an interactive world. We need to anticipate the results of those interactions. In almost every kind of business, we need to negotiate deals, prepare for future negotiations, identify what our trading partners and our competitors are likely to do next, and position ourselves accordingly. We need to get ready for market conditions that haven't arisen yet, which we can influence by our participation.

Game theory allows us to deal with these interactions in a clear, and often quantitative, way. Business leaders have been gradually waking up to this. Publishers have reported a growing demand for game theory books for lay readers. *A Beautiful Mind* has given game theory an additional push.

There isn't yet one book that will teach an executive all the game theory concepts needed in business.

Scott Borg
(scottborg@aol.com) is a research fellow at Dartmouth's Tuck School of Business. In addition to lecturing at many leading universities, he has been a featured contributor on Public Radio International's *Marketplace Morning Report*.

Worse, most of the existing game theory texts are littered with mathematical formulas that even mathematically literate physical scientists and engineers find confusing. Thus, putting together a "virtual text" by dipping into several introductory books is probably the best approach to exploring this exciting, expanding field.

One of the best places to get a general sense of game theory is a work in progress by Roger A. McCain, available free on the Internet. It's currently titled *Strategy and Conflict: An Introductory Sketch of Game Theory* and runs to about 75 pages. Using only simple arithmetic, Professor McCain introduces a significant portion of the concepts, definitions, and examples that have been central to game theory. More important, he helps readers get a feel for the kind of analysis game theory provides.

But to understand game theory's business applications requires a deeper dive. We've recently experienced something of a revolution in business thinking. Instead of isolated companies producing standalone products, we now think in terms of business networks producing product systems. Instead of individual exchanges of brief duration with little sharing of information, we now think in terms of sustained relationships with extensive sharing of information. Game theory enables us to investigate these increasingly interactive and complex relationships.

Consider these four basic principles of business:

1. In business, we interact not just with a large, cumulative market, but with small numbers of other players whose specific strategic choices directly affect the payoffs we will receive from our choices.

2. We make choices that not only affect the outcome of our activities within an existing market, but also have the ability to affect the kind of market we are in.

3. We have the option of creating alliances and partnerships, with binding agreements on joint actions and on the sharing of profits.

4. We don't just allocate existing value or create value by means of assets that produce a set return. We are able to create *new* value at *new* rates of return by putting together *new* combinations of assets.

Conventional economics without game theory is generally of little help in these matters. This is because conventional economists tend to assume that a company is interacting with the market as a whole, rather than with other individual companies or combinations of companies. In other words, conventional economics essentially leaves out the entire realm of intermediate interactions where most business activity actually takes place. Game theory, in contrast, tackles this realm head-on.

The field of game theory, in practice, divides into two main branches. The first two principles listed above give rise to one branch, known as noncooperative game theory. The latter two principles give rise to the other branch, cooperative game theory. It's very important to be aware of the ways in which these two main branches of game theory have diverged because each branch is built on different concepts and has different uses. When businesspeople become frustrated with game theory, or feel it doesn't meet their needs, it is often because they are trying to solve the problems addressed by one branch with concepts from the other.

The branch of game theory that's most widely discussed is noncooperative theory. It explores situations in which we interact with small numbers of other players whose strategic choices directly affect our payoffs, as well as situations in which our choices will determine the kind of market we are in. Most such situations involve "noncooperative games" because each player is choosing the strategy that will benefit that player individually. There are no cooperative agreements being made between players that will allow them to

maximize their gains collectively. Noncooperative games are usually characterized by payoff tables that list what each player will receive, depending on the strategy that player chooses and the strategies the other players choose.

Dr. Nash's big contribution was to provide some concepts for characterizing the outcomes of these games. In particular, he demonstrated that noncooperative games can result in something called a Nash equilibrium. This is when each player makes the optimal choice given what the other players might choose, even though these choices don't necessarily result in the best outcomes for everyone, *or even for anyone*. In other words, playing the game out move by move gets you to a result you wouldn't choose if you could make some kind of cooperative deal.

The best known noncooperative game is "the prisoner's dilemma." This is a scenario in which two prisoners who have committed a crime together each confess and implicate the other, accepting a moderate prison term. They do this in order to avoid the very long sentence one of them would have to serve if only the other had confessed. The kicker is that if *neither* had confessed, they would each have drawn very short terms. But confessing is the "dominant strategy" because it gives each player the best payoff for each of the other player's choices. The resulting double confession illustrates the Nash equilibrium because neither player could unilaterally improve his payoff by adopting a different strategy.

Businesses experience something like the prisoner's dilemma every time a move by a competitor drives them to do things that leave each business worse off than it would have been otherwise. A business will launch an expensive promotion, for example, in order to match a competitor's price promotion, even though each might have been better off without any promotion. Sometimes customers are the beneficiaries of this competitive dilemma. But exactly who benefits and what the best strategies will be depends on the exact way the game is formulated or defined in a specific business situation.

Because this branch of game theory is by far the most developed, there are quite a few books that explain it and apply it to business problems. Two textbooks presenting noncooperative game theory are especially readable: Joel Watson's recently published *Strategy: An Introduction to Game Theory* and Prajit K. Dutta's *Strategies and Games: Theory and Practice*. Both use a significant amount of math, but they keep it simple. The writing is accessible enough so that, with a little patience, you can dip into them and learn a great deal, without having to take a formal course.

For readers who want a more popular treatment, one of the best is Avinash K. Dixit and Barry J. Nalebuff's *Thinking Strategically: The Competitive Edge in Business, Politics, and Everyday Life*. This book uses payoff tables, simple graphs, and decision trees, but avoids all mathematical equations. Its examples move from military campaigns to tennis matches to Hollywood movies. John McMillan's *Games, Strategies, and Managers: How Managers Can Use Game Theory to Make Better Business Decisions* is also excellent and has the advantage of focusing more specifically on business problems. It discusses such matters as the design of contracts and the management of subcontractors.

Since Dr. Nash wrote his seminal papers, a huge analytic effort has focused on the sort of noncooperative games that result in one or more Nash equilibria. John Harsanyi expanded the theory of Nash equilibria to encompass games in which the players have incomplete information about the other players' preferences. Reinhard Selten showed how the idea of Nash equilibria could be applied to games unfolding over time through the selection of certain outcomes that are more reasonable than others. The relevance of this work for economics was acknowledged in 1994 when the

Cooperative game theory is a powerful tool for assessing the viability of new ventures, products, technologies, and markets.

Nobel Prize was awarded jointly to Nash, Harsanyi, and Selten for their development of the idea of equilibria in noncooperative games. Currently, noncooperative game theory is being used to design auctions and other online interactions, and to help align corporate incentives with corporate interests. (See "Beating the B2B Odds," by Tim Laseter and David Evans, *s+b*, Second Quarter 2001.)

The other main branch of game theory may have even more applications to business practice. It is called cooperative game theory because it deals with situations in which players can make cooperative agreements, enabling them to carry out joint strategies and to share the resulting payoffs. Since this is what businesspeople do every time they put together a new business or a new combination of businesses, these activities are prime subjects for cooperative game theory.

Cooperative game theory does not focus on the specific moves or strategies that a player will choose as the game is played out. Instead, it focuses on the way players interact and can arrange themselves into different groups to create different amounts of value. Cooperative game theory is especially useful when it comes to deciding which people and assets to include in a business, which businesses to include in a corporation, and which corporations to include in an alliance. Furthermore, it will predict how much value each of these units can expect to collect in exchange for its participation. This makes cooperative game theory a powerful tool for assessing the viability of new ventures, products, technologies, channels of supply and distribution, and markets.

Because cooperative game theory focuses on groupings, rather than moves or strategies, the concepts it employs are very different from those used in noncooperative game theory. In place of payoff tables for individual actions, cooperative game theory is concerned with the "characteristic function," which describes the value that would be created by each possible combination of players. And instead of identifying the Nash equilibria, cooperative game theory seeks to identify "the core" — groupings likelier to be stable because the players won't be able to do better by defecting to another group.

When people describe a noncooperative game in business, they are almost always assuming there is some cooperative game that takes place earlier and determines the structure of the noncooperative game. This is because cooperative games are generally necessary to produce the value that noncooperative games use for their payoffs, and because the way that value is created determines the bargaining power of the participants. If the players are organized into different cooperative groupings, then the amount of value created and the way it gets divided will often be drastically different.

Take the classic prisoner's dilemma, for example, and look at how the results change if the prisoners start playing a cooperative game among themselves. Suddenly, they have a way of getting to the optimum payoff. If there are more than two prisoners and the different prisoners can command different payoffs, the cooperative games that can be established become even more important.

This less-restricted version of the game is more like real life than the classic prisoner's dilemma. Most business is conducted with unrestricted bargaining, except where the government rules that it would get in the way of *other* bargaining.

Game Theory Resources

Works mentioned in this review.

Adam M. Brandenburger and Barry J. Nalebuff, *Co-opetition* (Currency Doubleday, 1996), 290 pages, $16.95; http://mayet.som.yale.edu/coopetition/index2.html

Avinash K. Dixit and Barry J. Nalebuff, *Thinking Strategically: The Competitive Edge in Business, Politics, and Everyday Life* (W.W. Norton & Co., 1992), 400 pages, $15.95.

Prajit K. Dutta, *Strategies and Games: Theory and Practice* (MIT Press, 1999), 476 pages, $65.

Roger A. McCain, *Strategy and Conflict: An Introductory Sketch of Game Theory* (Web book in progress, 2002), free; http://william-king.www.drexel.edu/top/eco/game/game.html

John McMillan, *Games, Strategies, and Managers: How Managers Can Use Game Theory to Make Better Business Decisions* (Oxford University Press, 1992), 252 pages, $17.95.

Sylvia Nasar, *A Beautiful Mind: The Life of Mathematical Genius and Nobel Laureate John Nash* (Simon & Schuster, 1998), 464 pages, $26.

John von Neumann and Oskar Morgenstern, *Theory of Games and Economic Behavior* (Princeton University Press, 1944), 648 pages, $37.50.

Joel Watson, *Strategy: An Introduction to Game Theory* (W.W. Norton & Co., 2002), 334 pages, $71.

The sheer creativity of businesspeople means that they are constantly producing the sort of new combinations that are the subject of cooperative game theory.

Although cooperative game theory hasn't received nearly as much attention as the noncooperative kind, it too has a long and distinguished history. The book that actually launched modern game theory in 1944, John von Neumann and Oskar Morgenstern's *Theory of Games and Economic Behavior*, devotes more space to cooperative games than to noncooperative games. If the Nobel committee had decided to recognize contributions to cooperative game theory, rather than the noncooperative variety, the economics prize could have been appropriately awarded to Lloyd Shapley, Martin Shubik, and Robert Aumann, three key figures in the history of the field. Currently, one of the most important uses of cooperative game theory is to help companies make more reliable decisions about mergers and divestments.

The nonmathematical book that currently provides the best introduction to cooperative game theory business applications is Adam M. Brandenburger and Barry J. Nalebuff's *Co-opetition*. This book provides some remarkably clear answers to questions about what businesses a company should be in and how a company should try to influence the landscape in which it operates. It wears its theory so lightly that most readers are barely aware of how deeply it is grounded in cooperative game theory.

The next wave of game theory books will be distinguished from the earlier ones by the increased attention many of them will give to cooperative game theory. Innovative theorists, such as Columbia University's Harborne Stuart, have also been exploring ways of combining cooperative and noncooperative game theory to guide strategic decisions. Companies using the resulting models will gain a better idea both of what value they can create and of what value they can collect. These new efforts should bring a rigor and clarity to the areas of business most in danger of succumbing to madness. ✚

Reprint No. 03110