

BOOKS

THE EVOLUTION OF COOPERATION

by Robert Axelrod

(Basic Books; 256 pp.; \$17.95)

Warren L. Mason

Over the past forty years and more, classic game theory has created a mathematical logic designed to illuminate complex social situations. Based on the game-playing strategies for overcoming opponents in poker and other contests, it was quickly elaborated to include similar phenomena in economic and political life. That John McDonald's cleverly illustrated volume *Strategy in Poker, Business and War* was published in 1950 demonstrates how rapidly the theoretical work of John von Neumann and Oskar Morgenstern, published in 1944 as *Theory of Games and Economic Behavior*, was popularized, and how enthusiastically it came to be applied to the reinterpretation of important problems of human relations. But as the pioneers of game theory themselves acknowledged, the approach had little to say about change, was based mainly on the win-lose logic of zero-sum games, and assumed a perfect information not common in the real world. As a result, early attempts to extend its implications to economic and political situations suffered from the artificiality of laboratory simplicity.

By the late 1960s, however, Karl Deutsch had already identified a "post-Neumannian stage" of game theory in which conditions more nearly analogous to decision-making in the political arena were part of the calculus. Incomplete information and "non-zero-sum" situations of mixed conflict and cooperation began to appear in the work of economists and political scientists alike. The continuing attraction of this approach, of course, was the remarkable clarity and insight that the mathematical logic of game theory could bring to complex decision-making problems.

Robert Axelrod has been part of a generation of scholars that has continued to refine our understanding of decision-making. His approach is both theoretical and practical: He wants to improve the framework for understanding decision-making so that people will make better and more effective decisions. In a 1976 work, *The Structure of Decision*, he explained his goal: "If we had a better idea of the methods people use to analyze and evaluate complex

policy choices, then we would be in a better position to design a formalized system to help them do their analysis." In the present work Professor Axelrod has brought both game theory analysis and the practical analysis of decision-making to a new level of development. He turns away from the conflict orientation of much of the literature and poses one of the most fundamental questions of human society: "Under what conditions will cooperation emerge in a world of egoists without central authority? In situations where each individual has an incentive to be selfish, how can cooperation develop?"

Axelrod, painting with a broad brush, outlines his game theory approach to social interaction and gives a wide range of examples to show its relevance for real-world situations. "The framework is broad enough," he concludes, "to encompass not only people but also nations and bacteria." An impressive scope by any criterion!

He begins with a general discussion of cooperation, conceived abstractly in terms of the Prisoner's Dilemma. Here, briefly, is the dilemma:

A prosecutor approaches two thieves separately and offers a deal. "Confess and implicate your buddy. If your buddy refuses to confess, you'll go free and he'll get five years. If you both confess, of course, you'll both get four. If neither confesses, you'll both get only two years, because our evidence isn't very strong." Thief A reasons: If I implicate B and he doesn't implicate me, I could get off free. Of course if he implicates me and I don't implicate him, I could get five years myself. I'd better not depend on him to keep quiet. I'd better implicate him. Thief B reasons in the same way, and they both end up with four years. Of course, if neither had implicated the other, each would have gotten two.

Cooperation, then, is the best strategy for any pair of individuals, viewed as a set, but it is not an optimal strategy from the perspective of any one of them viewed separately.

In the next chapter Axelrod discusses his computer tournament experiment. Experts

in game theory were invited to submit strategies for solving the Prisoner's Dilemma, and their responses were submitted to computer analysis. A simple rule emerged as the most successful and enduring and the one most likely to produce cooperation in an uncertain and unfriendly world: Cooperate on the first move, and thereafter do whatever the other player did on his previous move—or, tit for tat.

Time is central to Axelrod's theory, and Chapter Three follows up with a fascinating discussion of the chronology of cooperation. When the shadow of the future is long and individuals recognize a high probability of dealing with one another again, they "have a stake in their future interaction" and cooperative patterns can emerge. The stages through which cooperation evolves culminate in a stable pattern of cooperative behavior based on reciprocity—one that is capable, the author discovers, of protecting itself against the intrusion of less cooperative behavior. "Thus, the gear wheels of social evolution have a ratchet."

Under various assumptions of the importance of past and future transactions, the author tests the evolution of cooperation through a number of generations—both in societies in which individuals have random contact with one another and in those where they are found in stable "territorial" relationships. The results confirm, over and over, the robustness of the tit-for-tat formula for social interaction, the importance of the shadow cast by future relations, and the way in which cooperative social behavior can emerge and grow in a population of noncooperators.

Chapters Four and Five apply the theoretical findings to circumstances in which there is neither friendship nor foresight. In a sense, these are worst-case tests. One such case is the "live-and-let-live" system that emerged between enemies in the protracted trench warfare of World War I. Axelrod takes a detailed look at the reciprocity practiced along the front by soldiers who refrained from shooting to kill. In the static conditions of trench warfare, where small units faced each other for long periods, he contends, cooperation based on such reciprocity could emerge even between bitter antagonists. In the other case, Axelrod collaborates with biologist William D. Hamilton to explore cooperation theory as it applies in biological systems. They link cooperative strategy with Darwin's notion of individual advantage to show that cooperation can emerge and thrive even when there is neither consciousness of consequences nor any relationship between in-

dividuals.

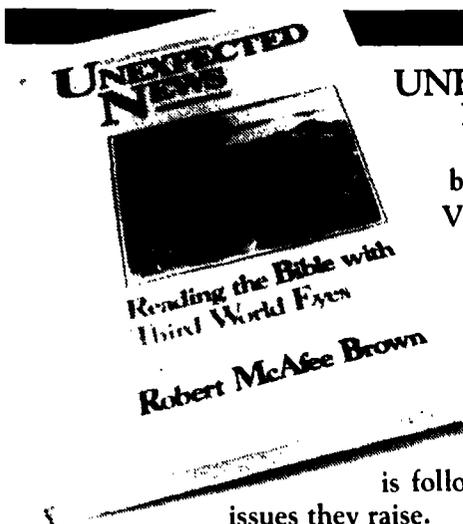
Having explained the logic of cooperation theory and illustrated its application in some of its most difficult—if intriguing—settings, Professor Axelrod puts on his reformer's hat to offer advice to people who must make decisions in situations of the Prisoner's Dilemma type. With disarming simplicity he marshals his experimental evidence and theoretical propositions to offer four suggestions for success: "Do not be envious of the other player's success; do not be the first to defect; reciprocate both cooperation and defection; and do not be too clever." Then, taking the perspective of the reformer who wants to promote cooperation, he looks at a variety of methods that touch on topics "from the strength of bureaucracy to the difficulties of Gypsies, and from the morality of TIT FOR TAT to the art of writing treaties."

The two final chapters extend the implications of Cooperation Theory to domains that have been hardly touched before by game theory logic. The role of reputation, stereotyping, and status hierarchies in social structures is explored, as is the strategy of governments in achieving optimal compliance in areas as diverse as pollution control and the administration of divorce settlements. When Axelrod turns to discuss cooperation among people who do know and care about each other and where there is a central authority, he discusses what it takes to make mutual cooperation stable and even to accelerate the evolution of cooperation.

This work is without doubt a fascinating exercise in the logic of game theory. It opens fresh insights into interpersonal relations and into the success and stability of social groups. All the usual reservations about the distortions and oversimplifications and restrictive assumptions of game theory approaches seem irrelevant in discussing a work of this type. For one thing, Axelrod appears to break genuinely new ground and to raise the logic of game theory to a new level of subtlety and sophistication. Many of the restrictive assumptions and divergencies from real-world circumstances are simply not there. But beyond that, this is a "think piece" even more than it is an exercise in experimental theory-building. It invites new perspectives on ancient questions and does so with an admirable simplicity and clarity. It does not deny complexity so much as step back from it in order to examine more basic relationships touching on cooperation and conflict. It is a delightful study—at once simple and profound, traditional and fresh, carefully argued yet slightly outrageous. (WV)

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