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## *Preface*

Strolling down Bourbon Street in New Orleans, three authors were discussing *On Any Sunday*, a football film by Oliver Stone. The first described a scene in which an experienced coach tries to explain to his star quarterback what players miss after retirement. “It’s not the winning or the awards. It’s not the fans or the cheering or the locker room. What you miss is that feeling of eleven people, all facing the same direction, all moving down the field together.” The second, not much of an athlete himself, lamented that he would never have that feeling. “What do you mean?” said the third. “Aren’t the three of us all here, right now, moving down the field together?”

He was right, of course. More important, he was right in a way that highlights the similarities and differences between collaboration and cooperation, two concepts that are often confused. A football team is one kind of collaboration. Players in fixed structural positions seek to execute a play, kick a field goal, prevent a first down. Their roles are limited and specific, working together to outscore an opponent. Since they are human beings, they like it when they win, but they like it even better when they actively help each other along the way—a process that may also be called teamwork. Three friends exploring a city together have determined, for the present, to *take each other’s interest into account*. There is no specific “objective” for their cooperative interactions, except in the expressive sense of enjoying each other’s company. Such important but diffuse activities are inherent in all social interactions with positive affect, and they are distinct from instrumental goals such as manufacturing a car, building a church, or writing a book.

Taking the interests of others into account is the basis of cooperation, a fundamental social process. Collaboration—our main interest here—involves something more, a shared objective. The shared objective is what brings social actors together and induces them to create plans, proce-

dures, and lasting structures. It is difficult to imagine collaboration without cooperation among individuals in some minimal sense. But collaboration itself is not a form of social interaction on the same plane as cooperation, conflict, and competition: a goal, or a set of goals, is crucial. Considered as a social *object*, collaboration is an aggregation of social actors or identities. Often it is intendedly ephemeral, in which case it is distinct from complex organizations that are designed to last. When goals are met or resources disappear, collaborations expire. Considered as a social *process*, collaboration is a way of organizing, oriented toward common objectives. One implication of this characterization of collaboration versus cooperation is that organizations are capable of only the former, while people can do both. Only human beings can take each other's interests into account.

For individuals to collaborate effectively, individual interests must sometimes be sacrificed for the sake of the common objective. The threats and rewards of working within an organization have traditionally supplemented moral commitment to ensure that such objectives are met. Today, collaboration among organizations is a growing phenomenon in all spheres of human activity, science and technology included. Modernization, globalization, new communication technologies, and competition in the efficient utilization of human, financial, and technological resources have brought about a general tendency to develop knowledge in new organizational structures. In a variety of fields, it is rapidly becoming the norm for researchers from different locations and institutions to work together on common projects: scientific and technological collaborations are part of a general trend toward more fluid, flexible, and temporary organizational arrangements. Joint ventures, strategic alliances, consortia, partnerships, and all manner of networks characterize many sectors of the economy. As modern production and services become increasingly knowledge-based, and as technological innovation becomes more complex and diversified, organizations begin more and more to interpenetrate—entities combine and recombine in processes that blur traditional enterprise boundaries. We assume all this as background. Our starting point is that science and technology are integral to the networking dynamic that characterizes the modern social order, and that scientific work itself has been affected by these global tendencies that involve collaboration.

Of course, our work is collaborative. More important, we did not initiate the project that gave rise to our work. The origin of this study dates to the late 1970s, when historians and archivists at the American

Institute of Physics' Center for the History of Physics conducted a study of U.S. national laboratories and recognized that no one was attempting to document the activities of multi-institutional collaborations of researchers who were conducting experiments at the national laboratories. The collaborations were disbanding after completing their experiments without any assessment of the records they had created and without any provisions for preserving their historically or scientifically valuable records.

In 1989, AIP archivist Joan Warnow-Blewett initiated a long-term study to address this problem of documentation. She enlisted historians and sociologists to develop the knowledge that archivists and administrators would need to identify records that should be preserved for posterity. She sought and received funding from the National Science Foundation, the Department of Energy, the National Historic Preservation and Records Commission, and the Mellon Foundation. (The National Science Foundation, under its Program in Science and Technology Studies, later supported our integration of the three phases of the AIP study into one data set.) The first phase examined 24 collaborations in high-energy physics. The second examined six collaborations in space science and eight in geophysics. The third phase examined 23 collaborations in ground-based astronomy, materials science, heavy-ion and nuclear physics, medical physics, and computer-mediated collaborations.

In all, about 600 participants in these collaborations were interviewed about their origins, their organization, their management, their communication practices, the relationships among scientists, and the collaborations' outcomes. The objective was to build an empirical base for understanding how records have been created, used, and collected. The current volume is based on historical and sociological examination of these interviews, focusing on the structure of scientific collaborations. After all the interviews had been transcribed and all the reports written, we set out to reanalyze and interpret the whole. It is good to write a small book on a large project.

Joan Warnow-Blewett died in May 2006. We dedicate this volume to her memory. Her energy and zeal were obvious to her most casual acquaintances. Her passion for documentation research was legendary among her colleagues. She was the Principal Investigator of the AIP Study of Multi-Institutional Collaborations in Physics and Allied Sciences. There is no way to overstate our gratitude and indebtedness to her. R. Joseph Anderson, her successor, helped in more ways than we can count, even before taking over as archivist. He sat with us for hours, argued with us about our methodology, and greatly improved our study.

We honor Spencer Weart, director of the AIP Center for History of Physics, as a constant source of constructive criticism. He was convinced that this book should be written, he encouraged us to write it, and he improved it through his comments. We thank the AIP staff and consultants who conducted interviews with us over the years. A study such as this cannot be conducted without considerable expertise in the subject matter, and we consider ourselves extremely lucky to have worked with Anthony Capito, Ron Doel, John Krige, Janet Linde, Lynn Maloney, Frederick Nebeker, and Arturo Russo. The late David Edge and Mike Lynch, successive editors of *Social Studies of Science*, were instrumental in helping us refine our notions of trust and performance. We are very much indebted to Edward Hackett and Ulrike Felt for assistance and feedback during several phases of the project, as well as to our friend and editor Wiebe Bijker, who helped us immensely in bringing the volume to fruition. Near or far, one cannot wish for better colleagues than Ed, Uli, and Wiebe.

Since one may also be indebted to an entire community, we are grateful for the annual meetings of the Society for Social Studies of Science and the History of Science Society, which have been receptive venues over the years. In particular, the intellectual development of our ideas owes a great deal to Karin Knorr Cetina, Michel Callon, Sheila Jasanoff, and Bruno Latour. Many scientists, historians, and scholars provided special help on certain phases of the project. For high-energy physics our main consultants were Peter Galison, Roxanne Nilan, Lynne Zucker, and Lowell Hargens. Others who provided advice were Helen Samuels, Anne Millbrooke, Sharon Gibbs Thibodeau, Richard McKay, Victoria Davis, Louise Addis, David Berley, Sheldon Glashow, Bernard Hildebrand, Herbert Kinney, William Kirk, Ronald Kline, Derek Lowenstein, Robert Smith, William Wallenmeyer, Robert Wilson, Stanley Wojcicki, and Harriet Zuckerman. For space science and geophysics we also relied heavily on Naomi Oreskes and Deborah Day. Additional advice and criticism came from Arthur Davidsen, Stewart Gillmor, Robert Heinmiller, Frank McDonald, Chandra Mukerji, John Naugle, William Nierenberg, Arthur Nowell, Kenneth Pedersen, John Perry, Charles Prewitt, Mary Rabinowitch, Jeffrey Rosendhal, and James Van Allen. For the last phase, we also consulted Gabriel Aeppli, Alan Berson, Robert Dickman, Paul Fleury, Phillip Geil, Russell Huebner, Thomas Humanic, Goetz Oertel, Thomas Rosenbaum, Ulrich Strom, Paul Vanden Bout, John Watson, Sidney Wolff, John Knauss, Robert Williams, Joseph

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We are eternally indebted to our informants, the scientists, engineers, and managers who described with wit and detail some of the most fascinating collaborations in twentieth-century science. Although we have removed their names from the quotations in this volume, almost all generously allowed their interview transcripts to be archived at the American Institute of Physics and made available for scholarly research at the AIP's Niels Bohr Library. We hope to persuade our readers that the transcripts are well worth using.