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978-0-521-11570-4 - Scientific Productivity: The Effectiveness of Research Groups in Six Countries

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Scientific productivity

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Scientific productivity

The effectiveness of
research groups in six countries

Frank M. Andrews, editor

*Institute for Social Research,
University of Michigan*

Contributing Authors:

George Aichholzer

Frank M. Andrews

Joseph Bonmariage

Gerald A. Cole

Csaba Fajsz

Arpad Halász

Agnes Haraszthy

Y. de Hemptinne

Peter Hunya

Karin D. Knorr

Salomea Kowalewska

Edmond Legros

Roland Mittermeir

Rikard Stankiewicz

Veronica Stolte-Heiskanen

Lajos Szántó

Michel Vessière

Nicole Visart

George Waller

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Foreword by Unesco

The complexity of modern society and the sweeping changes that have occurred in everyday life over the past thirty years have placed new responsibilities on governments. The variety of concerns with which they are involved has increased enormously. Governmental programs exist today that were unknown even a decade ago. Other programs have expanded their responsibilities to take account of modern social wants and needs. Thus, the competition for resources has intensified greatly.

At the same time, citizens in many countries are asking for more public accountability. They want to know the use to which their resources are put, and they demand that the programs that receive support be both efficient and effective. In many countries, these concerns have been raised with particular reference to support of scientific and technological research. As a consequence, the importance of improving the productivity and the effectiveness of scientific research has been recognized.

More important perhaps, is that the gap between those countries with abundant financial and technological resources and those with fewer such resources will widen if some intervention is not undertaken. This has been obvious for many years, even prior to the initiation of the project reported in this book. The formal recognition of this situation occurred when the Declaration on the Establishment of a New International Economic Order was adopted by the General Assembly of the United Na-

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tions in 1974. An implication of the declaration is the need to make available to developing countries the methods and achievements of modern science and technology. Elucidating the means of engaging in effective scientific and technological research activities represents one of Unesco's contributions to this goal.

Meeting in 1976 in Nairobi at its nineteenth session, the Unesco General Conference, through Programme Resolution 2.01, reaffirmed "Unesco's front-ranking role and responsibility . . . for . . . the promotion . . . of scientific and technological progress (and) the encouragement of the application of scientific and technological advances to development," and authorized the Director-General "to place special emphasis on programmes in the field of science and technology aimed at . . . the building up and strengthening of institutional infrastructures." The work reported in this volume is thus part of Unesco's activities described in the foregoing resolution and in similar resolutions passed at earlier sessions of the General Conference.

In building a research team composed of people from a variety of national and institutional settings to undertake this work, Unesco consciously sought not only to encourage cross-national cooperation and fertilization of ideas, but to produce a work that, because of its origins, would be useful in many national and institutional settings.

The number of people and organizations that have made vital contributions to this International Study is very large. Clearly, the study could not have proceeded without the cooperation of the thousands of respondents who participated as members of the research units being studied, or without the dedicated work of the scores of people who collected and processed the data, or without the financial and institutional support of the sponsoring organizations in each of the participating countries. For this international cooperation and particularly for the valuable contribution of Dr. Frank M. Andrews, the scientific editor and one of the authors of this volume, Unesco wishes to express its gratitude. The members of the International Research Team that has been responsible for carrying out the study, all of whom are authors of chapters in this volume, are profoundly grateful for the many kinds of support that have been provided. It is the team's strong hope that the uses of the data and results – for both applied and theoretical purposes – will constitute a compelling justification of the resources and efforts that have been invested. Finally, it is appropriate to acknowledge the contributions of Dr. Michael Pesci, who for several years devoted his professional efforts to furthering this International Study.

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The authors contributing to this volume have done so as individual professionals; neither Unesco nor the authors' employing institutions are responsible for the views and opinions expressed herein.

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The nature of this book

This book reports results from The International Comparative Study on the Organization and Performance of Research Units. (For this study, a *research unit* is a cluster of scientists and technical support personnel working under single leadership, sometimes as a team, on a specific research or experimental development project.) Results from Round 1 of the study, involving data collected from over 11,000 participants in approximately 1,200 research units in six European nations, are presented here.

The study has had two broad purposes. One is goal oriented: to find ways to enhance the performance effectiveness of research units and of their members. The second is methodological: to develop and test methods for assessing the organization and performance of research units. Results relevant to both these purposes are described in this book.

Unesco initiated this study, under its Program of Science and Technology Policies, and has been responsible for its coordination. The design and implementation of Round 1 were carried out by a small international team of social scientists, natural scientists, and managers of research and experimental development (R & D). These are the individuals who wrote the chapters that follow.

As readers of this volume will quickly perceive, the interests

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of the authors are broad and varied. (There is a corresponding breadth to the International Study.) Each chapter is an independent presentation, the product of its own authors' interests, preferred analytic approaches, and professional judgments. With the exception of Chapters 1 and 2, which constitute the introduction to the book, there is no necessary or logical order among the chapters (indeed, within Parts 2 and 3 the sequence is alphabetical by the authors' national or international affiliation). However, although the chapters are independent presentations, they are not unrelated to one another: They share a common conceptual framework; they report analyses of a common set of empirical data; and they draw upon and refer to one another for complementary results and descriptive information.

Although each chapter will appeal to some readers, it is not expected that every chapter will interest every reader. Hence, to help readers find their way among the many topics discussed in this book, the following section describes the organization of the book and comments briefly on each of the chapters. The reader should also note that each chapter (except the first) concludes with a short summary or discussion of many of the key ideas, which can be used to help locate material of particular interest.

An overview of the chapters

The book is organized into three main parts. Part 1 consists of two chapters that introduce the background and purposes of the International Study and that describe the methods by which the Round 1 data were collected and analyzed. These chapters provide essential information that readers will need in order to fully understand the later chapters. Part 2 is made up of eight chapters that focus on relationships between various organizational factors and the performance effectiveness of research units and/or their members. Most chapters in this section begin by reviewing results obtained in previous investigations in scientific or other types of organizations and then proceed to extend this previous work through statistical analysis of the rich data from the International Study. Part 3 consists of four chapters with strong methodological orientations. These chapters focus primarily on issues of measurement quality, meaning, and procedures in the International Study, and link these issues to relevant prior research.

In Chapter 1, de Hemptinne and Andrews describe the considerations that led Unesco, within its program on Science and Technology Policies, to initiate the study; note some of the ma-

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job design features of the project and ways it differs from previous research on R & D; summarize some of the broad trends of the statistical results that are reported in greater detail later in the book; and warn the reader about possible misinterpretations of the data.

Chapter 2 continues the introductory material by providing details about the design of the International Study. Described here are the sources of the data and the measurement procedures. In addition to laying the foundations for the analyses reported later in the book, Chapter 2 provides a brief but reasonably comprehensive description of a methodology that has proven helpful for studying the effectiveness of research units and that is now available for further development in future applications.

Chapter 3, by Knorr, Mittermeir, Aichholzer, and Waller, the first chapter in Part 2, selects one particular indicator of scientific performance—published written products (primarily articles)—and explores its relationships with a wide range of factors that might account for differences in individual and group productivity in academic and industrial research units. The social position of an individual within the social hierarchy of a research unit proves to be one important correlate of differences in performance at the individual level, and the size, age, and scientific exchanges of the research unit are additional factors that relate to group productivity.

Chapter 4, also by Knorr, Mittermeir, Aichholzer, and Waller, takes a different indicator of performance—ratings of a research unit's R & D effectiveness—and examines how this indicator of performance relates to selected organizational characteristics. A major conclusion is that the results from academic research units seem to be in accord with the "human relations thesis," that is, with the idea that good leadership leads to high group morale, and that high morale leads to increased productivity by group members. This chapter includes a brief discussion of how its results link to those presented in the preceding chapter.

Chapter 5, by Stolte-Heiskanen, examines the relationships between the levels of externally determined resources of research units (material resources, human resources, and information resources) and the rated performance of those units. Contrary to what some people would expect, the results show that satisfaction with resources, rather than objective resource levels, had the higher relationship to performance, and that of the several types of resources considered, human resources stood out as most significant.

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Chapter 6, by Haraszthy and Szántó, is addressed to problems of research planning, with a particular emphasis on science policy planning in Hungary. Comparisons between Hungary and other countries participating in Round 1 of the International Study are presented for a number of variables relevant to the selection and completion of R & D projects by research units.

Chapter 7, by Kowalewska, was stimulated by some previous studies that suggest that the effectiveness of an organization may partly depend on the amount of influence different members have over decision making. Chapter 7 reports that results similar to those found in previous research emerge in the Round 1 data for the kinds of R & D performance more relevant in academic units, but that different results emerge for more applied aspects of performance.

Chapter 8, by Stankiewicz, explores relationships among the size, age, and effectiveness of research units. Drawing from previous studies of R & D, several competing hypotheses about these relationships are proposed and then tested in the Swedish data of the International Study. It is found that the hypotheses' applicability depends on several factors, including levels of group cohesiveness and characteristics of the group leaders. Although the chapter focuses exclusively on Swedish academic units, the key results have been replicated in the International Study's data from Austrian and Belgian academic units (according to a personal communication from Stankiewicz).

Chapter 9, by Visart, addresses the relationship between research-unit effectiveness and levels of communication within and between research units. The results show that higher levels of effectiveness tend to occur where there is more communication. The chapter details the particular indicators of effectiveness and communication for which this trend appeared, and other indicators where it did not appear, and explores numerous other characteristics of units that also relate to communication and effectiveness.

Chapter 10, by Andrews, investigates how the performance of research units relates to the motivation of their members and to the presence of "diversity" in the working environment of the unit. In accord with the results of previous research on R & D, a pervasive trend is found in the data of the International Study showing that higher-performing units tended to have more dedicated professional members with more diverse working roles and intellectual resources.

Chapter 11, by Bonmariage, Legros, and Vessièrè, the first chapter in Part 3, describes a methodological exploration of the

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ratings of research-unit effectiveness. With substantial reliance on the statistical technique of factor analysis, this chapter examines the extent to which the “meaning” and relevance of different performance measures varies across different types of research-unit settings and different types of raters.

Chapter 12, by Hunya, Halász, and Fajsz, describes a hierarchically oriented analysis strategy used by the authors in exploring the whole range of data collected in Round 1 of the International Study. Although the analysis procedure is rather different from that employed by other authors, in general it corroborates the results reported elsewhere in the book. One of the analyses that is unique to this chapter, however, is an examination of the relationships between R & D facilities and research-unit performance using data aggregated up to the country level.

Chapter 13, by Cole, details the theoretical and empirical considerations that led to the development of a scheme by which the research units of Round 1 could be classified into one of a small number of distinct types. This “typology” is based on distinctive patterns of research-unit performance (as identified through a multidimensional scaling technique) and proved strongly related to different patterns in the distribution of influence over the work of the unit. The typology plays an important role in the analyses performed by many of the other authors contributing to this volume.

Chapter 14, by Andrews, develops estimates of the quality of the rated-effectiveness measures using a structural modeling technique. Numerical estimates are presented for the portion of each measure’s variation that is valid (i.e., estimated to reflect “true” differences), that is attributable to correlated errors, and that is attributable to random error. The chapter also discusses the implications of these estimated quality levels for the observed relationships reported in other analyses in this book.

Authors’ addresses

Because the authors contributing to this volume are independently responsible for their respective chapters (within broad limits overseen by the editor), because some readers may wish to contact particular authors, and because the authors are widely scattered across eight countries, it seems desirable to list here the mailing addresses (as of early 1978) for those whose names appear first on each chapter.

Frank M. Andrews, Institute for Social Research, University of Michigan, Ann Arbor, Michigan 48109, U.S.A.

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Joseph Bonmariage, Belgian Archives for the Social Sciences,
Batiment SH2, B-1348 Louvain-la-Neuve, Belgium

Gerald A. Cole, Institute of Public Policy Studies, University
of Michigan, Ann Arbor, Michigan 48109, U.S.A.

Agnes Haraszthy, Group for Science Organization, Hungarian
Academy of Sciences, V. Munich Ferenc u. 18, Budapest 19,
Hungary

Y. de Hemptinne, Division of Science and Technology Poli-
cies, Unesco, 75700 Paris, France

Peter Hunya, Jate Laboratory of Cybernetics, Jozsef Attila
University, Aradi Vertanuk tere 1, 6722 Szeged, Hungary

Karin D. Knorr, Institute for Advanced Studies, Stumpergasse
56, A-1060 Vienna, Austria

Salomea Kowalewska, Institute of Philosophy and Sociology,
Polish Academy of Sciences, ul Nowy Swiat 72, 00-330
Warsaw, Poland

Rikard Stankiewicz, Research Policy Programme, Lund Uni-
versity 8, 22-362 Lund, Sweden

Veronica Stolte-Heiskanen, Institute of Sociology, University
of Helsinki, Franzeninkatu 13, SF-00500 Helsinki 50, Fin-
land

Nicole Visart, Division of Science and Technology Policies,
Unesco, 75700 Paris, France

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A general acknowledgment of the many kinds of support that have contributed to this International Study appears in the concluding portion of the Foreward. In addition, many of the individual chapters of this book include acknowledgments to persons and organizations that made particular contributions to work reported in that chapter. Here, however, it is appropriate to acknowledge contributions to the actual processing of the manuscript for this book that have been made by Gregory A. Marks and Verna Yarrington: Their advice and skills have been of great help to the editor.

Frank M. Andrews, editor