EFFECTIVE MANAGEMENT OF RESEARCH AND DEVELOPMENT

By the same author
INERT ATMOSPHERES
HIGH-EFFICIENCY AIR FILTRATION

EFFECTIVE MANAGEMENT OF RESEARCH AND DEVELOPMENT

P. A. F. WHITE, O.B.E., B. Sc., C. Eng., F. I. Mech. E.,
F. I. Chem. E.

ISBN 978-1-349-02380-6

ISBN 978-1-349-02378-3 (eBook)

DOI 10.1007/978-1-349-02378-3

© P. A. F. White 1975

Softcover reprint of the hardcover 1st edition 1975 978-0-333-17260-5

All rights reserved. No part of this publication may
be reproduced or transmitted, in any form or by
any means, without permission.

First published 1975 by
THE MACMILLAN PRESS LTD
London and Basingstoke
Associated companies in New York
Dublin Melbourne Johannesburg and Madras

SBN 333 17260 4

Contents

<i>Preface</i>	ix
1 INTRODUCTION	1
Unique characteristics of R & D management	2
Changing nature of research management (the justification of R & D)	3
Meaning of research and development	5
(Place of R & D in Cash Flow of a project)	8
Invention and innovation	9
Chief activities of an R & D department (effect of organisational aims on balance of effort)	9
The management role	11
Objectives of the book	14
Pay-off of improved management	15
Summary	15
2 GENERAL CONSIDERATIONS OF R & D ACTIVITIES	17
Total national expenditure on R & D	18
Expenditure by different sectors	21
Expenditure in universities and research associations	24
Cost per professional scientist	25
Research in industry	26
Effect of size of firm (special situation of small firms)	30
Internal v. external research	33
Data from USA	34
Profitability and research ratio	42
The customer/contractor relationship	44
Summary	46

3	THE STRUCTURE OF R & D ORGANISATIONS	48
	From large government laboratories to small industrial laboratories	48
	Purpose of laboratory	50
	The structure of R & D organisations	51
	Horizontal structure	52
	Vertical structure	59
	The nature of organisations	60
	The structure of organisations	63
	Hierarchical structure in research establishments	67
	Size of research establishment v. effectiveness: economies of scale	73
	Relation between research and design	75
	Relation between internal and external research	77
	Summary	79
4	AVAILABLE SOURCES OF RESEARCH EFFORT	81
	Universities and polytechnics	81
	Government departments	85
	Technical spin-off from advanced R & D	86
	Government laboratories	87
	Research associations	93
	Sponsored research institutes	96
	Consultants	97
	National Research Development Corporation (NRDC)	98
	Research in industry	99
	Social implications of science	100
	Summary	101
5	THE CHOICE OF AN R & D PORTFOLIO	118
	Objective decided	119
	Objective known generally	121
	Objective unknown	123
	Source of new research ideas	124
	Selection of portfolio	127
	Study of an actual portfolio in US industry	132
	Quantitative analytical methods of project selection	133

CONTENTS		vii
	PABLA	134
	Critical path planning and branched networks	139
	Cost benefit analysis	146
	Choice of research project – appraisal graphs	150
	Benefits of using formal project review	151
	Defining project to ‘customer’ requirements	152
	Changing the portfolio – stopping projects	156
	Technology assessment	160
	Summary	161
6	CONTROL OF R & D PROJECTS	163
	General management role	163
	Budgeting and cost control	165
	Critical path networks for control of research projects	174
	Management by exception	176
	Management by objectives	176
	Cash flow diagrams as control techniques	181
	Communications	182
	Communications in the laboratory	187
	Difference between management and direction	192
	The end-point of project-orientated research	193
	Patents and positive publication policy	195
	Summary	200
7	EFFICIENCY AND PRODUCTIVITY IN R & D	202
	The place of efficiency in R & D	202
	Economy of experimentation	204
	Scale of experimentation	206
	Tools of research	207
	Measuring productivity in R & D	208
	Techniques for the efficient use of staff	212
	Use and control of labour	214
	Job evaluation	216
	Work study/activity sampling	217
	Engineering services	219
	Using the available system	221
	Summary	221
8	STAFF SELECTION, DEVELOPMENT AND MANAGEMENT	223
	Recruitment and promotion	223

Staff development	227
Management of staff in R & D environment	232
Organisation and freedom	234
Power and conflict within organisations	237
Summary	240
9 LABORATORY PLANNING AND ADMINISTRATION	242
General planning	242
Relationship with architect/engineer	245
Selection of site	249
Control of building activities	249
Commissioning and take-over	251
Laboratory management	253
Summary	256
10 TECHNICAL ASSISTANCE TO R & D STAFF	258
Services – direct and indirect	258
Information and library services	259
Engineering services	261
Administrative controls	261
Safety	263
Consultants	265
Human sciences	266
Summary	268
11 LEADERSHIP IN RESEARCH ORGANISATIONS	270
Analogy with orchestral playing	270
Place of individual research worker	271
Maintaining high standards	272
Leadership	273
Typical responsibilities of head of R & D department	275
Attributes of research leader	278
Summary	279
<i>References</i>	281
<i>Index</i>	287

Preface

The Research and Development scenario has undergone a substantial change over the last decade or so. From a setting in which total effort was expanding rapidly with a faith that more R & D was inevitably rewarding, has come the much more critical atmosphere in which, firstly, efforts were made to increase the productivity of research and, secondly, much greater perception of the necessity of fitting research to social needs has arisen.

The move towards quantifying or at least logical planning of research has become more refined while the relationship of R & D to 'marketability' factors has also assumed greater importance. Methods of inspiring creativity in relation to innovation have received much attention as have the nature of the structure of scientific organisations and methods of managing creative scientists.

This book is concerned with the situation as it appears now – with the rational tools available for assisting in management, with the many aspects of increasing efficiency and productivity in the laboratory and with the many factors which go to directing a successful R & D effort tuned to the needs of its parent authority from customer/contractor relationship to methods of structuring R & D organisations and management styles. Data related to expenditure on R & D in various fields is given for both the UK and the USA.

It may be that the refinement of the tools for such rationalisation of the management of R & D has sometimes misguided managers into forgetting that it is still the quality of the output of the front-line researchers which decides whether advances are feasible and this book continually emphasises the need for creating the right environment for researchers as the prime task of the R & D management.

Literature on the subject of R & D management was prolific about a decade ago, when the new quantifiable techniques

were first gaining recognition but is harder to find in relation to the present outlook. This book is written largely from the author's experience as the Head of the Division of Chemical Technology at the UKAEA Aldermaston (now Ministry of Defence) for the last sixteen years together with experience of industrial and civil service research before that, as well as from much of the literature of recent years.

It is felt that it is now timely for a book to appear on the present changed scenario. It is hoped that it will be of help to those already engaged in the managing and directing of research and to those who aspire to such a goal. It should also be of value to students in universities and polytechnics, particularly in the technological disciplines, who wish eventually to work in some field of applying research to practical problems or any others who seek a text for training in the wider issues of managing the application of research. Managers of other departments than the research department might find this book useful to tell themselves of the nature of the problems of their technical colleagues.

There are many people who have played a part indirectly in the production of this book – particularly the many staff at AWRE Aldermaston with whom the methods of managing large and small scale R & D enterprises were jointly forged over the years.

More directly I should particularly like to thank Dr J. W. Weale, Superintendent of Nuclear Physics at AWRE Aldermaston for help in methods of applying management by objectives in the research field; Mr R. L. Latham, Senior Superintendent, Engineering, at AWRE Aldermaston for help in relation to his own development of Problem Analysis by Logical Approach; Dr P. M. S. Jones, Head of the Programmes Analysis Unit, Chilcott, Harwell, for information regarding cost/benefit analysis studies; Mr A. J. Richards of the Department of Trade and Industry for up-to-date information about the industrial research associations.

Acknowledgement is also due to each of the following for permission to reproduce figures: Chapman & Hall Ltd (Figures 5.7–5.10), Her Majesty's Stationery Office (Figure 4.1), International Communications Ltd (Figure 7.1) and the United Kingdom Atomic Energy Authority (Figures 1.2 and 1.3).