LABORATORY ADMINISTRATION

by E. S. Hiscocks

LABORATORY ADMINISTRATION

BY

E. S. HISCOCKS

M.Sc., F.R.I.C.

SECRETARY, NATIONAL PHYSICAL LABORATORY

LONDON

MACMILLAN & CO LTD

NEW YORK · ST MARTIN'S PRESS

1956

MACMILLAN AND COMPANY LIMITED
London Bombay Calcutta Madras Melbourne

THE MACMILLAN COMPANY OF CANADA LIMITED
Toronto

ST MARTIN'S PRESS INC
New York

PRINTED IN GREAT BRITAIN

'A good laboratory is one where you find bright men producing good results.'

SIR EDWARD BULLARD, F.R.S.

'It is as easy to waste money on research as on anything else; especially if it is someone else's money.'

SIR HENRY TIZARD, G.C.B., A.F.C., F.R.S :
A Scientist in and out of the Civil Service, 1955

'Let me therefore conclude by underlining the importance of good administration, but by reminding you also that administration in science will not, of itself, produce a single new idea and without new ideas science would cease to exist.'

SIR BEN LOCKSPEISER, K.C.B., F.R.S.: *Research and Technical Progress:*
Lecture to the Institute of Public Administration, 1950

INTRODUCTION

SIR CHARLES DARWIN in *The Next Million Years* considered that mankind has experienced four revolutions—the last and greatest of them being the scientific revolution during which we are now living.

Science has long since ceased to be a dilettante interest of the rich. The results of scientific discovery now affect the lives of all of us and scientific investigation has become the principal means not only of safeguarding and improving the sustenance, health and general amenities of mankind as a whole but also of improving that industrial productivity on which the economic life of our country depends. It is also the principal means of maintaining our existence as a political entity in the world.

Governments and industry now spend tremendous sums on scientific research and development and a significant proportion of this is spent on laboratory work. Although much has been written about the place of science in industry and the state, practically nothing has been written in this country about the internal organisation or management of scientific work, that is, about the administration or management of scientific laboratories—very possibly because many scientists believe that scientific research cannot be managed. In certain respects they may be right but in others they are demonstrably wrong.

The main product of a scientific laboratory is ideas. It isn't possible exactly to assess the value of the work of a specific laboratory—partly because the work of any one institution provides only one piece of a tremendous and very complex jig-saw puzzle, but mainly because the value or otherwise of the discoveries often depends wholly on how other people use them afterwards. However, the lack of a simple yardstick should not deter us from attempting to get the best return for outlay, and one factor in achieving this is to examine the requirements in organisation and management which will provide the conditions in which scientific work can be most productive. This becomes increasingly important not only from the point of view of cost, but

because it is becoming increasingly necessary to spread the available research ability over constantly expanding requirements.

Many scientists, as their careers progress, become responsible for the supervision of the work of others and are thus introduced to the art or science of management. Their approach to the problems of management is normally conditioned only by their own experience, because little if anything is done to enable them to study the subject and to learn from the experience of others.

It is hoped that this book will assist those whose job it is to manage laboratory work, even though it often merely states a problem without supplying the answer. It may also help those who, not being scientists themselves, have nevertheless to make decisions affecting the establishment or operation of laboratories.

A laboratory is a place where practical investigations into natural science are conducted. The word is used variously to connote anything from one room to a large institution, and throughout this book I have used it in the latter sense. Management, as such, of laboratories becomes only of special significance when the institution is so large that the individual in charge cannot hope to have a working knowledge of all that is happening there. I have assumed, therefore, that what I have to say will apply in the main to laboratories employing more than, say, 200 people in all. I have drawn many of my illustrations from government establishments not only because the State is the largest single employer of scientific labour, but because my only first-hand experience has been gained in the Scientific Civil Service. I have, however, sought the help and advice of those concerned with other laboratories whenever possible.

I have also quoted extensively the present practices of the National Physical Laboratory—not only because I, as its Secretary, have detailed knowledge of the management of that Laboratory and have tried out certain experiments in management there, but also because I regard it as a good case for study. It is now 56 years old, and therefore covers the whole range of staff age groups; it is medium large as laboratories go, with a total staff of over 1,000. It covers a wide range of physical science in its fundamental and applied aspects. It was founded by the Royal Society and did not become part of a Government Department until seventeen years later. During these years it acquired a sturdy individualism which 38 years as part of a Government Department have not

obliterated—no doubt because even now some members of its staff were recruited before its transfer, but mainly because the Royal Society still fulfils the very important function of ' managing ' its scientific work. Finally, it carries out scientific tests and investigations for payment for industry and other government departments, thus fulfilling some of the functions of a sponsored research institution. It is at the same time faced with the problem of getting the results of much of its work over to potential users —an aim which is only in part filled by the publication of scientific papers.

I find that most scientists of my acquaintance describe as ' administration ' such of their activities as are not strictly scientific. I had intended calling this book ' Laboratory Management ', which would, I think, be a more apt title, but in view of the almost technical significance attached to the word ' administration ' in laboratories, I have worded the title accordingly. My theme is therefore administration in its management sense, and I have not attempted to cover such matters as the choice of the research objective and higher policy-making except in so far as they affect the day-to-day running of the establishment.

Neither have I attempted to deal with those processes, such as searching the literature or the design and execution of experiments, which are usually regarded more as part of the research work itself than of the management of the laboratory.

I have considered whether any discussion of salaries and wages or, for that matter, any other costs is worth while in view of the probability that any figures quoted will become out-of-date whilst this book is being printed. This is the inevitable penalty of writing about such matters during a period of accelerated inflation, but, even so, I think figures are of value at least for showing relativities, and for this reason have decided to include them.

I have been granted official facilities for collecting and compiling some of the material I have used in this book but the opinions expressed are my own and do not necessarily represent the views of the Laboratory or of the Department of Scientific and Industrial Research.

TEDDINGTON, MIDDLESEX
August 1955

INITIATION

THE use of initials as shortened forms of the names of institutions or groups of staff is now commonplace.

Full names have been given when initials are first used (except where space does not allow of this in some appendices) but for convenience a list, with interpretations, is given below :

A.E.R.E.	Atomic Energy Research Establishment
A.E.O.	Assistant Experimental Officer
A(Sci.)	Assistant (Scientific)
A.S.E.A.	Allmanna Svenska Elektriska Aktiebolaget, Sweden
A.Sc.W.	Association of Scientific Workers
B.A.S.F.	Babische Anilin-und-Soda-Fabrikat, Germany
B.M.A.	British Medical Association
B.R.S.	Building Research Station
C.D.	Civil Defence
C.D.O.	Civil Defence Officer
C.S.	Civil Service
C.S.C.	Civil Service Commission
C.S.C.A.	Civil Service Clerical Association
C.S.O.	Chief Scientific Officer
D.C.S.O.	Deputy Chief Scientific Officer
D.S.I.R.	Department of Scientific and Industrial Research
E.D.A.	Extra Duty Allowance
E.O.	Experimental Officer
F.B.I.	Federation of British Industries
F.S.S.U.	Federated Superannuation System for Universities
G.E.C.	General Electric Co. Ltd.
H.M.S.O.	Her Majesty's Stationery Office
I.C.I.	Imperial Chemical Industries Ltd.
I.P.C.S.	Institute of Professional Civil Servants
I.V.A.	Ingeniorsvetenskapsakademien
J.S.C.	Joint Staffs Committee
M.O.S.	Ministry of Supply
M.O.W.	Ministry of Works
M.S.A.	Mutual Security Agency
N.B.S.	National Bureau of Standards, Washington
N.H.I.	National Health Insurance
N.I.M.R.	National Institute for Medical Research
N.P.L.	National Physical Laboratory
N.R.C.	National Research Council of Canada
N.R.D.C.	National Research Development Corporation
O.E.E.C.	Organisation for European Economic Co-operation
O.N.R.	Office of Naval Research, U.S.A.
P.S.O.	Principal Scientific Officer
P.S.R.B.	President's Scientific Research Board
R.A.E.	Royal Aircraft Establishment
S.E.O.	Senior Experimental Officer
S.O.	Scientific Officer
S.P.S.O.	Senior Principal Scientific Officer
S.S.O.	Senior Scientific Officer
T.G.W.U.	Transport and General Workers' Union
T.W.I.	Training within Industry

ACKNOWLEDGMENTS

I WISH to acknowledge the courtesy and help of the directors and staff of the laboratories I have visited. These include :

Professor J. F. Baker and the staff of the Cambridge University Engineering Laboratory.

Sir Lawrence Bragg and the staff of the Cavendish Laboratory, Cambridge.

Dr. J. Bronowski and the staff of the National Coal Board Central Research Establishment, Stoke Orchard.

Sir Arnold Hall and the staff of the Royal Aircraft Establishment.

Sir Charles Harington and the staff of the National Institute for Medical Research.

Mr. D. Hennessey and the staff of the National Research Development Corporation.

Mr. O. W. Humphreys and the staff of the Research Laboratories of the General Electric Company Ltd.

Mr. E. A. C. Liddiard and the staff of the Fulmer Research Laboratories Ltd.

Mr. W. d'Leny and the staff of the Research Laboratories, Imperial Chemical Industries Ltd., Billingham.

Sir William Ogg and the staff of the Rothamsted Experimental Station.

Mr. E. H. Plowman and the staff of the Paints Division, Imperial Chemical Industries Ltd.

Sir Francis Simon and the staff of the Clarendon Laboratory, Oxford.

Dr. F. C. Toy and the staff of the British Cotton Industries Research Association.

My thanks are also due to the following for permission to quote from private papers or publications :

Sir Charles Darwin
The Institute of Physics
The Royal Institute of Chemistry

The National Research Council of Canada
The National Bureau of Standards, Washington
Dr. H. A. Shepard, Massachusetts Institute of Technology.
Sir Ewart Smith
The Controller, H.M. Stationery Office
The Committee of the N.P.L. Professional Staffs Association.

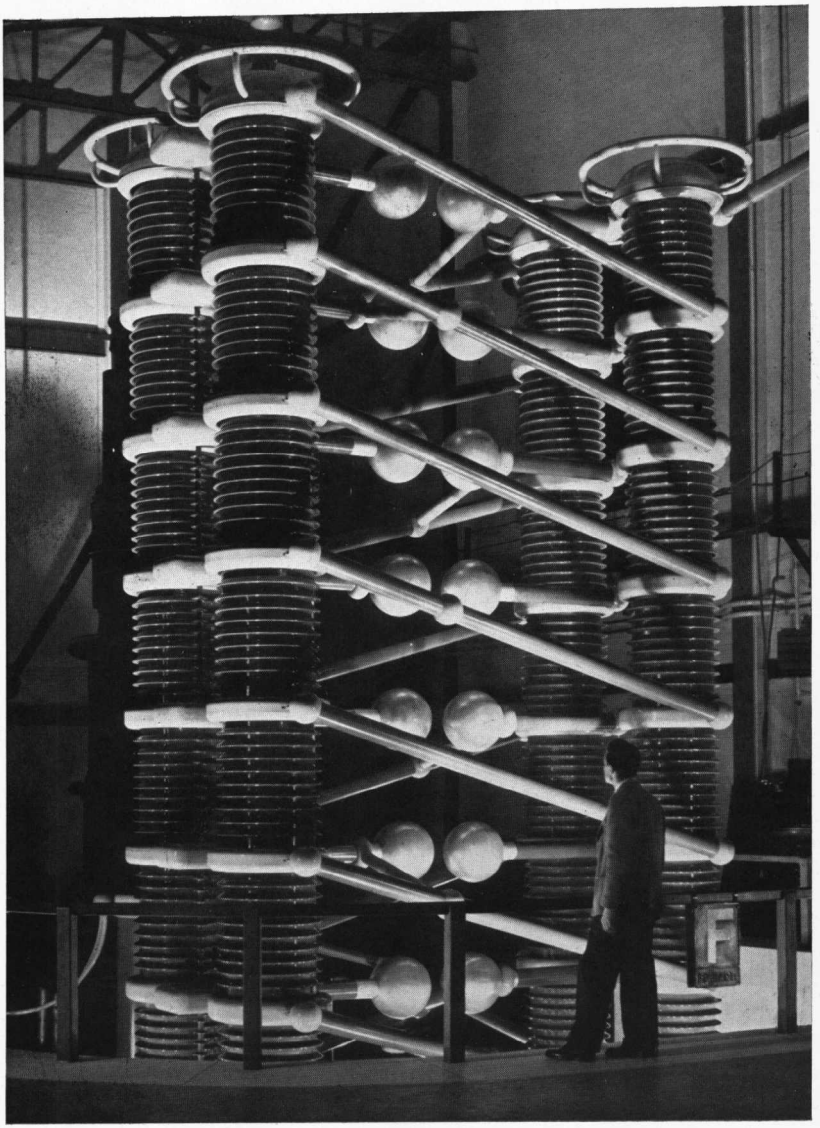
I also wish to acknowledge the encouragement and assistance of my colleagues in Administration, N.P.L., in D.S.I.R. (including the scientific attachés in Paris, Stockholm and Washington, and Research Branch, Germany) and in particular of my Director and friend, Sir Edward Bullard, both for granting me valuable facilities without which I could not have carried out this survey, and for his ever-stimulating views when requested.

Grateful acknowledgment is also made to the many Departments, authorities and editors who have generously given permission to reproduce illustrations and tables or other matter. These are too numerous to mention individually here, but sources are indicated in the text.

In conclusion, I wish to express my appreciation of the invaluable help and encouragement of my colleague Miss Hope Lovell. But for her efforts this book might never have reached the publisher.

E. S. HISCOCKS

August 1955



Example of large-scale laboratory equipment. 3·25 million volt surge generator, High Voltage Laboratory, N.P.L. (Department of Scientific and Industrial Research).

(*Photograph N.P.L. Central Photographic Section. Crown Copyright reserved.*)

CONTENTS

CHAPTER PAGE

INTRODUCTION xi

INITIATION xiv

ACKNOWLEDGMENTS xv

1. GENERAL CONSIDERATIONS 1

Importance and cost of research (1) : management of research (3) : scientists (4) : directors (5) : scientists and management (7) : training for management (9) : the scientific Civil Service (11) : support ratio (12) : value of costing systems (13) : economy in use of staff (14) : assessment and promotions of staff (15) : scientists' salaries (17) : equipment (18) : laboratory organisation (19) : types of organisation (21) : the National Physical Laboratory (22) : U.K. Government laboratories (25) : types of laboratory work (26) : promulgation of results (27).

2. THE HEAD OF THE ESTABLISHMENT 30

Effect of size of laboratory (30) : functions (36) : channels of communication (39) : appointment from staff (40) : devolution by (41) : keeping informed (43) : the research programme (44) : selection for (44) : best age for (45) : science administrators (48).

3. FUNCTIONS OF STAFF 49

Staff groupings (49) : Scientific Civil Service classes (50) : staffing of N.P.L., N.B.S. and N.R.C. (53) : qualifications of staff (54) : technicians (56) : drawing office staff (57) : functions of individuals (59) : scientists and administration (61) : personnel officers (62) : finance officers (63) : co-ordination by meetings of section heads (64).

4. GENERAL RECRUITMENT POLICY, REMUNERATION, INDUSTRIAL STAFF 65

Costs per worker (65) : satisfactions of scientists (65) : recruitment (68) : salary comparisons (69) : central recruitment (70) : basic qualifications (74) : Technical and Scientific Register (75) : incentives in industry (76) : conditions of appointment (77) : interviews (78) : probation (80) : remuneration (81) : comparative pay in U.S.A. (85) : bonuses (87) : leave and timekeeping (89) : industrial staff (91) : remuneration (92) : apprenticeship schemes (93).

5. ASSESSMENT, PROMOTION, TRANSFERS, THE OLDER MAN 98

Assessment of staff (98) : at N.P.L. (99) : Sir Ewart Smith's papers (101) : in D.S.I.R. (102) : in U.S.A. (107) : in Canada (109) : assessment of industrial staff (110) : in U.S. Office of Naval Research (112) : promotion (117) : transfers of scientific staff (119) : training (123) : retirement (128) : age distribution (134) : pension schemes (135) :

CHAPTER PAGE

6. STAFF ORGANISATIONS AND WELFARE 139

Staff organisations (139) : in the Scientific Civil Service (142) : Whitley Council (143) : trade unions (145) : welfare (150).

7. THE FLOW OF INFORMATION 154

Promulgation of research results (154) : scientific papers (155) : N.P.L. publications (156) : use of the press (158) : exhibitions (159) : reports and books (160) : construction of papers (162) : libraries (163) : abstracts (166) : Royal Society Information Conference (168) : reprints (170) : flow of results to industry (171) : internal flow at N.P.L. (173) : information meetings and symposia (174) : open days (176).

8. FINANCE 180

Finance (180) : budgeting (182) : control of expenditure (186) : costing of research (189).

9. PROGRAMMING 194

Research programmes (194) : at N.P.L. (195) : in development laboratories (197) : at National Coal Board (199) : at Royal Aircraft Establishment (200) : in U.S.A. (202) : batch programming (203).

10. EVALUATION 205

Evaluation of research (205) : cost per qualified man (208) : staff support ratios (213) : staff and equipment ratios (217) : main categories of work (218) : costing figures (219) : working space per staff member (219) : recommendations (220).

11. GENERAL SERVICES 224

Administrative services (224) : office services (226) : handling visitors (232) : civil defence (235).

12. TECHNICAL SERVICES AND SAFETY PRECAUTIONS 241

Workshops (241): draughtsmen (246) : photography, computation, electronic equipment (247) : instruments, general store (248) : chemicals, balances (250) : glassworking, safety precautions (251) : radioactivity (255).

13. LABORATORY BUILDINGS AND THEIR MAINTENANCE 256

Choice of site (256) : flexibility in site, layout and in buildings (257) : architectural planning (258) : comparison of costs (250) : standardisation of furniture and fittings (261) : supply of services (262) : space requirements (265): specialised rooms and buildings (269) : maintenance of buildings (271) : and supply services (272).

14. PATENTS, COPYRIGHT AND TRADE MARKS 275

Principles for a patent policy (275) : effect of source of funds (276) : changing patent policy of D.S.I.R. (277) : practical arrangements (279) : National Research Development Corporation (270) : protection of ownership rights (284) : ownership of copyright in written communications (286) : certification trade marks (288).

CHAPTER PAGE

15. TRAINING FOR MANAGEMENT 290

Distinction between supervision and management (290) : Ministry of Education Committee on training for management (291) : training on the job (293) : American practice (293) : courses at the London School of Economics and the Administrative Staff College (295) : Treasury Courses for the Scientific Civil Service (296) : and methods of continuous progressive training (299) :

NOTE ON THE N.P.L. TEST HOUSE 304

APPENDICES

I Salary surveys : Institute of Physics and Royal Institute of Chemistry 307

II Scientific Officer Class rates of pay 310

III Notes on terms of engagement of chemists 311

IV Salary scheme : Imperial Chemical Industries 316

V Duties of experimental mechanics 320

VI Annual assessments of staff : N.P.L. scheme 325

VII Recruitment, Training and Promotion of Technical Staff—Sir Ewart Smith 331

VIII Annual confidential reports on staff D.S.I.R. 339

IX Do. National Bureau of Standards, U.S.A. 345

X Do. National Research Council, Canada 348

XI Do. Ancillary classes : D.S.I.R. 351

XII Scientific Civil Service promotions
(*a*) Scientific Officer Class 355
(*b*) Experimental Officer Class 356

XIII Educational attainments : Laboratory Assistants Imperical Chemical Industries 357

XIV Age distributions in the Civil Service 359

XV Staff costs 360

XVI Staff ratios 362

XVII Salaries and wages : D.S.I.R. 363

XVIII N.P.L. Administration chart 364

XIX Royal Aircraft Establishment organisation chart 365

XX National Bureau of Standards organisation chart 366

XXI The Theme system of filing 367

XXII Safety precautions : radioactivity 369

BIBLIOGRAPHY 378

ENVOI 384

INDEX 385

LIST OF PLATES

Large scale laboratory equipment	*facing page* 1
Laboratory lecture halls	16
The flow of information—the written word	160
The flow of information—sound and vision	177
A laboratory workshop	224
Laboratory services	241
Flexible laboratory building	256
Laboratory services	273

CHAPTER I

GENERAL CONSIDERATIONS

' Scientific research is not itself a science ; it is still an art or craft.'
W. H. GEORGE

SCIENTIFIC investigation is now established as an essential part in the machinery of government and industry. Governments must sponsor research and development so as to maintain the effectiveness of their defence forces and productive economy relative to those of other nations. Industry must maintain and improve the efficiency of existing processes, discover and develop new products and new processes so as to ensure survival and, if possible, provide a means for profitable expansion. It must also have the skill and knowledge to appraise and assess the value of new products and new processes developed in other organisations to determine what effect these will have on existing business.

Scientific research is costly. In 1900 the total government expenditure on research in this country for civilian purposes was £61,000. At present it is about £16 million, to which must be added an appreciable proportion of the £12 million annual grant to universities, administered through the University Grants Committee. In 1900 the total expenditure by industry on research was well below £1 million, to-day it is nearer £50 million.[1] An estimate given in the House of Commons placed the total expenditure on civilian research in 1951 as probably about £70 million. In the United States the increases have been even more spectacular. Government expenditure in 1953 was over $2,000 million, and Astin and Asay [2] refer to ' The 4,000 million dollar research and development business throughout the U.S.A.' There is a general belief that scientific research pays. The business man probably looks upon his expenditure on research much as he does that on advertising—the value of the individual item cannot be

[1] These estimates are given by Sir Harold Hartley, F.R.S., in the first Fawley Foundation Lecture, May 20, 1954.

[2] *Nature*, 1954, December 4, vol. 174, p. 1043.

measured but the accumulated expenditure is obviously worth while.

Very little is known whether the results are bought dearly or cheaply. In general there is no easy answer to this. Even if some industrial organisations can claim that they have profited from their research expenditure they have little idea whether their profits might not have been larger or the cost of their products cheapened if the research process had been organised differently.

We can at least examine some of the methods and means of obtaining scientific information from the point of view of the efficiency of the process. Such an examination may disclose differences between organisations and suggest new lines of thought and possible experiment. In this chapter I propose to outline some of the salient factors affecting the organisation and management of laboratories, although most of these factors are discussed in greater detail in subsequent chapters.

A laboratory is a place for conducting investigations into natural science. In the early years of this century laboratories were very simple organisations, and scientific research was largely an affair of individuals or of small groups centred on an individual who worked on such subjects as interested him and supplied the inspiration for the unit. The approach was largely philosophical and the experimental methods were on the whole those of ' sealing wax and string '.

During this century we have seen the ' patriarchal ' laboratory, centred on the intellectual drive of one great researcher, give way to the institutional laboratory employing hundreds and sometimes thousands of workers. Some of these workers need, and most of them claim, the freedom of creative workers, but their work has, nevertheless, to be co-ordinated into the general purpose of the institution. It is obvious that the time has come for the organisation of scientific research to move forward into a more highly developed system, as has happened in most other major branches of human activity when the exertions of the solitary human are replaced by team work or group activity coupled with an increasing division of labour.

The romantic view is frequently taken that scientific research depends upon creative genius and the breath of inspiration, and that no amount of organisation can contribute to the discovery of scientific principles. To counter this is the more realistic view