SCIENCE, INDUSTRY AND SOCIETY

Stephen Cotgrove and Steven Box

ROUTLEDGE LIBRARY EDITIONS:
HISTORY AND PHILOSOPHY OF SCIENCE

ROUTLEDGE LIBRARY EDITIONS: HISTORY AND PHILOSOPHY OF SCIENCE

SCIENCE, INDUSTRY AND SOCIETY

SCIENCE, INDUSTRY AND SOCIETY

Studies in the Sociology of Science

By

STEPHEN COTGROVE AND STEVEN BOX

Volume 7

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

First published in 1970

This edition first published in 2009 by
Routledge
2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

Simultaneously published in the USA and Canada
by Routledge
270 Madison Avenue, New York, NY 10016

Routledge is an imprint of the Taylor & Francis Group, an informa business

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging in Publication Data
A catalog record for this book has been requested

ISBN 10: 0-415-42029-6 (Set)
ISBN 10: 0-415-47446-9 (Volume 7)

ISBN 13: 978-0-415-42029-7 (Set)
ISBN 13: 978-0-415-47446-7 (Volume 7)

Publisher's Note
The Publisher has gone to great lengths to ensure the quality of this reprint but points out that some imperfections in the original copies may be apparent.

Disclaimer
The Publishers have made every effort to trace copyright holders and would welcome correspondence from those they have been unable to contact.

Science, Industry and Society

studies in the sociology of science

by

STEPHEN COTGROVE

Professor of Sociology
Bath University of Technology

and

STEVEN BOX

Lecturer in Sociology
University of Kent at Canterbury

London
GEORGE ALLEN & UNWIN LTD
Ruskin House Museum Street

FIRST PUBLISHED IN 1970

SBN 04 301021 0 *cased*
04 301022 9 *paper*

Printed in Great Britain at the Pitman Press Bath

Preface

Two major changes have characterised science in the twentieth century. Firstly, there has been its extremely rapid growth. Indeed most of the scientists who have ever lived are alive today. Secondly—and central to the theme of this book—science is no longer mainly an academic activity carried on in universities. Industry will soon be the largest single employer of scientists.

Such changes have generated a series of problems and given rise to much anxiety. There is growing concern lest the bureaucratisation of science shall threaten creativity. A substantial literature in America argues that scientists in industry experience particular strains and conflicts, centring round the limitations on their autonomy and restrictions on publication. And, during the period of the researches reported in this study, there has been a growing concern about the failure of industry to recruit the 'best' graduates, and the need to modify university courses to bring them closer to the needs of industry. It is such issues that this book is about.

We found less evidence of strain and conflict among industrial scientists than we had been led to expect. But this we discovered was partly explained by the kinds of scientists recruited. Indeed, a major contribution of this study is an attempt to distinguish between types of scientist; between academics on the one hand dedicated to the advancement of knowledge, and 'organisational' scientists on the other hand, who are more likely to find rewarding the application of science in the development of new products. It is the academic scientist who experiences most strains and conflicts in industry, but industry recruits relatively fewer of these, and is, in any case, more likely to employ them on basic research.

But if industry recruits relatively fewer of the academic scientists, it also recruits few of the most 'able'. However, we would put much less emphasis, than many recent reports, on the influence of the universities in producing 'academics' who, when the time comes to look for a job, find industry uncongenial. Our evidence indicates that it may be because academic research is seen to be more attractive than industry

to the good honours graduate, that some undergraduates *become* academics. It is identification with a future occupation, and not the injection of academic values, which is the key. In short, just as the medical student *becomes* a doctor at medical school, so the scientist who is attracted to university research is more likely to become an academic. The crucial problem is, how can industry be made more attractive as a career for scientists? And we would argue that this will involve more than a public relations job.

If we found less evidence of strain among industrial scientists than we expected, we *did* find considerable evidence to suggest that industry is failing to use the skills and capacities of many of its scientists to the full—a major factor in the failure of industry to attract the best graduates. Moreover, we found considerable differences between laboratories. Some have succeeded in accommodating scientists in such a way that they are well satisfied. Others, partly because of the kinds of scientists they have recruited, but partly, too, because of their managerial policies, may well be failing to do their best not only for their scientists but also for themselves.

This book is written in the hope that it will make a constructive contribution to the problems of relating the two worlds of science and industry. But it is also offered as a contribution to sociology. The more technical aspects, however, have been dealt with in extended chapter-end notes and appendices. Thus, after a preliminary chapter, which places the problem in the broad context of the growth of science and its increasing application to industry and growing bureaucratisation, Chapter 2 explores more deeply the nature of science as a social system, the meaning of science to the scientist, and the different types of scientist and his relation to the values of science. Chapters 3 and 4 examine the making of a scientist and throw new light on the sociology of occupational socialisation and selection. Chapters 5, 6 and 7 explore the interactions between individuals and organisation in the industrial research setting. Chapters 5 and 6 investigate the career problems of scientists in industrial research, including problems of role strain and conflict. Chapter 7 probes the relative significance of individual and organisational variables in role performance, as measured by the productiveness of scientists.

The book is the joint effort of the authors, but Chapters 3 and 4 were contributed mainly by Steven Box, who studied the socialisation of scientists in a doctoral thesis for the University of London. We are also indebted to Julienne Ford for her contribution to Chapter 4.

We should like to thank the Social Science Research Council (then DSIR) for a grant which made possible the field research reported in this book, the Polytechnic, Regent Street, for accommodating the research unit and providing data processing facilities during this phase, and the Editors of *Sociology* and *Technology and Society* for permission to reproduce in Chapters 3 and 7 previously published material. We are particularly grateful to the many scientists working on the bench, or in the direction of research, who gave so generously of their time and received us in so friendly and helpful a fashion. Without the help of all of these, this study could not have been written. Lastly, we wish to thank Mrs Avril Fordham for the expert way in which she typed a difficult manuscript for publication.

STEPHEN COTGROVE
Bath University of Technology

STEVEN BOX
University of Kent at Canterbury

July, 1969

Contents

Chapter 1

Science and Industry

Between 80 and 90 per cent of all scientists who have ever lived are alive today. And nearly 90 per cent of the current stock of scientific knowledge has been discovered within the last fifty years. Indeed, ever since the eighteenth century, the number of scientists, of publications and of abstracting journals have been doubling every ten to fifteen years.[1]

Size alone will inevitably raise problems. And there are a number of ways in which Big Science is likely to differ from Little Science.[2] The publications explosion and the growing problem of communication is an obvious example. One man can monitor only a small fraction of the 30,000 journals. Indeed, it is estimated that the half-life of papers in physics in the USA, is now about two and a half years.

THE CHANGING ROLES OF SCIENTISTS

But it is not with the problems of size with which we are mainly concerned here. The growth of Big Science has been accompanied by changes in the sources of scientific patronage. Consequently, there have been major changes in the roles which scientists perform. Science is no longer mainly an academic activity. Particularly since the first World War, governments and industry have become the big employers. Industry will soon be the main single employer of scientists. Already in the United Kingdom 28 per cent of all scientists are employed in industry,[3] and about 70 per cent of all chemists engaged in research and development work are to be found in industrial laboratories. And it is this increasing industrial application, and the resulting growing demand for scientists to work in industry, which is generating a series of problems and difficulties. Such problems stem in part from the essential

differences between universities and university science, and industrial science. The objectives of universities and industry are basically different. The universities are concerned with the advancement and dissemination of knowledge. It is not surprising, therefore, that those who work in university science attach the greatest importance to free inquiry and to the disinterested pursuit of knowledge, regardless of any possible practical application. By contrast, industry is interested in scientific knowledge only in so far as it can be applied to the development of new or improved products.

CAREERS: ACADEMIC VERSUS INDUSTRIAL

It is hardly surprising then, that, when industry comes to employ science graduates fresh from university, there are complaints about their lack of awareness of industry's needs—they are not cost-conscious; are preoccupied with academic scientific solutions rather than practical ones, and lack a sense of urgency. More recently, there has been growing anxiety over the reluctance of the majority of the most highly qualified graduates to choose a career in industry. The report of the Swann Committee[4] drew attention to the fact that 79 per cent of the 'firsts' in chemistry went on to research or further academic study. For all disciplines, above average proportions of all 'firsts' and 'upper seconds' are found in universities, and a below average proportion of scientists (*not* technologists) with good honours degrees choose industry.[5] Subsequently, a high proportion (40 per cent) of those with higher degrees in chemistry gain employment in higher education and research, compared with 18 per cent in industry, although the proportions recruited to industry in other science subjects are higher.[6]

Now, one point of very considerable significance to which the Swann Report drew attention is the fact that 52 per cent of those who achieved 'firsts' or 'upper seconds' had not made up their minds about their future jobs on entering university, while 13 per cent were aiming at a university career. But before taking finals, 47 per cent had already decided on a university career, while the proportions making other choices had remained roughly constant. The inference drawn by the Swann Committee is that these findings 'confirm our views on

the importance of the role of education in influencing patterns of employment'. But the problem is clearly complex. There are other factors at work besides the influence of education. Both good honours and pass degree students are exposed to the influence of education. And although the Swann Report shows marked differences in the characteristics of jobs as seen by scientists in the various sectors, this information by itself is not sufficient to explain the reasons for choice. For example, 79 per cent of scientists in universities, compared with 21 per cent in industry, saw their jobs as providing opportunities for intellectual development.[7] But this does not tell us how *important* it is to such scientists to enjoy such opportunities, and therefore how much such factors influenced their choice of job. In short, as Swann recognises, we need more information on the motivations of scientists. As the report emphasises, we know little about the complex process of occupational choice at this level, and it is to an exploration of this process that we turn in Chapters 3 and 4.

But anxieties about present trends are not confined to those who are alarmed about the reluctance of able graduates to enter industry, and the unsuitability of undergraduate courses for future industrial employment. There are others who are equally alarmed about the possible implications for science of the increasing employment of scientists in large scale organisations.

THE BUREAUCRATISATION OF SCIENCE

From Weber onwards, many leading sociologists have looked on the growth and proliferation of bureaucracies with despair and disenchantment, some writers even attributing all the 'ills' of modern civilisation to the increased size and scope of organisations. The resulting increase in the division of labour, epitomised in work on the assembly-line, results in the growing alienation of man, expressed in such terms as powerlessness, meaninglessness, isolation and self-estrangement[8]. Thus man is prevented from realising his full potentialities through self-actualisation in work.[9] Moreover, outside work, man has been increasingly separated from membership in voluntary associations and communities, and is left isolated and

unprotected against manipulation in the atomised world of 'mass society'.[10] Nor are these dominant themes confined to some sociological writers—they can also be readily seen as influential lines of thought in the visual arts, particularly films and theatre, and also in literature, notably the 'existentialist' novel of western Europe.

The bureaucratisation of science, it is argued, is now facing scientists with threats to their autonomy, to loss of control over the goals and methods of research, and loss of control over the products of their intellectual activity, and with a consequent loss of meaning in their daily lives. In short, those who have been among the most autonomous, whose lives have been among the most meaningful and have provided the greatest opportunities for self-actualisation, these too are threatened with alienation—with separation from control over the processes and products of their work.[11]

Much of the earlier discussion of this theme has centred around the assertion that there are potential tensions and conflicts wherever professionals are employed in bureaucratically-structured organisations.[12] Any organisation is faced with the basic problem of allocating specific areas of activity to individuals and of co-ordinating the activities of large numbers in the pursuit of the goals of the organisation. This involves, above all, a chain of command, the exercise of control by some individuals over others, a hierarchy of authority. And if we forget any perjorative overtones which may be attached to the terms 'bureaucracy', this is essentially what any organisation of individuals requires—the allocation of roles and their co-ordination through a set of rules governing spheres of competence and procedures.

Now whatever ambiguities[13] there may be attached to the concept of a professional, there is general agreement that a professional has acquired knowledge and skills through a lengthy training, and in this sense is an expert in his field. It was natural, therefore, for the earlier writers on this problem to treat scientists as professionals.[14] The essential conflict between professionals and organisations centres around the distinction between professional and bureaucratic authority. The authority of the administrator flows from his position in the hierarchy. But the authority of the professional rests on his

expertise. Employment in an organisation therefore, represents a potential threat to the autonomy of the professional to exercise his expertise, subject only to the judgement of his peers who are alone competent to assess his performance.

These generalisations can be illustrated from a fairly extensive literature, dating at least from Drucker's[15] observations in 1952, that industrial corporations need to make considerable changes in their traditional structures if they are to utilise the recent expansion in professionals employed in industry. More specifically, he argued that the administrative criteria for promotion could not be applied to professionals whose orientation was towards others with technical competence; that recognition by the organisation was not adequate for professionals who particularly sought extra-organisational professional recognition; that company goals and professional goals would often clash; that personnel practices were not applicable to professionals; and finally, that industry was particularly prone to under-employ professional capacities either because management had no proper grasp of scientists' potential contributions, or because management merely employed scientists for window-display purposes.[16]

Moore and Renck,[17] after examining work dissatisfactions experienced by 587 scientists and engineers, came to the conclusion that 'it can be stated *categorically* . . . that the chronic dissatisfaction of *professional* employees emerges out of a fundamental conflict which exists between the expectations and values of professional employees and the opportunities which they need to realise their ambitions in the industrial setting'. Furthermore, a 'number of complaints . . . suggest that the "chain of command" which typifies industrial organisations may be a source of considerable tension in the engineering departments and research laboratories. Any job-oriented person seeks recognition for himself . . . for the merit of his work'.

As a further example of the professional versus non-professional conflict Burns and Stalker,[18] suggested that scientists, compared with other longer established employees, claimed more recognition, higher status, more control, and more independence of the authority of management. These claims were partially responsible for the political and status struggle

between departments, since they were seen by non-professionals as threats to existing social relationships and authority hierarchies. The resultant struggles prevented the electronics firms in this study from adopting an 'organic' organisational structure which the authors considered more suitable for firms needing to innovate.

Orth[19] too, when discussing the optimum climate for industrial research, reveals the same theoretical assumptions. 'Professional training in itself, whether it be in medicine, chemistry, or engineering, appears to predispose those who go through it to unhappiness or rebellion when faced with the administrative process as it exists in most organisations. Scientists and engineers *cannot* or *will* not . . . operate at the peak of their creative potential in an atmosphere that puts pressure on them to conform to organisational requirements which they do not understand or believe necessary.'

The most comprehensive synthesis of the relevant (mainly American) studies was undertaken by Kornhauser,[20] who summarised the conflicts between science, as a system of professional values, and industry, with its emphasis on economic and administrative values, into four main groups. Firstly, there are conflicts over goals. Scientists, Kornhauser argues, want to work as near to fundamental research as possible, to make a significant contribution to science, or at least work on the frontiers of it. Industrial management, on the other hand, wants scientists to concentrate only on those problems where results would be of benefit to the company. Where scientists are allowed to pursue other more fundamental research, their security is always precarious and project termination is endemic, often without adequate consultation. This leads to a second area of conflict: control over the work situation. Kornhauser argues that professional scientists seek to maximise their control in terms of 'how', 'where' and 'when' to tackle a project. Industrial management, however, prefer organised research teams working against a time-schedule, and wish to determine at any time which project shall be given priority. Thirdly, Kornhauser suggests there are conflicts over incentives. Professional scientists prefer rewards related to their professional needs—more autonomy, 'free-time',

equipment, freedom to attend scientific conferences, etc.—rather than traditional organisational rewards such as promotion to management, albeit research management. Lastly, there is a conflict centred around the responsibility for the utilisation of the scientists' 'products'. The professional feels some ethical responsibility for his knowledge, and the use to which it is put; management considers this is their domain, and that the decision should be mainly determined by commercial considerations.

CONFLICT OR ACCOMMODATION?

Two main lines of solution have been suggested. Some writers have argued that the initial conflict can be at least moderated by modifications in the attitudes of the professional scientist; by a measure of re-socialisation, or by changes in the education of undergraduates. Abrahamson[21] suggests that the initial conflict between professionals and administrators centres around the different expectations each has about the appropriate level of autonomy a researcher should be granted. The new entrant, fresh from graduate school or university typically wants too much autonomy; research administrators are typically prepared to give too little. However, over time, research management becomes prepared to grant more research freedom to the scientist, who indicates his ability to be responsible, in management terms, without tight supervision. In addition, the scientist usually comes to desire less research freedom than he did previously, because he comes to realise that in an industrial setting, his earlier aspirations were not realistic. Thus, by this gradual mutual shift in position, a satisfactory accommodation between professional and employer is forged.

Whyte,[22] in his polemic against the anti-individualism of the modern corporation, sees the process rather as one of the deliberate company indoctrination of 'eccentric' scientists, through an emphasis on team planning, group research, harmonious inter-personal relations, and insistence on company loyalty. Marcson,[23] described the practice of a large electronics company which sent scouts to universities a full year before graduates' studies were programmed to be completed. These scouts attempted to select scientists with interests in projects

that higher management had already decided to have investigated. Once employed, the scientist's research aspirations were continuously redefined by supervisors, using the criteria of what was technically and personally feasible, and what was financially supportable. Soon the recruit, through this 'cooling-out'[24] process, comes to accept the definition of the situation as established by higher management. This process of 'acculturalisation' thus reduces some of the strain of the new recruit with research interests not completely fitted to the requirements of the company. It was such company strategies that Whyte referred to as 'indoctrination'.

The second main line of argument has been to suggest that the distinctive needs of the scientist should be recognised, and various means adopted to accommodate him into industrial organisation. For example, Shepard[25] has argued that those companies which employ numbers of scientists in more basic and applied research, should develop a dual system of status hierarchies, with loose formal and informal links between the research sections and higher management via research directors and group leaders. In this way, scientific control over research work could be increased. However, the evidence from America is that this strategy is not widely pursued, and even where it is, higher research management are often selected simply because they reflect the firm's definition of research.[26] Laporte[27] found in his study of an aerospace industrial complex, that accommodation between scientists and managers was arrived at by a process of structural separation of scientists, managers and administrators. Thus, the research laboratories were able to establish some degree of functional autonomy.[28] This led to a reduction of accounting and administrative routines that were only suitable for production and not research. By such structural rearrangements, the research staff became more integrated.

Kaplan,[29] in a study of scientific productivity, argued that laboratories will tend to be more effective the more they satisfy five requisite conditions. Firstly, by showing enthusiasm for new ideas and by being receptive to innovation. Secondly, be removing the typically high level of pressure on employees that characterises other types of production. Thirdly, by tolerating 'odd-balls', researchers who do not fit in with the strictness of organisational conformity. Fourthly, by giving

researchers more freedom to choose problems and by allowing them to change research direction. Lastly, by devising suitable professional incentives and rewards, such as more freedom to attend scientific meetings, both nationally, and internationally.[30]

Kornhauser summarises the position by suggesting that both the need for 'structural autonomy', which, he argues, characterises the professional groups of scientists, and the need for 'functional integration' which the overall organisation requires, can only be resolved by mutual accommodations. Each should recognise their mutual interdependence—the scientists rely on the organisation for resources; the organisation relies on scientists for innovations. This reciprocity should be the foundation on which better understanding is built. Thus he suggests industry should allow more basic research in return for more developmental effort; research concerns should be controlled by colleagues although hierarchically co-ordinated; industry should provide scientific career ladders as an option to the normal administrative career ladder. Whilst these accommodations tend to favour scientists, the latter should not press for an extension of responsibilities over the utilisation of their intellectual products, since this would not allow for an establishment of some measure of 'functional autonomy'. But, unless they establish a degree of structural separation from production, they will be unable to untangle themselves, and their research, from the commercial-nexus.

SCIENTISTS, PROFESSIONALS OR ORGANISATION MEN?

Now a major weakness in the argument so far is the assumption that all men with a BSc or PhD are 'scientists', in the sense that they are dedicated to the pursuit of scientific knowledge, and need an environment which allows their creativity to blossom. Both the impressions of those who have anything to do with scientists, and a growing volume of research, concur in supporting the view that this is too simple a picture.[31] The case rests in part on a methodological weakness. We cannot infer motives and values from behaviour. The fact that an individual acts the role of a scientist does not by itself tell us what are his

values and motivations.[32] Yet it is this kind of assumption which underlies much of the argument about the bureaucratisation of science, and the conflicts between science and industry.

If then, as both experience and the literature suggest, the term 'scientist' embraces a rather heterogeneous group of individuals, only some of whom are dedicated to the pursuit of knowledge, what are their characteristics—their needs, values, motivations, aspirations? What, in short, are the meanings which science can have for different individuals? What leads some to careers in industry? And what are the specific rewards, strains, frustrations, for different kinds of scientist in the range of industrial roles, from fairly fundamental basic research to quality control, trouble-shooting, or technical roles?

In short, to penetrate the complexity of such issues, we need a clearer picture of the nature both of science and of scientists, and of the roles which scientists play. Only then can we explore compatibilities, strains, conflicts, and the wider implications of the growth of industrial science. And it is to such issues that we turn in the remainder of this study.

THE RESEARCH PROJECT

In order to obtain empirical evidence on such problems, two main surveys were carried out.[33] Firstly, we interviewed a number of research scientists and administrators in nine industrial research laboratories. Our criterion for selection was simply that they were qualified chemists, and employed in an R and D department. We chose chemists because they constituted the largest single group employed in industry and we kept to one discipline because we wanted to control for as many variables as possible. Our findings relate therefore, specifically to graduates in chemistry. In addition to the interviews, we contacted a much larger number by postal questionnaire and followed these up by a further series of intensive interviews.[34]

The second main project[35] reported here was a postal questionnaire survey of undergraduate and postgraduate students in chemistry at three universities. The object of this part of the inquiry was to try to penetrate more deeply into an

understanding of the factors which led individuals to choose to study science, why some become more committed to science than others, and why some choose a career in industry and others in the universities. This part of the research is reported mainly in Chapters 3 and 4.

NOTES

1. D. J. de Solla Price, *Little Science—Big Science* (1963). For figures relating specifically to Britain, see T. R. Pike, *History of Scientists in Britain*, unpublished M.Sc. Econ. thesis, Univ. of London (1961).
2. On these issues, see D. J. de Solla Price, op. cit. (1963); N. W. Storer, *The Social System of Science* (1966); W. O. Hagstrom, *The Scientific Community* (1965).
3. *The Flow into Employment of Scientists, Engineers & Technologists* (Swann Report), Cmd. 3760 (1968), p. 46.
4. ibid., para. 44.
5. ibid., para. 55.
6. See also, S. Hatch and E. Rudd, *Graduate Study and After* (1969); R. K. Kelsall, *A National Survey of University Graduates qualifying in* 1960.
7. ibid., p. 89, Table 14.
8. See, for example, R. Blauner, *Alienation and Freedom* (1964).
9. A number of works, based on Maslow's 'self-actualisation' motivational model believe individuals are prevented from self-realisation in modern organisations. The implicit thesis in these writings is that the individual seeks to mature, or achieve actualisation at work, but is prevented by organisational demands. The individual is thus less than his 'essence'. See C. Argyris, *Integrating the Individual and the Organisation* (1964); F. Herzberg, *Work and the Nature of Man* (1966); D. McGregor, *The Human Side of Enterprise* (1960); A. Kornhauser, *Mental Health of the Industrial Worker* (1965). These works have been coming under criticism recently; see particularly G. Straus, 'The Personality-versus-Organisation Theory,' in Sayles, L. R. (ed.) *Individualism and Big Business* (1963), pp. 67–80. Other writers have tended to stress the conformity, subservience, and apathy of organisational employment, and its implicit threat to liberal-democratic values. See R. Presthus, *The Organisational Society* (1962); W. H. Whyte, *Organisation Man* (1957).

   It is also interesting to note that of the two historical themes open to modern writers on bureaucracy, Weber's 'pessimism' should have been wholly stressed, whilst Saint Simon's 'optimism,' his belief that organisations were a liberating force, helping to lift the yoke of work from man's back, has been ignored. See on this, A. W. Gouldner, 'Metaphysical Pathos and the Theory of Bureaucracy,' in A. Etzioni, (ed.) *Complex Organisations* (1962), and 'Organisational Analysis', in R. K. Merton *et al.*, *Sociology Today* (1959), pp. 400–28.

10. W. Kornhauser, *The Politics of Mass Society* (1960).
11. The term is being used here in the sense defined by R. Blauner, op. cit. (1964).
12. See P. M. Blau and W. R. Scott, *Formal Organizations* (1963).
13. Sociology is constantly faced with this problem. Terms such as bureaucracy, profession, working-class, are part of the public language of society. Attempts by sociologists to communicate with a wider audience constantly face the difficulty by specifying a more rigorous definition. Alas, the tasks is not made easier by the too frequent lack of consensus among sociologists.
14. We shall later raise objections to this.
15. P. F. Drucker, 'Management and the Professional Employee,' *Harvard Business Review*, XXX (1952), pp. 84–90.
16. Since that date, Drucker has revised many of his ideas, see 'Twelve Fables of Research Management', *Harvard Business Review*, XLI (1963), pp. 103–14.
17. D. G. Moore and R. Renck, 'The Professional Employee in Industry', *Journal of Business* (Jan., 1955). A similar explanation for low morale among scientists can be found in Opinion Research Corporation, *The Conflict between the Scientific Mind and the Management Mind*, Princeton Opinion Research Corporation (1959).
18. T. Burns and G. M. Stalker, *The Management of Innovation* (1961); P. Brown, 'Factionalism and Organisational Change in a Research Laboratory,' *Social Problems*, III (1956), pp. 235–43; C. Shepard and P. Brown, 'Status, Prestige and Esteem in a Research Organisation,' *Administrative Science Quarterly*, I (1956), pp. 340–60.
19. C. D. Orth, 'The Optimum Climate for Industrial Research,' *Harvard Business Review* (Mar.–April, 1959), pp. 55–64. See also, N. Kaplan, 'Some Organisation Factors Affecting Creativity', *IRE Transactions on Eng. Management*, VII (1960), pp. 24–9; L. Meltzer, 'Scientific Productivity in Organisational Settings,' *Journal of Social Issues*, XXII (1956), pp. 32–40; E. Raudsepp, *Managing Creative Scientists and Engineers: A New Management Programme for Increasing Professional Creativity in Industry* (1963), esp. Ch. 4.
20. W. Kornhauser, *Scientists in Industry* (1962).
21. M. Abrahamson, 'The Integration of Industrial Scientists,' *A.S.Q.*, IX (1964), pp. 208–18.
22. W. H. Whyte, *Organisation Man* (1956).
23. S. Marcson, *The Scientist in American Industry* (1960).
24. This 'cooling-out' process seems to be employed in many situations and organisations. See for exposition and example, E. Goffman, 'Cooling the Mark Out: Some Aspects of Adaptation to Failure,' *Psychiatry* XV (1952), pp. 451–63; and B. R. Clark, 'The Cooling-Out Function in Higher Education,' *A.J.S.*, LXV (1956), pp. 559–76.
25. For example, see H. A. Shepard, 'The Dual Hierarchy in Research,' *Research Management*, I (1958). See also, W. Kornhauser, op. cit., pp. 117–30.
26. W. Kornhauser, op. cit., pp. 56–73.