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THE SCIENTIST AND ENGINEER IN RESEARCH AND DEVELOPMENT:

A STUDY OF THE SALARIED PROFESSIONAL

by

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TABLE OF CONTENTS

PAGE

INTRODUCTION

Chapter 1. DRAFTING THE QUESTIONNAIRE.	1
Chapter 2. COMPOSITION OF THE RESEARCH AND DEVELOPMENT EFFORT IN CANADA	4
2.1 The Manufacturing Industry in Canada	7
2.2 The Research and Development Expenditures in Canada Relative to the United States and United Kingdom	11
2.3 Trends in Research and Development Expenditures in Canada	13
2.4 Scientists and Engineers in Research and Development in Canada	15
2.5 Research and Development in the Federal Government	17
2.6 Research and Development in the Canadian Manufacturing Industry	20
2.7 Research and Development in the Physical Sciences in the Federal Government and Canadian Manufacturing Industry	25
Chapter 3. COMPOSITION OF THE SAMPLE	29
3.1 Percentage Returns	30
3.2 Date of Receipt of Questionnaire	31
3.3 Distribution by Duty	32
3.4 Distribution by University Degree	36
3.5 Distribution by Field of Training	37
3.6 Salary Range	40

	PAGE
3.7 Experience Since Graduation	41
3.8 Salary Range Vis-a-Vis Experience in Years Since Graduation	42
3.9 Age Group	45
3.10 Normal Work Week, Hours	46
Chapter 4. THE RATING OF RESEARCH AND DEVELOPMENT ESTABLISHMENTS	48
4.1 Recruitment	49
4.2 Initial Indoctrination	52
4.3 Internal Training	54
4.4 Professional Development	56
4.5 Comparison of the Professional Development Program to the Participation of the R-D Personnel in Professional Development	58
4.6 Progress Appraisal	59
4.7 Career Plan	62
4.8 Upward Communications - The Accessibility of Senior Management.	64
4.9 The Human Element in R-D Management - Personal Recognition	70
4.10 Rewards	74
4.11 Satisfaction with the Promotion System	75
4.12 Satisfaction with Salary	77
4.13 Flexibility	82
4.14 Internal Association	83

	PAGE
Chapter 5. THE DEPENDENCE OF PREFERRED REWARDS AND IMPORTANT WORK FEATURES ON DUTY	86
5.1 Rewards	86
5.2 Important Work Features	91
Chapter 6. COMPARISON BETWEEN R-D PERSONNEL IN CANADA AND OFFICE STAFF EMPLOYEES IN THE UNITED KINGDOM	102
6.1 Age Group	102
6.2 Satisfaction with Promotion System	103
6.3 Satisfaction with Salary	107
6.4 Important Work Features	109
6.5 Job Satisfaction	111
Chapter 7. THE CORRELATION OF THE JOB SATISFACTION OF THE INDIVIDUAL R-D WORKER WITH HIS SATISFACTION WITH THE PROMOTION SYSTEM AND SALARY, THE ACCESSIBILITY OF SENIOR MANAGEMENT, PERSONAL RECOGNITION BY HIS SUPERVISOR, CONTEMPLATION OF RESIGNATION, PRODUCTIVITY, AGE, AND SALARY.	115
7.1 Satisfaction with Promotion System	115
7.2 Satisfaction with Salary	117
7.3 Accessibility of Senior Management, Upward Communications	120
7.4 Personal Recognition	121
7.5 Contemplating Resignation	125
7.6 Productivity	127
7.7 Age	129
7.8 Salary	131

	PAGE
Chapter 8. THE PRESTIGE RANKING OF PROFESSIONAL OCCUPATIONS	136
CONCLUSION	141
REFERENCES	144
Appendix 1. EXPENDITURE FOR PERFORMANCE OF RESEARCH AND DEVELOPMENT IN CANADA, THE UNITED STATES, AND THE UNITED KINGDOM	148
Appendix 2. TRENDS IN EXPENDITURE FOR PERFORMANCE OF RESEARCH AND DEVELOPMENT IN CANADA, 1951-1961.	161
Appendix 3. TRENDS IN EMPLOYMENT OF SCIENTISTS AND ENGINEERS IN RESEARCH AND DEVELOPMENT IN CANADA, 1951-1961.	166

INTRODUCTION

The accommodation of the professional worker in large complex organisations has been the subject of a growing number of investigators.(1)(2)(3)(4) The changes apparent in the professions are their growing size and specialisation, and the shift from self-employment to salaried employment.

The classical model for the professional is that of the self-employed ministering to a client(5)(6) as in medicine and law, and, therefore, the salaried professional is a contradiction in terms.(7) The professional, as defined in this thesis, is a member of a social system characterised by advanced specialised training with a considerable intellectual content which he controls, who is subject to a code of ethics of an association to which he belongs, and who serves and is responsible to the community. How closely the scientist and engineer complies with

- (1) "White Collar", C.W. Mills, Oxford University Press, 1951, Chapter 6.
- (2) "Scientists in Industry", W. Kornhauser, University of California Press, 1962.
- (3) "Professional Persons in Bureaucratic Organisations", D.N. Solomon, Symposium on Preventive and Social Psychiatry, 1958.
- (4) "The Scientist in American Industry", S. Marcson, Department of Economics, Princeton University, 1960.
- (5) "The Professions", A.M. Carr-Saunders et al, Oxford Press, 1933, page 446.
- (6) "Men and Their Work", E.C. Hughes, Free Press, 1958, page 139.
- (7) "Nine Dilemmas in Industrial Research", H.A. Shepard, Administrative Science Quarterly, Vol. 1, 1956, page 307.

these three criteria will determine his status in the profession and in the community at large. As an employee he acquires status from his position in the hierarchy.

Rewards for accomplishments must, therefore, reflect the orientation of the scientist and engineer who will want recognition by his profession, by the public, and by his management. The forms of recognition will in each case differ. Professional recognition will mean advanced training and professional development, public recognition will mean the publication of individual accomplishments, and recognition by his employer will require a promotion or salary increase. An incentive system satisfying all three may not be possible.

The professional occupational group is one of the fastest growing in Canada. "In the past 25 years the number of professional workers in Canada increased twice as rapidly as the total labour force, and the number of engineers increased four times as rapidly."⁽¹⁾ The total number of engineers and scientists in Canada⁽²⁾ totalled 42,100 in 1962, out of which 10,100, i.e., 24%, were employed in research and development. The number of R-D workers in the Federal government totalled 4,500, in industry about the same number, i.e., 4,700, and in all other municipal, provincial, and non-profit organisations, 900. The number of R-D workers in the Federal government is

- (1) "Trends in Professional Manpower Supplies and Requirements", Department of Labour, Economics and Research Branch, Bulletin 1, August 1957.
- (2) Appendix 3, "Scientists and Engineers in Research and Development in Canada."

approximately 45% of all professional staff in the public service, and the number of R-D workers in industry is about 15% of all engineers and scientists in industry.

The expenditures on research and development has increased dramatically. In the period 1955 to 1961, the period for which statistics are available, expenditures for the performance of research and development⁽¹⁾ in both the Federal government and industry has about doubled, exceeding \$300 million, i.e., 0.84% of the GNP in 1961. The extramural expenditure on research and development in the Federal government was \$155 million, in industry \$113 million, and in all other municipal, provincial, and non-profit organisations \$40 million.

Research and development in Canada is seen to be a major business, and the scientists and engineers a major resource. The purpose of this study is to examine their work environment with particular attention to the system of incentives, and in so doing, contribute to the improved utilisation of this major resource.

The group chosen for study consists of physical scientists and engineers in two Federal government departments, and in five private companies. The source of data is the response to a questionnaire circulated during 1963 to professional workers at grades from entry to early supervisory levels. The composition of the sample is described in Chapter 3.

(1) Appendix 2, "Trends in Research and Development Expenditures in Canada".

By means of the questionnaire the extent of the employer's program of recruitment, indoctrination, internal training, professional development, progress appraisal, and career plans is examined in Chapter 4 and correlated with the employee's satisfaction with, and participation and interest in the programs. In addition, the accessibility of senior management and its record in regard to personal recognition is examined. This "human element" in the management of scientists and engineers is correlated with the percentage contemplating resignation from the organisation. Finally, the rewards preferred by scientists and engineers are indicated and correlated with their satisfactions with the organisation's system of rewards. Rewards which enhance the worker's position in the hierarchy, rewards which are a function of research orientation, financial rewards, and rewards which enhance the worker's professional status are included.

The dependence of preferred rewards and important work features on duty is examined in Chapter 5 in order to determine if differences in orientation exist between the research scientist and the production engineer. Although the thesis is restricted to scientists and engineers in research and development, a bonus of 31 replies was received in error from production engineers and is included in the analysis within Chapter 5.

A comparison of preferred rewards and important work features between the professional occupational group of this study and office staff employees in the United Kingdom is made in Chapter 6. Here similarities are examined exclusive of rewards and work features of singular interest to the professional worker. Thus, work features such as salary, promotion prospects, nature and challenge of assignments are included; association with able professionals, and opportunity to contribute to basic knowledge are excluded from the analysis.

The data which were examined on an organisational basis in Chapter 4 are re-examined in Chapter 7 on an individual basis. Here the job satisfaction of the individual R-D worker is correlated with his contemplation of resignation, age, salary, satisfaction with salary, satisfaction with the promotion system, accessibility of senior management, personal recognition by his supervisor, and productivity.

Finally, in Chapter 8, the ranking by the scientist and engineer of other professional occupations relative to his own, and his concern with occupational prestige, is examined.

CHAPTER 1

DRAFTING THE QUESTIONNAIRE

A copy of the questionnaire is enclosed in its return envelope and attached to the inside of the front cover of this thesis.

The gathering of information by conduction of interviews was not resorted to because interviews are time-consuming and in addition the questionnaire gives the respondent complete assurance of the anonymity of the information disclosed.

The content of the questionnaire is in three interlocking phases. Firstly, background information on the characteristics of the respondent, such as age, experience, and education. Secondly, questions which were intended to yield information on the training and professional development programs of the organisations and the attitude of the professional employees to these programs. Finally, questions which were intended to yield information on the worth of other features and rewards of the professional employees' work relative to training and development.

The questionnaire went through several drafts. The major problem was to shorten the length to the point that response would be high and yet not leave out desirable bits of information. Prior to publication, the final draft was tried out on my fellow colleagues in the DRB HQ staff, timed, and the final editing completed.

During the drafting stage, interviews were held with the professional personnel administrators in both government research laboratories and in private industry in the Ottawa-Toronto-Montreal triangle. These interviews served the dual function of cataloguing the many elements that make up a professional training and development program - the questionnaire is simply the envelope of these contributions - and of enlisting their approval and cooperation in the distribution of the questionnaire to their research and development scientists and engineers.

In every single case the personnel directors interviewed were most helpful and cooperative in describing their training and development programs. However, I did not secure the approval of all the organisations desired for the distribution of the questionnaire. The reason given for refusal in the case of a government organisation was "their personnel appeared satisfied with the existing programs and the questionnaire would only disturb this situation". In the case of a private laboratory, the interview closed amicably, with approval to be confirmed by letter after discussion with senior management. The confirming letter simply stated "that no useful purpose could be served by asking our professional engineers to answer them". It should be added that the government laboratory had a very superior program and the industrial laboratory had no program.

Organisations outside the Ottawa-Toronto-Montreal triangle were contacted by identical letter, with an enclosed copy of the questionnaire. Thus, in these cases, their approval for distribution was requested but they did not contribute to the content of the questionnaire. Approval was received by some with what can only be described as enthusiasm. Others did not acknowledge

the letter, or on receipt of a second prompting request refused on the basis as in one example "that we have reached the conclusion that we should not distribute the proposed circular to staff in our organisation. This decision stems largely from the opinion that a poll of this kind could be handled more effectively by a professional association". Of those contacted by letter who refused to participate, the extent of their training and development programs is unknown.

A particularly Canadian flavour was attached to one conditional approval in the case of a research establishment in Quebec. Approval was granted provided the questionnaire were translated into French. The added expense precluded compliance with this provision.

Circulation of the questionnaire took place to those organisations who had consented beginning in March 1963, and ending in October 1963. The reason for this span of time was simply that publication of the questionnaire was limited to 1000 copies due to cost and time required to analyze the returns, and within this limitation the sample had to bear a direct relation in its component parts to the total research and development population in both government and industry. This required, therefore, that each organisation had to be approached in turn, the size and composition of the response determined, and only then could the next organisation be approached.

CHAPTER 2

COMPOSITION OF THE RESEARCH AND DEVELOPMENT EFFORT IN CANADA

Introduction

The essence of research and development is innovation. The goal of business is to meet competition, to develop new products that can be sold at a profit. "If innovation is necessary to achieve these goals, then research and development are vital to the success of the enterprise. The primary purpose of the research and development laboratory, therefore, is to discover and develop new methods and new products." (1) The primary purpose of the Canadian Government in devoting money to research and development in both government and industrial laboratories is to encourage and stimulate Canadian industry. (2)

There is a continuous spectrum from the most fundamental scientific research through applied research, development, engineering, product design, and production. (3) This continuum is implied in the common definition of research and development by the Department of Labour (4) and the Dominion Bureau of Statistics (5), which does not differentiate between research and development.

- (1) Op cit. "The Scientist in American Industry", S. Marcson, 1960, page 4.
- (2) "The Royal Commission on Government Organisation", Report 23, Scientific Research and Development, 1962, page 230.
- (3) "The Scientist in Industry", R.W. Jackson, The Business Quarterly, Fall 1961, page 148.
- (4) "Employment Outlook for Professional Personnel in Scientific and Technical Fields", 1962-1964, Department of Labour, Economics and Research Branch, Report #13, December 1962.
- (5) "Federal Government Expenditures on Scientific Activities, Fiscal 1960-61", Catalogue No. 13-401, Dominion Bureau of Statistics, Business Finance Division; "Industrial Research and Development Expenditures in Canada, 1961", Catalogue No. 13-520, Dominion Bureau of Statistics, Business Finance Division.

Research and development are activities directed to basic research and to the concept and development of new products and processes or major changes in existing products. This definition covers laboratory scale activity, the design and operation of pilot plants, and the development of techniques or processes to the stage where the operation could be taken over by production departments.

Production and operations, on the other hand, is work primarily related to the production processes or operations of an organisation such as inspection, quality control, and routine product testing.

There are numerous attempts to define the elements in the research and development spectrum.⁽¹⁾⁽²⁾⁽³⁾⁽⁴⁾ No attempt to do so was made in the questionnaire. The respondents were simply requested to indicate which element or duty in their view predominated in their work. Fundamental principles of science are established through basic research, a term which is synonymous with pure or fundamental research. The motivation of basic research is curiosity about natural phenomenon. Applied research is mainly concerned with the exploitation of basic research to the control of environment in fields which have specific commercial objectives. Development concerns the application of knowledge derived from applied research to provide economic methods of design

- (1) "Research and Canadian Industry", R.W. Nicolls, The Business Quarterly, Fall 1963.
- (2) "Preliminary Report on Applied Research to the Canadian Productivity Council", September 25, 1961, J. Convey, page 7.
- (3) "Report of the Committee on the Management and Control of Research and Development", Sir S. Zuckermann, HMSO, paragraph 18.
- (4) "Methodology of Statistics on Research and Development", National Science Foundation, NSF-59-36, December 1958.

and manufacture of specific products for eventual sale, the final step before routine production.

This chapter examines the magnitude and composition of the research and development effort in Canada.

2.1 The Manufacturing Industry in Canada

"Progress lies in the acceptance of the idea that material strength of a country rests primarily on a high order of scientific technology." (1)

Dr. C.J. Mackenzie, 1961.

The indication that a state is becoming industrialized is the decreasing employment in agriculture and the increasing employment in the manufacturing industries. This is the case in Canada as revealed in Tables 1 and 2.

Table 1

Net Added Value of Production and Employment in the Canadian Agricultural and Manufacturing Industries

Year	Net Added Value of Production, (2) Billion Dollars		Employment, Thousands	
	Agriculture	Manufacturing Industry	Agriculture (3)	Manufacturing (4) Industry
1947	1.608	4.292	1122	1132
1950	1.887	5.942	1018	1183
1953	2.264	7.993	858	1328
1958	1.925	9.793	712	1290
1959	1.850	10.321	692	1304
1960	2.001	10.517	675	1295

(1) "The Significance of the Recent Scientific Explosion", Dr. C.J. Mackenzie, President of Atomic Energy of Canada Ltd., an address to the Chemical Institute of Canada, Montreal, February 15, 1961.

(2) "Canada Year Book", Dominion Bureau of Statistics, 1962, page 1070.

(3) Ibid, page 708.

(4) Ibid, page 616.

Table 2Value Added per Employee, in the Canadian
Agricultural and Manufacturing Industries

Year	Value Added per Employee, Dollars	
	Agriculture	Manufacturing Industry
1947	1433	3792
1950	1853	5020
1953	2640	6020
1958	2703	7590
1959	2675	7920
1960	2965	8120

It is seen that in the decade 1950 to 1960, the net value of production of the agricultural industry in current dollars remained at approximately 2 billion dollars with employment meanwhile dropping from 1 million to less than 700,000. Concurrently, the net value of production of the manufacturing industries doubled from approximately 5 billion dollars to over 10 billion dollars, with employment showing a slight increase, from 1.2 to 1.3 million. Further, the value added per employee is almost three times as great for the employee in manufacturing as in agriculture.

It is concluded, therefore, that to improve the employment situation in Canada, while at the same time increasing the standard of living, the vitality of the manufacturing industries is of prime importance.

9

Increased productivity, lower unit costs, improved products to meet the competition from abroad, to service a discriminating domestic market, to increase exports, follows from the application of improved management techniques. One element in this is the recognition of the need and continuing application of new ideas and techniques to the productive process. This is the *raison d'être* of research and development. In the manufacturing industry, in the age of the research revolution, to be competitive, to grow, to survive, will depend on the regular and systematic investment in scientific research and development. (1)

One significant feature of manufacturing industry in Canada is its concentration. This concentration is in location and in the degree to which a small number of firms account for a large proportion of the real assets and employment of the industry. In the study by G. Rosenbluth (1957) (2) out of a total of 30,000 separate manufacturing corporations, 28 with assets over \$100 million held about 29% of the real assets of all manufacturing firms, 143 with assets over \$25 million held about 53% of these real assets. In half the industries studied, 9 or less of the

- (1) This hypothesis is not disputed by scientists and engineers. See for example "Research and Canadian Industry", Op. cit, R.W. Nicolls, The Business Quarterly, Fall 1963; "Scientific and Technical Personnel in Industry", 1960, National Science Foundation, NSF-61-75, page 3; "Preliminary Report on Applied Research to the Canadian Productivity Council", Op. cit, September 25, 1961, J. Convey, Page 1; "Research and Productivity", J. Convey et al, page 1, presented to the First Meeting of the Research Management Association, Montreal, October 4, 1963; "Review of the National Research Council", 1963, NRC No. 7426, page 15.
- (2) "Concentration in Canadian Manufacturing Industries", National Bureau of Economic Research, Princeton University Press, 1957, G. Rosenbluth. Based on statistics for the year 1948 this study is brought up to date and amplified in "Economics-Canada", edited by M.H. Watkins, D.F. Forster, 1963.

leading firms account for 80% of employment, and in one-third of the industries studied less than 5 firms account for 80% of employment. The four cities of Montreal, Toronto, Hamilton, and Windsor account for 41% of total employment in the manufacturing industries.

It is clear that a small number of large corporations dominate this leading sector of the Canadian economy. Since research and development effort, it is argued, can only be afforded by large corporations, there is no reason why Canada cannot afford industrial research and development.

This study by G. Rosenbluth (1957) also shows that control of Canada's large corporations is highly concentrated, firstly by foreign and particularly U.S. business interests, and secondly by a small Canadian 'elite'.⁽¹⁾

Table 3

Capital Subject to Foreign Control,
All Manufacturing Firms

	1946	1953	1955	1959
	<hr/>			
		%		
USA	35	43	47	--
Total Foreign	44	50	57	57.

In individual industries USA control is nearly complete, for 1959, being 95% in automobiles and parts, 89% in rubber, 75% in petroleum and natural gas, and 64% in electrical apparatus. Foreign control is seen to be over half of all manufacturing firms and increasing, of which the USA control three-quarters of all foreign investment.

Out of 170 dominant corporations, there were 1613

(1) Ibid, G. Rosenbluth (1957), for years 1939-46. For later years "Canada Year Book", 1962, page 1082. For a discussion of the implications see "Secondary Manufacturing Industry in the Canadian Economy", W.F. Lougheed, 1961.

directorships, of which 1304 are held by 907 Canadian residents, 45% are held by 203 individuals, and 28% by 90 individuals.

Thus, the high concentration in the Canadian manufacturing industries explodes the myth that Canada cannot afford research and development. The high incidence of foreign control, however, is likely to restrict management decisions in respect to increased research and development efforts in Canada, especially in those subsidiaries where there already exists a large research and development laboratory at the parent company in the USA or UK.

2.2 The Research and Development Expenditures in Canada Relative to the United States and United Kingdom (See Appendix 1)

"For basic scientific research we recommend a level of the order of 0.2% of the GNP as a target for all countries. For applied research and development the experience of technically advanced countries indicates that a goal of 2% of GNP is both desirable and achievable future leadership in science and technology will go to those nations which make the fullest use of their scientific potential by adequate financial support."

Report of NATO Scientific Study Group, Oct. 1960.

In order to draw comparisons with the USA and UK, it is necessary that expenditures are put on an equivalent basis. That specified by the National Science Foundation was used, i.e., no capital expenditures or technical services are included but depreciation is included.

This involved, in the modification of the total figures available for the UK, the subtraction of capital expenditures, the addition of depreciation, and the adjustment of the GNP due to a

differing definition.⁽¹⁾ For Canada, only intramural expenditures for research and development performed in government facilities was used, which excludes capital expenditures and technical services. The one weakness of the Canadian data is the lack of information on expenditures in organisations other than the Federal government and industry, i.e., provincial or municipal governments, educational and other non-profit organisations, which are financed by these 'other' organisations. It was assumed to be 12% of the expenditures financed by the Federal government in government facilities, because it gave the best fit to the data of the Forty-fourth Annual Report of the National Research Council of Canada, 1960/61.

The conclusions that can be drawn from the data are:

1. The research and development expenditures in Canada are approximately 0.8% of the GNP, in USA about 3.0% of the GNP and in UK about 2.5%, i.e., the total research and development performed in the USA is about four times that performed in Canada and in the UK about three times that performed in Canada.
2. Canada performs about 1/3 the total research and development recommended by the NATO Scientific Working Group (2.2%). Both the UK and USA exceed this recommended figure.
3. The research and development performed in Canadian government establishments is about equal to that in the USA and about 70% of that performed in the UK government establishments.

(1) As suggested by Mr. G.T. McColm, Economic Studies, National Research Council, and consultant to the Dominion Bureau of Statistics.

4. The research and development performed in USA industry is about nine times that performed in Canadian industry and in the UK industry about six times that performed in Canada.

5. The research and development financed by the USA government is about 3.5 times that financed by the Canadian government, and in the UK about 2.7 times that financed by the Canadian government.

6. The research and development financed by USA industry is about five times that financed in Canadian industry, and in the UK about four times that financed in Canadian industry.

In summary, therefore, based on the relative magnitude of the research and development expenditures in the three English-speaking countries, there appears to be a strong case for increased effort in research and development in Canadian industry, which will require increased funding from both the government and industry.

The statement by Dr. C.J. Mackenzie⁽¹⁾, is pertinent here. "We must greatly expand our scientific and research expenditures in the most promising directions within the framework of a well-considered scientific policy."

2.3 Trends in Research and Development Expenditures in Canada (See Appendix 2)

Examination of the contributions to the total expenditure indicate some surprises. Although the total expenditures remain relatively stagnant in relation to GNP, there has been a steady increase in expenditures on research and development by the Federal

(1) "The New Scientific Technology", Dr. C.J. Mackenzie, an address to the Chemical Institute of Canada, Montreal, June 1963.

government at about 10% per year in government organisations and universities. The change in the total research and development expenditures is entirely due to the reduced government expenditures by the three Armed Services and by industry in industrial research and development. Both reductions occurred in 1959 as a direct result of an abrupt change in defence policy following close behind a change in Government. It is confined entirely to the defence industries, primarily in the transport equipment sector.

The present efforts by the government to increase industrial research and development are being made through the new DRB Defence Industrial Research (DIR) program, the NRC Industrial Research Assistance Program (IRAP), and the Department of Defence Production 'Development Sharing' program.⁽¹⁾

In the period 1955 to 1961, the period for which statistics are available, the performance of research and development in both Federal government and industrial research and development organisations has about doubled, to over \$150 million per year and \$110 million per year, respectively. The total expenditures on research and development in Canada exceeded \$300 million during 1961. The Federal government finances approximately \$190 million, i.e., three-quarters of this total, industry approximately \$90 million, the remainder at the expense of provincial, municipal, and university, i.e., 'other' research organisations.

(1) For a discussion of these R-D programs, see "The State of Research in Canada", L. Marion, presented at the First Conference of the Canadian Research Management Association, Montreal, October 3, 1963.

To examine the figures in another way, the Federal government spends \$190 million, over \$150 million in-house, i.e., over three-quarters, with the remainder split evenly between industry and 'other' organisations. Or again, industry performs approximately \$115 million worth of research and development, and finances approximately \$90 million of this, i.e., over three-quarters.

Table 4

Intramural Expenditures on R-D in Canada, 1961

(Million Dollars)

	Federal Government	Industry	Other	Total
Performed by:	154.5	113.3	40.3	308.1
Financed by:	190.1	91.5	26.3	307.9

2.4 Scientists and Engineers in Research and Development in Canada
(See Appendix 3)

The estimated number of professional research and development employees in the service of the Federal government and industry is shown in Table 5.

Table 5

Professional R-D Employment in the Canadian
Federal Government and Industry, 1961

	Federal Government (excluding 3 Armed Services)	Industry
Bachelor degree	1770	3600
Masters degree	1080	500
Ph.D.	<u>1650</u>	<u>570</u>
	4500	4670

Using a 1962 sample from the Department of Labour⁽¹⁾, the number of research and development scientists and engineers in municipal government is 10, provincial governments, 300, and in universities, 600, for a total in 'other' organisations of 900.

Table 6

Total Professional R-D Employment in Canada, 1961

Federal Government	4,500
Industry	4,670
Other	<u>900</u>
	10,070

The figure for the Federal government is approximately 45% of the total professional staff⁽²⁾ in the public service (Civil Service plus Crown Corporations) and the total is approximately 24% of the total engineers and scientists in Canada.

One cause for concern should be the relation between expenditures and employment revealed in Table 7.

Table 7

Expenditure per Employee, 1961

	Expenditures for Performance	Employment	Expenditure per Employee
Federal Government ⁽³⁾	\$132 M	4,500	\$29,300
Industry	\$114 M	4,670	\$24,400

- (1) "1962 Survey of Employment and Requirements for Engineering and Scientific Manpower," Economics and Research Branch, Department of Labour (unpublished).
- (2) "The Royal Commission on Government Organisation," Management of the Public Service, Personnel Management, Table 8, page 335.
- (3) Excluding 3 Armed Services.

It would appear from this that the industrial worker is inadequately supported, especially when it is recognized that he will be more likely working in the costly development end of the basic research-applied research-development spectrum.

2.5 Research and Development in the Federal Government

"Almost the entire research activity has been concerned with the physical and life sciences. Research in the social sciences - anthropology, economics, political science, sociology, history, economic geography - has benefited from no more than token federal support." (1)

Further, the performance in the physical sciences is predominantly in four organisations, the Department of Mines and Technical Surveys (DM&TS), the Defence Research Board (DRB), the National Research Council (NRC) and the Atomic Energy of Canada Ltd. (AECL). The Defence Research Board was formed out of the National Research Council in 1947, and the Atomic Energy of Canada Ltd. in 1952.

(1) "The Royal Commission on Government Organization", Report 23, Scientific Research and Development, 1962, page 195.

Table 8

Intramural R-D Expenditures and Employment in the
Federal Government in the Physical Sciences

	Intramural R-D Expenditures, 1960/61 \$1000	Engineers and Scientists ⁽¹⁾ 1960/61	Total Intramural Scientific Activity per Professional 1960/61 ⁽³⁾
NRC	20,145	624	35,200
AECL	19,250	535	43,200
DM&TS	10,635	653	33,900
DRB	<u>25,687</u>	<u>584</u>	46,000
	\$75,717	2,396	--
DOT	608	68	15,350
Canadian Arsenals	1,034	65	15,900
	<u>1,642</u>	<u>133</u>	--
Total, Physical Sciences	\$77,359	2,529	\$38,000

The performance in the life sciences is predominantly in three organisations, the Department of Agriculture, Forestry, and Fisheries.

- (1) Opcit, "Federal Government Expenditures on Scientific Activities", Fiscal Year 1960/61. DBS Catalogue No. 13401.
- (2) Opcit, "The Royal Commission on Government Organisation", Report No. 23, Scientific Research and Development, 1962, Appendix 12.
- (3) Ibid, Appendix 8.

Table 9

Intramural R-D Expenditures and Employment in the
Federal Government in the Life Sciences, 1960/61

	Intramural R-D Expenditures, (\$1000)	Engineers and Scientists	Total Intramural Scientific Activity per Professional
Agriculture	23,548	934	25,850
Fisheries	5,574	218	26,800
Forestry	<u>8,266</u>	<u>308</u>	<u>26,800</u>
	\$37,388	1,460	--
NA	1,290	151	20,200
NHW	<u>1,643</u>	<u>123</u>	14,130
	<u>2,933</u>	<u>274</u>	--
Total Life Sciences	\$40,321	1,734	24,650

Table 10

Total Intramural R-D Expenditures in the
Federal Government, 1960/61

	Intramural R-D Expenditures, (\$1000)	Engineers and Scientists	Total Intramural Scientific Activity per Professional
Physical Sciences	77,359	2,529	38,000
Life Sciences	40,321	1,734	24,650
Misc. (1)	451	7	--
3 Armed Services	<u>20,462</u>	<u>653</u>	<u>34,200</u>
	138,593	4,923	32,600

(1) Comprised of Department of Defence Production, Post Office,
St. Lawrence Seaway, Veterans Affairs, and National Film
Board.

It is seen that the physical sciences in four organisations spend over twice that for the life sciences in three organisations at a unit cost per professional 50% greater. It should be understood that the cost per professional is for a research 'unit' consisting of the professional plus skilled technicians and craftsmen. These supporting personnel average about two in Agriculture, DM&TS, and NRC, and about four in AECL and DRB, which explains in part the higher cost per professional or research 'unit' in these latter two organisations.

It is also seen that 66.2% of the total Federal government expenditures on intramural research and development are spent in the physical sciences.

2.6 Research and Development in the Canadian Manufacturing Industry

Breaking the industrial expenditures⁽¹⁾ into the same categories as for Federal government, i.e., under physical sciences, life sciences, and miscellaneous, it is immediately evident that industry spends the greatest portion in the physical sciences.

(1) Op. cit, "Industrial Research and Development in Canada", 1961, DBS Catalogue 13520.

Table 11

Intramural R-D Expenditures and Employment in the
Manufacturing Industry, 1961

	Intramural Expenditures (\$1000)	Employment	Total Intramural Expenditure per Professional
<u>Physical Sciences</u>			
Transportation Equipment	19,857	794	25,000
Electrical Apparatus	21,745	1,040	20,900
Chemical Products, Products of Petroleum and Coal	25,290	1,047	24,000
Mineral Products	<u>15,843</u>	<u>508</u>	<u>31,200</u>
	82,735	3,389	24,400
<u>Life Sciences</u>			
Food and Beverages	2,785	157	17,750
Rubber Products	1,372	69	19,900
Textile Products	1,058	48	22,050
Wood Products	177	5	35,400
Paper Products	<u>7,003</u>	<u>281</u>	<u>24,900</u>
	12,395	560	22,100
Miscellaneous	<u>5,195</u>	<u>220</u>	<u>23,600</u>
Total Manufacturing Industry	100,325	4,169	24,100
Non-Manufacturing	<u>12,931</u>	<u>504</u>	<u>25,700</u>
Total Industrial Expenditures	113,256	4,673	24,250
<u>Total</u>			
Physical Sciences	82,735	3,389	24,400
Life Sciences	12,395	560	22,100
Miscellaneous	5,195	220	23,600
Non-Manufacturing	<u>12,931</u>	<u>504</u>	<u>25,700</u>
	<u>113,256</u>	<u>4,673</u>	<u>24,250</u>

RESEARCH AND DEVELOPMENT, CANADA,
FEDERAL GOVERNMENT AND MANUFACTURING
INDUSTRY

It is seen that the physical sciences in four industrial groups spend 82.4% of the total for all of manufacturing industry, that only 12.4% is spent in life sciences.

Of some interest is the source of funds for research and development in Canadian Manufacturing Industry.

Table 12

Intramural Expenditures, 1961
(in 1000s)

Physical Sciences	Industry	Federal Government	Other	Total
Transportation Equipment	12,349	6,777	730	19,856
Electrical Products	10,719	9,465	1,561	21,745
Chemical Products	25,034	179	77	25,290
Mineral Products	<u>15,757</u>	<u>79</u>	<u>8</u>	<u>15,844</u>
	63,859	16,500	2,376	82,735
Life Sciences	10,694	40	1,661	12,395
Miscellaneous	<u>2,494</u>	<u>1,470</u>	<u>1,230</u>	<u>5,194</u>
	77,047	18,010	5,267	100,324

It is seen that the Federal government is the source of funds for 34.1% of the expenditures in transportation equipment, 43.5% in electrical products, but only 0.7% in chemical products, 0.5% in mineral products, and 0.3% in all of Life Sciences.

A second significant feature of research and development in Canadian manufacturing industry is its concentration, i.e., the large corporations with over \$50 million in sales perform most of the research and development in Canada. In 1959, the last year

for which information is available, 5 firms with over \$50 million in sales in transportation equipment performed 49.2% of the research and development, the remaining 17 firms performed the remaining 50.8%. Similarly in electrical products 3 firms with over \$50 million in sales performed 50.1% of the research and development, with the remaining 48 firms performing the remaining 49.9%. In chemical products (excluding petroleum and coal products) 7 firms with over \$50 million in sales perform 59.8% of the research and development, while 89 firms perform the remaining 40.2%. In mineral products 31 firms with over \$10 million in sales perform 82.5% of the research and development while the remaining 65 firms perform the remaining 17.2%.

The concentration in the Life Sciences is similar.

Foreign control of all firms with over \$50 million in sales is virtually complete in transportation equipment and electrical products, and nearly complete in chemical and mineral products.

The high concentration simplified the task of securing the approval and cooperation of management by limiting the number of organisations contacted. On the assumption that the most adequate incentive programs are in large research and development organisations where such programs can be afforded, and since large research and development organisations are connected to large manufacturing corporations, and these are few in number in Canada, the number of available contacts were small and, therefore, easily made.

2.7 Research and Development in the Physical Sciences in the Federal Government and Canadian Manufacturing Industry

The comparison between the effort in research and development within the Federal government and the Manufacturing industry indicates that the effort is greatest in the physical sciences and at about equal level, both in regard to expenditures and employment.

It was, therefore, decided that the study into incentive programs would be in the physical sciences. It is worthy because it is at a high level of effort and increasing and any comparison between government and industrial organisations is more valid because of similar size.

High concentration of R-D effort, both in the Federal government and in the Canadian manufacturing industry, restricts the survey to four R-D organisations in the Federal government and four groups of companies in the Manufacturing industry.

The four Federal government organisations are the National Research Council, Atomic Energy of Canada Ltd., Department of Mines and Technical Surveys, and the Defence Research Board. The four groups of manufacturing industries are transportation equipment, electrical, chemical, and mineral products groups.

Table 13

Research and Development in the Physical Sciences in the Federal Government and
Canadian Manufacturing Industry

	Expenditures (\$M)		Employment by Degree			Total Employment	
	1958/59	1960/61	B	M	D Total	1958/59	1960/61
Federal Government							
National Research Council	17.1	20.2	162	125	337	587	624
Atomic Energy of Canada Ltd.	---	19.3	323	72	140	483	535
Department of Mines and Technical Surveys	6.9	10.6	362	87	204	558	653
Defence Research Board	22.7 <u>46.7</u>	25.7 <u>75.8</u>	231 <u>1078</u>	175 <u>459</u>	178 <u>859</u>	599 <u>2044</u>	584 <u>2396</u>
		%	45.0	19.2	35.3		100.0
Manufacturing Industry	1957	1959	1961			1957	1959 1961
Transportation Equipment	64.6	25.6	19.9	738	42	14	794
Electrical Products	14.4	15.9	21.8	902	101	37	1040
Chemical Products	14.7	17.9	25.3	638	130	279	1047
Mineral Products	10.8 <u>104.5</u>	12.8 <u>72.2</u>	15.8 <u>82.8</u>	414 <u>2692</u>	49 <u>322</u>	45 <u>375</u>	508 <u>3389</u>
		%	79.4	9.5	11.1		100.0

RESEARCH AND DEVELOPMENT IN THE PHYSICAL SCIENCES

Summary

The research and development effort in Canada is characterised by geographical concentration, by heavy concentration in a few large establishments, by heavy foreign control in industry, by relatively low levels in industry relative to the United States and the United Kingdom, by a steady growth pattern with the single exception of the transport equipment sector in industry, and by heavy concentration in the physical sciences.

The research and development effort in the physical sciences in the Federal government and the Manufacturing industry is at about equal level, both in regard to expenditures and employment, and is at a high level and increasing. For this reason the recipients of the questionnaire were selected from the physical sciences.

CHAPTER 3

COMPOSITION OF THE SAMPLE

Introduction

This survey was made among physical scientists and engineers in government and industry. Do the results, however, fairly represent the attitudes and experiences of the individual, collectively the attitudes and experiences of the work group in each of the seven organisations participating in the survey, and collectively the attitudes and experiences of physical scientists and engineers for government and industry as a whole?

The validity of the information received from the individual will depend on his understanding of the language of the questionnaire, the existence of bias in the questions asked, and his care and frankness in completing the questionnaire. The use of ready-made questions from other surveys wherever possible, simplicity of language, balance in choices, and trial runs with professional colleagues were the means used to improve the quality of data. The attractiveness of the questionnaire format, coupled with the assurance of the preservation of anonymity were the means used to generate care and frankness on the part of the respondent.

The validity of the information received from the work group as a whole is dependent on two sources of error. These are due to differences in composition between the respondents and the recipients and differences in attitude and experiences between the respondents and nonrespondents. The data are comprised of replies from those who

were sufficiently generous of their time to fill in a lengthy questionnaire. These data may differ from that of the nonrespondents. The magnitude of this difference could only be revealed by resorting to interviews, a difficult if not impossible task. Both errors are reduced with increase in percentage response.

The percentage response and composition of the response is the subject of this chapter.

3.1 Percentage Returns

941 questionnaires were circulated and 448 useable questionnaires were returned, for a percentage return of 47.6%.

Table 14

Percentage Returns

	Distributed	Returned	Percentage Return
Federal Government			
G1(1)	216	121	56.0
G2	134	80	59.7
Miscellaneous(2)	-	1	--
	<u>350</u>	<u>202</u>	<u>57.7</u>
Manufacturing Industry			
I1(1)	60	24	40.0
I2	180	85	47.2
I3	131	67	51.1
I4	70	41(3)	58.6
I5	150	26	17.3
Miscellaneous(2)	-	3	--
	<u>591</u>	<u>246</u>	<u>41.6</u>
Total	941	448	47.6

(1) G1 is first Federal Government R-D organisation, I1 is the first Manufacturing Industry R-D organisation. This nomenclature is used throughout.

(2) Includes the four cases which could not be sorted into separate organisations.

(3) In addition three were returned completely blank.

The percentage returns from the Federal government laboratories was 57.7% and from industry 41.6%, or if 15 is excluded 49.9%.

3.2 Date of Receipt of Questionnaire

About 70% of the total returns were received within the time requested, i.e., 7 days, 85% in 2 weeks, 90% in 3 weeks, and 95% in 4 weeks. The last 5% took over 4 weeks.

Table 15

Date of Receipt of Questionnaire

	G	I	Total Returns
	%	%	%
First week	64.8	73.2	69.6
Second week	20.3	12.4	15.8
Third week	4.4	5.4	5.0
Fourth week	4.4	4.5	4.5
Over four weeks	<u>6.1</u>	<u>4.6</u>	<u>5.2</u>
	100.0	100.1	100.1

3.3 Distribution by Duty

Table 16

Distribution by Duty(1), All Respondents

	Basic Res.	Applied Res.	Engi- neering Dev.	Pro- duction	Sales	Manage- ment/ Super- visory	Totals
<u>Government</u>							
G1	36.7	61.5	7.3	--	--	12.5	118
G2	34.8	22.2	11.7	--	--	10.3	79
Misc.	<u>1</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>1</u>
	72.5	83.7	19.0	--	--	22.8	198
<u>Industry</u>							
I1	--	10.5	9.5	2.0	--	2	24
I2	1	6.7	37.2	26.5	--	13.7	85
I3	2	22	40.3	0.8	--	0.8	66
I4	16	13	3	--	--	8	40
I5	7	5.5	--	2	5	6.5	26
Misc.	<u>1</u>	<u>--</u>	<u>--</u>	<u>2</u>	<u>--</u>	<u>--</u>	<u>3</u>
	27.0	57.7	90.0	33.3	5.0	31.0	244

Because the survey is restricted to scientists and engineers in research and development, and part time in the administration of research and development, those involved outside of research and development⁽²⁾ either partly or in total, and those who are full time in administrative duties were eliminated to yield Table 17.

- (1) Equivalent number in each duty, assuming where respondent indicates more than one duty, time is spent equally in each duty indicated.
- (2) The response from those in production was fortuitous as shown in Chapter 5.

Table 17

Distribution by Duty, R-D Respondents Only

	Basic Research	Applied Research	Engineering Development	Management Supervisory (Part Time)	Total
<u>Government</u>					
G1	36.7	61.5	7.3	6.5	112
G2	34.8	22.2	11.7	2.3	71
Misc.	<u>1</u>	<u>--</u>	<u>--</u>	<u>-</u>	<u>1</u>
	72.5	83.7	19	8.8	184
%	39.4	45.5	10.3	4.8(1)	100.0
<u>Industry</u>					
I1	0	10.5	9	0.5	20
I2	1	6.7	36.5	2.8	47
I3	2	22	39.5	0.5	64
I4	16	13	3	1	33
I5	7	5.5	0	0.5	13(3)
Misc.	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>
	27	57.7	88	5.3	178
%	15.2	32.4	49.5	3.0(2)	100.1

- (1) The DBS estimate for the administrators of R-D for both physical and life scientists, is 184 in a total of 4327 or 4.3% in 1960/61.
- (2) The DBS estimate for the administrators of R-D for both physical and life scientists, is 139 in a total of 4673 or 3.0% in 1961.
- (3) This response is only 8.7% of the recipients of the questionnaire and was not considered to fairly represent the organisation in the analysis of Chapter 4.

DBS does not break down the statistics into duty other than in regard to administrators of R-D. The total R-D professional scientists and engineers are about equal in G and I which is as required.

The histogram is skewed toward research in G and toward development in I, or in other words, G is primarily basic and applied research and I is primarily applied research and development.

This is quite different from distribution by duty in the USA and UK as shown in Table 18, indicating the relative lack of development in both G and I in Canada.

Table 18

Distribution by Duty in the USA, UK, and Sample

	Basic %	Applied %	Development %	Total %
Federal Government				
USA(1) (1959/60)	12.0	25.1	62.8	99.9
UK(2) (1961/62)	12.9	34.0	53.0	99.9
Sample (1963)	39.4	45.5	10.3	95.2
Industry				
USA(3) (1960)	3.7	19.6	76.8	100.1
UK(2) (1961/62)	3.4	19.7	76.9	100.0
Sample (1963)	15.2	32.4	49.5	97.1

- (1) "Trends in Funds and Personnel for Research and Development, 1953-61," National Science Foundation, NSF 62-9.
- (2) "Annual Report of the Advisory Council on Scientific Policy, 1961-62," HMSO, London, Cmd 1920. Includes administrators of R-D.
- (3) "Research and Development in Industry, 1960," National Science Foundation, NSF 63-7. Includes administrators of R-D.

3.4 Distribution by University Degree

Table 19

Distribution by University Degree

Government	Bachelor	Masters	Doctorate	Other	Total
G1	70	20	25	0	115
G2	29	28	14	1	72
Miscellaneous	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>
	100	48	39	1	188
%	53.2	25.5	20.7	0.5	99.9
Industry					
I1	15	3	1	1	20
I2	38	6	0	3	47
I3	33	24	3	5	65
I4	19	5	7	2	33
I5	5	4	4	0	13
Miscellaneous	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>
	111	42	15	11	179
%	62.0	23.5	8.4	6.1	100.0

The histogram is skewed toward the bachelor degree and is skewed more in industry.

The comparison with DBS estimates is shown in Table 20.

Table 20

Distribution by Degree

	Bachelor	Masters	Doctorate
Government			
DBS(1) (1960/61)	45.0	19.2	35.3
Sample (1963)	53.7	25.5	20.7
Industry			
DBS(1) (1961)	79.4	9.5	11.1
Sample (1963)	68.1	23.5	8.4

The comparison is favourable with the exception that the sample has fewer Doctorates in G and more Master's degrees in Industry.

The sample was based on the DBS information in fiscal year 1960/61 for G and Calendar Year 1959 for I. The industrial effort for 1961 was not available until December 1963, too late to have any effect.

3.5 Distribution by Field of Training

The engineers and scientists are grouped into seven fields of training, four of which are closely allied to the four industrial groupings:

(1) Table 13.

1. Aeronautical, Mechanical Engineering - Transportation Equipment
2. Electrical, Electronics Engineers - Electrical Products
3. Chemical Engineering, Chemists - Chemical Products
4. Metallurgists, Earth Scientists - Mineral Products
5. Physicists, Engineering Physics, Mathematics and Physics, Mathematicians
6. Miscellaneous

The exception is the group of physicists, mathematicians, etc., who are found in all of the four industrial groupings, but primarily in the 'aerospace' industries - Transportation Equipment and Electrical Products. This should be of interest to university science and engineering students who do not wish to specialize or who are undecided on their specialty.

Table 21

Distribution by Field of Training

	Federal Government		Manufacturing Industry	
	DBS(1960/61) %	Sample %	DBS(1961) %	Sample %
1. Aeronautical, Mechanical	10.5	4.9	25.0	23.4
2. Electrical, Electronics Engineers	11.1	14.6	29.8	27.5
3. Chemical Engineering, Chemists	27.5	23.8	26.7	15.6
4. Metallurgists, Earth Scientists	13.1	28.6	5.3	0.6
5. Physicists, Mathematicians, etc.	22.9	23.3	4.3	25.2
6. Miscellaneous	<u>15.0</u> <u>100.1</u>	<u>4.9</u> <u>100.1</u>	<u>8.9</u> <u>100.0</u>	<u>7.8</u> <u>100.1</u>

The field of training is not shown for each separate organisation in order to preserve anonymity.

Comparing the DBS estimate with the sample is favourable with two exceptions. The G sample has more mining engineers and metallurgists, and the I sample fewer chemical engineers and chemists.

3.6 Salary RangeTable 22

Salary Range

Federal Government	Under \$5000	\$5000-\$7499	\$7500-\$9999	\$10,000-\$12,500	Over \$12,500	Total
G1	2	27	35	36	14	114
G2	1	27	37	7	--	72
Misc.	--	--	--	<u>1</u>	--	<u>1</u>
	3	54	73	43	14	187
%	1.6	28.9	39.0	23.0	7.5	100.0
Manufacturing Industry						
I1	0	6	13	1	0	20
I2	1	16	20	7	2	46
I3	1	36	23	4	1	65
I4	0	13	16	5	0	34
I5	0	3	1	5	1	13
Misc.	<u>0</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>
	2	75	76	22	4	179
%	1.2	41.9	42.5	12.3	2.2	100.1

The sample indicates salary levels in G to be higher than in I. This is shown later to be due to the greater age and experience of the G respondents.

3.7 Experience Since GraduationTable 23

Experience Since Graduation, Years

Federal Government		Under 5	5-9	10-14	15-19	20 or over	Total
G1		17	19	27	15	37	115
G2		19	33	16	3	0	71
Misc.		<u>0</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>1</u>
		36	52	44	18	37	187
	%	19.3	27.8	23.5	9.6	19.8	100.0
Manufacturing Industry							
I1		3	7	9	1	0	20
I2		3	19	12	5	8	47
I3		26	26	5	3	4	64
I4		8	7	7	9	2	33
I5		4	5	3	0	1	13
Misc.		<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>
		45	64	36	18	15	178
	%	25.3	36.0	20.2	10.1	8.4	100.0

The sample shows G with a balanced histogram, and I with a histogram skewed toward a lower experience level. Research and development has, of course, come only very recently to I.

40%

3.8 Salary Range Vis-a-vis Experience in Years Since Graduation

Table 24

Salary Range Vis-a-vis Experience in Years Since Graduation

<u>Federal Government</u>	Under \$5000	\$5000- \$7499	\$7500- \$9999	\$10,000- \$12,500	Over \$12,500
-------------------------------	-----------------	-------------------	-------------------	-----------------------	------------------

Experience Since Graduation

Under 5 years	2	29	6	--	--
5 - 9	1	22	22	7	--
10 - 14	-	2	27	15	--
15 - 19	-	1	6	9	1
20 or over	-	0	13	12	11

Industry

Experience Since Graduation

Under 5 years	1	43	1	--	--
5 - 9	1	22	35	5	--
10 - 14	-	7	23	5	1
15 - 19	-	1	7	5	2
20 or over	-	1	6	7	1

When plotted against the median salary for Professional Engineers in Ontario, December 1, 1962⁽¹⁾, and for Scientific and Technical Professions⁽²⁾ it is concluded that the sample is consistent with the trend of salary vis-a-vis experience for both G and I.

(1) "Salary Survey Report," December 1, 1962, The Professional Engineer and Engineering Digest, February 1963.

(2) "Employment and Earnings in the Scientific and Technical Professions", 1958-1961, Department of Labour, Report 12, September 1962.

SALARY / EXPERIENCE

SALARY / EXPERIENCE

SALARY, DOLLARS

MANUFACTURING INDUSTRY

N 174

PROFESSIONAL ENGINEERS

DEC 1 1962

N 209657

DEPARTMENT OF LABOUR

SCIENTISTS N 3114

ENGINEERS N 9442

NUMBER OF SCIENTISTS AND
ENGINEERS IN EACH CATEGORY
FROM SAMPLE

25

20

15

10

5

0

APPLICABLE EXPERIENCE

SINCE GRADUATION

YEARS

15000

10000

5000

0

3.9 Age GroupTable 25

Federal Government	Age Group, Years					Total
	Under 21	21-30	31-40	41-50	Over 50	
G1	0	23	36	36	20	115
G2	0	36	29	7	0	72
Misc.	<u>0</u>	<u>--</u>	<u>--</u>	<u>1</u>	<u>--</u>	<u>1</u>
	0	59	65	44	20	188
%	0.0	31.4	34.6	23.4	10.6	100.0

Manufacturing Industry

I1	0	7	10	3	0	20
I2	0	14	23	7	3	47
I3	0	33	25	5	2	65
I4	0	11	13	8	2	34
I5	0	5	8	0	0	13
Misc.	<u>0</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>
	0	71	79	23	7	180
%	0.0	39.4	43.9	12.8	3.9	100.0

The sample for the G is seen to be an older group.

3.10 Normal Work Week, HoursTable 26

Normal Work Week, Hours

Federal Government	Under 40	40-45	46-50	Over 50	Total
G1	77	27	3	4	111
G2	41	25	3	2	71
Misc.	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>
	119	52	6	6	183
%	65.0	28.4	3.3	3.3	100.0

Manufacturing Industry

I1	15	5	0	0	20
I2	26	16	2	1	45
I3	53	10	1	0	64
I4	4	27	2	0	33
I5	7	5	1	0	13
Misc.	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>
	106	63	6	1	176

The comparison between histograms show no marked differences between G and I. The arithmetic mean for both is approximately 39 hours.

Summary

Approximately half of the questionnaires circulated were returned, 70% in the time requested, i.e., 7 days.

The sample indicates strong orientation toward research duties in government, and to development in industry, which is reflected in a heavier concentration in higher degrees in government relative to industry. The sample indicates that the salary level in government is higher than in industry, consistent with the greater age and experience of the government respondents.

The comparison of the sample to the available statistical data of the Dominion Bureau of Statistics for the Federal government and Manufacturing Industry as a whole is favourable, with the exception that the sample has fewer Doctorates in government and more Master's degrees in industry; and more metallurgists and mining engineers in government and fewer chemists and chemical engineers in industry.

The comparison of the sample to available data on the composition of the seven organisations is not revealed in order to preserve anonymity. The purpose, however, of this thesis is not to rate organisations per se but to show the relationship between the work environment and satisfactions. It is left to the seven organisations to examine whether the composition fairly represents their organisation and thus allow adjustment to the ratings based on the response.

CHAPTER 4

THE RATING OF RESEARCH AND DEVELOPMENT ESTABLISHMENTS

Introduction

Just as a continuum exists in research and development such that the elements can only be defined in relation to the elements that remain, and into which they diffuse, the professional work environment must be viewed as an integrated whole. The elements in the work environment include recruitment, initial indoctrination, internal training, professional development, progress appraisal, and career plans, and stretch in time from the moment first contact is made to retirement. These programs are important to the employee professional, to satisfy his expectations as a member of a professional group and as a member of an organisation. The extent of these programs are examined in this chapter and correlated with the employee's satisfaction with and participation in these programs.

In addition, the accessibility of senior management and its record in regard to personal recognition is examined. This 'human element' in the management of scientists and engineers is correlated with the percentage contemplating resignation from the organisation.

Finally, the rewards preferred by scientists and engineers are correlated with their satisfactions with the organisation's system of rewards. Rewards which enhance the worker's position in the hierarchy, rewards which are a function of research orientation, financial rewards, and rewards which enhance the worker's professional status are included.

4.1 Recruitment

"We believe that the best recruiting device a laboratory can have is outstanding staff whose reputation in their respective fields will command the attention and admiration of the best young men. Good research people are always anxious to work with the name men in their fields."

F.T. Rosser⁽¹⁾, National Research Council.

Recruitment was examined in this study by asking the respondent how he first made contact with his present organisation and by asking him for his comments on the best way to recruit professional employees. The number of answers received in each category is shown as a percentage of the total number of answers received in Table 27.

It is clear that the results of the respondents' own experience and comments are:

1. Not enough use is made of professional journal advertisements or newspaper advertisements. Although "good places draw good men the best laboratory still needs its publicity agents. From the recruiting angle, if for no other, time and effort quietly devoted to singing the praises of the establishment will be well spent." (2)

- (1) "Staff Selection and Assessment", F.T. Rosser, Paper at the Symposium on the Direction of Research Establishments, 1956, National Physical Laboratory, England.
- (2) "The Human Element in Research Management", B.E. Noltingk, Elsevier Publications, 1959.

Table 27

Recruitment

	G %		I %	
I entered this organisation as a result of:	My Way	Best Way	My Way	Best Way
Answering a newspaper advertisement	6.9	13.8	18.7	27.3
Answering a professional journal advertisement	2.8	30.8	6.1	34.0
The suggestion of a professional colleague	25.8	2.7	15.4	2.9
The recommendation of university staff	9.2	6.9	6.5	2.4
My inquiry to the personnel department	30.0	3.7	36.9	1.9
The personal request of management	7.4	2.7	4.2	1.0
To this list respondents added the following comments:				
Professional recruiting team at university (junior personnel)	6.5	16.0	4.7	9.1
Personal contact (experienced personnel)	1.4	11.2	0.5	6.2
Professional organisation	-	4.3	0.5	1.0
Professional registry	1.4	1.1	0.9	1.0
Reputation of the organisation	-	0.5	-	3.1
Offer good salaries	-	0.5	-	2.9
Other	<u>8.7</u>	<u>5.9</u>	<u>6.5</u>	<u>7.2</u>
	100.1	100.1	99.9	100.0

2. The best way to recruit professional employees is not to wait for him to contact the organisation, or to rely on the suggestion of professional colleagues or recommendations of university staff, but to go out and find him, through advertising primarily, and by means of a professional recruiting team at university for junior personnel and through personal contact for experienced personnel.

In answer to a question concerning recruitment of scientific personnel, Col. D.F. MacRae⁽¹⁾ replied "Ability is where you find it. We search all over we advertise in scientific journals in this country and in other countries we ask everybody we know we look at membership lists in the scientific associations if you really dig hard enough you will find them but it does take a lot of digging."

3. There is the suggestion that G personnel consider more highly than I personnel recruitment through personal contact, through the university, the recommendation of university professors and through professional organisations. This 'professional

(1) "Problems of Research Administration", Tenth Annual Conference, The Institute of the Public Administration of Canada, September 1958, page 127, Colonel D.F. MacRae, Director, Industrial Research Services, Ontario Research Foundation.

orientation' is noted in Chapter 5 under important work features where G consider association with able professionals more highly than I. A check on the trend as duty goes from basic research to production indicated a greater response from the research worker but the highest response from the research worker in G.

The above results do not signify that the reputation of the organisation is not important. What the results do, however, is indicate areas of neglect.

4.2 Initial Indoctrination

"Recruitment is, of course, only the first step towards building up an effective organisation a good start can be made with new recruits if they are given a welcome when they join and if they know to whom they can go for help and advice. Anything ranging from an introductory talk to a more elaborate but brief course of instruction can also be of assistance at or soon after the time of joining."⁽¹⁾

"In any initial indoctrination program it is necessary to acquaint the trainee with his organisation. At the Armour Foundation, a candidate for technical employment is always given a fairly complete picture of the purpose, organisation, policies and practices of the Foundation. He is acquainted with typical research programs in the fields in which his services will be utilised.

"On his first day of employment the trainee is received by the assistant director in charge of personnel and is given a complete description of employment benefits. These include educational opportunities, retirement program, insurance program, and hospitalisation and surgical benefits. At the same time we review with him the purposes, policies, and practices of the Foundation.

"The new employee then meets with his department chairman who outlines specific policies of the department and reviews such matters as the organisational plan of the Foundation and the educational program of the Foundation. As a final step in this initial indoctrination, the new employee meets with his section supervisor. His supervisor discusses in considerable detail the organisation of the section and reviews its major programs, with particular emphasis upon the programs to which the new staff member

(1) "Selection and Personal Assessment of Staff", W.A. Bristowe, Imperial Chemical Industries, Ltd., Symposium on the Direction of Research Establishments, 1956, National Physical Laboratory, England.

will be assigned."(1)

The rating of the initial indoctrination for the R-D organisations of this study is given in Table 28.

Table 28

Initial Indoctrination

	%					
	G1	G2	I1	I2	I3	I4
On entering this organisation I was given:						
1. A description of the fringe benefits	81.2	75.0	79.2	83.1	92.5	86.7
2. An outline of its educational and training programs	19.4	17.3	4.3	40.5	62.1	43.3
3. A description of its purposes, policies, and practices	64.2	60.3	8.7	49.4	71.2	93.3
4. Its organisational plan	58.6	62.3	0.0	34.6	71.7	90.0
5. A review of its major programs	49.5	48.7	54.1	51.2	51.6	65.5
6. An introduction to departmental and management senior staff	70.5	64.5	56.5	28.1	57.8	75.9
The initial indoctrination was adequate	62.1	46.8	37.5	45.3	64.1	67.9
Overall rating of initial indoctrination	57.8	54.8	34.3	48.0	68.0	75.8

In each case the number of Yes answers is shown as a percentage of the answers to the question. The overall rating of the initial indoctrination program is the arithmetic mean of the percentages listed for the six questions.(2)

- (1) "Training of Young Researchers", H.A. Leedy, Director, Armour Research Foundation, Illinois Institute of Technology, Proceedings of the Second Annual Conference on Industrial Research, June 1951.
- (2) The same method is used to give the rating for all programs in this chapter.

The graph shows the direct positive relation between the rating of the indoctrination and employee satisfaction with the indoctrination.

4.3 Internal Training

"In many respects, the most effective training program for a young researcher is comparable to the internship of medical doctors by observing how research is carried on in a good laboratory, the young researcher can develop into a first-class research scientist. In other words, place the right man in a good research environment and the result is inevitable - a new well-trained researcher." (1)

H.A. Leedy, 1951.

(1) Op. cit, "Training of Young Researchers", 1951.

"Training refers to the process of developing skills, habits, knowledge, and attitudes in employees for the purpose of increasing the effectiveness of employees in their present positions as well as preparing employees for future positions." (1)

W.G. Torpey, 1953.

The measure of the research and development organizations internal training program for new entrants was gauged by the response to the questions included in Table 29.

Table 29

Internal Training

	G1	G2	I1	I2	I3	I4
This organisation has a training plan which includes:						
1. Special assignments outside normal work	26.0	19.1	0.0	13.4	11.3	27.3
2. Attendance at lectures or discussion groups	62.5	81.5	7.7	48.6	88.7	88.9
3. Attendance at committees or meetings outside normal work	67.5	44.3	0.0	11.9	47.6	60.0
4. Accompanying or representing my superior at meetings	54.7	36.7	26.7	23.9	51.7	68.0
Satisfaction with the internal training plan	33.3	37.7	13.3	37.7	39.7	45.8
Overall rating of internal training plan	50.2	45.4	8.6	24.5	49.8	61.1

(1) "Public Personnel Management", W.G. Torpey, Von Nostrand, Chapter 5, 1953.

The results indicate a low level of satisfaction with the internal training plan, and good correlation between satisfaction and rating, with the one exception that I2 has a relatively high order of satisfaction in spite of a poor rating.

The lack of adequate training programs is most evident in I1 and I2.

4.4 Professional Development

"After selecting the young worker and assigning him to a job in the organisation, the maximum gain to the organisation can be obtained only by the full flowering of his professional potential.

"Personnel development programs of various types are used for the purpose of assisting all of their personnel to become more proficient in their profession and thereby of more benefit to the R-D program of the university, industrial or governmental R-D establishment. The chief methods used were found to be advanced educational opportunities, membership in technical societies, attendance at seminars, study of publications, internal training programs and travel."(1)

G.W. Howard, 1954.

(1) Op. cit, "Common Sense in Research and Development Management", 1954.

"It is the intention of the Defence Research Board to encourage and, where appropriate, to assist members of its professional staff to develop their capacities to the mutual benefit of themselves and the organisation."(1)

Memorandum to Heads of Establishments, 1960.

The extent of professional development programs was gauged by the response to the questions given in Table 30.

Table 30

Professional Development

	G1	G2	I1	I2	I3	I4
This organisation encourages my professional development by:						
			%			
1. Paying expenses for at least one major meeting per year	70.5	49.4	26.1	17.9	63.6	80.0
2. Paying expenses when I present a technical paper	94.6	94.8	40.9	35.9	87.5	80.0
3. Paying expenses for travel to exchange information	87.2	86.9	45.5	45.6	80.3	80.0
4. Paying tuition fees for correspondence or evening courses successfully completed	28.7	17.6	34.8	95.3	97.0	57.2
5. Allowing time off work to attend training courses	71.1	55.4	54.5	41.8	70.8	55.6
6. Allowing ample time to read technical journals	92.8	87.2	78.3	54.2	81.8	83.3
7. Providing adequate library and information services	97.4	94.9	79.2	91.8	100.0	93.4
8. Sponsoring seminars with invited speakers						
- during working hours	67.3	87.0	13.0	22.9	69.7	89.7
- outside working hours	54.7	30.7	20.8	42.2	31.2	42.9
9. Sponsoring lectures by staff	51.8	90.9	12.5	42.2	94.0	96.6
Overall rating of professional development program	72.2	69.8	40.4	49.3	78.0	76.3

(1) Memorandum, Chairman of DRB to Heads of Establishments, entitled "Professional Development", March 1960.

The results indicate a low overall rating for I1 and I2 relative to other organisations.

There is an unexplained lack of encouragement by government organisations for personnel to take correspondence or evening classes.

There is a consistently high rating for library and information services.

4.5 Comparison of the Rating of the Professional Development Program to the Participation of the R-D Personnel in Profession Development

"In the final analysis the professional development of a scientist can only be achieved through a mutual interest and initiative on the part of both the individual and of the organisation."

DRB Memorandum, 1960.

The participation of the individual researcher in professional development was rated by the response to the list of questions in Table 31.

Table 31

Participation in Professional Development

	G1	G2	I1	I2	I3	I4
1. I belong to my professional society	89.9	79.7	75.0	69.5	79.1	73.4
2. I attend meetings, often, rarely, or never(1)	63.3	52.8	41.3	48.7	41.0	74.1
3. I attend a night course related to my profession	15.3	16.7	4.2	38.1	55.4	33.3
4. I attend at least one related seminar during 1962	57.3	71.8	37.5	28.6	67.2	66.7
5. I attended my organisation's annual technical meeting in 1962	38.7	41.0	16.7	18.3	20.0	31.0
Rating of participation by employee in professional development	52.9	52.4	43.0	40.7	52.6	55.7

(1) This question was scored by specifying 2 points for often, 1 point for rarely, and none for never summed as a percentage of the maximum score possible. Thus 100% signifies often, rarely as 50%, and

The results indicate the lowest overall rating for I1 and I2 relative to the other organisations.

The positive correlation between the rating of the professional development program and the worker's participation in professional development leads to the conclusion that the more professional the attitude of the organisation the more professional the attitude of the worker attracted to the organisation.

Note also when encouragement is given to individual elements of a development program, as for example to take evening courses, the participation is correspondingly high.

4.6 Progress Appraisal

"In a very small organisation the heads of departments and personnel managers may be able by conscious effort to get to know and to understand all the staff quite well, but as the organisation grows in size the case strengthens for introducing some more formal method of personal assessment as an aid to knowledge of the men.

"The object of a personal assessment scheme can include some or all of the following:

1. To give a record of employee's progress, development, and work during his career.
2. To provide information which will be of help in placing employees in jobs appropriate to their ability, qualifications, and experience, and to provide a basis for selection, promotion, or special training.
3. To improve the morale of staff through the knowledge that they are receiving regular, careful, and individual consideration.
4. To impress on those in authority the importance of providing themselves with a detailed knowledge and understanding of the capabilities of their subordinates.
5. To provide data which will assist in assessing the increases in salary deserved by the individual's performance in his job.
6. To note and record talent and misfits with a view to long-term planning in the case of men with high potential and early action in the case of misfits.

"One great advantage which can be claimed for an assessment scheme is that it enforces careful and methodical thought by heads of departments and by others to the men who work for them and to their possible future progress."(1)

(1) Op. cit, "Selection and Personal Assessment of Staff", 1956.

The rating of the R-D organisations program for personnel assessment was based on the response to the list of questions given in Table 32.

Table 32

Progress Appraisal

	G1	G2	I1	I2	I3	I4
This organisation follows my performance:						
1. By requiring a periodic summary of my activities	80.4	74.3	43.5	33.8	51.6	90.0
2. By requiring me to describe my project, its status, aims, and trouble areas	65.1	43.3	65.2	15.9	63.5	86.2
3. By periodic invitation to lunch with management, to discuss my projects	5.8	6.7	4.3	0.0	4.7	7.1
4. By periodic appraisal before a committee of senior technical and management personnel	31.1	39.2	13.6	14.5	40.0	67.9
5. I talk to senior management often, occasionally, never ⁽¹⁾	61.0	48.0	45.8	28.1	50.0	53.6
6. By informing me about the appraisal of my progress	29.8	60.0	21.7	13.1	50.8	86.2
Rating of progress appraisal	45.6	45.3	32.4	17.6	43.4	65.2

The results indicate a low overall rating for I1 and I2, that there is strikingly little reliance on the use of invitations to lunch with management to discuss projects, and little reliance on appraisal before a committee of senior staff in government organisations.

(1) This response was scored in same way as a similar question under professional development.

4.7 Career Plan

"Systems housing professionals requires growth and expansion, a lead time adequate to train and develop people, financial resources sufficient to continuously reinvest in the long-term future value of people, a continuous reappraisal of the occupational mix to keep pace with market, scientific and technological changes, a relative balance in the age and service composition in all critical occupations without either heavy over-concentrations or vacuum areas, a free and open policy of competition, with strict limits on nepotism, favouritism, and seniority, and above all the persistent ability to attract and retain outstanding people for a life's career."⁽¹⁾

J.M. Rosow, 1962.

The rating of the career plans is based on the response to the two questions given in Table 33.

Table 33

Career Plan

	G1	G2	I1	I2	I3	I4
1. I am informed of probable future vacancies in my organisation	48.0	21.9	4.5	11.3	9.8	29.6
2. My career plan is a joint effort with management	20.2	32.8	0.0	6.4	22.2	28.0
Rating of career plan available	34.1	27.4	2.3	8.9	16.0	28.8

The results show there is little career planning in both government and industry with the least in I1 and I2.

(1) Op. cit, "The Growing Role of Professional and Scientific Personnel", 1962.

The employee's interest in career planning was measured by the response to the three questions given in Table 34.

Table 34

Interest in Career Planning

	G1	G2	I1	I2	I3	I4
1. I am aiming for a senior position	67.9	65.8	87.5	81.9	77.3	76.9
2. I know that training is needed to qualify for this position	76.8	71.2	81.0	64.1	74.6	60.9
3. I have a plan to prepare myself for this position	60.7	57.8	59.1	60.6	60.3	50.0
Rating of interest in career planning	68.5	65.0	76.1	69.2	70.8	63.0

There is a negative correlation between the rating of the career plan available and rating of interest in career planning, which only reflects the need for improvements in the field of career planning.

4.8 Upward Communications - The Accessibility of Senior Management

"One of the most effective things which a research manager can do on a limited scale is to maintain personal contact with research staff at all levels The extent to which knowledge is passed on by personal contact may well be a measure of the health of a research organisation, just as freedom from obstruction of arteries may well indicate the state of health of a living organism."⁽¹⁾

C.G. Williams, 1956.

"Separating the scientist into those who have frequent contact with their chief (once a day on the average, or more often) and those who have infrequent contact with them (only a few times a week or less often) for those who see their chief daily, the highest performance is shown by those who have considerable independence in pursuing their own work but at the same time maintain daily relations with the chief we are becoming more and more convinced that this active interest in the outgoing work, combined with a hands-off policy concerning its direction is one of the most fruitful things a research chief can do - particularly with his younger personnel."⁽²⁾ Evidently, "if freedom is to contribute to high performance, the individual must be part of an active social system⁽³⁾ where there is frequent contact and interaction."⁽⁴⁾

D.C. Pelz, 1957.

A measure of this "personal contact⁽⁵⁾" is based on the response to the question given in Table 35.

- (1) "Internal Communications in a Large Research Laboratory", C.G. Williams, Director and General Manager of Shell Research Ltd., Symposium, The Direction of Research Establishments, 1956, National Physical Laboratory, England.
- (2) "Motivation of the Engineering and Research Specialist", General Management Series, No. 186, American Management Association, D.C. Pelz, 1957, pages 33-35. This hypothesis is discussed in "Some Social Factors Related to Performance in a Research Organisation", D.C. Pelz, Administrative Science Quarterly, Vol. 1, 1956, pages 310-325.
- (3) The concept of 'social system' is discussed in "Management and Morale", F. Roethlisberger, 1941, especially Chapter IV, "The Social Structure of Industry".
- (4) "New Patterns of Management", R. Likert, Institute for Social Research, University of Michigan, 1961, page 24.
- (5) Using the choice of words of C.G. Williams, Op. cit, "Internal Communications in a Large Research Laboratory".

Table 35

Personal Contact

	G1	G2	I1	I2	I3	I4
I talk with senior management about my work - often, occasionally, never	61.0	48.0	45.8	28.1	50.0	53.6

The "health"(1) of the organisation was measured by the percentage of respondents who indicated they were contemplating resigning as shown in Table 36.

Table 36

Contemplating Resignation

	G1	G2	I1	I2	I3	I4
Remaining in Canada	19.3	24.6	13.3	19.1	22.2	15.4
Emigrating to USA	7.2	21.0	26.7	57.2	14.8	0.0
Other	<u>0.0</u>	<u>7.0</u>	<u>6.7</u>	<u>7.1</u>	<u>5.6</u>	<u>3.8</u>
Total	26.5	52.6	46.7	83.4	42.6	19.2

(1) Using the choice of words of C.G. Williams, Op. cit, "Internal Communications in a Large Research Laboratory".

The graph indicates that the organisation with the least personal contact has the highest potential turnover in employment.

Other measures of this personal contact with or accessibility of senior management is based on responses to the following questions given in Table 37.

Table 37

Upward Communications

	G1	G2	I1	I2	I3	I4
1. On entering this organisation I was given an introduction to department and management senior staff	70.5	64.5	56.5	28.1	57.8	75.9
2. This organisation follows my performance by periodic invitation to lunch with management to discuss my projects	5.8	6.7	4.4	0.0	4.7	7.1
Overall communications rating ⁽¹⁾	45.8	39.7	35.6	18.7	37.5	45.5

(1) Including the response given in Table 35.

Further support to this conclusive correlation between upward communications, i.e., accessibility of senior management, and the percentage contemplating resignation is given when three separate divisions of the same organisation, are analysed on the same basis, as shown in Table 38.

Table 38

Upward Communication in Separate Divisions
of One Organisation

	Division		
	1	2	3
I talk to senior management about my work - often, occasionally, never	70.8	50.0	41.3
Overall upward communication rating	60.0	42.6	33.7
Percentage contemplating resignation	20.0	50.0	62.9

In a study by I. Hirsch⁽¹⁾, et al, of 148 professional members of aeronautical and electronic societies in California, an effective means to increase the utilisation of scientists was shown to be in the reduction of turnover. "Turnover, is obviously expensive and wasteful, primarily because of the time which must be spent in adjusting to a new environment. No matter how skilled and proficient a scientist may be, he must spend some time learning the operating system of the new company, its physical layout, and his new associates. Understanding the requirements of a new job and determining communication paths to superiors and subordinates is no easier in a research department than in a marketing or production department."

(1) "Increasing the Productivity of Scientists", I. Hirsch et al, Harvard Business Review, March-April 1958, page 69.

This correlation between upward communications and turnover is critical in a period when there is a shortage of trained R-D personnel. In addition, based on a study by R. Likert⁽¹⁾, there is a correlation between communication and performance for the kind of work done by people engaged in such tasks as research and engineering⁽²⁾. Thus, high turnover is compounded by the poor performance of those R-D personnel remaining⁽³⁾.

Table 39

Relation Between Upward Communications and Turnover⁽⁴⁾

Upward Communication Scale	Mean Productivity	Confidence and Trust in Supervisors	Measure of Tension and Conflict
65	6	63	60
73	40	63	53
83	46	73	50
90	71	88	20

(1) Op. cit, "New Patterns of Management, R. Likert, 1961.

(2) Ibid, page 78.

(3) In a study by J.B. Boyd conducted among engineers in a utility company, a substantial proportion of those resigning was among the most promising and those who did not mind routine or detailed work were more likely to stay. "Interests of Engineers Related to Turnover, Selection and Management", Journal of Applied Psychology, June 1961, pages 143-149.

(4) Op. cit, "New Patterns of Management", adapted from Fig. 9-5, 9-6, 9-8, and 9-13.

The upward communications scale varies from 0% - communication with the management is very difficult - to 100% - communication is very easy. The productivity scale varies from 0% - low - to 100% - high. Confidence and trust in supervisors varies from 0% - I don't trust - to 100% - my trust is very great. The measure of tension varies from 0% - none - to 100% - a great deal.

To quote again from R. Likert: "The general pattern of operations of the highest producing managers tends to differ from that of the managers of low producing units by more often showing the characteristic of efficient and effective communications there is a flow from one part of the organisation to another of all relevant information important for each decision and action. The leadership in the organisation has developed what might well be called a highly effective social system for interaction and mutual influence."(1)

A measure of productivity or performance can be gauged on the basis of the number of papers published since 1960. However, this is a dangerous criteria because the number of papers in both of function of research content within the organisation and industrial proprietary regulations.

Table 40

Productivity

	G1	G2	I1	I2	I3	I4
Average number of papers published since 1960	2.04	1.73	0.27	0.36	0.79	1.22
Measure of research content(2)	71.4	75.6	50.0	37.6	46.9	77.8

(1) Op. cit, "New Patterns of Management", R. Likert, 1961, pages 98-99.

(2) Scored on basis of 3 for personnel in basic research, 2 for applied, and 1 for development, and 0 for supervisors summed as a percentage of maximum possible score.

It is seen when making allowance for research content of programs, that firstly I1 and I2 indicate the least productivity, and secondly, government is twice as productive but this may be due to company proprietary regulations.

4.9 The Human Element in R-D Management - Personal Recognition

"The high producing managers have developed their organisations into highly coordinated, highly motivated, cooperative social systems the underlying principle on which they rely is that those supervisors and managers whose pattern of leadership yields consistently favourable attitudes more often think of employees as human beings rather than just as persons to get the work done. Consistently, in study after study, the data show that treating people as human beings rather than cogs in a machine is a variable highly related to the attitudes and motivations at every level in the organisation each of us wants appreciation and recognition, influence, a feeling of accomplishment, and a feeling that people who are important to us believe in us, and respect us." (1)

R. Likert, 1961.

The personal recognition rating of each organisation is based on the response to the two questions in Table 41.

Table 41

Personal Recognition

	G1	G2	I1	I2	I3	I4
1. When I have done a particularly good job, I am told - always, sometimes, never (2)	60.4	55.2	52.1	42.4	56.4	61.7
2. When I have made a mistake, I am told - always, sometimes, never (3)	56.9	56.4	47.8	45.0	52.7	51.7
- in public, in private						

- (1) Op. cit, "New Patterns in Management", 1961, pages 100-101.
 (2) Scored on basis of always = 2, sometimes = 1, never = 0, as a percentage of maximum possible score.
 (3) Scored on basis of always, in private = 2, sometimes in private = 1, all other cases = 0, as a percentage of maximum possible score.

The graphs indicate that the organisations with the poorest rating are I1 and I2, and in the case for how often the man who has done a particularly good job is told the graphs indicate a direct negative correlation with the percentage contemplating resigning. The case for how often the man is told when he makes a mistake is not conclusive.

When these two questions were asked of 1090 Civil Servants and 650 desk workers in the UK⁽¹⁾ and allowed to choose between the replies "Usually" and "Hardly Ever", it was "found that the percentage of all respondents who felt that they were hardly ever told of their mistakes did not vary much between those who were satisfied and those who were dissatisfied with their jobs. But when it came to being told of one's successes, the difference was very significant Clearly this grievance has some connection with low job satisfaction."

For the case of three separate divisions of the same organisation the correlation between personal recognition and percentage contemplating resignation is not conclusive, as shown in Table 42.

Table 42

Personal Recognition in Separate Divisions of One Organisation

	Division		
	1	2	3
1. When I have done a particularly good job, I am told - always, sometimes, never	59.1	50.0	56.0
2. When I make a mistake, I am told - always, sometimes, never. - in public, in private	70.0	46.9	56.8
Percentage contemplating resignation	20.0	50.0	62.9

(1) "Morale in the Civil Service", N.D. Walker, Edinburgh University Press, 1961, page 222. See also Chapter 6.

In J.W. Riegel's study⁽¹⁾, interviews were held with 276 non-supervisory industrial engineers and scientists. "The non-supervisory employees who were asked to explain their satisfaction or dissatisfaction with the intangible rewards which they derived from their work gave 252 explanations of their feelings. Almost one-third (80) of these references were to recognition of the man's personal contributions by his superiors or to their withholding of such recognition. No classification of reasons was mentioned as frequently as this one."

A recent study by M.S. Myers (1964)⁽²⁾, Manager of Personnel Research, Texas Instruments Incorporated, of 282 subjects equally distributed among three salaried job categories including Scientists, Engineers, and Manufacturing supervisors, concludes that "Earned recognition is a manifestation of justice, an act of approval which confirms successful achievement and individual worth Perhaps recognition as an end product derives much of its value from the fact that for many workers who personally see only a miniscule portion of the total task, recognition is the only criterion of achievement and progress available to them recognition disappointments result in dissatisfactions the double edged potential of recognition offers no support to the philosophy expressed in the cliché "If they don't hear from me, they know they are doing o.k".

- (1) "Intangible Rewards for Engineers and Scientists", Report No. 9, J.W. Riegel, University of Michigan, Bureau of Industrial Relations, 1958.
- (2) "Who Are Your Motivated Workers", M.S. Myers, Harvard Business Review, Jan.-Feb., 1964, pages 73-88.

4.10 Rewards

"Scientists are concerned with how much they should be motivated by the tangible rewards that they anticipate from their work and how much they will conflict with the impersonality, the freedom from bias, and the objectivity to which they are dedicated they postulate that they and their colleagues are motivated differently from persons who go into business, for example, and that, therefore, the prevalent notions of business success are inapplicable to science.

"On the other side are the scientists who state that there is no inherent disagreement between how science is done and how business is done, that, in fact, creativity and originality in science are facilitated by, and to some extent impossible without, the adoption of those techniques that have been recognized as the cultural modes of success."⁽¹⁾

The rewards that the respondents most prefer for doing exceptionally good work are given in Table 43.

Table 43

Rewards

	G1	G2	I1	I2	I3	I4
Tangible Rewards:						
Promotion	82.0	85.9	95.0	91.5	81.5	87.9
Increase in Salary	85.6	94.4	95.0	89.4	95.4	84.9
Cash bonus	17.1	11.3	30.0	38.3	26.2	24.2
Percentage profit from sales	4.5	7.0	25.0	27.7	27.7	30.3
An all-expense holiday	16.2	12.7	10.0	6.4	18.5	12.1
Increased job security	23.4	11.3	35.0	40.4	23.1	45.5

(1) "Scientists, Their Psychological World", B.T. Eiduson, **Basic Books**, 1962, page 177.

Rewards which are a function of research content:

	G1	G2	I1	I2	I3	I4
Increased staff of subordinates	45.9	45.1	35.0	36.2	30.8	45.5
Increased laboratory facilities	64.0	65.2	25.0	25.5	53.9	45.5
Measure of research content	71.4	75.6	50.0	37.6	46.9	77.8

Rewards giving professional status:

Assignment to a training course	21.6	31.0	35.0	36.2	36.9	27.3
Attendance at Professional Meetings	38.7	50.7	50.0	34.1	46.2	12.1

Reward giving personal recognition:

Public Acknowledgement	37.8	31.0	30.0	19.2	20.0	27.3
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It is immediately evident that the respondents much prefer promotion or increase in salary as a reward for doing exceptionally good work, the rewards that are "the prevalent notions of business success".(1)

It behooves the organisation, therefore, to have its R-D employees satisfied with both the promotion system and salary.

4.11 Satisfaction with the Promotion System

Satisfaction with the promotion system⁽²⁾ is measured by the respondents answer to the question given in Table 44.

Table 44

Satisfaction with the Promotion System

	G1	G2	I1	I2	I3	I4
This organisation's promotion system works:	64.8	58.8	55.9	44.9	69.5	61.3

As fairly as possible, Fairly on the whole,
Somewhat unfairly, Very unfairly.

(1) Op. cit, "Scientists, Their Psychological World", B.T. Eiduson, 1962, page 177.

(2) Scored on the basis of As fairly as possible x 3, Fairly on the whole x 2, Somewhat unfairly x 1, Very unfairly x 0, summed as a percentage of the maximum possible score.

The things that count most for promotion are given in Table 45.

Table 45

The Things that Count Most for Promotion

	G1	G2	I1	I2	I3	I4
The five things that count most for promotion at my level in the organisation are:						
Technical Competence	73.8	72.9	70.0	41.3	74.6	71.9
Initiative	56.8	57.2	75.0	50.0	60.4	68.8
Experience	61.2	44.3	70.0	67.4	79.4	50.0
Seniority	55.8	41.4	25.0	58.7	52.4	34.4
Age	5.4	8.6	5.0	4.3	7.9	0.0
Hard Work	26.1	27.2	25.0	19.6	22.2	46.9
Appearance, social graces	9.0	14.3	5.0	28.3	11.1	12.5
Administrative Competence	27.9	51.4	55.0	37.0	52.4	37.5
Those things that are more a function of research than of development:						
Number of published technical papers	41.4	48.6	5.0	0.0	14.3	12.5
Number of degrees	36.0	54.3	20.0	0.0	31.8	46.9
Measure of research content	71.4	75.6	50.0	37.6	46.9	77.8
Measure of concentration in ⁽¹⁾ higher degrees	53.6	59.3	41.7	37.6	48.7	47.5
Those things that are cynical:						
Being in right place at right time	26.1	32.9	45.0	78.3	30.2	15.6
Good relations with superiors	43.2	41.5	55.0	73.9	49.2	37.5

(1) Scored on basis of Ph.D. = 3, Master's Degree = 2, Bachelor Degree = 1, summed as a percentage of maximum possible score.

It is seen that I2 has the lowest satisfaction with the promotion system, and it is the organisation with the highest percentage of employees who are cynical about the system, consider that seniority and appearance are important for promotion, and the lowest percentage who consider that technical competence, initiative, and hard work are important for promotion.

In addition, it is seen that those who marked "Number of published technical papers" and "Number of degrees" as among the things that count most for promotion are members of the organisations with a high research content and a heavy concentration in higher degrees.

4.12 Satisfaction with Salary

Satisfaction with salary is measured by the respondent's answer to the question given in Table 46.

Table 46

Satisfaction with Salary

	G1	G2	I1	I2	I3	I4
I consider my salary is reasonable for the position I hold:	76.2	79.7	44.5	42.9	62.8	65.6

As before the lowest satisfaction is shown for I2, but in this case closely followed by I1.

It should not be a surprise, therefore, that the attitude towards the job⁽¹⁾ is lowest for I2 and the number contemplating resignation the highest, as shown in Table 47.

Table 47

Job Satisfaction						
	G1	G2	I1	I2	I3	I4
Attitude towards job:						
Like very much	83.4	85.2	86.2	78.9	88.5	90.1
Like moderately						
Indifferent						
Dislike						
Dislike very much						
Percent contemplating resigning	26.5	52.6	46.7	83.4	42.6	19.2

(1) Scored on the basis of 'like very much' x 4, like moderately x 3, indifferent x 2, dislike x 1, and dislike very much x 0, summed as a percentage of the maximum possible score.

What is surprising is the high level of enjoyment in conjunction with the high potential turnover. This is interpreted to mean that the R-D personnel generally like their work but not necessarily the organisation where they are now employed. Their choice of occupation may be irrevocable, but not their choice of work-place in a free, affluent society.

It is seen in Table 48 that the three separate divisions of the same organisation are in close agreement with the general relation of job satisfaction vis-a-vis percentage contemplating resignation.

Table 48

Job Satisfaction in Separate Divisions of One Organisation

	Division		
	1	2	3
Job Satisfaction	91.7	86.8	83.3
Percent Contemplating Resigning	20.0	50.0	62.9

A study by M.I. Stein⁽¹⁾, a clinical psychologist, is pertinent here. Forty-six research chemists, in two industrial organisations, were asked to complete a questionnaire.

"Our subjects were asked to assume that they had just developed a major product for their company. The company had a series of 12 rewards which it wanted to give to the men. He was asked to list the order in which he would like to receive them 4 rewards were in the area of science (i.e., they would enhance the men's scientific development), 4 in the area of administration, and 4 financial rewards."

(1) "Creativity and the Scientist", M.I. Stein, Yale University, published in the Proceedings of a Symposium at the National Physical Laboratory, September 1956, HMSO 1957, and included in "The Sociology of Science", edited by B. Barber and W. Hirsch, 1962.

In order of ranking the results were:

1. Make you assistant to the research director	1	Promotion
2. Send you to an executive training program	6	Assignment to a Training Course
3. Give you a substantial increase in salary	1	Increase in salary
4. Give you a percentage of the profits from your research	9	Percentage profit from sales
5. Give you administrative experience in other divisions within the company	-	
6. Permit you to choose your own problems	-	
7. Give you more people to carry out your ideas	5	Increased staff of subordinates
8. Make you assistant coordinator of research, production, and sales	-	
9. Send you to all professional meetings, expenses paid	7	Attendance at professional meetings
10. Give you a flat cash bonus	8	Cash bonus
11. Increase your laboratory space, and facilitate the purchase of equipment	3	Increased laboratory facilities
12. Guarantee your job for five more years	4	Increased job security

The author then concludes that "the surprising thing to us in this list of rewards was the fact that scientific factors were ranked lower than we anticipated and administrative and monetary factors were ranked higher than we anticipated." (1)

The right hand column is the ranking for all industrial basic and applied research employees from the present work. The same strong ranking of promotion and salary is evident. The differences are that Canadian workers rate higher the reward of increased laboratory facilities and job security which is possibly a reflection of need, and rate lower the reward of percentage profit

(1) Ibid, "Creativity and the Scientist", M.I. Stein.

from sales, which is possibly a reflection of a poorer profit picture for the Canadian companies sampled.

The main reasons given by the respondents for contemplating resigning are:

Table 49

Reasons Given for Contemplating Resignation

	G1	G2	I1	I2	I3	I4
Pay	5	3	3	8	5	-
Challenge or nature of assignments	2	2	1	6	6	-
Promotion prospects	3	2	3	6	-	2
Competent direction and supervision	-	5	1	6	1	-
Need for further education, experience	2	3	1	1	4	1
To teach	4	1	-	-	4	-
General atmosphere of R-D in Canada	2	1	1	2	-	-
Number contemplating resigning	22	30	7	36	24	5
N	83	57	15	42	54	26
%	26.5	52.6	46.7	83.4	42.6	19.2

It is seen that pay and promotion prospects are among the major reasons given for contemplating resigning, and the most preferred rewards for doing exceptionally good work. The negative correlation between resignation and communication (Table 37) and personal recognition (Table 41) is supported by the ranking of 'competent direction and supervision', based on the data of Table 39. The questionnaire was deficient in that it did not measure the

respondent's satisfaction with the challenge or nature of assignments⁽¹⁾. It is considered among the most important features of his job (Table 53), but the indication above is that there may be a correlation between turnover and satisfactions with the challenge of the job as well as pay, promotion, and the respondent's view of the competence of the administration.

4.13 Flexibility

A measure of the stagnation within the R-D organisations is based on the ability of the worker to transfer internally, a horizontal mobility to improve promotional possibilities, coupled with whether the staff complement is too stable thus preventing promotion and the introduction of fresh ideas.

Table 50

Flexibility

	G1	G2	I1	I2	I3	I4
Regarding transferral from one job to another within this organisation:						
1. Transfers are disapproved	31.0	5.4	25.0	47.3	15.5	0.0
2. Transfers are made too often	3.2	7.6	4.2	3.9	13.8	11.1
3. The present staff complement is too stable	41.5	31.6	47.8	49.4	12.1	22.2
4. Stability of present staff interferes with the introduction of fresh ideas	35.6	34.7	35.4	54.6	15.8	25.9

(1) I. Hirsch, et al, op. cit, in his study "Increasing the Productivity of Scientists", showed the low efficiency of utilisation of the unique training of the scientist in industry. "Only a little over a third of the average scientist's time is spent on problems for which he needs his special training and experience." The corollary is that about two-thirds of the scientist's time is spent on routine technical and non-technical activities which lack challenge.

It is seen that few state that transfers are made too often, in fact a large percentage in G1 and I2 consider that transfers are disapproved. With the exception of I3 and I4 there is significant adverse comment on the stability of staff, which in their view, interferes with the introduction of fresh ideas. I1 and I2 have the record for the most stagnant organisations, and as already shown in Table 44 the least satisfaction with the promotion system.

4.14 Internal Association

One means for better relations between management and employees is an effective internal association to enable the mutual discussion of rewards. Either the organisation has an association or not, but the measure of effectiveness is taken to be the percentage of workers who think they have.

Table 51

Effectiveness of the Internal Association

	G1	G2	I1	I2	I3	I4
This organisation has an internal association to enable professional employees to discuss with management:						
1. Rewards such as pay, working conditions	55.8	21.5	8.7	8.2	24.2	20.7
2. Rewards such as professional recognition and status	48.6	21.5	8.7	8.2	24.6	17.2
Effectiveness Rating	52.2	21.5	8.7	8.2	24.4	19.0

It is seen that no organisation has an effective internal association. At best, approximately 50% of the employees from G1 consider that they have an association. The least effective internal association is that for I1 and I2.

SummaryTable 52

Summary Table

	G1	G2	I1	I2	I3	I4
Rating of Programs in:						
Initial Indoctrination	57.8	54.8	34.3	48.0	68.0	75.8
Internal Training	50.2	45.4	8.6	24.5	49.8	61.1
Professional Development	72.2	69.8	40.4	49.3	78.0	76.3
Progress Appraisal	45.6	45.3	32.4	17.6	43.4	65.2
Career Plan	34.1	27.4	2.3	8.9	16.0	28.8
Rating of:						
Upward Communication	45.8	39.7	35.6	18.7	37.5	45.5
Personal Recognition	60.4	55.2	52.1	42.4	56.4	61.7
Job Satisfaction	83.4	85.2	86.2	78.9	88.5	90.1
Potential Turnover	26.5	52.6	46.7	83.4	42.6	19.2
Productivity	2.04	1.73	0.27	0.36	0.79	1.22
Satisfaction Rating:						
Initial Indoctrination	62.1	46.8	37.5	45.3	64.1	67.9
Internal Training	33.3	37.7	13.3	37.7	39.7	45.8
Participation Rating:						
Professional Development	52.9	52.4	43.0	40.7	52.6	55.7
Satisfaction with Rewards:						
Promotion	64.8	58.8	55.9	49.9	69.5	61.3
Salary	76.2	79.7	44.5	42.9	62.8	65.6
Stability of Staff Complement	41.5	31.6	47.8	49.4	12.1	22.2
Effectiveness of Internal Association	52.2	21.5	8.7	8.2	24.4	19.0

The R-D establishments with the highest job satisfactions, the lowest potential turnover, and highest productivity are characterised by a consistently high rating for their initial indoctrination, internal training, professional development, progress appraisal, and career planning programs. In addition, these establishments are characterised by the highest rating for upward communications and personal recognition.

The professional personnel within the establishments which have the highest job satisfactions, the lowest potential turnover, and highest productivity have the highest satisfactions with the initial indoctrination and internal training programs, the highest participation in professional development programs, and the highest satisfaction with the promotion system and salary.

These data indicate that the research and development organisations with the highest utilisation of its professional personnel are characterised by the highest satisfactions with the organisation's program of incentives. This incentive program is seen to contain tangible and intangible rewards and work features to satisfy the scientists' and engineers' expectations as a member of a professional group and as a member of an organisation.

The following chapter examines differences in orientation between the scientist and engineer, a factor which must be reflected in the successful integration of the professional and organisational elements of an incentive program.

CHAPTER 5

THE DEPENDENCE OF PREFERRED REWARDS AND IMPORTANT WORK FEATURES ON DUTY

Introduction

Because incentive systems to motivate employees to meet the goals of the organisation should reflect the differing orientations of its employees, this chapter will examine the dependence of preferred rewards and important work features on the research content of the work in G and I.

Only those full time in the duty checked are included. The analysis is broadened by the fortuitous response from 31 full time production workers.

5.1 Rewards

The dependence of preferred rewards on the duty performed is given in Table 53, where it is seen that there is a general similarity between G and I with few exceptions. One exception is "percentage profit from sales" which is not applicable to G. A second exception is "increased job security" which reflects the respondents' view of the prevailing situation in I vis-a-vis G employment. The final exceptions are "attendance at professional meetings" and "increased laboratory facilities" indicated the greater 'professional' orientation of G personnel, first noted in the respondents' suggestions for the best way to recruit professional employees.

The trend as duty goes from basic research to production is firstly the reduced preference for "increased laboratory facilities" as a reward which indicates the 'science' orientation of the research worker, and secondly the increased preference given to "assignment to a training course", which reflects the "already trained" belief of the research worker who typically has a Ph.D. degree.

In agreement with the data in the previous chapter, the greatest preference is shown for promotion and salary as a reward. No apparent trend with duty for these rewards is indicated. This preference for promotion and salary as a reward presents a particularly different problem to the organisation where salary is tied to promotion in a single administrative channel. As stated by H.A. Shepard (1956)⁽¹⁾:

"In American industrial society, success is measured largely by the size of the organisation one controls. But not all successful engineers and scientists are temperamentally suited for supervisory or administrative work, nor could they, as creative research workers, be most profitably employed in such work. Engineers and scientists are themselves somewhat ambivalent about organisational advancement. On the one hand, it may be regarded as the only generally accepted evidence of their value. On the other hand they fear loss of professional status and competence Many laboratory managements have attempted to solve their own dilemma and the successful scientists' dilemma by establishing a dual hierarchy. One way up is promotion through the ranks of supervision and management. The other way up is through special privileges, autonomy, high salaries, and impressive titles which can be obtained without incurring supervisory responsibilities."

(1) Op. cit, "Nine Dilemmas in Industrial Research", H.A. Shepard, Administrative Science Quarterly, Vol. 1, 1956, pages 295-309.

Table 53

The Dependence of Preferred Rewards on Duty

	Basic Research		Applied Research		Development		Production	
	G	I	G	I	G	I	G	I
Preferred reward for exceptionally good work:								
Promotion	86.0	82.0	89.4	87.2	85.7	89.8	--	93.6
Increase in Salary	94.8	88.0	94.0	85.1	92.8	96.2	--	90.4
Cash bonus	7.0	32.0	24.3	21.3	14.3	35.9	--	32.3
Percentage Profit from Sales	3.5	20.0	6.1	17.0	0.0	30.8	--	3.2
An all-expense holiday	15.8	4.0	16.7	17.0	14.3	12.8	--	9.7
Increased Job Security	17.6	44.0	15.2	42.6	21.4	27.0	--	45.2
Increased Staff of subordi- nates	35.1	44.0	53.0	29.8	57.2	32.1	--	42.0
Increased Laboratory Facili- ties	73.7	60.0	60.6	51.1	64.3	27.0	--	12.9
Assignment to a training course	22.8	24.0	30.3	38.3	42.9	35.9	--	58.1
Attendance at professional meetings	42.1	20.0	44.0	38.3	50.0	41.1	--	38.7
Public acknowledgement	<u>21.1</u>	<u>28.0</u>	<u>33.4</u>	<u>31.9</u>	<u>14.3</u>	<u>24.4</u>	--	<u>19.4</u>
N	57	25	66	47	14	78	--	31

5.2 Important Work Features

The dependence of the importance assigned to work features on the duty performed is given in Table 54, when the most striking result is the general similarity between G and I, with few exceptions. The exceptions are that I consider "promotion prospects" and "opportunity to accept responsibility" as more important features of their work than do G, and G consider the "opportunity to contribute to basic knowledge" and "opportunity to work with able professionals" more important features of their work than I. These data indicate the greater 'organisational' orientation of the industrial employee, and alternatively, the greater 'professional' orientation of the G employee previously noted in section 5.1 concerned with preferred rewards, and in section 4.1 concerned with recruitment.

The trend as duty goes from basic research to production is the reduced importance given to "facilities", and "opportunity to contribute to basic knowledge", and increased importance given to the "opportunity to see ideas applied", and the "opportunity to work on highly engineered products". These data indicate the 'science' orientation of the research worker and the 'engineering' orientation of the development and production worker. In addition, the trend as duty goes from basic research to production is the reduced importance given to "association with able professionals" and "opportunity for professional development". These data indicates the greater 'professional' orientation of the research worker.

Table 54

The Dependence of the Importance Assigned to
Work Features on Duty

	Basic Research		Applied Research		Development		Production	
	G	I	G	I	G	I	G	I
The five most important features of my work are:								
Pay	50.8	60.0	47.1	72.4	64.3	61.6	--	42.0
Hours of work	9.8	12.0	11.8	10.6	21.4	18.0	--	19.4
Holidays	8.2	8.0	4.4	8.5	28.6	6.4	--	3.2
Pension and Insurance Plans	16.4	20.0	17.7	8.5	21.4	12.8	--	16.1
Job Security	26.3	20.0	19.1	25.5	50.0	18.0	--	29.0
Promotion Prospects	18.0	20.0	19.1	46.8	7.1	43.6	--	45.2
Geographical Location	19.7	28.0	25.0	17.0	35.7	20.5	--	25.8
Physical Conditions of Work	8.2	12.0	4.4	4.3	21.4	19.2	--	12.9
Facilities	50.8	40.0	44.1	25.5	21.4	26.9	--	12.9
Technical Staff Support	19.7	16.0	16.2	2.1	7.1	6.4	--	9.7
Financial Support of Projects	9.8	16.0	11.8	4.3	0.0	9.0	--	3.2
Nature of Assignments	29.5	24.0	53.0	25.5	35.7	39.8	--	45.2
Challenge of Assignments	34.5	36.0	38.3	46.8	35.7	44.9	--	54.9
Workload	1.6	0.0	2.9	2.1	0.0	2.6	--	16.1
Paper Work	1.6	0.0	0.0	0.0	0.0	1.3	--	3.2
Sense of urgency of my work	1.6	8.0	8.8	0.0	14.3	9.0	--	12.9
Opportunity to accept responsibility	11.5	24.0	11.8	29.8	21.4	33.3	--	35.5
Opportunity to use initiative	41.0	40.0	32.4	31.9	35.7	30.8	--	32.3
Opportunity to contribute to basic knowledge	54.2	24.0	29.4	19.2	0.0	5.1	--	3.2
Opportunity to see my ideas applied	8.2	16.0	23.5	21.3	21.4	21.8	--	25.8

Table 54 (continued)

	Basic Research		Applied Research		Development		Production	
	G	I	G	I	G	I	G	I
Opportunity to work on highly engineered products	0.0	0.0	1.5	10.6	0.0	16.7	--	22.6
Opportunity for internal training	0.0	0.0	2.9	6.4	0.0	3.9	--	0.0
Opportunity for professional development	21.3	20.0	14.7	34.0	7.1	18.0	--	12.9
Association with able professionals	36.1	12.0	33.8	19.2	35.7	10.3	--	3.2
Competent direction and supervision	6.6	4.0	8.8	10.6	0.0	10.3	--	0.0
Status in community	0.0	0.0	1.5	2.1	0.0	0.0	--	0.0
Public attitude to my work	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0
Professional regard for this organisation	4.9	0.0	7.3	4.3	0.0	2.6	--	0.0
Personal relations with colleagues	6.6	4.0	10.3	10.6	7.1	14.1	--	16.1
Personal appraisal or approval by management	0.0	8.0	0.0	6.4	0.0	1.3	--	3.2
Writing and signing my reports and correspondence	0.0	0.0	2.9	2.1	0.0	1.3	--	3.2
Security restrictions to publication of my work	1.6	4.0	0.0	0.0	0.0	1.3	--	0.0
N	61	25	68	47	14	78	--	31

A study by J.W. Riegel is pertinent here⁽¹⁾. Interviews with 276 non-supervisory industrial engineers and scientists indicated the importance of stated sources of intangible rewards. "It was evident in the interviews that persons engaged in research attached more importance to some sources than did engineers engaged

(1) Op. cit, "Intangible Rewards for Engineers and Scientists", 1958.

IMPORTANT WORK FEATURES

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IMPORTANT WORK FEATURES

in application and development and engineers whose work is closely related to operations and production." Data from the Riegel study are repeated for ready reference in Table 55.

Table 55

Intangible Rewards, Adapted from J.W. Riegel⁽¹⁾

	Research	Development and Application	Operations and Production
	Table V	Table VI	Table VII
Challenge of project assigned to me	88	93	91
Freedom to manage my own work	86	90	87
See my ideas put to use	81	95	91
Association with able professionals	81	70	71
Favourable regard of top management for my work	79	81	79
Opportunity to contribute to scientific knowledge	79	54	43
Opportunity to influence work on technical projects	78	78	79
Respect of fellow professionals for my work	78	72	59
Variety of work	76	78	75
Treatment as a professional	72	79	77
Job security	71	77	68
Member of company producing reputable goods	67	76	82
Member of company highly regarded by professionals	57	68	61
Favourable regard of community for my work	52	46	50
Opportunity to work on highly engineered products	46	72	71
Association with able non- professionals	36	54	48

(1) Scored on basis of great importance x 2, some x 1, of little importance

It is seen from the Riegel study in industry that the trend as duty goes from research to operations reduced importance is given to "opportunity to contribute to scientific knowledge" and increased importance is given to "seeing his ideas put to use", being a "member of a company producing reputable goods", and "opportunity to work on highly engineered products". These data indicates the 'science' orientation of the research worker and the 'engineering' orientation of the development and production worker in agreement with the data of the present study. Further, the reduced importance given to "association with able professionals", and "respect of fellow professionals for my work", indicate the greater 'professional' orientation of the research worker in agreement with the data of the present study.

The most important work feature is shown to be pay, with no apparent trend indicated with duty. Although increased salary is the most preferred reward (Table 53) and the most important work feature (Table 54), and high satisfaction with salary characteristic of the organisation with the least turnover (Table 46), Chapter 7 analyses the seeming paradox that satisfaction with pay appears to have only a slight correlation with job satisfaction.

The least important work feature is shown to be "public attitude to my work" and to "status in the community". No respondent took the opportunity to add to the list that an important feature of his work was the "opportunity to serve his community". Because the definition of the professional⁽¹⁾ includes the criterion that he serves his community, and compliance determines his status in the

(1) See the INTRODUCTION

100

community, the seeming indifferences of the scientist and engineer is analysed in Chapter 8.

Summary

The data indicate differences in orientation between the research scientist and the development engineer, and between the G and I employee in the same duty. Firstly, the research scientist is seen to have a greater 'professional' orientation than the development or production engineer, and apparently this orientation is more intensive in the government employee. Secondly, the industrial scientist and engineer is seen to have a greater 'organisational' orientation. Finally, the not very profound conclusion is reached that the scientist and engineer is 'job' oriented. For example, the scientist is oriented towards the essence of scientific endeavour, i.e., contributing to basic knowledge, the development engineer towards the essence of engineering endeavour, i.e., the application of knowledge derived from research to provide economic methods of design and manufacture, the production engineer is oriented towards the essence of the production process, i.e., the quantity manufacture of a salable product.

To accommodate the differing orientations in a system of incentives may not be easy as indicated by W. Kornhauser⁽¹⁾ (1962).

"As a professional, an individual acquires stature from his colleagues in the profession. As an employee, he acquires status from his superiors in the organisation. A series of accomplishments and rewards in the profession constitutes a successful professional career. A series of progressively higher positions in the organisation constitutes a successful bureaucratic career professional and organisational incentives may be in part incompatible."

(1) Op. cit, "Scientists in Industry", W. Kornhauser, Institute of Industrial Relations, University of California, 1962, page 117.

The data of the present study indicates that the successful integration of professional and organisational incentives is most amenable to solution with the industrial scientist and engineer because of his greater 'organisational' orientation; and alternatively, the integration is most difficult with the government research scientist because of his marked 'professional' orientation. Therefore, "if to succeed in the organisation one cannot remain in research but must aspire to management, the net result will be a great many managers and few able researchers a real test of organisation is the extent to which the laudable theory of 'parallel paths of progress' is actually embraced in the operating practice of the organisation."(1)

- (1) "Recruiting Scientists and Engineers for the United States Civil Service", Conference on Scientific Manpower, Washington D.C., 1959, page 2.

CHAPTER 6

COMPARISON BETWEEN R-D PROFESSIONAL PERSONNEL IN CANADA AND OFFICE STAFF IN THE UNITED KINGDOM

Introduction

The data examined shows that the professional worker is motivated by incentives that one would anticipate motivates other "white collar" workers, as for example salary, promotion, and the nature and challenge of assignments. The data also shows the 'professional' orientation of the professional worker, exemplified by his desire for "association with able professionals" and "opportunity for professional development"; and his 'job' orientation, exemplified by the scientists' desire to "contribute to basic knowledge" and the engineers' desire to "work on highly engineered products".

A recent study by N.D. Walker⁽¹⁾ (1961) in the United Kingdom of 1090 Civil servants in Administrative, Executive and Clerical grades in two Ministries and 650 staff members in equivalent levels in two firms enable a comparison of the attitudes and experiences of "white collar" workers exclusive of rewards and work features of singular interest to the scientist and engineer.

6.1 Age Group

The comparison of age is given in Table 56, where it is seen that the mean age of the G employees is greater than I for both Canada and the UK, with the greatest mean age that of the G employee in the UK.

(1) "Morale in the Civil Service", N.D. Walker, Edinburgh University Press, 1961.

Table 56

Age Group

	R-D, Canada			Office Staff ⁽¹⁾ , UK	
	G	I		G	I
Under 21	0.0	0.0	Under 20	1.0	8.6
21-30	31.4	39.4	20-29	11.3	35.7
31-40	34.6	43.9	30-39	28.6	26.9
41-50	23.4	12.8	40-49	27.8	18.0
Over 50	<u>10.6</u>	<u>3.9</u>	50 or over	<u>31.3</u>	<u>10.8</u>
N	188	180		1090	650
Mean Age	37.4	34.2		43.6	33.4

6.2 Satisfaction with Promotion System

Satisfaction with the promotion system for Canada is measured by the response to the question given in Table 57, and is compared to the UK response to a similar question in Table 58. It is evident that there are general similarities between G and I in Canada, and that these organisations are generally similar to G in the United Kingdom. The I group in the UK show the greatest satisfaction with the promotion system, containing about twice the number in the category "as fairly as possible". The relatively low rating for the I group in Canada is seen to be due to the response in two organisations, I1 and I2, in Table 44.

(1) Ibid, Table 8.01

Table 57

Satisfaction with the Promotion System, Canada

This Organisation's System of Promotion Works:

	As Fairly as Possible	Fairly on the Whole	A little Unfairly	Very Unfairly	Total
Federal Government					
G1	18	61	21	2	102
G2	8	38	20	2	68
Misc.	<u>==</u>	<u>==</u>	<u>==</u>	<u>==</u>	<u>1</u>
	26	100	41	4	171
%	15.2	58.5	24.0	2.3	100.0
Manufacturing Industry					
I1	2	8 $\frac{1}{2}$	5 $\frac{1}{2}$	1	17
I2	6	12	20	8	46
I3	12	41	5	1	59
I4	3	22	7	-	32
I5	2	9	1	1	13
Misc.	<u>==</u>	<u>1</u>	<u>==</u>	<u>==</u>	<u>1</u>
	25	93 $\frac{1}{2}$	38 $\frac{1}{2}$	11	168
%	14.9	55.6	22.9	6.6	100.0

Table 58

Satisfaction with the Promotion System

This Organisation's System of Promotion Works:	R-D, Canada	
	G	I
As fairly as possible	15.2	14.9
Fairly on the whole	58.5	55.6
A little unfairly	24.0	22.9
Very unfairly	<u>2.3</u>	<u>6.6</u>
N	171	168

How Does the System of Promotion Work at Your Level?	Office Staff ⁽¹⁾ , UK	
	G	I
As fairly as possible	19.4	28.7
Fairly on the whole	46.3	47.4
A little unfairly	24.4	18.8
Very unfairly	<u>9.9</u>	<u>5.1</u>
N	1090	650

(1) Ibid, Table 8.21.

Comparing the things that count most for promotion also show general similarities, as indicated in Table 59.

Table 59

The Things That Count Most for Promotion, Canada and UK

The Five Things that Count Most for Promotion at My Level in the Organisation are:	R-D, Canada	
	%	
	G	I
Seniority	50.6	44.3
Technical competence	73.1	65.6
Hard work	26.4	28.2
Experience	55.0	69.0
Number of degrees	43.4	26.4
Administrative competence	37.4	46.0
Being in right place at right time	44.0	40.2
Good relations with superiors	<u>29.1</u>	<u>52.9</u>
	N	
	182	174
The Two Things that Count Most for Promotion at Your Level in Your Office:	Office Staff ⁽¹⁾ , UK	
	%	
Seniority	51	18
Ability	50	59
Hard work	5	15
Experience	21	37
General education	8	10
Management of subordinates	1	2
Being in right place at right time	35	27
Good relations with superiors	<u>28</u>	<u>27</u>
	N	
	1090	650

(1) Ibid, Table 8.21. Percentage of total who checked two things from a list of 8. Canadian score is percentage of total who checked 5 things from a list of 12.

The evidence indicates that for both Canada and the UK, the things that count most for promotion are ability, seniority, and experience, and the thing that counts least is hard work. The two major differences are that the R-D personnel consider education and administrative competence more important than UK office staff.

6.3 Satisfaction with Salary

Satisfaction with salary for Canada is measured by the response to the question given in Table 60, and compared to the UK response in Table 61. It is evident that there are general similarities between G personnel in Canada and the UK, but very considerable differences among industrial workers. In Canada there is considerably more dissatisfaction with salary among I workers than G workers, and the reverse is true in the UK. The poor rating for the I group in Canada is seen to be due to the response of two organisations, I1 and I2, in Table 46.

Table 60

Satisfaction with Salary, Canada

My Salary is Reasonable for Position I Hold:

Federal Government	Yes.	No	Total
G1	80	25	105
G2	51	13	64
Misc.	<u>--</u>	<u>--</u>	<u>---</u>
	131	38	169
%	77.5	22.5	100.0
Manufacturing Industry			
I1	8	10	18
I2	18	24	42
I3	32	19	51
I4	21	11	32
I5	<u>10</u>	<u>3</u>	<u>13</u>
	89	68	157
%	56.7	43.3	100.0

Table 61

Satisfaction with Salary, Canada and UK

R-D, Canada

G	I
%	

My salary is reasonable	77.5	56.7
-------------------------	------	------

My salary is not reasonable	<u>22.5</u>	<u>43.3</u>
-----------------------------	-------------	-------------

N	169	157
---	-----	-----

Office Staff⁽¹⁾, UK

I am overpaid, or fairly paid	72.6	83.6
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I am underpaid	<u>27.4</u>	<u>16.4</u>
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N	1090	650
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6.4 Features

Important work features for Canada is given in Table 62 and the attractions of the job for the UK is given in Table 63. It is seen that the similarities are more striking than differences.

It is evident from this comparison that Canadian R-D personnel rate pay and promotion prospects higher than UK office staff, and alternatively rate job security lower. Interest in the work, hours of work, physical conditions of work, and status in community are all given approximately the same importance. Fringe benefits and holidays are rated higher by the UK personnel in G than in Canada. The greater 'organisational' orientation of the industrial worker is indicated by his response to "promotion prospects", in both Canada and the UK.

This comparison is dangerous, however, firstly because the Canadian score concerns the importance given to features of the work and the UK score concerns the attractions of the job, i.e.,

an 'importance' score vis-a-vis an 'experienced' score, and secondly because the Canadian R-D worker used up his choices in checking off the professional features of his work which would have the effect of a reduced score for remaining features.

Table 62

Important Work Features, Canada

Important Work Features:	R-D, Canada	
	G	I
	%	
Pay	50.4	64.6
Promotion prospects	17.5	40.7
Job security	25.2	20.7
(Challenge of assignments	36.3	44.0
(Nature of assignments	41.2	32.7
Pension and Insurance Plans	17.5	12.7
Holidays	8.4	7.3
Hours of work	11.9	14.7
Physical conditions of work	7.7	13.3
Status in community	0.7	0.7
Personal relations with colleagues	<u>8.4</u>	<u>11.3</u>
N	143	150

Table 63

Attractions of the Job, UK

Attractive Job Features:	Office Staff ⁽¹⁾ , UK	
	G	I
	%	
Pay	21	39
Promotion prospects	7	21
Security of job	63	40
Interest of the work	32	50
Pension rights	34	16
Holidays	26	3
Hours of work	13	13
Physical conditions of work	4	12
Status in community	3	5
Social life with colleagues	<u>2</u>	<u>8</u>
	N	
	1090	650

6.5 Job Satisfaction

The respondents' "attitude towards his job" is shown, for Canada, in Table 64 and compared to how the respondent "feels about his present job", for the UK, in Table 65. Because of the general similarities indicated between Canadian R-D workers and UK Office Staffs for satisfactions with the promotion system and salary and for important work features, it is not surprising that the results to the summing-up question of overall job satisfaction shows striking similarities.

- (1) Ibid, Table 8.20. Percentage who assigned 1st or 2nd place to 10 potential attractions. Figures for Canada R-D personnel are percentage who placed these features among first 5 most important out of 32 features.

Table 64

Job Satisfaction, Canada

Federal Government	Attitude Towards Job					Total
	Like Very Much	Like Moderately	Indifferent	Dislike	Dislike Very Much	
G1	53	46	5	2	2	108
G2	29	38	2	-	-	69
Misc.	<u>2</u>	<u>1</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>1</u>
	82	85	7	2	2	178
%	46.1	47.7		6.2		100.0
Manufacturing Industry						
I1	9	11	-	-	-	20
I2	14	25	2	3	-	44
I3	34	22	3	-	-	59
I4	21	13	-	-	-	34
I5	9	3	-	1	-	13
Misc.	<u>2</u>	<u>1</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>1</u>
	87	75	5	4	-	171
%	50.8	43.9		5.3		100.0

Table 65

Job Satisfaction, Canada and UK

Attitude Toward Job:	R-D, Canada	
	G	I
	%	
Like Very Much	46.1	50.8
Like Moderately	47.7	43.9
Indifferent-Dislike-Dislike Very Much	<u>6.2</u>	<u>5.3</u>
	N	
	178	171

How Do You Feel About Your Present Job:	Office Staff ⁽¹⁾ , UK	
	G	I
I love it, I am enthusiastic about it, I like it very much, like it a good deal	39.7	54.4
I like it on the whole, I like it fairly well, like it a little	51.4	37.8
Indifferent, on the whole I don't like it, dislike it, hate it	<u>8.9</u>	<u>7.8</u>
	N	
	1090	650

(1) Ibid, Table 3.05.

Summary

A comparison between the response from research and development workers in Canada to the response from office staffs in the UK shows similarities in attitudes and experiences exclusive of rewards and work features of singular interest to the scientist and engineer.

The pattern of satisfactions with the promotion system and salary, and with overall job satisfaction, is common to both "white collar" groups. The things that count most for promotion and the work features that are considered important also show general similarities.

The professional worker has much in common with his fellow "white collar" workers. The differences lie in the areas, which are the prerequisites of the professional, identified with his unique professional and job orientation.

CHAPTER 7

THE CORRELATION OF JOB SATISFACTION OF THE INDIVIDUAL R-D WORKER WITH HIS SATISFACTION WITH THE PROMOTION SYSTEM AND SALARY, THE ACCESSIBILITY OF SENIOR MANAGEMENT, PERSONAL RECOGNITION BY HIS SUPERVISOR, CONTEMPLATION OF RESIGNATION, PRODUCTIVITY, AGE, AND SALARY.

Introduction

The data examined in Chapter 4 indicate that the research and development organisations with the highest utilisation of its professional personnel are characterised by the highest satisfactions with the organisation's program of incentives. The tangible and intangible rewards and work features of this program of incentives that comply with the scientists' and engineers' expectations as a member of an organisation are examined in this chapter to determine if they correlate with job satisfaction. These elements of a satisfying work environment include satisfaction with the promotion system and salary, the accessibility of senior management and personal recognition.

In addition, the correlation of job satisfaction with the contemplation of resignation, productivity, age, and salary are examined.

7.1 Satisfaction with the Promotion System

The correlation of job satisfaction and satisfaction with the promotion system is given in Table 66, where it is seen that the greater the satisfaction with the promotion system the more likely he enjoys his work. This correlation is conclusive in I with only a slight trend indicated in G, reflecting the greater 'organisational' orientation of the industrial engineering worker.

Table 66

Satisfaction with Promotion System

		Attitude Toward Job							
		Like Very Much		Like Moderately		Dissatisfied*		Total	
		No	%	No	%	No	%	No	%
Federal Government									
This Organisation's Promotion System Works:									
As fairly as possible		12	46.2	13	50.0	1	3.8	26	100.0
Fairly on the whole		48	48.5	48	48.5	3	3.0	99	100.0
Somewhat unfairly		17	42.5	18	45.0	5	12.5	40	100.0
Very unfairly		<u>1</u>	<u>25.0</u>	<u>2</u>	<u>50.0</u>	<u>1</u>	<u>25.0</u>	<u>4</u>	<u>100.0</u>
N		78	46.1	81	47.9	10	5.9	169	99.9
Manufacturing Industry									
As fairly as possible		19	76.0	6	24.0	0	0.0	25	100.0
Fairly on the whole		52	56.6	37	40.2	3	3.3	92	100.1
Somewhat unfairly		12	30.8	23	59.0	4	10.2	39	100.0
Very unfairly		<u>4</u>	<u>44.5</u>	<u>4</u>	<u>44.5</u>	<u>1</u>	<u>11.1</u>	<u>9</u>	<u>100.1</u>
N		87	52.7	70	42.4	8	4.9	165	100.0

* Indifferent, dislike, or dislike very much.

7.2 Satisfaction with Salary

The correlation of job satisfaction and satisfaction with salary is given in Table 67. It is seen that there is only a slight trend indicating that if the worker considers his salary unreasonable, he is more likely to be dissatisfied with his job. This information supports the findings of M.S. Myers⁽¹⁾ where "the role of pay as an incentive is controversial pay itself is less potent as a motivation than as a dissatisfaction The factors in the work situation which motivates employees are different from the factors that dissatisfy employees. Motivation stems from the challenge of

(1) "Who Are Your Motivated Workers", M.S. Myers, Harvard Business Review, Jan/Feb 1964, Pages 73-88.

the job through such factors as achievement, responsibility, advancement, and earned recognition. Dissatisfactions more often spring from such maintenance factors as physical, social, security, and economic factors Thus motivation, or the achievement of personal goals, is not fulfilled by management actions which over-rate maintenance needs, but rather by actions which provide conditions of motivation Paradoxically, satisfying motivational needs is not only the more realistic approach for satisfying personal goals and sustaining the organisation, but it is also less expensive."

The study by N.D. Walker⁽¹⁾ states that "Attitudes to pay had remarkably little connection with job satisfaction." Clearly, the satisfaction with salary has little correlation with job satisfaction, especially in comparison, for example, to personal recognition which is examined in section 7.4.

(1) Op. cit, "Morale in the Civil Service", N.D. Walker, 1961, page 211.

Table 67

Satisfaction with Salary

		Attitude Toward Job							
		Like Very Much		Like Moderately		Dissatisfied		Total	
		No	%	No	%	No	%	No	%
Federal Government									
My Salary is Reasonable for the Position I Hold:									
Yes		62	47.7	63	48.5	5	3.9	130	100.1
No		<u>19</u>	<u>50.0</u>	<u>15</u>	<u>39.5</u>	<u>4</u>	<u>10.5</u>	<u>38</u>	<u>100.0</u>
N		81	48.2	78	46.4	9	5.4	168	100.0
Manufacturing Industry									
Yes		49	56.4	36	41.4	2	2.3	87	100.1
No		<u>30</u>	<u>46.2</u>	<u>31</u>	<u>47.7</u>	<u>4</u>	<u>6.2</u>	<u>65</u>	<u>100.1</u>
N		79	52.0	67	44.1	6	4.0	152	100.1

SATISFACTION WITH SALARY

7.3 Accessibility of Senior Management, Upward Communications

The correlation of job satisfaction and upward communications with senior management is given in Table 68, where it is seen that the more frequent the contact between the R-D worker and management the more likely the worker is satisfied. The correlation is unmistakable in I but inconclusive among G personnel, showing again the need for incentive systems to reflect the greater 'organisational' orientation of the industrial engineering worker.

Table 68

Upward Communications

		Attitude Toward Job							
		Like Very Much		Like Moderately		Dissatisfied		Total	
		No	%	No	%	No	%	No	%
Federal Government									
I talk to Senior Management About my Work:									
Often		29	63.0	14	30.4	3	6.5	46	99.9
Occasionally		37	37.0	58	58.0	5	5.0	100	100.0
Never		<u>13</u>	<u>50.0</u>	<u>12</u>	<u>46.2</u>	<u>1</u>	<u>3.8</u>	<u>26</u>	<u>100.0</u>
N		79	45.9	84	48.8	9	5.2	172	99.9
Manufacturing Industry									
Often		19	79.2	5	20.8	0	0.0	24	100.0
Occasionally		54	53.4	44	43.5	3	3.0	101	99.9
Never		<u>12</u>	<u>28.6</u>	<u>24</u>	<u>57.2</u>	<u>6</u>	<u>14.3</u>	<u>42</u>	<u>100.1</u>
N		85	50.9	73	43.7	9	5.4	167	100.0

7.4 Personal Recognition

The correlation of job satisfaction and how often the professional is told when he has done a particularly good job is given in Table 69. The evidence conclusively supports the statement that the less often the worker is told when he has done a particularly good job, the more likely he will be dissatisfied with his work. This unmistakable correlation is only matched by the strength of the correlation between the contemplation of resignation and job satisfaction examined in section 7.5.

Table 69

Personal Recognition

		Attitude Toward Job							
		Like Very Much		Like Moderately		Dissatisfied		Total	
		No	%	No	%	No	%	No	%
Federal Government									
When I Have Done a Particularly Good Job, I am Told:									
Always		26	63.4	14	34.2	1	2.4	41	100.0
Sometimes		52	42.6	63	51.6	7	5.7	122	99.9
Never		<u>4</u>	<u>26.7</u>	<u>8</u>	<u>53.4</u>	<u>3</u>	<u>20.0</u>	<u>15</u>	<u>100.1</u>
	N	82	46.1	85	47.8	11	6.2	178	100.1
Manufacturing Industry									
Always		21	70.0	8	26.7	1	3.3	30	100.0
Sometimes		58	49.6	56	47.9	3	2.6	117	100.1
Never		<u>7</u>	<u>30.4</u>	<u>11</u>	<u>47.8</u>	<u>5</u>	<u>21.7</u>	<u>23</u>	<u>99.9</u>
	N	86	50.6	75	44.1	9	5.3	170	100.0

The correlation between job satisfaction and how often the professional is told when he makes a mistake is given in Table 70, where it is seen that the less often the worker is told in private he has made a mistake the more likely he will be dissatisfied with his work. This is, however, not as conclusive as the case for how often the worker is told when he has done a particularly good job. These findings are in agreement with the study by N.D. Walker⁽¹⁾ (1961) among salaried office workers in G and I in the UK, and with the study by M.S. Myers⁽²⁾ (1964) among industrial salaried workers in the USA, already described on pages 72 and 73, respectively.

- (1) Op. cit, "Morale in the Civil Service", N.D. Walker, 1961, page 222.
- (2) Op. cit, "Who Are Your Motivated Workers", M.S. Myers, 1964, pages 73-88.

Table 70

Personal Recognition

Attitude Toward Job

	Like Very Much		Like Moderately		Dissatisfied		Total	
	No	%	No	%	No	%	No	%
Federal Government								
When I Make a Mistake, I Am Told:								
Always in private	23	56.1	16	39.0	2	4.9	41	100.0
Sometimes in private	46	43.0	57	53.3	4	3.7	107	100.0
Never, or in Public	<u>5</u>	<u>27.8</u>	<u>8</u>	<u>44.5</u>	<u>5</u>	<u>27.8</u>	<u>18</u>	<u>100.1</u>
N	74	44.6	81	48.8	11	6.6	166	100.0
Manufacturing Industry								
Always in private	17	43.6	22	56.4	0	0.0	39	100.0
Sometimes in private	59	59.0	39	39.0	2	2.0	100	100.0
Never, or in Public	<u>8</u>	<u>26.7</u>	<u>16</u>	<u>53.4</u>	<u>6</u>	<u>20.0</u>	<u>30</u>	<u>100.1</u>
N	84	49.7	77	45.6	8	4.7	169	100.0

7.5 Contemplating Resignation

The correlation of job satisfaction and whether the professional is contemplating resignation is given in Table 71. The result is an almost linear trend between job satisfaction and the percentage contemplating resigning, i.e., the greater the dissatisfaction the greater the likelihood the worker is contemplating resigning.

Table 71

Contemplating Resigning

Attitude Toward Job

	Like Very Much		Like Moderately		Dissatisfied*		Total	
	No(1)	%	No	%	No	%	No	%
Federal Government								
I am Contemplating Resigning to Go:								
to industry	1	1.4	7.2	10.9	1	3.3	9.2	6.2
government	0.5	0.7	.7	1.0	-	0.0	1.2	0.8
university	4.5	6.4	14.2	21.5	2	16.7	20.7	14.0
USA	6.5	9.3	7	10.6	3.5	29.2	17	11.5
other	<u>1.5</u>	<u>2.1</u>	<u>1</u>	<u>1.5</u>	<u>2.5</u>	<u>20.8</u>	<u>5</u>	<u>3.4</u>
	14	19.9	30	45.5	9	75.0	53	35.9
N	70		66		12		148	
%	20.0		45.5		75.0		35.8	
Manufacturing Industry								
to industry	5	6.5	8.5	10.4	2	16.7	15.5	9.1
government	-	0.0	4	4.9	-	0.0	4	2.3
university	2	2.6	11	13.4	-	0.0	13	7.6
USA	13	16.9	20.5	32.3	8	66.7	47.5	27.8
other	<u>2</u>	<u>2.6</u>	<u>6</u>	<u>7.3</u>	<u>2</u>	<u>16.7</u>	<u>10</u>	<u>5.8</u>
	22	28.6	56	68.3	12	100.1	90	52.6
N	77		82		12		171	
%	28.6		68.3		100.0		52.6	

(1) Equivalent number in each category, where respondent is undecided equal weight is given.

CONTEMPLATING RESIGNATION

7.6 Productivity

The correlation between job satisfaction and productivity is given in Table 72, where it is seen that the greater the productivity the more likely the worker enjoys his work very much.

Table 72

Productivity

		Attitude Toward Job							
		Like Very Much		Like Moderately		Dissatisfied		Total	
		No	%	No	%	No	%	No	%
Federal Government									
Number of Papers Published Since 1960:									
0		19	32.2	36	61.0	4	6.8	59	100.0
1-2		28	48.3	27	46.5	3	5.2	58	100.0
3 or over		<u>31</u>	<u>58.5</u>	<u>18</u>	<u>34.0</u>	<u>4</u>	<u>7.6</u>	<u>53</u>	<u>100.1</u>
	N	78	45.9	81	47.6	11	6.5	170	100.0
Manufacturing Industry									
0		41	43.6	46	48.9	7	7.5	94	100.0
1-2		20	51.3	19	48.7	0	0.0	39	100.0
3 or over		<u>17</u>	<u>89.5</u>	<u>1</u>	<u>5.3</u>	<u>1</u>	<u>5.3</u>	<u>19</u>	<u>100.1</u>
	N	78	51.3	66	43.4	8	5.3	152	100.0

7.7 Age

The correlation between job satisfaction and age is given in Table 73, where it is seen that there is a trend indicating that the older the worker the more likely it is that he enjoys his work. This trend is not conclusive in I, but is affected by the small response in the older categories. All respondents who were over 50 either liked their work very much or moderately.

Time either has a mild therapeutic effect of some sort or works as a filter to eliminate all those who do not enjoy R-D work. This agrees with the study by M.D. Walker⁽¹⁾ where he confirms that

(1) Op. cit, "Morale in the Civil Service, M.D. Walker, 1961, pages 171-175.

the effect of age is to increase the likelihood the salaried worker enjoys his work. "One's enjoyment of one's work can increase through some process that is quite beyond anybody's control. Whether the process is one of constitutional change, or whether we simply learn, like Solon, that the ideal job is unobtainable this side of the grave is still an open question." (1)

Table 73

		Age							
		Attitude Toward Job							
		Like Very Much		Like Moderately		Dissatisfied		Total	
Federal Government		No	%	No	%	No	%	No	%
Age, Years.									
Under 21		--		--		--		--	
21-30		23	39.7	28	48.3	7	12.1	58	100.1
31-40		27	41.5	35	53.9	3	4.6	65	100.0
41-50		23	53.5	18	41.9	2	4.7	43	100.1
Over 50		<u>12</u>	<u>63.2</u>	<u>7</u>	<u>36.8</u>	<u>0</u>	<u>0.0</u>	<u>19</u>	<u>100.0</u>
N		85	46.0	88	47.6	12	6.5	185	100.1
Manufacturing Industry									
Under 21		--		--		--		--	
21-30		34	47.9	31	43.7	6	8.5	71	100.1
31-40		44	57.9	30	39.5	2	2.6	76	100.0
41-50		9	40.9	12	54.5	1	4.6	22	100.0
Over 50		<u>3</u>	<u>42.9</u>	<u>4</u>	<u>57.2</u>	<u>0</u>	<u>0.0</u>	<u>7</u>	<u>100.1</u>
N		90	51.1	77	43.7	9	5.1	176	99.9

(1) Ibid, "Morale in the Civil Service", N.D. Walker.

7.8 Salary

The correlation between job satisfaction and salary is given in Table 74, where it is seen that those R-D workers earning more than \$10,000 per year are more likely to enjoy their work very much than those earning less than \$10,000. Apparently, once the R-D worker is earning over \$10,000, he is rarely dissatisfied with his job.

Because high salary is compatible with age, this result is consistent with the aging process. It is noteworthy, further, that only a slight trend with salary is indicated at low salary levels, especially in comparison, for example, to personal recognition. It is apparent that both satisfactions with salary, and

actual salary level correlates only slightly with job satisfaction and is, therefore, less of a motivator than is generally believed. Because increased salary is the most preferred reward (Table 53) and high satisfaction with salary characteristic of the organisation with the least turnover (Table 46), this seeming paradox that satisfaction with pay appears to have only a slight correlation with job satisfaction is explained in the words of M.S. Myers, 1964. "'Maintenance' factors have little motivational value, but their fulfillment is essential to the avoidance of dissatisfaction. In other words, in a situation of satisfied motivation needs, maintenance factors have relatively little influence either as satisfiers or dissatisfiers. However, the removal of opportunity for meaningful achievement sensitizes the individual to his environment, and his perception of maintenance factors becomes coloured by a readiness to find fault."(1)

(1) Op. cit, "Who Are Your Motivated Workers", M.S. Myers, 1964, pages 73-88.

Table 74

Salary

Attitude Toward Job

Federal Government Salary, Dollars.	Like Very Much		Like Moderately		Dissatisfied Total			
	No	%	No	%	No	%	No	%
Under 5000	2	66.7	1	33.3	0	0.0	3	100.0
5000-7499	20	38.5	25	48.1	7	13.5	52	100.1
7500-9999	28	40.0	39	55.7	3	4.3	70	100.0
10,000-12,500	19	45.3	21	50.0	2	4.8	42	100.1
Over 12,500	<u>13</u>	<u>92.9</u>	<u>1</u>	<u>7.1</u>	<u>0</u>	<u>0.0</u>	<u>14</u>	<u>100.0</u>
N	32	45.3	87	48.1	12	6.6	181	100.0
Manufacturing Industry								
Under 5000	1	50.0	1	50.0	0	0.0	2	100.0
5000-7499	37	50.0	34	46.0	3	4.1	74	100.1
7500-9999	32	43.8	35	48.0	6	8.2	73	100.0
10,000-12,500	22	84.6	4	15.4	0	0.0	26	100.0
Over 12,500	<u>2</u>	<u>50.0</u>	<u>2</u>	<u>50.0</u>	<u>0</u>	<u>0.0</u>	<u>4</u>	<u>100.0</u>
N	94	52.5	76	42.5	9	5.0	179	100.0

Summary

The individual R-D worker who has the highest job satisfaction is less likely to be contemplating resignation, is more likely to be satisfied with the promotion system, is more likely to have easy access to senior management, is more likely given personal recognition for doing good work, and is more likely to have the highest productivity.

There is only a slight correlation between satisfaction with salary or actual salary level and job satisfaction.

The greater 'organisational' orientation of the industrial R-D worker is evidenced by the relatively stronger correlation between job satisfaction and satisfaction with the promotion system and accessibility of management. It behooves the industrial R-D managers to reflect this strong orientation in their system of incentives.

CHAPTER 8

THE PRESTIGE RANKING OF PROFESSIONAL OCCUPATIONS.

"Status is a frame of mind, encompassing a state of existence, hung on a wall of quicksand."

B.C. (Comic Strip), Nov. 11, 1962.

Introduction

The professional, as defined in this thesis, is a member of a social system characterised by advanced specialised training with a considerable intellectual content which he controls, who is subject to a code of ethics of an association to which he belongs, and who serves and is responsible to the community.

How closely the scientist and engineer comply with these three criteria will determine his status in the profession and in the community. As a salaried professional, he acquires status from his position in the hierarchy of the R-D organisation. Previous chapters have analysed the professional and organisational orientation of the scientist and engineer, and how it differs in degree depending on the research content of the work, and how effective utilisation is dependent on satisfactions with the professional and organisational incentives.

In this chapter the orientation of the scientist and engineer to the community is analysed to show its effect on the occupational prestige ranking of this professional group.

The respondents were asked, from a list of occupations named as guarantors on Canadian passport applications, to give the status in the community of their positions relative to his own. Their response is given in Table 75.

Table 75

Occupational Prestige Ranking

Status is:	G				I			
	Higher	Lower	Higher-Lower	% (1)	Higher	Lower	Higher-Lower	%
Mayor	139	12	127	82.0	126	14	112	76.7
Doctor	122	5	117	75.3	110	14	96	66.8
Public Magistrate	116	21	95	61.2	109	25	84	57.6
Lawyer	100	22	78	50.2	105	17	88	60.2
Clergyman	86	46	40	25.8	88	39	49	33.6
Bank Manager	82	52	30	19.4	83	47	36	24.7
School Principal	70	53	17	11.0	81	48	33	22.6
Chartered Accountant	38	88	-50	-32.3	44	80	-36	-24.7
	N							
	155				146			

It is seen that there is a striking similarity between the relative position each professional occupation is placed by government and industry. Both government and industrial R-D personnel place themselves below mayors, doctors, public magistrates, lawyers, clergymen, bank managers, and school principals, and place themselves above chartered accountants, in that order.

- (1) Column Higher-Lower as a percentage of N, the number of respondents answering the question.

In response to the question in Table 54 of what features of his work are most important, only 2 respondents out of a total of 324 considered "status in the community" as among the five most important features from a list of 32, and none considered "public attitude to his work" among the five most important features. No respondent took the opportunity to add to the list that an important feature of his work was the "opportunity to serve his community".

In response to the question in Table 43 concerning preferred rewards, the low preference attached to "public acknowledgement" is noted and the fact that it does not vary with duty is noted in Table 53. It should not come as a surprise, therefore, that this seeming indifference is reflected in the occupational prestige ranking given by the public.

The public image of the engineer relative to other professions (doctors not included) is given in Table 76 taken from a study⁽¹⁾ in the State of Washington, USA, based on 806 replies from people of both sexes, ages 21-60, whose educational level varied from none to graduate level, and whose duties varied from student through professional and managerial positions.

(1) "We've Got to Tell Them", an address by Dr. J.J. McKetta, Department of Chemical Engineering, University of Texas, to the Texas Society of Professional Engineers, and printed in The Professional Engineer and Engineering Digest, June 1963, page 20.

Table 76

Occupational Prestige Ranking

Which profession or occupation has the most prestige:	Clergyman	35%
	Public Official	26%
	Lawyer	20%
	Teacher	10%
	Engineer	3%

It is seen that the public at large places the engineer in last place among the above professional or occupational groups, and we have already seen that the engineer and scientist places himself in the same position relative to the same groups.

In answer to the question whether the respondents were concerned that engineers and scientists are not named as guarantors(1), about half indicated concern, with slightly more concern indicated by industrial personnel, as shown in Table 77.

Table 77

Concern with Occupational Prestige

	G		I	
	Yes	No	Yes	No
I am concerned that my profession is not named:				
No.	71	85	85	68
%	<u>45.5</u>	<u>54.5</u>	<u>55.6</u>	<u>44.4</u>
N	156		153	

- (1) It is of interest that professional engineers are now listed as guarantors, their occupation to appear when present passport applications in stock are out of print. This was brought to my attention by the Association of Professional Engineers of the Province of Ontario, and by six respondents to the questionnaire.

Summary

The scientist and engineer working in research and development places himself at or near the bottom of a list of professional occupations. The public in responding to an apparent indifference on the part of the scientist and engineer for the accolades of the public places him at about the same relative position.

CONCLUSION

The physical scientist and engineer working in research and development represents a large capital investment. Over a life's career of 40 years this professional is a potential two million dollar investment. Only through the maximum utilisation of this resource can the R-D organisation be assured of getting the maximum return on its investment.

Data derived from a questionnaire completed by 448 salaried physical scientists and engineers indicate that the R-D organisations with the highest utilisation of its professional personnel are characterised by the highest satisfactions with the organisation's system of incentives. This incentive program is seen to contain tangible and intangible rewards and work features to satisfy the scientists' and engineers' expectations as a member of a professional group and as a member of an organisation. Elements of an incentive system that the respondents preferred, or considered important, are shown in Table 78.

Further, the data indicates that the incentive system is three-dimensional because it must reflect the differing organisational, professional, and job orientations of the scientist and engineer. Firstly, the research scientist is seen to have a greater 'professional' orientation than the development engineer, and apparently this orientation is more intensive in the government worker. Secondly, the industrial scientist and engineer is seen to have a greater 'organisational' orientation than his colleagues in government employment. Finally, differing

'job' orientations are revealed when the research scientist is seen to be oriented toward the essence of scientific endeavour, i.e., the contribution to basic knowledge, and the development engineer toward the essence of engineering endeavour, i.e., the application of knowledge derived from research to provide economic methods of design and manufacture.

To show this third dimension in Table 78, the elements of particular concern to the industrial engineer are tagged with an asterisk, and the elements of particular concern to the government research scientist are tagged with a double asterisk, bearing in mind that the industrial scientist has the same 'organisational' orientation as the industrial engineer and somewhat less 'professional' orientation than the government scientist. The elements that appear to be of equal concern to all scientists and engineers are not tagged.

These data support the hypothesis that the effective utilisation of the salaried physical scientist and engineer is dependent on a work environment which successfully integrates tangible and intangible rewards and work features in a system of incentives reflecting the 'professional', 'organisational', and 'job' orientation of the physical scientist and engineer.

Table 78

Incentive System

Preferred Rewards and Important Work Features	Organisational Incentives	Professional Incentives
Tangible	Increase in Salary *Promotion Prospects	**Increased Laboratory Facilities
Intangible	Personal Recognition Accessibility of Senior Management Initial Indoctrination Program Progress Appraisal Program Career Plan *Opportunity to Accept Responsibility	Nature and Challenge of Assignments *Assignment to a Training Course *Opportunity to See My Ideas Applied *Opportunity to Work on Highly Engineered Products **Association with Able Professionals **Opportunity for Professional Development **Opportunity to Contribute to Basic Knowledge

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APPENDIX 1

Expenditure for Performance of Research and Development in
Canada, the United States, and the United Kingdom

- Table 79: Expenditure for Performance of Research and Development, Canada, 1955-1961, Million Canadian Dollars.
- Table 80: Expenditure for Performance of Research and Development, Canada, 1955-1961, Percentage of Gross National Product.
- Table 81: Expenditure for Performance of Research and Development, United States, 1953-1960, Million USA Dollars.
- Table 82: Expenditure for Performance of Research and Development, United States, 1953-1960, Percentage of Gross National Product.
- Table 83: Expenditure for Performance of Research and Development, United Kingdom, 1955-1961, Million Pounds.
- Table 84: Expenditure for Performance of Research and Development, United Kingdom, 1955-1961, Percentage of Gross National Product.

Table 79

EXPENDITURE FOR PERFORMANCE OF RESEARCH AND DEVELOPMENT

CANADA, MILLION CANADIAN DOLLARS

	1955	1956	1957	1958	1959	1960	1961	
Performed by Federal government	80.0	90.0	100.0	111.2	119.5	138.6	154.5	(1)
Performed by industry	51.4	110.0	124.5	132.5	96.6	81.8	113.3	(2) = (9) + (11) + (13)
Performed by others	15.5	18.8	23.2	26.1	28.8	36.1	40.3	(3) = (10) + (12) + (14)
	<u>146.9</u>	<u>218.8</u>	<u>247.7</u>	<u>269.8</u>	<u>244.9</u>	<u>256.5</u>	<u>308.1</u>	(4) = (1) + (2) + (3)
Financed by Federal government	109.0	147.0	168.5	168.4	151.8	171.9	190.1	(5) = (1) + (11) + (12)
Financed by industry	25.9	57.0	61.9	83.8	76.5	66.0	91.5	(6) = (9) + (10)
Financed by others	12.0	14.8	17.3	17.5	16.6	18.6	26.3	(7) = (13) + (14)
	<u>146.9</u>	<u>218.8</u>	<u>247.7</u>	<u>269.7</u>	<u>244.9</u>	<u>256.5</u>	<u>307.9</u>	(8) = (5) + (6) + (7)
Financed by industry in industry	24.0	54.0	57.7	80.0	73.2	62.2	87.2	(9)
Financed by industry in other	1.9	3.0	4.2	3.8	3.3	3.8	4.3	(10)
Financed by Federal government in industry	25.0	52.0	61.5	48.3	21.1	17.6	18.2	(11)
Financed by Federal government in other	4.0	5.0	7.0	9.0	11.2	15.7	17.5	(12)
Financed by others in industry	2.4	4.0	5.3	4.2	2.3	2.0	7.8	(13)
Financed by others in other	9.6	10.8	12.0	13.3	14.3	16.6	18.5	(14) = 12% of (1)

Source: "Federal Government Expenditures on Scientific Activities", Dominion Bureau of Statistics, Fiscal Year 1958/59, Catalogue No. 13515.

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Table 80

EXPENDITURE FOR PERFORMANCE OF RESEARCH AND DEVELOPMENT

CANADA, PERCENTAGE OF GROSS NATIONAL PRODUCT

	1955	1956	1957	1958	1959	1960	1961
GNP (Million Dollars)	27132	30585	31909	32894	34784	35928	36844
Performed by Federal government (% GNP)	.295	.294	.313	.338	.343	.386	.419
Performed by industry	.190	.360	.390	.403	.278	.228	.308
Performed by others	$\frac{.057}{.542}$	$\frac{.054}{.708}$	$\frac{.067}{.770}$	$\frac{.070}{.811}$	$\frac{.077}{.698}$	$\frac{.100}{.714}$	$\frac{.109}{.836}$
Financed by Federal government	.402	.481	.529	.512	.436	.478	.516
Financed by industry	.096	.183	.192	.249	.218	.184	.248
Financed by others	$\frac{.044}{.542}$	$\frac{.044}{.708}$	$\frac{.050}{.771}$	$\frac{.049}{.810}$	$\frac{.044}{.698}$	$\frac{.052}{.714}$	$\frac{.071}{.836}$
Financed by Federal government in industry	.092	.170	.193	.147	.061	.049	.049
Financed by industry in industry	.089	.177	.181	.243	.211	.174	.237
Financed by others in industry	$\frac{.009}{.190}$	$\frac{.013}{.360}$	$\frac{.016}{.390}$	$\frac{.013}{.403}$	$\frac{.007}{.278}$	$\frac{.006}{.228}$	$\frac{.021}{.308}$
Performed by industry	.190	.360	.390	.403	.278	.228	.308

Table 81

EXPENDITURE FOR PERFORMANCE OF RESEARCH AND DEVELOPMENT

USA, MILLION USA DOLLARS

	1953	1954	1955	1956	1957	1958	1959	1960	
Performed by Federal government	970	950	1090	1280	1140	1730	1830	2060	(1)
Performed by industry	3630	4070	4640	6540	7660	8300	9550	10500	(2) = (9) + (11) + (13)
Performed by others	550 <u>5150</u>	600 <u>5620</u>	660 <u>6390</u>	790 <u>8610</u>	930 <u>10030</u>	1040 <u>11070</u>	1240 <u>12620</u>	1480 <u>14040</u>	(3) = (10) + (12) + (14) (4) = (1) + (2) + (3)
Financed by Federal government	2740	3070	3670	5095	6380	7170	8290	9220	(5) = (1) + (11) + (12)
Financed by industry	2240	2365	2510	3265	3390	3620	4030	4490	(6) = (9) + (10)
Financed by others	170 <u>5150</u>	185 <u>5620</u>	210 <u>6390</u>	250 <u>8610</u>	260 <u>10030</u>	280 <u>11070</u>	300 <u>12620</u>	330 <u>14040</u>	(7) = (13) + (14) (8) = (5) + (6) + (7)
Financed by industry in industry	2200	2320	2460	3210	3330	3540	3940	4370	(9)
Financed by industry in other	40	45	50	55	60	80	90	120	(10)
Financed by Federal government in industry	1430	1750	2180	3330	4330	4760	5610	6130	(11)
Financed by Federal government in other	340	370	400	485	610	680	850	1030	(12)
Financed by others in industry	0	0	0	0	0	0	0	0	(13)
Financed by others in other	170	185	210	250	260	280	300	330	(14)

Source: "National Science Foundation, 12th Annual Report, March 1962, page 135.

Table 82

EXPENDITURE FOR PERFORMANCE OF RESEARCH AND DEVELOPMENT

USA, PERCENTAGE OF GROSS NATIONAL PRODUCT

	1953	1954	1955	1956	1957	1958	1959	1960
GNP (Billion Dollars)	365.4	363.1	397.5	419.2	442.8	444.2	482.1	504.4
Performed by Federal government (% GNP)	.265	.261	.274	.306	.325	.390	.380	.410
Performed by industry	.994	1.120	1.169	1.561	1.730	1.875	1.985	2.090
Performed by others	.151	.165	.166	.189	.210	.234	.258	.294
Financed by Federal government	.750	.845	.925	1.218	1.440	1.611	1.722	1.835
Financed by industry	.613	.652	.632	.780	.765	.816	.837	.893
Financed by others	.047	.051	.053	.060	.059	.063	.062	.066
Total	1.410	1.550	1.608	2.058	2.265	2.490	2.620	2.794
Financed by Federal government in industry	.392	.482	.549	.795	.978	1.077	1.168	1.223
Financed by industry in industry	.602	.639	.620	.766	.752	.798	.817	.867
Financed by others in industry	---	---	---	---	---	---	---	---
Performed by industry	.994	1.120	1.169	1.561	1.730	1.875	1.985	2.090

Table 83

EXPENDITURE FOR PERFORMANCE OF RESEARCH AND DEVELOPMENT

UNITED KINGDOM, MILLION POUNDS

	1955	1958	1961	
Performed by government	70	130	151	(1)
Performed by industry	178	254	356	(2) = (9) + (11) + (13)
Performed by others	$\frac{26}{274}$	$\frac{48}{432}$	$\frac{85}{592}$	(3) = (10) + (12) + (14) (4) = (1) + (2) + (3)
Financed by government	202	289	358	(5) = (1) + (11) + (12)
Financed by industry	63	123	200	(6) = (9) + (10)
Financed by others	$\frac{9}{274}$	$\frac{20}{432}$	$\frac{34}{592}$	(7) = (13) + (14) (8) = (5) + (6) + (7)
Financed by industry in industry	46	101	177	(9)
Financed by industry in other	17	22	23	(10)
Financed by government in industry	132	153	177	(11)
Financed by government in other	0	6	30	(12)
Financed by others in industry	0	0	2	(13)
Financed by others in other	9	20	32	(14)

Source: "Annual Report of the Advisory Council on Scientific Policy", 1959-1960, HMSO, Cmd 1167, Ministry of Science.

"Industrial Research and Development Expenditures, 1958", Department of Scientific and Industrial Research.

"Industrial Research in the Manufacturing Industry, 1959-1960", Federation of British Industries.

Table 84

EXPENDITURE FOR PERFORMANCE OF RESEARCH AND DEVELOPMENT

UNITED KINGDOM, PERCENTAGE OF GROSS NATIONAL PRODUCT

	1955	1958	1961
GNP (Billion Pounds)	19.2	22.7	25.6
Performed by government (% GNP)	.364	.573	.590
Performed by industry	.927	1.120	1.391
Performed by others	.135	.212	.332
Financed by government	1.050	1.272	1.400
Financed by industry	.328	.543	.781
Financed by others	.047	.090	.133
Total	1.425	1.904	2.314
Financed by government in industry	.688	.674	.691
Financed by industry in industry	.240	.445	.691
Financed by others in industry	.000	.000	.008
Performed by industry	.927	1.120	1.391

CANADA

EXPENDITURE FOR PERFORMANCE OF RESEARCHAND DEVELOPMENT, PERCENTAGE OF GNP

CURRENT EXPENDITURES ONLY
 NO CAPITAL EXPENDITURE
 DEPRECIATION INCLUDED
 TECHNICAL SERVICES NOT INCLUDED

P PERFORMED
 F FINANCED
 G FEDERAL GOVERNMENT
 I INDUSTRY

CANADA

EXPENDITURE FOR PERFORMANCE OF RESEARCH

AND DEVELOPMENT IN INDUSTRY, PERCENTAGE OF GNP

CURRENT EXPENDITURES ONLY
 NO CAPITAL EXPENDITURE
 DEPRECIATION INCLUDED
 TECHNICAL SERVICES NOT INCLUDED

P PERFORMED
 F FINANCED
 G FEDERAL GOVERNMENT
 I INDUSTRY

1.0%-

30%-

20%-

10%-

0%

UNITED STATES
EXPENDITURE FOR PERFORMANCE
OF RESEARCH AND DEVELOPMENT
PERCENTAGE OF GND

P PERFORMED

F FINANCED

G FEDERAL GOVERNMENT

I INDUSTRY

CURRENT EXPENDITURES ONLY
 NO CAPITAL EXPENDITURE
 DEPRECIATION INCLUDED
 TECHNICAL SERVICES NOT
 INCLUDED

UNITED STATES
EXPENDITURE FOR PERFORMANCE OF RESEARCH
AND DEVELOPMENT IN INDUSTRY, PERCENTAGE OF GNP

UNITED KINGDOM

EXPENDITURE FOR PERFORMANCE
OF RESEARCH AND DEVELOPMENT
PERCENTAGE OF GNP

P PERFORMED
F FINANCED
G GOVERNMENT
I INDUSTRY

CURRENT EXPENDITURES ONLY
NO CAPITAL EXPENDITURE
DEPRECIATION INCLUDED
TECHNICAL SERVICES NOT INCLUDED

UNITED KINGDOM
EXPENDITURE FOR PERFORMANCE OF RESEARCH
AND DEVELOPMENT IN INDUSTRY, PERCENTAGE OF GNP

2.0%-

CURRENT EXPENDITURES ONLY
 NO CAPITAL EXPENDITURES
 INCLUDED

DEPRECIATION INCLUDED
 TECHNICAL SERVICES NOT
 INCLUDED

P PERFORMED
 F FINANCED
 G GOVERNMENT
 I INDUSTRY

APPENDIX 2

Trends in Expenditure for Performance of Research and
Development in Canada

The source material for the graphs of APPENDIX 2 is found in the following list of Federal government documents.

1. "Federal Government Expenditures on Scientific Activities", Dominion Bureau of Statistics, Business Finance Division.

Fiscal Year 1958-1959, Catalogue No. 13-515
Fiscal Year 1960-1961, Catalogue No. 13-401.

2. "Industrial Research and Development Expenditures in Canada", Dominion Bureau of Statistics, Business Finance Division.

1957, Catalogue No. 13-509
1959, Catalogue No. 13-516
1961, Catalogue No. 13-520

3. "Scientific Research and Development", Royal Commission on Government Organisation, Volume 4, Report 23, 1962, the "Glassco Report".

TRENDS IN EXPENDITURE FOR PERFORMANCE
OF RESEARCH AND DEVELOPMENT
CANADA.

TRENDS IN EXPENDITURE FOR PERFORMANCE
OF RESEARCH AND DEVELOPMENT
CANADA

TRENDS IN EXPENDITURE FOR PERFORMANCE
OF RESEARCH AND DEVELOPMENT
CANADA

TRENDS IN EXPENDITURE FOR PERFORMANCE
OF RESEARCH AND DEVELOPMENT
CANADA

APPENDIX 3

Trends in Employment of Scientists and Engineers in
Research and Development in Canada

The source material for the graphs of APPENDIX 3 is found in the following list of Federal government documents.

1. "Federal Government Expenditures on Scientific Activities", Dominion Bureau of Statistics, Business Finance Division.

Fiscal Year 1958-1959, Catalogue No. 13-515
Fiscal Year 1960-1961, Catalogue No. 13-401.

2. "Industrial Research and Development Expenditures in Canada", Dominion Bureau of Statistics, Business Finance Division.

1957, Catalogue No. 13-509
1959, Catalogue No. 13-516
1961, Catalogue No. 13-520.

3. "Scientific Research and Development", Royal Commission on Government Organisation, Volume 4, Report 23, 1962, the "Glassco Report".

TRENDS IN EMPLOYMENT OF SCIENTISTS
AND ENGINEERS IN RESEARCH AND DEVELOPMENT
CANADA

TRENDS IN EMPLOYMENT OF SCIENTISTS
AND ENGINEERS IN RESEARCH AND DEVELOPMENT
CANADA

TRENDS IN EMPLOYMENT OF SCIENTISTS
AND ENGINEERS IN RESEARCH AND DEVELOPMENT
CANADA

TRENDS IN EMPLOYMENT OF SCIENTISTS
AND ENGINEERS IN RESEARCH AND DEVELOPMENT
CANADA

A SURVEY OF PROFESSIONAL DEVELOPMENT

This questionnaire is part of a research study to assess the attitudes, experiences, and expectations of professional technical personnel. It is being conducted under the auspices of the Department of Public Administration, Carleton University, and directed by Professor R.O. MacFarlane. Your organization approves of and is co-operating in this research, but you are under no obligation to fill in the questionnaire.

You are asked to complete the questionnaire, and seal it, *unsigned*, in the postage paid, addressed envelope attached. As the questionnaire does not contain any distinguishing mark, your reply will be completely anonymous. You are in no way being rated. Your reply will contribute to the improvement of professional training and development programs.

Further, the report of the investigation will contain only statistical summaries of the answers, so that it will *not be possible* to identify any individual or his organization.

The questionnaire will take approximately 30 minutes to complete.

Comments are especially welcome.

Please return the completed questionnaire within 7 days.

Please use check marks ☒ where appropriate, strike out one of *Yes/No*, or enter brief information in blank spaces provided. Mark NA on items not applicable to you.

QUESTIONNAIRE

1. Gross earned salary range:

Under \$5,000 ☐ \$5,000-7,499 ☐ \$7,500-9,999 ☐ \$10,000-12,500 ☐ over \$12,500 ☐

I consider my salary is reasonable for the position I hold. *Yes/No*

2. Age group Under 21 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ over 50 ☐

3. Normal work week, including average overtime, but not including training programs,..... hours

4. Employment I work in: Industry ☐ Government ☐ University ☐

I intend to make my career in

5. My duties are predominantly:

management/supervisory ☐	research (fundamental, basic) ☐
engineering (applied) research ☐	sales ☐
engineering development ☐	teaching ☐
production engineering ☐	other (please specify)

I am aiming for a career in

6. Experience since graduation:

industry	Number of different firms
government	Number of different departments
university staff	Number of different universities

If experience was with more than one organization, main reason for last change was

7. Education: I hold the following degrees:

BA ☐ majoring in	MSc ☐ majoring in
BSc ☐ majoring in	MASc ☐ majoring in
BASc ☐ majoring in	PhD ☐ majoring in
MA ☐ majoring in	Other majoring in

I (plan to take/am taking) the degree of

majoring in

This degree course is available in Canada. *Yes/No*

8. Present employment: I entered this organization as a result of:

answering a newspaper advertisement ☐	the recommendation of university staff ☐
answering a professional journal advertisement ☐	my inquiry to the Personnel department ☐
the suggestion of a professional colleague ☐	the personal request of the Management ☐

Other (please specify)

I think the best way to recruit professional employees is

9. Indoctrination On entering this organization, I was given:

- a description of the fringe benefits it offers. Yes/No
- an outline of its educational and training programs. Yes/No
- a description of its purposes, policies, and practices. Yes/No
- its organizational plan. Yes/No
- a review of its major programs. Yes/No
- an introduction to department and management senior staff. Yes/No
- other (please specify)
- The initial indoctrination was adequate. Yes/No

10. Training Plan This organization has a training plan. Yes/No

I am satisfied with this plan. Yes/No

It includes: summer employment prior to graduation. Yes/No

probationary period. Yes/No

job rotation. Yes/No

special assignments outside normal work. Yes/No

attendance at lectures or discussion groups. Yes/No

attendance at committees or meetings outside normal work. Yes/No

accompanying or representing my superior at meetings. Yes/No

Other (please specify)

11. Career Plan I am aiming for a senior position. Yes/No

I know what training is needed to qualify for this position. Yes/No

I have a plan to prepare myself for this position. Yes/No

I am informed of probable future vacancies in my organization. Yes/No

My career plan is a joint effort with management. Yes/No

12. Progress This organization follows my performance by:

requiring a periodic summary of my activities. Yes/No

requiring periodic abstracts from the technical literature. Yes/No

requiring me to describe my project, its status, aims and trouble areas. Yes/No

periodic invitation to lunch with management, to discuss my projects. Yes/No

periodic appraisal before a committee of senior technical and management personnel. Yes/No

other (please specify)

I talk with senior management about my work: often ☐ occasionally ☐ never ☐

13. This organization encourages my professional development by:

informing me about the appraisal of my progress. Yes/No

paying professional society dues. Yes/No

paying expenses for at least one major meeting per year. Yes/No

paying expenses when I present a technical paper. Yes/No

paying expenses for travel to exchange information. Yes/No

paying tuition fees for correspondence or evening courses successfully completed. Yes/No

allowing time off work to attend training courses. Yes/No

allowing ample time to read technical journals. Yes/No

providing adequate library and information services. Yes/No

sponsoring seminars with invited speakers (a) during work hours. Yes/No

(b) outside work hours. Yes/No

sponsoring lectures by staff. Yes/No

giving leave of absence for attendance at university: part time ☐ full time ☐

without pay ☐ half pay ☐ full pay ☐ other (please specify)

14. Maintaining professional competence I belong to my professional society. Yes/No

I attend society meetings: often ☐ rarely ☐ never ☐

I attend a night course related to my profession. Yes/No

I attended at least one related seminar during 1962. Yes/No

I attended my organization's annual technical meeting in 1962. Yes/No

I published papers since 1960.

Other (please specify)

15. Recognition and Promotion

The *five* things that count most and the *five* that count least for *promotion* at my level in the organization are:

	Most Important	Least Important
Seniority	☐	☐
Initiative	☐	☐
Appearance, social graces	☐	☐
Competence — technical	☐	☐
— administrative	☐	☐
Age	☐	☐
Hard work	☐	☐
Experience	☐	☐
Number of degrees	☐	☐
Number of published technical papers	☐	☐
Being in right place at right time	☐	☐
Good relations with superiors	☐	☐
Other (please specify)	☐	☐

16. This organization's promotion system works:

As fairly as possible ☐ Somewhat unfairly ☐
 Fairly, on the whole ☐ Very unfairly ☐

17. If I have done exceptionally good work, the *five* rewards I would most prefer are:

Promotion ☐
 Increase in salary ☐
 Cash bonus ☐
 Percentage profit from sales ☐
 Increased job security ☐
 Increased staff of subordinates ☐
 Increased laboratory facilities ☐
 Assignment to a training course ☐
 Attendance at professional meetings ☐
 An all-expense holiday ☐
 Public acknowledgment ☐
 Other (please specify)

18. When I have done a particularly good job, I am told: Always ☐ Sometimes ☐ Never ☐

This acknowledgment is: In public ☐ In private ☐

When I make a mistake, I am told: Always ☐ Sometimes ☐ Never ☐

I am told: In public ☐ In private ☐

19. People in the following occupations may be named as guarantors on Canadian passport applications. The status in the community of their positions, relative to my own, is:

	Status is — Higher Lower			Status is — Higher Lower	
Mayor	☐	☐	Public Magistrate	☐	☐
Postmaster	☐	☐	Collector of Customs	☐	☐
Clergyman	☐	☐	School Principal	☐	☐
Lawyer	☐	☐	Bank Manager	☐	☐
Doctor	☐	☐	Chartered Accountant	☐	☐

I am concerned that my profession is not named. Yes/No

20. This organization has an internal association to enable professional employees to discuss with management:

- (a) rewards such as pay, promotion, working conditions. Yes/No
 (b) rewards such as professional recognition and status. Yes/No

21. The *five* features of my work that are most important, and the *five* that are least important are:

	Most Important	Least Important
Pay	☐	☐
Hours of work	☐	☐
Holidays	☐	☐
Pension and insurance plans	☐	☐
Job security	☐	☐
Promotion prospects	☐	☐
Geographical location	☐	☐
Physical conditions of work (noise, lighting, heating, etc.)	☐	☐
Facilities (equipment, library, etc.)	☐	☐
Technical staff support	☐	☐
Financial support of projects	☐	☐
Nature of assignments (variety, monotony)	☐	☐
Challenge of assignments	☐	☐
Work load	☐	☐
Paper work	☐	☐
Sense of urgency of my work	☐	☐
Opportunity to accept responsibility	☐	☐
Opportunity to use initiative	☐	☐
Opportunity to contribute to basic knowledge	☐	☐
Opportunity to see my ideas applied	☐	☐
Opportunity to work on highly engineered products	☐	☐
Opportunity for internal training	☐	☐
Opportunity for professional development	☐	☐
Association with able professionals	☐	☐
Competent direction and supervision	☐	☐
Status in community	☐	☐
Public attitude to my work	☐	☐
Professional regard for this organization	☐	☐
Personal relations with colleagues	☐	☐
Personal appraisal or approval by management	☐	☐
Writing and signing my reports and correspondence	☐	☐
Security restrictions to publication of my work	☐	☐
Other (please specify)		

22. Attitude towards job

Like very much ☐ Like moderately ☐ Indifferent ☐ Dislike ☐ Dislike very much ☐

23. Flexibility Regarding transferral from one job to another within this organization:

Transfers are disapproved Yes/No
 Transfers are made too often Yes/No
 The present staff complement is too stable Yes/No
 Stability of present staff interferes with introduction of fresh ideas Yes/No

24. I am contemplating resigning:

to go to industry ☐ government ☐ university ☐
 to go to the USA ☐
 other

My main reason is