AN OPINION SURVEY IN THE ENGINEERING PROFESSION

by Paul Andre Verdier, B.A., B.Sc.

Ottawa, Canada, 1950.

A DESCRIPTIVE STUDY OF EMPLOYER OPINIONS TOWARDS THE UNIVERSITY AND THE APPRENTICESHIP TRAINED ENGINEER

by Paul Andre Verdier, B.A., B.Sc.

Thesis presented to the Institute of Psychology of the University of Ottawa in partial fulfillment of the requirements for the Master of Arts degree.

Ottawa, Canada, 1950.

RECOGNITION

This thesis has been prepared under the direction of the director of the Institute of Psychology of the University of Ottawa, Father Raymond-Henri Shevenell, O.M.I.

The following are also thanked for their kind and welcome cooperation, which has enabled this survey to be carried out.

The Engineering Institute of Canada, for supplying the use of their library and literature, and the names and locations of their members in senior engineering positions.

The Members of the Engineering Institute of Canada, for their kind cooperation in filling out the questionnaires of this survey.

Dr. Thomas W. Cook, of the University of Saskatchewan, and Dr. Harry L. Stein, of the University of Manitoba, for their helpful suggestions in the design of the questionnaire.

The Dominion Bureau of Technical Personnel, Ottawa, for their countrywide classification on the engineering profession.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

A rapid development in professional engineering in Canada is taking place today due to the increasing importance of the university in engineering education. A record number of 6,958 engineers graduated from university in Canada between the years 1942 and 1948.[1] The total engineering population in Canada in 1946 was estimated to be 21,367 by the Wartime Bureau of Technical Personnel.[2] A rapid increase in the numbers of university trained engineers is influencing the engineering profession as a whole, as the university engineer has not, traditionally, been the dominant group within the total structure. The engineer who "worked his way up" to professional status was at one time in predominant numbers. This is the "practical" engineer who has not graduated from a university, and who, considered as a group, is facing extinction.

In the struggle for dominance, and for jobs in professional engineering, the university and the non-university trained engineer may be likened to two sub-groups within a larger organization. As such, their interactions, their attitudes towards one another, and their opinions about each other's efficiency may be studied. The existence of preferences for, and which of the two engineers that engineer employers consider to be the more competent could open another possible avenue of investigation.

---

1 The National Research Council, Ottawa, Canada, Registration in Canadian Universities, Dec. 1948, in the Engineering Journal, Vol.31, No.12, Dec. 1948.

2 The Wartime Bureau of Technical Personnel, Ottawa, Canada, Classification of Engineers, 1946.

This latter aspect is the more important, and as such the determination of which of the two types of engineer is considered by employers to be the more competent is the primary aim of this research. That any findings of difference between the two types of engineer may be forwarded to the professional organization is only a matter of secondary concern to this research.

The first chapter of this thesis shows that professional engineering in Canada comprises both university and non-university trained members. Some aspects of, and the definition of these two types of professional engineer, as well as their differences in background is traced. The plan to determine which type of engineer that employers consider the more competent is also evolved. Instances of preference for both types of engineer are likewise given.

The problem of the persons best able to evaluate the engineer's proficiency is the main topic of the second chapter. We also see the manner in which evaluations and opinions were drawn from a senior group of executive engineers regarding the ability of both types of engineer on the job. Included is a technical discussion of the subject population, as well the adequacy of the questionnaire as a survey instrument.

The third chapter illustrates the actual manner in which the survey was carried out and the resultant practical problems. The manner in which the maximum response was obtained from the interviewed proportion of the engineer employers is also described.

In the fourth chapter there is included only the immediate transformation of the statistical data of the research to a manageable

and easily comprehended verbal form. Each set of data as it is presented is progressively interpreted and integrated into the following set of data, from which only the immediate conclusions are drawn.

In the fifth and final chapter the conclusions of this research are summarized in an attempt to discern what the employers thought of the competence of the two types of engineer. The effectiveness of rating scales in the hands of the employers as well as the influence of their own training backgrounds upon their ratings is evaluated. A comparison of the personality traits with the traits of a learned technical character are also drawn up, and some conclusions extracted. The ratings of both engineer types upon each individual trait receives the bulk of analysis, with the emphasis upon establishing critical differences. The final purpose, however, is to reveal personality differences of a general nature between these two types of professional engineers with their respective backgrounds of training.

CHAPTER I

THE TRAINING OF ENGINEERS IN CANADA

It is claimed by many that the initial training of an engineer will influence his later professional life, his future employment and his promotion possibilities. Professional engineers in Canada may therefore be divided into two groups according to the type of training they have received. The university graduate engineer receives all his initial essential training in the university, and upon graduation is thrust into industry as a fully qualified engineer in the professional sense. He may, however, be subjected to further specialized training in the industry with the purpose of increasing his knowledge of the practical aspects of his job. Training of this type primarily converts his general knowledge into practical channels.

On the other hand, the professional engineer not in possession of a university degree receives the bulk of his training in industry. This is usually of a specific nature with direct reference to problems in the particular industry in which he receives his training. For classification purposes, a more exact definition of the two types of engineers will be used in this manuscript.

(1) "The Practical Engineer", is the engineer who has undergone either the British apprenticeship training, or a long practical training in a particular industry. This training includes systematic experience in each department, and means actually working in it. This group includes those engineers who have written the membership requirement examination

for entry into the Engineering Institute of Canada, but have possession of limited formal background.

(2) "The University Engineer", is a designation for the engineer who receives formal technical training in university and graduates with an engineering degree in his particular specialty.

Both the university and the non-university trained engineers are admitted to full membership in the Engineering Institute of Canada when they have complied with the Institute's professional requirements. It is quite probable that many older engineers, in their employer capacity, have experience, or dealings with both groups. When questioned in this survey, it was found that most employers were easily able to identify both types as being active in Canadian professional engineering circles. These elder engineer employers also had their own personal opinions about the relative merits of these two methods of training engineers. Some of these opinions were preferential, which when not related to the requirements of the job, and not based upon an intimate knowledge of the job applicant's qualifications, may enter into, and influence the employer's choice, and so result in job discrimination. Do these unconscious preferences exist, and is there job discrimination because of them among Canadian engineers? Preference may very well be related to the type of training that the engineer employer undergoes at the commencement of his career.

The importance of a fair evaluation of the merits of engineers trained by both methods is shown by greater degree of significance that many large organizations attach to the engineer's training, rather than to

his experience when he is considered for possible employment. An open preference for engineers of practical training is apparent in the Royal Canadian Navy, in the engine room branch. Practical engineers who are in possession of an engine room steam or diesel watchkeeping ticket and who understand the practice and functioning of steam and diesel propulsion equipment may commence work as engineer Officers with little or no retraining. This knowledge is best gained through the apprenticeship system of training as it gives specific instruction and experience in the handling of steam and diesel equipment. The university does not give this practical type of training, only general instruction in steam and thermodynamic principles. During World War II and the period following, the two chief engineers of the Royal Canadian Navy were both practical men, and were of Flag, that is, Admiral's rank.

Conversely, as an example of an attitude that influences the selection of engineers the Civil Service of Canada may be described.[1] An engineer in the Civil Service is required to hold a university degree in the particular field of engineering that is designated by the job outline. This will automatically allow only our university engineer to be classed as an engineer in the Federal Civil Service. The practical engineer of our description is accepted into the Civil Service to fill jobs that have identically the same human requirements, but only under the title of "technical officer", regardless of his work attainments, his experience, and the number of professional societies to which he belongs. Indirectly, as senior engineers are often employers, occupational loyalty, and good feeling within the profession may be endangered or divided by this type

---

1 Civil Service of Canada, Basic Requirements of Engineers, 1948.

of discrimination between its members.

When the engineer seeks employment, the existence of a personal preference by the employer which is not based upon a sound knowledge of the engineer's background of training may cause a company to lose, or not hire, an engineer who would be very suitable for the job for which he is applying. This may be either because he appears to be too theoretical, as the so-called "degree man" is sometimes considered, or because he has no university degree, as in the case of the practical engineer. This circumstance in turn could very well depend upon whether the chief engineer who does the employing is a "degree" or a "practical" man himself, and whether he favors only those of a similar training background to that of his own. Any information derived as a result of an investigation of this problem of personal preference may rightly be considered as a contribution to the field of scientific personnel selection.

Which of the two types of engineer is generally considered to be the more competent; the practical or the university trained engineer? Those engineers who are also employers should best know the answer to this question. Engineers, as a rule, are employed, hired and fired by other engineers who have risen to the head of their department and supervise the work of those underneath them. It is proposed, in this research, to question a select group of Canada's highest placed, eldest, and most experienced engineers about the relative merits of both methods of training engineers. Dependent upon whether the employer engineer is a practical or a university man himself, it is to be ascertained if there exists any bias, or if he seems to prefer those engineers of a background similar to that of his own, to the exclusion of others.

As the Engineering Institute of Canada is the largest, oldest, and most recognized engineering body in Canada, it is proposed that the survey group be drawn from their membership list, this being facilitated by the co-operation of the secretary of the Institute. This means the use of their library at the National headquarters in Montreal, as well as their confidential files and membership list.

With no statistical evidence, but upon examination of old documents, it is surmised virtually that the Engineering Institute of Canada was comprised preponderantly of practical engineers when incorporated in 1887 as the Canadian Society of Civil Engineers. This is understandable, as the only type of training available at the time was that of an apprenticeship nature. A university graduate in the applied sciences was then a rare man. This was Canada's greatest period of expansion in railways, bridges, and large scale construction. At that time university courses in the applied sciences were given only in rare instances.

In 1932 the practical engineer totalled only 44.6 per cent of the membership of the Institute.[2] From this evidence it may be seen that the university was taking over the training of engineers which was formerly carried out predominantly by industry.

In this chapter it was shown that engineers may be divided into two groups, dependent upon their initial training inside or outside of the university. Preference for one or the other type of engineer was noted in such large organizations as the Civil Service of Canada and the Royal Canadian Navy. The Engineering Institute of Canada was seen

---

2 The Engineering Institute of Canada, List of Members, May 1932.

to be a well established and representative group composed of both university and non-university trained engineers. For purposes of this research, group opinion is defined as "the average judgment or consensus of the individuals of a group regarding a given issue, institution, or person".[3] Therefore, it will be seen that group opinion, or the opinion of elder members of the Engineering Institute of Canada is to be solicited to determine which produces the more competent engineer, industry, or the university.

---

3 McNemar, Quinn, Opinion-Attitude Methodology, in the Psychological Bulletin, Vol. 43, No. 4, July 1946, p.289.

CHAPTER II

THE GROUP AND THE SURVEY INSTRUMENT

This chapter will require a consideration of the group of employers whose opinions are to be solicited with respect to their being an "adequate sample" of persons who may best answer the question of differences between the university and the practically trained engineer. This topic will be treated under the heading of "the group surveyed". The design of the instrument to be used to gather the opinions of the group will be considered in the latter part of this chapter.

(a) The Group Surveyed:

The engineer's technical ability to perform his work may best be appraised by those authorities who are directly responsible for, and who direct the work of the engineer. Opinions gathered from these authorities consider the complexity of the engineer's work and his individual contribution towards the end result, whether it is a machine or a construction project. A group of engineer employers are themselves as a rule, of necessity, engineers, since technical training is necessary to direct work of a technical nature. For this survey each employer must have adequate experience in dealing with engineers of both types of background. This would be achieved only by senior engineers who have had considerable experience over a long period of time in an employer and administrative capacity. The group must also include engineers of both types of training background. It will then be possible to evaluate and compare their type of training with their attitude towards those of a different background.

The number of ratings of the engineer is a factor in the reliability and validity of the survey results. The reliability of a single rating may be expected to be as low as that of a single item test. Various estimates have been made as to the optimum number of raters. Kornhauser[4] found that the average reliability of ratings increased as the number of raters was enlarged to four; after that number, there was no improvement. Symonds's[5] summary of the research on the question of reliability of ratings indicates that, although a rating by a single judge is generally unreliable, human character can be appraised accurately enough for practical purposes on the basis of from three to eight independent ratings. From these rating standards our survey group of thirty four individuals may be considered as large enough. As a generalized concept of an engineer is being rated instead of a specific individual, a larger number of ratings combined with a statistical approach was felt to be a wiser attack to the problem.

As mentioned previously, the engineer employer group whose opinions are to be gathered will be selected from the membership files of the Engineering Institute of Canada. This group is to be one half practical engineers, and the other half will be university trained engineers. This classification is to be determined from the member's original qualifications for membership into the Institute. This information is available in the Institute's files, and the last list of members which is complete with all

---

4 Kornhauser, Arthur W., The Reliability of Average Ratings, in the Journal of Personnel Research, Vol. V, issue of 1926-27, p.309-17.

5 Symonds, Percival M., Diagnosing Personality and Conduct, New York and London, The Century Company, 1931, pp. 602.

background information.[6]

Senior engineers of twenty years or more of experience will be chosen to fill out the questionnaires, as they are most likely the only ones who have had sufficient experience with both types of engineer to form a concrete opinion as to the merits of both groups. For this reason the 1932 List of Members is considered as satisfactory, as the later lists do not include information upon the engineer's background and entrance qualifications. The use of the 1932 list will then eliminate the necessity of a lengthy perusal into the Institute's personal files. The proportions of practical versus university trained engineers is also more even in the 1932 List of Members, approximating forty-five per cent practical, and fifty per cent university trained. Later lists tend to show a lack of balance in the proportions between the two groups, as the trend is for the university to take over the training of engineers to an increasing extent, and so exclude the practical engineer.[7]

The aforementioned precludes the possibility of younger engineers having positions of responsibility with which they can have effective dealings with both groups. As his numbers seem to be decreasing in proportion to the total engineering population, the practical engineer will automatically be unable to present himself as often as the university engineer before the view of the average employer of engineers. The two types of engineer to be questioned in this survey are both legitimate

---

6 The Engineering Institute of Canada, op. cit.

7 Massue, Huet, A Study of the Engineering Institute of Canada, Montreal, May 1947. An original monograph showing memberships, etc., over a period of twenty-five years, regions of population, estimates of graduates, and registration in Canadian Universities.

professional engineers with full memberships in the Engineering Institute of Canada. The adequacy of the full membership requirement can best be illustrated by the Institute's description of the professional requirements of a Member, which are as follows;[8]

> A Member shall have engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the council. In every case a candidate for election shall have held a position of professional responsibility for a least two years. The occupancy of a chair as professor, assistant professor, associate professor or lecturer in a faculty of applied science or engineering shall be considered as professional responsibility. Every candidate who has not graduated from a school of engineering recognized by the council shall be required to pass an examination as prescribed by council, on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged.

The group surveyed may therefore be considered as a senior, select one. Besides having professional status, the employers must be familiar with, and have had experience with both groups. A question is included in the survey questionnaire to assure compliance with this qualification. The other survey group criteria are age, the number of years of membership in the E.I.C., and the importance of the positions the engineer has held, or is holding at present. With an eye upon this last criterion, an attempt will be made to obtain returns from the highest placed engineers in the Dominion of Canada. Returns from the highest placed engineers will help to assure that members of the group surveyed will have had maximum experience in employing other engineers. It is seen that the employer will be charged

---

8 Engineering Institute of Canada, Professional Requirements of a Member, in the Engineering Journal, Vol.32, No.10, Oct.1949.

with a double responsibility, which is; assessing himself as an engineer with a particular type of training background, and also evaluating both methods of training engineers, in the role of an employer of engineers.

The ratios in percentages of engineers employed after being interviewed in relation to the percentages of each type of engineer previously interviewed is shown on Table I upon the following page. This information was acquired from the questionnaire returns of the survey, and an analysis reveals that engineer employers hire a greater proportion of engineers with a background similar to their own. This is indicated by the ratio between the types of engineers interviewed, and the types later hired.

In the case of the employer with the practical training background; of the total number of engineers that he interviews for employment 58.2 % are of university background, but of the total number that he hires only 41.2 % are of university background. When this employer considers engineers with a practical background, they comprise 41.8 % of the total interviewed, but are 58.8 % of those later hired by the practical engineer employer.

In the case of the employer with the university background; there is a correspondence in the proportions of each type of engineer initially interviewed, when compared to the proportions reported by the practical engineer employer. Of the total number of engineers he interviews for employment, 60.8 % are of university background. This group comprises 68.9 % of the total number later hired by the university trained employer. The engineers of practical background comprise 39.2 % of those interviewed by

TABLE I.-

Percentages of Engineers Employed in Relation to the Number Previously Interviewed, From Questionnaire Returns.

Employer interviewer	Engineers interviewed for employment		Engineers actually employed	
	University engineer	Practical engineer	University engineer	Practical engineer
By practically trained engineer employers	58.2	41.8	41.2	58.8
By university trained engineer employers	60.8	39.2	68.9	31.1
By both types of engineer employers	59.5	40.5	55.0	45.0

(34 cases)

the university trained employer, but only 31.1 percent of those who were later hired by him.

On Table I the proportions of engineers claimed to have been interviewed by both types of employers combined upon the questionnaire returns are 40.5 percent practical, and 59.5 percent university trained engineers. The Engineering Institute's 1932 List of Members indicates 44.6 percent as being practical, and the remainder as being university trained. The rough estimates of the interviewer's answers to the question, "Try to recall roughly what proportions of each type of engineer that you have interviewed for employment?" were then in general accord with the true engineering population.

In order to determine the validity of Table I the hypothesis had to be set up that a certain proportion of the employers gave a tenable or approximately true estimate of the proportions of each type of engineer that they interviewed prior to employing them. A certain percentage of these employers would then be expected to make a correct estimate of proportions when compared to the true engineering population. If this hypothesis is tenable then the descrepancy between the observed (the employer's guess), and the expected (the true population), should then be no larger than might arise on the basis of chance. If the descrepancy between observed and expected is too large, i.e., not apt to arise by chance, the hypothesis becomes suspect. Using the Chi Square test between proportions of

engineers interviewed by the university trained employers as observed, and the true engineering population as expected, we obtained a Chi Square value of 1.178. When this value is interpreted upon a Table of Chi Square[9] at one degree of freedom it shows that it can occur less than 30 out of 100 times. We may therefore regard this value as not very significant and accept the Null Hypothesis[10] of no difference between the observed and expected proportions as shown on Table 1.

The same procedure was repeated with the proportions reported by the practical employers on Table I. A Chi Square value of .318 was obtained, which when referred to the Table of Chi Square at one degree of freedom showed an occurence in about 60 out of 100 times. We may also regard this value as not very significant and accept the null hypothesis of no difference between the observed and expected proportions. When the two types of employers were combined in their estimates of proportions of the two types of engineers interviewed and compared to the true engineering population the Chi Square test yielded a value of .681. Upon the Table of Chi Square at one degree of freedom it was found that this difference occured in about 45 out of a 100 cases. We may also regard this value as not very significant and accept the null hypothesis of no difference between the observed and the expected proportions. As the estimated proportions of both types of engineers

---

9 Fisher and Yates, Statistical Tables for Biological, Agricultural and Medical Research, Table IV, Oliver and Boyd, Ltd., Edinburgh.

10 McNemar, Quinn, Psychological Statistics, John Wiley and Sons, New York, 1949, p.65-71.

interviewed by employers are thus shown to be in accord with the true engineering population the validity of the first two columns of Table I is inferred, and may be considered as quite valid. As the estimated proportions of both types of engineers, shown in the latter two columns of Table I as being later employed, cannot be compared to any known criterion or population, it is not possible to estimate their validity on a statistical basis, as on the previous two columns. However, the validity of the latter two columns may be inferred from the validity of the two previous columns, and as this is the only recourse, this method must be used to evaluate their representing the truth.

Looking at the total picture, these two groups of employers tend to negate their influence in the employment of engineers, that is, the practical engineer employers take up the residue of practical engineers who are rejected by the university trained employers, and vice versa. The proportions between those interviewed and later hired by each type of employer are roughly equalized by their preferences.

The survey group turned out to include subjects with a maximum of administrative and professional experience. Returns came from two engineer admirals in the R.C.N., three air marshalls in the R.C.A.F., the president of a large firm of management engineers in Montreal, the chief engineers of Department of Public Works of Canada, several engineer officers in the Canadian Army, the chief engineers of a number of private firms and utility companies, one return came even from a Cabinet Minister in the Federal Government. The group that was sampled fulfilled the maximum requirements of age, professional ability, and experience with subordinate engineers.

(b) The Design of the Instrument to be Used to Enable the Survey Group to Evaluate the Engineer:

The questionnaire. The instrument of this research was designed to gather the opinion of each of the two types of engineer within the professional structure concerning both methods of training engineers. The questionnaire includes rating scales, one half of which are designated by the letter "P", for personality trait rating scales, and the other half by the letter "L", for technical achievement rating scales. The L traits are based upon technical learned aspects of the engineer's basic education, whereas the P traits are the more overt manifestations of the engineer's personality. These personality considerations may be directly influenced or caused by the engineer's training background, or have no relationship to the engineer's training. As the practical engineer is engaged in a profession where a university degree is highly valued, his struggle to professional status without such an asset may be directly reflected upon the ratings given on the personality trait rating scales. The L trait rating scales have been included in the questionnaire in order objectively to allow the survey group to evaluate the achievement, or degree of competency, of both types of engineer.

The inclusion of rating scales in a questionnaire to a group untrained in their use may be considered as rather hazardous. Their use however, is justified, when considered from a questionnaire standpoint, as it can be seen that a considerable number of possibilities exist, regarding scoring and numerical interpretation. It is recognized, however, that from a strict rating scale standpoint the technique employed is rather

crude. As the engineer is in all likelihood untrained in the use of rating scales, extremely objective and sound scaling practice must be subordinated to simplicity of design and assurance of returns. Five grades upon the rating scales have been selected after a statement by Kingsbury[11] upon the degree of quality of each trait. He found out that the scale of five items, closely related to the work being considered, proved the most satisfactory for use by executives without training in psychology.

There has been some suggestion about altering the order of the ratings, that the highest value be placed to the right in one trait, and to the left in the following trait, and so on alternatively. This would no doubt have the effect of making the ratings more objective, but the ensuing confusion to the untrained rater may more than offset this advantage. This may again be considered as making the instrument too complex for the untrained judge.

To avoid confusion as to who answers the questionnaire each one is numbered, and a record kept of the addressee, his qualifications, and his training background. Omission of this practice is a common pitfall, according to Franzen and Lazarsfeld.[12] They point out that we do not often know who it is who answers the questionnaire. In this research all the interviewees were requested to sign their questionnaire upon completion.

If the numerical distribution of responses on the rating scales of the questionnaire were normal, should not the centre boxes on the

---

11 Kingsbury, Forrest A., Making Rating Scales Work, in the Journal of Personnel Research, Vol. IV, May, 1925, p.1-6.

12 Franzen, Raymond, and Paul F. Lazarsfeld, Mail Questionnaire as Research Problem, in the Journal of Psychology, Vol.20, 2nd half, Oct. 1945, p.294.

rating scales be large, and the others decrease in size as they neared the outside periphery? In the interest of being able to get all of the boxed categories on the rating scale it was decided to give them all equal size. It must also be remembered that we did not possess any weights for each box, and their frequency of occurence in the population was unknown. It may also be debated as to whether it is wise to give graphic illustration to the distribution of replies upon the rating scales, as the suggestive effect of the larger size box may cause the rater to mark it in preference to the smaller ones upon the periphery.

The rough design of the scales, the form, and the wording and scoring procedure of the questionnaire was completed using Burtt[13] as a guide.

An introductory sheet of instructions to the Members of the Engineering Institute of Canada, a separate sheet of questions concerning experience and the proportions of engineers interviewed and later employed, and a ten trait double rating scale sheet, a total of three pages, was first designed. When a number of engineers were questioned as to what they thought about this questionnaire, they expressed the opinion that this three page arrangement was too long and tedious. Furthermore, upon examination, the ten trait rating scale sheet was found to contain a slight duplication of the first six traits by the last four traits. This long three page arrangement was then discarded. A sample copy of this discarded questionnaire has been included in Appendix 1.

---

13 Burtt, Harold Ernest, Principles of Employment Psychology, New York, Harper and Bros., 1942, p.370-4.

A shorter questionnaire was then designed, it combined on a single sheet the questions concerning the engineer's experience, the proportion of engineers interviewed and later employed by him, and six double graphic rating scales. This was then administered, together with the original introductory sheet of instructions, to another small group of engineers. These engineers expressed satisfaction with the length of the shorter questionnaire, its logic to their way of thinking, and its clarity of presentation. This two page questionnaire was then adopted as practical for the survey, as it was considered that the survey group understood its meaning and the manner in which it was to be filled out. A sample copy of this questionnaire will be found in Appendix 2.

The scoring of the rating scales is of the 12345 sigma type for each scale. This simple scoring method has been favourably commented upon by McNemar.[14] He showed that there was increase of reliability from .78 to .88 when compared to scores secured by the Thurstone method, using the neutral point in the rating scale. This reliability was computed using the product-moment correlation formula between the two sets of measures. Emphasis was given to the interpretation of those means that appeared to have significant statistical differences.[15]

Each rating scale in the questionnaire is of the double type, one line being for the university trained, and the other line for the practically trained engineer, and so on alternatively. This enables the employer to see and compare the ratings that he gave to both types of engineer.

---

14 McNemar, Quinn, Opinion-Attitude Methodology, in the Psychological Bulletin, Vol. 43, No. 4, July 1946, p. 306.

15 id. ibid., p.338.

CHAPTER III

CARRYING OUT THE SURVEY

The administration of the instrument to the group surveyed, as defined in the previous chapter, was carried out by personal interview whenever possible. Where this procedure was not possible the questionnaire forms were mailed to the employers. The latest addresses were derived directly from the last issue of the List of Members of the Engineering Institute of Canada. It was attempted to interview only selected members who held higher engineering positions in Ottawa, and also a number in Montreal. During interviews the ten trait rating scale forms were used, as these contained material identical to that of the shorter form, these were marked by the interviewer only. When the interviewee wished it, he filled out the shorter form in the presence of the interviewer, who assisted him in any way possible. During interviews, these subjects were encouraged to make any personal remarks they saw fit, and to write these remarks in the space provided, or upon the back of the questionnaire.

In conducting the interview the interviewer was careful not to commit himself to either one or the other side of the question under survey. The interviewer was also careful about not siding up with one or the other methods of training engineers. This was a very necessary precaution, as it was observed that some engineers became rather vehement in defence of their own, or their preferred method of training engineers. This impartiality on the part of the interviewer seemed to elucidate a

more serious and considered response when the employer filled out the rating scale questionnaire.

The cooperation of the Engineering Institute of Canada was mentioned in the introductory page of the questionnaire as an aid towards receiving a higher proportion of returns from all employers who were interviewed, or who received mailed questionnaires. During the preliminary phase of the interview the names of a few of the more eminent respondents were mentioned, this was a form of prestige suggestion as to the importance of the problem of training engineers, and also to achieve maximum cooperation on the part of the employer.

A positive response upon the first question, "Have you had experience with both types of engineer?" was a pre-requisite before the questionnaire was accepted for evaluation and scoring. An employer could not very well be expected to evaluate a group of people with whom he had had no experience, hence the critical importance of this question. The mailed questionnaires contained stamped, addressed, and numbered return envelopes to help assure returns, and for easier identification of the completed forms.

It was noted which of the two types, the practical, or the university engineer, was the more cooperative as a group during the interview procedure. The differences in rating on the P traits, as compared to the L traits, may throw some light upon the engineer's evaluation of himself as a member of a group. This was statistically

compared in the results and analysis of returns.

Finally, an attempt was made to discern if the engineer felt that any discrimination was held against him because of his training background. In this respect special emphasis was placed upon the apprenticeship trained practical engineer, as he is losing his former position in Canadian engineering due to his decrease in numbers. The questionnaire denoted the university trained engineer as a "theoretical" engineer. This was considered a mistake in the wording of the questionnaire, but the survey was too far advanced for any correction to be made. This was explained orally during interviews.

CHAPTER IV

THE SURVEY RESULTS AND THE INTERPRETATION OF RETURNS

Of 55 questionnaires sent out to engineers in executive and employer positions, 37 were returned by the date that compilation was commenced. Of the 37 returned, 34 were used in the computation of data and three were rejected due to insufficient knowledge of the engineer's background, and improper and incompletely filled out rating scales. In this chapter the rating scale returns are given first, and are followed by the immediate interpretation. Emphasis is given to the interpretation of those means that appear to have significant statistical differences. This methodology is to be successively followed until all of the possibilities are exhausted.

Of all of the questionnaires returned there was a one hundred percent positive reply to the question; "Have you had experience with both types of engineer?" This consistency could be indicative of the engineer employer's awareness of the existence of the two groups in professional engineering positions in Canada. There was a further unquestioned acceptance of the two categories of engineer, with one exception, this being questionnaire number 101. This exception was a clear indication of rejection of the opposite group as being a professional one. The interviewee in this case substituted two categories of his own making, one of which was the professional, and the other the technician. This happened after he was told that both groups had official

professional status, and were recognized by well known organizations. The respondent then filled out the questionnaire, much to the advantage of his own group. Cantril explains a similar response to a questionnaire in the following way.[16]

> This rejection may be considered as a bias, and the individual's opinion to be more superficial and unstable than those of the more cooperative respondents.

About fifty percent of the respondents were interviewed, and the remainder mailed their returns. Upon the following page is shown a condensed tabular picture of the answers to the direct questions upon the instrument of the survey. The even numbers were questionnaires sent to employers of practical training background, whereas the odd numbered questionnaires were sent to university trained employers.

An examination of the personal remarks column of the questionnaire returns, and some accompanying letters, revealed that approximately thirty percent of the employers had no remarks. The remaining seventy percent enclosed remarks and letters ranging from outright cooperation to opinions about the nature of the survey, suggestions, and even a change in the classification, as mentioned previously (questionnaire number 101). The practical employers gave the more lengthy and elaborate discussions about the inclusion of practical training in the university curriculum, and longer descriptions of their experiences in the course of their careers.

---

16 Cantril, Hadley, Gauging Public Opinion, Princeton University Press, Princeton, 1944, p. 119-23.

TABLE II.-

Answers of the "Practical" Engineer Employers.

Questionnaire number	Have you had experience with both types ?		Proportions interviewed %		Proportions employed %		Personal remarks	
	Yes	No	T.	P	T	P	Yes	None
102	yes	-	90	10	-	-	yes	-
104	yes	-	60	40	65	35	yes	-
106	yes	-	75	25	40	60	yes	-
108	yes	-	50	50	50	50	yes	-
112	yes	-	50	50	50	50	-	none
114	yes	-	75	25	-	-	yes	-
120	yes	-	70	30	60	40	-	none
122	yes	-	25	75	25	75	yes	-
124	yes	-	30	70	30	70	yes	-
130	yes	-	70	30	50	50	yes	-
132	yes	-	-	-	-	-	yes	-
136	yes	-	-	-	60	40	yes	-
138	yes	-	60	40	25	75	yes	-
140	yes	-	-	-	40	60	yes	-
142	yes	-	-	-	-	-	-	none
144	yes	-	50	50	00	100	-	none
146	yes	-	50	50	40	60	yes	-
Means in %	100	00	58.2	41.8	41.2	58.8	76	24

Answers of the "Theoretical" Engineer Employers.

101	yes	-	25	75	75	25	yes	-
111	yes	-	40	60	70	30	-	none
115	yes	-	60	40	60	40	-	none
119	yes	-	25	75	25	75	yes	-
121	yes	-	-	-	-	-	-	none
123	yes	-	50	50	70	30	yes	-
133	yes	-	-	-	40	60	yes	-
137	yes	-	90	10	95	05	-	none
147	yes	-	-	-	-	-	-	none
151	yes	-	-	-	-	-	yes	-
153	yes	-	50	50	75	25	yes	-
155	yes	-	75	25	90	10	yes	-
157	yes	-	65	35	80	20	yes	-
159	yes	-	95	05	95	05	yes	-
161	yes	-	-	-	60	40	-	none
163	yes	-	-	-	-	-	yes	-
165	yes	-	70	30	30	70	-	none
Means in %	100	00	60.8	39.2	68.9	31.1	59	41

The university trained employers were considerably more brief, confined their remarks more to the nature of the survey, and were considerably more critical as to the value of the results.

The outstanding feature of the personal remarks were that a number of employers voiced opinions that the type of person rated should be given only with consideration for the job requirements. This was a very sound suggestion, and is considered good personnel practice.[17] Several employers went even further than this, and specified the type of work that each engineer's background is the more suitable for. The replies to the personal remarks column are listed in the Appendix beside the questionnaire number on which the return was made, this may be used for a convenient analysis. It will again be emphasized that the employer, by his written remarks, seems to be keenly aware of the existence of the two types of engineer. Several practical engineers came out with straight preferential remarks in favour of engineers of his own background. On the whole, the employers did not seem to have a great deal of difficulty in filling out the rating scales of the questionnaires.

It can be seen that some employers started out in the wrong manner. They did not seem to see that the theoretical, (university trained), and the practical scales alternated on each succeeding double rating scale. These engineers would then start out, get down to the fourth or fifth trait, erase or delete their errors, and then start over again. This fumbling is apparent in some questionnaires, as close examination reveals that a line

---

17 Ghiselli, Edwin E., and Clarence W. Brown, Personnel and Industrial Psychology, New York, McGraw-Hill, 1948, p. 140.

of check marks have been scrubbed out, and new starts made. This justifies our previous apprehension about making the rating scales too complicated, as engineers are untrained in their use.

Upon the succeeding pages of this chapter the numerical data of the returns is presented first, and is immediately followed by the interpretation. This procedure is adhered to throughout the remainder of this chapter. The first data on Table III shows the ratings given by all employers upon the ability of both types of engineers, and are given in a mean figure and its average deviation for each trait.

The average deviation has been used as the measure of variability for the data of this research for reasons which are outlined by Guilford.[18] He states that the average deviation finds its greatest usefulness in cases where N is rather small. The average deviation closely approximates the standard deviation, being approximately 0.8 as large in a normal distribution of data, and within a range of plus or minus one average deviation are to be expected about 58 percent of the cases. Guilford also makes the following comparison to the standard deviation.

> If a distribution should have an unusual number of extreme cases in one or both directions from the mean, the average deviation is a markedly better statistic than the standard deviation.

Whereas the interpretation of each individual trait is to be drawn from the comparison of the means and their deviations, the comparison of the total scores are to be made using the critical ratio between total

---

18 Guilford, J. P., Fundemental Statistics in Psychology and Education, New York, McGraw-Hill, 1st. Edition, 1942, p.59-61.

scores obtained on the questionnaires by both types of engineers. Riker[19] has demonstrated that when he compared the discriminating ability of three types of rating scale using the mean and a standard deviation no statistically significant difference was obtained between these measures. However the same author[20] later demonstrated that by using the critical ratio it was indicated that a reliable difference existed between the means. Using the method of critical ratios between the means of the total responses on the rating scale returns it is shown that no differences exist between the practical and the university engineer. The critical ratio is, however, computed for each set of data as a precaution, but the interpretation in the main is obtained by a comparison of means and their deviations upon each individual trait.

It may be noticed upon visual analysis of Table III that the practical engineer attained a higher rating in all of the personality traits than the university trained engineer. The differences are not very great however, and do not appear to be statistically significant. The greatest difference between means appears to be in trait (6), which is mathematical ability. The difference between ratings attained by the two types of engineer upon this trait is shown to be significant at all levels of prediction by an analysis of variance which may be seen in Appendix 4 of this thesis.

A scrutiny of the means of Table III shows that in general the

---

19 Riker, B. L., A Comparison of Methods Used in Attitude Research, in the Journal of Abnormal and Social Psychology, Vol.39, 1944, p.24-42.

20 A Comparison of Attitude Scales - a Correction, in the Journal of Abnormal and Social Psychology, Vol.40, 1945, p.102-3.

TABLE III.-

Ratings Given by all Employers upon the Ability of Both Types of Engineers.

	Traits	Practical Engineers Mn.	A.D.	University Engineers Mn.	A.D.
(1)	Initiative	3.65	.53	3.53	.52
(2)	Theoretical knowledge	3.12	.46	4.30	.50
(3)	Appearance	3.97	.49	3.73	.43
(4)	Practical knowledge	4.44	.58	3.59	.56
(5)	Co-operativeness	4.38	.56	4.12	.58
(6)	Mathematical ability	3.59	.38	4.86	.25

(N = 34)

overall ability of the university trained engineer is considered by employers to be slightly higher than that of the practical engineer, although not significantly so. When the critical ratio is drawn between the two means arranged from the total raw data of Appendix 3 it had a value of .259 times the sigma of the difference between the means. This C. R. of .259 upon interpretation on a table of normal curve functions gave a value of .80 times by chance. This indicates that differences as large as this occur in 80 cases out a hundred. We must therefore accept the null hypothesis of no significant differences between means. This mensuration is based upon the assumption of normality of distribution of the raw data if a large enough sample is drawn. The critical ratio is computed using the formula of the difference between means divided by the sigma of the difference between means, as illustrated by McNemar.[21]

As the critical ratio mentioned above yields no indication of difference between the practical and the university engineer we must return to the interpretation of differences in ratings upon each separate trait. All of the traits will be commented upon although it is only trait (6) that shows significant difference between the two types of engineers at all levels of prediction.

If all the means upon all traits were to be summed and averaged it would be seen that the university trained engineer is thought higher of than the practical engineer by the employers. This overall superiority depends greatly upon traits (2) and (6), which are theoretical knowledge, and

---

21 McNemar, Quinn, Psychological Statistics, John Wiley and Sons, New York, 1949, p.66.

mathematical ability, and upon which the mean differences are the highest. If an employer were to consider these traits to be of great importance, he may then prefer the university trained man. This situation could apply to positions in engineering design and research, where the work demands exceptional ability in these two traits.

To look at the practical engineer, he attained a higher, although not significant, rating in the other four traits. He could be looked upon by the employer as being the better rounded man, and may better fill the requirements of a job in maintenance and construction, as these traits are more heavily leaned upon in these two divisions of engineering practice. These comments are made with the sole purpose of roughly matching the requirements of the work with the engineer's abilities, as is the practice in employment psychology.

It remains to determine the numerical contributions towards the total scores from the viewpoint of who made them, the practical or the university trained engineer employers. Upon the following page Table IV shows the ratings on each trait in means and average deviations, as given by the practical employers.

As before, the critical ratio is drawn between means obtained from the raw scores given by the practical employers, and was found to have a value.585. Upon interpretation it was found that differences as large as those between the means of this raw data occur in 56 cases out of 100. We must therefore accept the null hypothesis of no significant difference between means on the total raw data of all traits as given by the practical employers. We are therefore left with the alternative of interpreting ratings upon each trait of Table IV.

TABLE IV.-

Ratings Given by the Practical Employers upon the Ability of the Two Groups.

Traits	Practical Engineers Mn.	A.D.	University Engineers Mn.	A.D.
(1) Initiative	4.06	.33	3.06	.79
(2) Theoretical knowledge	3.41	.48	4.12	.50
(3) Appearance	4.23	.45	3.41	.62
(4) Practical knowledge	4.53	.55	3.41	.67
(5) Cooperativeness	4.65	.50	3.88	.62
(6) Mathematical ability	3.82	.29	4.88	.21

(N = 17)

It may be observed from Table IV that the practically trained employer gave the practical engineer a higher rating than the university trained engineer upon all of the personality traits, although the only difference approaching significance appears to be upon initiative, which is trait (1). Mathematical ability, trait (6), is another trait upon which the practical employer rates the practical engineer significantly low when compared to the university engineer. Practical knowledge, trait (4), is a trait upon which the practical engineer is rated significantly high. In general, the high ratings given to the practical engineer by the practical employer may have been sufficient to account for the higher ratings that the practical engineer enjoyed upon all of the personality traits as seen on Table III. If this is the case, it will be apparent upon inspection of Table V, which will show the ratings given by the university trained employers upon both types of engineers.

That the practical employer is one of, and acquainted with the group that he rates the highest may help to explain why he considers them more competent than his university trained brother. Knight[22] has shown that the factor of acquaintance usually operates to make ratings more lenient, less critical, and less analytical, and to impart a "halo" to the general estimate. A similar explanation forwarded by Landis[23] is that intimate acquaintance with the individual rated, (the practical employer to the practical engineer) does affect the validity of ratings, it is probably

---

22 Knight, F.B., The Effect of the Acquaintance Factor Upon Personal Judgments, in the Journal of Educational Psychology, Vol. XIV, Issue of March, 1923, p. 129-42.

23 Landis, Carney, The Justification of Judgments, in the Journal of Personnel Research, Vol.IV, issue of May, 1925, p.7-19.

caused by inducing a "halo" effect which spreads over each of the items rated.

The practical employer gave his group a higher rating on four of the six traits, which compares identically with the distribution of ratings on the various traits given by both types of employer as shown on Table III. An analysis of Table V on the next page will determine whether the practical engineer's higher rating on traits (1), (3), (4), and (5) on Table III was obtained from the practical engineer employer's overloading of these four traits in favor of his own group, or if he has a moderate degree of support from the university employer. Table V is therefore given on the next page, and shows the mean and its deviation upon the various traits, as given by the university trained engineer employers.

The critical ratio was drawn between means obtained from the raw scores given by the university trained employers. This critical ratio was found to have a value of 1.17, which upon interpretation showed that differences as large as those between the means of this raw data occur in about 24 cases out of 100. We must therefore accept the null hypothesis of no significant differences between means on the total raw data of all traits as given by the university employers. We must therefore continue with the alternative of interpreting ratings upon each trait of Table V.

It may be observed from Table V that the university employer gave his group a higher rating than the practical engineer upon all traits with the exception of trait (4), which is practical knowledge. His ratings on personality differences between the two groups show a very slight difference between means when compared to the ratings given by the practical employers.

TABLE V.-

Ratings Given by the University Employers upon the Ability of the Two Groups.

	Traits	Practical Engineers		University Engineers	
		Mn.	A.D.	Mn.	A.D.
(1)	Initiative	3.23	.72	4.00	.24
(2)	Theoretical knowledge	2.82	.43	4.47	.50
(3)	Appearance	3.70	.53	4.06	.33
(4)	Practical knowledge	4.35	.61	3.76	.45
(5)	Cooperativeness	4.12	.62	4.35	.53
(6)	Mathematical ability	3.35	.46	4.82	.29

(N = 17)

It may therefore be seen that the overall differences between the practical and the university engineers as on Table III came from the practical employers themselves. This is with special reference to their differences upon the personality traits, which are to undergo further investigation upon Table VI.

From Table V it appears that the university trained employer considers his group to be of general higher competence than the practical engineer. From an analysis of the preceding tables it is seen that the advantage that the university engineer enjoys on traits (2) and (6) of Table III comes from the ratings given by both the practically and the university trained employers. The slightly higher rating that the practical engineer enjoys on traits (1), (3), (4), and (5) of Table III come mainly from the practical employer's overloading of these traits in favor of his own group. The exception was trait (4), upon which the ratings by both types of employers were unanimously in favor of the practical engineer, although not significantly so.

The reluctance of the university employers to give their own group higher comparative ratings upon the personality traits may be a reflection of their personalities as members of the group that enjoys a certain measure of social status and professional security. This is in contrast to the practical engineer employers who have had to fight their way to professional status without the benefits of a university degree, and who subsequently may be more aggressive and definite in their behaviour. As an employer the practical engineer may unconsciously give his own group a high rating as a defence of his prestige.

It remains to consider the two groups of employers, separated as to the ratings they gave to both types of engineers upon personality and learned traits. Upon the following page Table VI shows the ratings upon personality traits (1), (3), and (5), separated as to which type of employer contributed them. Upon the page succeeding this Table VII gives the ratings upon "L" traits (2), (4), and (6), separated as to which type of employer gave the rating.

When the critical ratios are calculated between the raw lumped scores attained by both types of engineers upon the three personality traits and the three learned traits, they had the following values:-

Contributor	Personality Traits	Learned Traits
Practical Employers	1.20	.363
University Employers	.218	.759

It may be seen that none of these critical ratios approach a value of 3, which is customarily accepted as an indication of significant difference. We must therefore accept the null hypothesis of no significant difference between the means of lumped data that the practical and the university engineer attained upon the grouped personality and learned traits. It remains, as is the established practice of this chapter, to interpret Tables VI and VII upon the bais of a difference existing in the ratings attained by the two types of engineer upon each separate trait.

TABLE VI.-

Ratings Given on the Personality Traits by Both Types of Employers.

	Traits	University Engineers Mn.	University Engineers A.D.	Practical Engineers Mn.	Practical Engineers A.D.
	Ratings given by the practical employers. (N = 17)				
(1)	Initiative	3.06	.79	4.06	.33
(3)	Appearance	3.41	.62	4.23	.45
(5)	Cooperativeness	3.88	.62	4.65	.50
	Ratings given by the university employers. (N = 17)				
(1)	Initiative	4.00	.24	3.23	.72
(3)	Appearance	4.06	.33	3.70	.53
(5)	Cooperativeness	4.35	.53	4.12	.62

TABLE VII.-

Ratings Given on the Learned Traits by Both Types of Employers.

	Traits	University Engineers Mn.	A.D.	Practical Engineers Mn.	A.D.
	Ratings given by the practical employers. (N = 17)				
(2)	Theoretical knowledge	4.12	.50	3.41	.48
(4)	Practical knowledge	3.41	.67	4.53	.55
(6)	Mathematical ability	4.88	.21	3.82	.29
	Ratings given by the university employers. (N = 17)				
(2)	Theoretical knowledge	4.47	.50	2.82	.43
(4)	Practical knowledge	3.76	.45	4.35	.61
(6)	Mathematical ability	4.82	.29	3.35	.46

Upon Table VI the results of the previous tables are confirmed, that is, that the practical employer tends to rate the practical engineer a great deal higher upon the personality traits than the university employer does the university engineers. This may be his only alternative, since he cannot claim superiority upon the more concrete learned traits he then bases his claims upon the more abstract personality characteristics. None of these personality differences approach the more significant levels of difference, the highest being the trait of initiative, as given to the practical engineers from the practical employers.

Table VII tells a somewhat different story. Both types of employers extoll the university engineer as being superior in theoretical knowledge and mathematical ability. The contribution of the practical employer on theoretical knowledge does not quite approach a significant difference, whereas the university employer states a significant difference. Upon mathematical ability the university engineer obtained a statistically significant advantage from both types of employers. The practical engineer is seen to be considered superior upon practical knowledge by both types of employer, but a significant difference is not claimed by either type of employer.

The summary and conclusions will now state the survey findings in more general terms upon the next chapter.

CHAPTER V

SUMMARY AND CONCLUSIONS

(1) A small group of Canadian executive engineers are conscious of the existence of two basically different methods of training professional engineers. These executives are aware of the existence of the practical engineer, as defined in this research. To the practical engineer he attributes a measurably different set of professional qualifications in comparison to the university trained engineer. An indication of this is shown by the one hundred percent positive response to the survey question; Have you had experience with both types of engineer?

(2) Some differences between the university and the non-university educated engineer are measurable upon six traits, namely, initiative, theoretical knowledge, appearance, knowledge of practical problems, cooperativeness, and mathematical ability. This finding is illustrated by the different ratings given to both types of engineer by the employers.

(3) From observations of engineers during interviews, it is reported that non-university trained engineers uniformly accept classification as "practical" engineers. University trained engineers tended to reject uniform classification as "theoretical" engineers, and generally considered themselves as "professional" engineers. The classification as a "theoretical" engineer, which was a mistake in the questionnaire wording, was uniformly rejected by the university trained engineers.

(4) The engineer's educational background is a determinant of his opinion as to the efficiency of each of the groups. Each type of engineer considers other engineers with a background of education similar to that of his own to be the more competent engineer.

This is concluded, and verified, by the total ratings that each group of engineers gave themselves upon all traits. From an analysis of these traits, it is shown that each engineer considers himself the better due to different causes. Practical engineers consider themselves more competent for the reason of a more adaptable personality, and gave themselves higher ratings upon initiative, appearance, practical knowledge, and cooperativeness. The university trained engineer considered himself more competent due to a better technical knowledge of engineering. He gave himself a higher rating upon all traits, with the exception of practical knowledge.

(5) These preferences are roughly related to actual employment practice, as it exists in professional engineering in Canada. This personal preference for an engineer of his own training background is put into practice by the engineer employer. He will employ an engineer with an educational background similar to that of his own more often than he will employ one of a different background. This is seen when the proportions of the two types of engineer that the employer interviews are compared with the proportions that he later hires. The employer's estimates of the proportions interviewed are seen to be in rough correspondence with the actual proportions that exist in the true engineering population. This confirms the employer's estimates as being somewhat truthful.

(6) Practical engineers seem to place more reliance upon their personality in the attainment of their professional status, and in the

carrying out of their professional duties. The practical engineer was found to be more definite and lengthy in his personal remarks on the questionnaire returns. This observation was also found to apply during interviews with practical engineers. The university trained engineer tended to be much more conservative and inhibited during oral interviews.

(7) The single trait of most significant difference between the two groups was number six, which was mathematical ability. An analysis of variance upon the ratings given to both groups on this trait has established a significant difference between the university and the practical engineer at all levels of prediction. The difference is so great that it would be tenable to estimate that the practical engineer is deficient in this trait, when compared to the demands of his occupation.

(8) The possession of a university degree was found to be a very touchy question among the practical engineers. During interviews some of these engineers evaded the direct query and talked of the correspondence and other coures they had taken, and of their indirect university affiliations, in an embarrased manner. Several expressed regret at not having a university degree although they did not rate themselves as deficient or handicapped in their ability to carry out their professional duties.

BIBLIOGRAPHY

Burtt, Harold Ernest, Principles of Employment Psychology, New York, Harper and Bros., 1942.

Cantril, Hadley, Gauging Public Opinion, Princeton, Princeton University Press, 1944, Pp.318.

Civil Service of Canada, Basic Requirements of Engineers, 1948.

Engineering Institute of Canada, List of Members, May 1932.

Engineering Institute of Canada, Professional Requirements of a Member, in the Engineering Journal, Vol.32, No.10, Oct.1949.

Fisher and Yates, Statistical Tables for Biological, Agricultural and Medical Research, Edinburgh, Oliver and Boyd Ltd.

Franzen, Raymond, and Paul F. Lazarsfeld, Mail Questionnaire as a Research Problem, in the Journal of Psychology, Vol.20, 2nd.half, Oct.1945.

Ghiselli, Edwin E., and Clarence W. Brown, Personnel and Industrial Psychology, New York, McGraw-Hill, 1948, Pp.475.

Guilford, J.P., Fundemental Statistics in Psychology and Education, New York, McGraw-Hill, 1942, Pp.333.

Kingsbury, Forrest A., Making Rating Scales Work, in the Journal of Personnal Research, Vol.IV, May 1925.

Knight, F.B., The Effect of the Acquaintance Factor Upon Personal Judgments, in the Journal of Educational Psychology, Vol.XIV, issue of March, 1923.

Kornhauser, Arthur W., The Reliability of Average Ratings, in the Journal of Personnel Research, Vol.V, issue of 1926-27.

Landis, Carney, The Justification of Judgments, in the Journal of Personnel Research, Vol.IV, issue of May 1925.

Massue, Huet, A Study of the Engineering Institute of Canada, an original monograph for the Engineering Institute of Canada, Montreal, 1947.

McNemar, Quinn, Psychological Statistics, New York, John Wiley and Sons, 1949, Pp.364.

McNemar, Quinn, Opinion-Attitude Methodology, in the Psychological Bulletin, Vol.45, No.4, July 1946.

Riker, B.L., A Comparison of Methods Used in Attitude Research, in the Journal of Abnormal and Social Psychology, Vol.39, 1944.

Riker, B.L., A Comparison of Attitude Scales - a Correction, in the Journal of Abnormal and Social Psychology, Vol.40, 1945.

Symonds, Percival M., Diagnosing Personality and Conduct, New York and London, The Century Company, 1931, Pp.602.

APPENDIX 1

Specimens of the questionnaire designed for and discarded from this survey.

To the Members of the Engineering Institute of Canada

A survey of opinions is being conducted by the Institute of Psychology of the University of Ottawa, with the co-operation of the Engineering Institute of Canada. This survey is to deal with two types of professional engineers of different backgrounds, both of which are practicing in Canada today. These two types are readily recognized by the senior engineer who is in a position to employ other engineers.

"The Practical Engineer", is the engineer who has had either the British apprenticeship training, or a long practical training in a particular industry. This training includes a systematic training in each department coupled with actual experience in it. This group may include those engineers that have written the membership requirement examination of the Engineering Institute of Canada, but have possession of only slight formal background.

"The Theoretical Engineer", is the the engineer who recieves formal technical training in university and graduates with an engineering degree in his particular specialty.

It is assumed that many senior Canadian engineers have had experience, or dealings with both groups, and that these engineers have their own personal opinions about the relative merits of these two methods of training. These opinions, when not expressed openly and objectively may result in job discrimination and rivalry. A survey of this kind may reveal if such a situation exists. If such is the case, this survey may aid in establishing harmony and understanding, to the advantage of the entire engineering profession.

Would you please fill out the enclosed questionnaire by placing a check mark in the spaces allocated. You will thus express your opinion in a manner that may be evaluated statistically. An addressed and stamped envelope is enclosed for the return of the questionnaire. Your information is confidential, no names will be divulged, and all the returned questionnaires will be destroyed upon the compilation of this data. Remember, it is your opinion that counts, you use it in everyday life. Please indicate what you truthfully believe.

(PAGE 1 OF THE ORIGINAL QUESTIONNAIRE)

Please indicate if you have had experience with both types of engineers.

Yes ( ) No ( )

What approximate proportion of "practical" versus "theoretical" engineers have you interviewed for employment ?

Practical		Theoretical		
( ) 0		( ) 100		
( ) 20		( ) 80		
( ) 40		( ) 60		
( ) 50	%	( ) 50	%	(check one only)
( ) 60		( ) 40		
( ) 80		( ) 20		
( ) 100		( ) 0		

Try to estimate the proportion of each type of engineer that you actually employed.

Theoretical		Practical		
( ) 0		( ) 100		
( ) 20		( ) 80		
( ) 40		( ) 60		
( ) 50	%	( ) 50	%	(check one only)
( ) 60		( ) 40		
( ) 80		( ) 20		
( ) 100		( ) 0		

Personal remarks :

(PAGE 2 OF THE ORIGINAL QUESTIONNAIRE)

(1) Consider the engineer's ability to go ahead with a task without being told every detail.

Practical						
	very original	resourceful	suggests occasionally	routine worker	needs constant supervision	I
Theoretical						

(2) Consider the engineer's ability to do problems which involve a great deal of basic theoretical knowledge.

Theoretical						
	highest quality	good quality	mediocre	careless	many errors	I
Practical						

(3) Consider the engineer's success in winning confidence and respect through his manner and appearance.

Practical						
	inspiring	favorable	indifferent	unfavorable	repellent	P
Theoretical						

(4) Consider the engineer's ability to do practical problems which involve personal knowledge of the machine shop and actual factory methods.

Theoretical					
	expert	competent	uninformed	neglects and mis-interprets facts	L
Practical					

(5) Consider the engineer's co-operativeness, his ability to work with others.

Practical					
	co-operative	falls in line	difficult	obstructionist	P
Theoretical					

(6) Consider the engineer's ability to present and interpret figures.

Theoretical					
	expert	competent	uninformed	misinterprets	I
Practical					

(7) Consider the engineer's energy and his application to his duties day in and day out.

Practical						
	very energetic	industrious	spasmodic	needs constant urging	lazy	I
Theoretical						

(8) Consider the engineer's knowledge of his work.

Theoretical						
	complete	well informed	moderate	meager	lacking	L
Practical						

(9) Consider the amount of work that the engineer accomplishes.

Practical						
	unusually high output	satisfactory output	average	limited output	unsatisfactory output	P
Theoretical						

(10) Consider the quality of his work by his accuracy and freedom from errors.

Theoretical						
	no errors	very careful	few errors	careless	many errors	I
Practical						

APPENDIX 2

Specimens of the questionnaire designed for and used in this survey.

To the Members of the Engineering Institute of Canada

A survey of opinions is being conducted by the Institute of Psychology of the University of Ottawa, with the co-operation of the Engineering Institute of Canada. This survey is to deal with two types of professional engineers of different backgrounds, both of which are practicing in Canada today. These two types are readily recognized by the senior engineer who is in a position to employ other engineers.

"The Practical Engineer", is the engineer who has had either the British apprenticeship training, or a long practical training in a particular industry. This training includes a systematic training in each department coupled with actual experience in it. This group may include those engineers that have written the membership requirement examination of the Engineering Institute of Canada, but have possesion of only slight formal background.

"The Theoretical Engineer", is the the engineer who recieves formal technical training in university and graduates with an engineering degree in his particular specialty.

It is assumed that many senior Canadian engineers have had experience, or dealings with both groups, and that these engineers have their own personal opinions about the relative merits of these two methods of training. These opinions, when not expressed openly and objectively may result in job discrimination and rivalry. A survey of this kind may reveal if such a situation exists. If such is the case, this survey may aid in establishing harmony and understanding, to the advantage of the entire engineering profession.

Would you please fill out the enclosed questionnaire by placing a check mark in the spaces allocated. You will thus express your opinion in a manner that may be evaluated statistically. An addressed and stamped envelope is enclosed for the return of the questionnaire. Your information is confidential, no names will be divulged, and all the returned questionnaires will be destroyed upon the compilation of this data. Remember, it is your opinion that counts, you use it in everyday life. Please indicate what you truthfully believe.

(PAGE 1 OF THE FINAL QUESTIONNAIRE)

Have you had experience with both types of engineers ? YES ( ) NO ( )

Try to recall roughly what proportion of each type of engineer that you have interviewed for employment, if any ?
"theoretical" was ( ) % of total interviewed.
"practical" was ( ) % of total interviewed.

50

Try to recall what proportion of each type that you actually employed.
"practical" was ( ) % of total employed.
"theoretical" was ( ) % of total employed.

Personal remarks :

Please put a check mark for both engineers in a marked off box on each line of the following six rating scales. (twelve checkmarks totally)

(1) Consider the engineer's ability to go ahead with a task without being told every detail.

	Practical					Theoretical
P	very original	resourceful	suggests occasionally	routine worker	needs constant supervision	L

(2) Consider the engineer's ability to do problems which involve a great deal of basic theoretical knowledge.

	Theoretical					Practical
L	highest quality	good quality	mediocre	careless	many errors	P

(3) Consider the engineer's success in winning confidence and respect through his manner and appearance.

	Practical					Theoretical
P	inspiring	favorable	indifferent	unfavorable	repellent	L

(4) Consider the engineer's ability to do practical problems which involve personal knowledge of the machine, shop and actual factory methods.

	Theoretical				Practical
L	expert	competent	uninformed	neglects and misinterprets facts	P

(5) Consider the engineer's co-operativeness, his ability to work with other

	Practical				Theoretical
P	co-operative	falls in line	difficult	obstructionist	L

(6) Consider the engineer's ability to present and interpret figures.

	Theoretical				Practical
L	expert	competent	uninformed	misinterpret	P

APPENDIX 3

RAW DATA FROM THE QUESTIONNAIRE RETURNS

Traits	P 1		L 2		P 3		L 4		P 5		L 6		Theoretical			Practical		
	T	P	T	P	T	P	T	P	T	P	T	P	Total	P	L	Total	P	L
102	2	4	4	4	4	4	4	5	3	4	5	4	22	9	13	25	12	13
104	4	3	4	3	4	4	3	4	5	5	5	4	25	13	12	23	12	11
106	2	4	5	4	3	5	3	5	4	4	5	4	22	9	13	23	12	11
108	4	3	5	3	3	4	4	5	4	3	5	4	25	11	14	22	10	12
112	3	4	4	3	3	4	4	5	5	4	5	3	24	11	13	23	12	11
114	3	4	4	3	3	4	4	5	5	4	5	3	24	11	13	23	12	11
120	5	4	4	3	4	4	4	5	3	5	5	4	25	12	13	25	13	12
122	3	4	4	3	4	3	3	4	5	5	4	3	23	12	1	22	12	10
124	4	5	4	3	4	5	4	5	5	5	5	4	26	13	13	27	15	12
130	3	5	4	4	4	5	3	4	3	5	5	4	22	10	12	27	15	12
132	3	4	4	4	3	4	5	3	4	5	5	4	24	10	14	24	13	11
136	5	4	4	3	4	4	4	5	3	5	5	4	25	12	13	25	13	12
138	2	4	1	4	2	4	2	4	3	5	5	4	15	7	8	25	13	12
140	3	4	5	3	3	5	3	4	4	4	5	4	23	10	13	24	13	11
142	1	4	4	3	3	4	2	5	3	5	5	4	18	7	11	25	13	12
144	2	5	4	4	2	4	3	5	4	5	4	4	19	8	11	27	14	13
146	3	4	5	3	4	4	4	4	4	5	5	4	25	11	14	24	13	11
	5269		7058		5872		5877		6679		8365		387	176	211	420	220	200
101	4	3	4	1	3	3	3	3	3	3	5	3	22	10	12	16	9	7
111	5	3	4	3	4	4	3	5	5	5	5	4	26	14	12	24	12	12
115	4	3	4	3	4	4	4	4	5	4	5	4	26	13	13	22	11	11
119	3	4	4	3	3	5	3	5	2	5	4	3	19	8	11	25	14	11
121	4	4	4	3	4	2	5	3	4	3	4	3	25	12	13	18	9	9
123	4	4	5	4	4	4	4	5	3	5	5	4	25	11	14	26	13	13
133	4	2	4	1	4	4	4	4	5	3	5	3	26	13	13	17	9	8
137	4	4	4	3	5	4	4	4	5	5	4	3	26	14	12	23	13	10
147	4	4	5	3	5	4	3	4	5	3	5	3	27	14	13	21	11	10
151	4	4	5	3	4	4	4	4	4	4	5	3	26	12	14	22	12	10
153	4	4	4	3	5	3	3	5	5	4	5	3	26	14	12	22	11	11
155	3	3	5	3	4	4	4	5	4	4	5	4	25	11	14	23	11	12
157	4	2	5	3	4	3	4	5	5	5	5	3	27	13	14	21	10	11
159	5	2	5	3	4	4	4	4	5	4	5	3	28	14	14	20	10	10
161	4	4	4	3	4	4	4	5	4	4	5	4	25	12	13	24	12	12
163	4	3	5	3	4	4	4	5	5	4	5	3	27	13	14	22	11	11
165	4	2	5	3	4	3	4	4	5	5	5	4	27	13	14	21	10	111
	6855		7648		6963		6474		7470		8257		433	199	220	367	190	181

RAW DATA FROM THE QUESTIONNAIRE RETURNS

Sums and Means
of the Previous Table

Traits	P 1 T	L 2 T	P 3 T	L 4 T	P 5 T	L 6 T	total	P	L
	52	70	58	58	66	83	387	176	211
	68	76	69	64	74	82	433	211	222
Totals	120	146	127	122	140	165	820	387	433
Means	3.53	4.30	3.73	3.59	4.12	4.86			

Traits	1 P	2 P	3 P	4 P	5 P	6 P	total	P	L
	69	58	72	77	79	65	420	220	200
	55	48	63	74	70	57	367	188	179
Totals	124	106	135	151	149	122	787	408	379
Means	3.65	3.12	3.97	4.44	4.38	3.59			

An analysis of variance on trait (6), mathematical ability, between groups T and P.

Raw Scores		Xs With Lowest Score Subtracted		X^2 Remainder Squared		
T	P	T	P	T	P	
5	4	2	1	4	1	
5	4	2	1	4	1	
5	4	2	1	4	1	
5	4	2	1	4	1	
5	3	2	0	4	0	
5	3	2	0	4	0	
5	4	2	1	4	1	
4	3	1	0	1	0	
5	4	2	1	4	1	
5	4	2	1	4	1	
5	4	2	1	4	1	
5	4	2	1	4	1	
5	4	2	1	4	1	
5	4	2	1	4	1	
5	4	2	1	4	1	
4	4	1	1	1	1	
5	4	2	1	4	1	
5	3	2	0	4	0	
5	4	2	1	4	1	
5	4	2	1	4	1	
4	3	1	0	1	0	
4	3	1	0	1	0	
5	4	2	1	4	1	
5	3	2	0	4	0	
4	3	1	0	1	0	
5	3	2	0	4	0	
5	3	2	0	4	0	
5	3	2	0	4	0	
5	4	2	1	4	1	
5	3	2	0	4	0	
5	3	2	0	4	0	
5	4	2	1	4	1	
5	3	2	0	4	0	
5	4	2	1	4	1	
	$(\Sigma X)_s$	63	20	83		$\Sigma(\Sigma X)_s$
	M_s	1.852	.588	1.22		M_s
	$(\Sigma X_s)^2$	3969	400	4369		$\Sigma(\Sigma X_s)^2$
	$(\Sigma X^2)_s$	121	20	141		$\Sigma(\Sigma X^2)_s$

Formulas -

$$\Sigma x^2 = \Sigma(\Sigma X^2) - \Sigma X \cdot M$$
$$141 - 83 \cdot 1.22$$
$$141 - 101.26$$
$$39.74$$

$$n\Sigma d^2 = \Sigma(\Sigma Xs)^2 / n - \Sigma X \cdot M$$
$$4369 / 34 - 83 \cdot 1.22$$
$$128.50 - 101.26$$
$$27.24$$

$$\Sigma x^2 s = \Sigma x^2 - n\Sigma d^2$$
$$39.74 - 27.24$$
$$12.50$$

F Ratio - (k is no. of groups)

	d.f.	s.s.	estimated variances
between sets	k - 1	$n\Sigma d^2 s$	
within sets	k(n-1)	$\Sigma x^2 s$	

d.f.	s.s.	estimated variances
1	27.24	27.14
66	12.50	.189
67		

$$\text{F ratio} = \frac{\text{between variance}}{\text{within variance}} = \frac{27.14}{.189} = 143.0$$

Using table for F, (Fisher and Yates)[24] at 60 degrees of freedom:

At the .05 level of significance = 4.00
" " .01 " " " = 7.08
" " .001 " " " = 11.97

The F ratio of 143.0 indicates a very significant difference between groups on trait (6).

---

24 Fisher and Yates, Statistical Tables for Biological, Agricultural and Medical Research, Table V, Oliver and Boyd, Ltd., Edinburgh.

Calculating the critical ratios:

C.R. = Difference / σ Difference

To get the S.E. of a difference within a set we take the square root of the variance:

$$\sigma_s = \sqrt{.189} = .435$$

Using $\sigma_D^2 = (\sigma_{M1}^2 \text{ plus } \sigma_{M2}^2) = (\sigma^2/n_1 \text{ plus } \sigma^2/n_2)$

$$= \frac{(.435)^2}{34} \text{ plus } \frac{(.435)^2}{34} = \frac{.378}{34}$$

$$= .011$$

$$\sigma_D = .105$$

Using	σ_D	x	C.R.	=	Diff.	(from t ratios, Fisher and Yates)[25]
	.10	x	2.000	=	.200	at the .05 level
	.10	x	2.390	=	.239	at the .02 level
	.10	x	2.660	=	.266	at the .01 level
	.10	x	3.460	=	.346	at the .001 level of prediction.

The actual difference for the column means is 1.22, so the difference is significant at all the above levels of prediction.

---

25 Fisher and Yates, op. cit., Table III.

APPENDIX 5

DATA FROM THE PERSONAL REMARKS COLUMN AND ACCOMPANYING LETTERS.

1. Data from the university trained engineer employers.

Questionnaire number:

101 - Changed classifications to Technical and Professional.

111 - No remarks.

113 - Very little experience with technical phases of engineering, our field being industrial, or management work.

115 - No remarks.

119 - Both the Theoretical and the Practical engineer seem to be uninformed in the liberal arts and social sciences. In an accompanying letter; "The relationship of the Practical and the Theoretical engineer is of increasing importance in the development of a useful profession, especially considering that the engineering profession as a whole is still in the infant stage in Canada." I hope that these questionnaires will help to throw some light on the situation.

121 - No remarks.

123 - To be factual, check marks below should in several cases be placed in more than one box of the same group on a percentage basis. Checks are therefore not necessarily estimated averages.

133 - Previous to 1942.

137 - No remarks.

147 - No remarks.

151 - In an accompanying letter; "I consider that this questionnaire tends to throw bias on the personal factor, questions 3, 4, and 5 have no bearing on how an engineer accomplishes his professional standing."

153 - Our engineers are drawn mainly from the university, which seems to me to be the only place where they can secure adequate training. Twenty five years ago the practical engineer was predominant in electrical engineering.

155 - I have found considerable variations in both the theoretical and practical engineers. The man's ability seems to be more important than his training.

157 - When the theoretical engineer has acquired the necessary experience he is by far the better man, and is more versatile, in all cases the man's personality and personal ability are major factors in his success or failure. In Canada today the great majority of the successful engineers are university graduates, and this majority is increasing every year.

159 - Practical engineers are O.K. for jobs in which they have been trained and experienced, but the theoretical engineers are better for tackling new problems.

161 - No remarks.

163 - Experience with the two types, all in the Services, in design, development, maintenance, repair and research, over a period of twenty years. I do not think that these assessments mean a great unless referred to a particular section of the work, e.g. design versus manufacturing, etc.

165 - No remarks.

2. Data from the practically trained engineer employers:

Questionnaire number:

102 - I was not in a position to employ, only to recommend, and my recommendations have been for practical men.

104 - In my judgement a practical engineer's services are as valuable as a theoretical engineer's to his employer, provided he has a good knowledge of higher mathematics.

106 - It is my conviction that students in mechanical engineering should take a practical course first in a machine shop, before starting the theoretical end. It makes him handy and self reliant, and these advantages are so great that I would go further, and for such students in a four year course I would merge the second and third years of the curriculum into one year at university. I did this with one of my sons (the other followed a legal course). He was first apprenticed in a machine shop. He then took a full three years at the bench, etc., and became a fully qualified mechanic. He then entered university where he took his full mechanical course. He is now the manager of a large machine factory, and is also a quick and accurate mechanic.

I am a consulting civil engineer, and even in this branch I would compel intending civil engineers to take concurrently a course of practical work at the university machine shop, so that he will learn to use his hands as easily as his head. I personally took an abridged course in a machine shop as a

youngster, and do not regret it. I am seventy two years old and have a small workshop of my own in the basement where I have made models of steel bridges I had previously built in the field. One of these is an arch nine feet long, containing 12,000 rivets. It took me a year to make.

108 - Have had experience with approximately five hundred engineers simultaneously, and have forty six years of engineering experience.

112 - No remarks.

114 - The two cannot be compared, they are both necessary, but rarely interchangeable.

120 - No remarks.

122 - Shortage of theoretical trained aeronautical engineers forced employment of practical men to meet wartime requirements.

124 - The following suggestions (ratings) are based on a theoretical man with three years experience after graduation, and a practical man with ten years experience.

130 - In an accompanying letter; There is a great deal to be said for the training of an engineer on the old British system of practical training, particularly for the mechanical or marine engineer who spends a lot of time in various shops, or departments, and at the same time receives theoretical training, usually at night courses. I think, however, that in England considerably more engineers now receive a university training than was the

case many years ago. It is my opinion that, as a general rule, an engineer, who has had a good theoretical training at a university combined with, or followed by, the necessary practical experience in the particular branch in which he intends to engage, is more competent than the one who has had only a practical training with little theory, although there are, no doubt, exceptions to this rule.

132 - I have not actually employed engineers. In my present capacity, however, I am in a position to see all applications and results of selection, and resultant employment. Since we are entering engineers into the Navy solely with the object of establishing a balanced staff of engineers the above cannot be answered (the interviewed versus employed part of the questionnaire)

136 - Engineers can be roughly divided into three classes - design, production, and administrative. If we are to leave out the Henry Fords and Ketterings then the field of design is left to the theoretical engineer, but production and administrative can well be either.

138 - Found practical man more efficient.

140 - Depends entirely upon the job requirement. Purpose of selection is to insure correct choice. Both are equally useful in their own fields, not otherwise.

142 - No remarks.

144 - No remarks.

146 - English and Scotch practically trained engineers have come under my observations more frequently than those of theoretical training.

APPENDIX 6

AN ABSTRACT OF

An opinion survey in the engineering profession[1]

The existence of two types of engineers in Canada is outlined in the first chapter of this thesis. Some aspects of, and the definition of the university and the non-university trained professional engineer, their differences in background, and their interactions with the industrial setting is traced. A plan to determine which type of engineer that employers consider the more competent is also evolved.

The consideration of a select group of engineer employers as being best representative of persons who may answer the question of difference between the university and the non-university engineer occupies the first part of the second chapter. The choice of an instrument to gather the opinions of the employers is resolved, and a questionnaire is decided upon. The subsequent development of, finding the employer's reaction to, and the adequacy of the questionnaire is then determined. The inclusion of rating scales is also discussed and justified in the latter part of this chapter.

The third chapter illustrates the practical problems of, and the actual manner in which the survey was carried out. As a good proportion of the engineer employers were interviewed, the manner in which their maximum response was obtained is described.

Chapter four is devoted to the immediate interpretation of returns. The total analysis revealed that about fifty percent of the respondents

---

1 Verdier, Paul A., An Opinion Survey in the Engineering Profession, an original thesis presented to the Institute of Psychology of the University of Ottawa, Ottawa, 1950, VIII-64 pages.

were interviewed and the other half mailed in their questionnaires. About seventy percent of the employers enclosed personal remarks in the column set aside for this purpose. The employers thought the survey to be reasonable, and that the two types of professional engineer did present more than a mere paper problem. The rating scales were scored on the Likert sigma simple scoring basis, and their resultant means and deviations upon several traits indicated significant differences on what the employers thought of the competence of the two types of engineers.

The conclusions, summarized in chapter five, indicate the following:

(1) That a small group of Canadian engineer employers are aware of the existence of the practical and the university trained professional engineer as representative of two different methods of training engineers.

(2) Some differences between the university and the non-university educated engineer are measurable upon rating scales of initiative, theoretical knowledge, appearance, knowledge of practical problems, cooperativeness, and mathematical ability.

(3) Non-university trained engineers tended to accept classification as "practical" engineers.

(4) The engineer employer's educational background influenced his opinion as to which type of engineer was the more competent.

(5) The employer's estimates of engineers interviewed were somewhat truthful, and in general accord with the true engineering population.

(6) Practical engineers place more reliance upon their personality rather than their technical knowledge in the attainment of their professional status when compared to the university trained engineer.

(7) The single trait of greatest difference between the two types of engineer was found to be mathematical ability.

(8) The possession of a university degree was found to be of considerable importance in itself to the engineer, even when not related to the requirements of the engineer's work.

Appended to the body of this thesis are the following:

1. A specimen of the discarded survey questionnaire, (a sample of the questionnaire that was discarded as unsuitable).

2. A specimen of the adopted survey questionnaire, (a sample of the questionnaire specially designed for and used on this survey).

3. Raw data from the questionnaire returns, (a concise summary of all the numerical returns from the questionnaire rating scales).

4. An analysis of variance on trait six, (computation of the degree of significance of the differences in rating that each type of engineer received upon mathematical ability).

5. Personal remarks and accompanying letters, (a numbered, direct listing of all the personal remarks and letters from the employers, for easy and convenient perusal).

6. An abstract of an opinion survey in the engineering profession.

FINISH

DEPARTMENT OF LABOUR
TECHNICAL PERSONNEL DIVISION
QUARTERLY BULLETIN

April - June 1952

Review of Technical Personnel Records

The review of the records of architects, engineers and scientists begun in 1951 in Canada is still under way. Some 39,000 questionnaires have been mailed to date and the response has been good. In this review use has been made of the membership lists of thirteen different professional societies and questionnaires have been mailed to about 27,000 members. Returns received from these professional groups average 80% with a high of 85% and a low of 72%. Follow-up letters are helping to bring in outstanding questionnaires. We have records of over 65,000 technical persons on file including the class of 1952, numbering some 4,000 and the classes of 1950 and 1951 numbering about 11,500. (The graduates of these three years are not included in the present review of our records).

When the completed questionnaire is received it is reviewed and the information provided is entered on tabulating sheets in code form. These tabulating sheets are then used to make punch cards, by means of which information regarding present location, sex, place of birth, allegiance, naturalization, year of birth, marital status, number of dependents, university training, military service, details of engineering or scientific skill, membership in professional bodies, employer type, remuneration, use of languages, and certain production experience on various groups of technical persons can be assembled. Approximately 21,000 punch cards have been made to date.

..... (2)

Statistics Relating to the Civil Engineering Group

In connection with this review punch cards have been made to date for 4040 who are coded under the Civil Engineering heading and are actively engaged. It should be noted that Civil graduates numbering over 1800 from the graduating classes of 1950, 1951, and the present year, 1952, are not included. Following are a few breakdowns of this 4040 sample which we feel might be of interest.

Birthplace:

Canada	3,299
United States	115
United Kingdom	408
Other Commonwealth Countries	62
Asia	12
Latin America and West Indies	6
Continental Europe	138
	4,040

Country of Allegiance

Canada	3,927
United States	42
British Commonwealth & Empire	37
Asiatic Countries	3
Continental Europe	29
Stateless	2
	4,040

Marital Status

Single	513
Married	3,458
Widowed, divorced, etc.	69
	4,040

Physical Condition

Physical defect	65

Age

Over 65	355
61-65 inclusive	463
56-60 "	308
51-55 "	283
46-50 "	348
41-45 "	355
36-40 "	390
31-35 "	615
26-30 "	838
21-25 "	85
	4,040

Median age of this sample is 42 years

From the age breakdown it would appear that the replacement demand due to retirements and deaths would be about 10% in the next 5 years or 2% per year.

..... (3)

Languages

English only	3,048
French only	9
English and French	693
English or French or both and one or more other languages	290
	4,040

Present total Remuneration

No information supplied	444
$1800 - 2400 inclusive	13
2500 - 2900 "	40
3000 - 3400 "	241
3500 - 3900 "	496
4000 - 4400 "	451
4500 - 4900 "	429
5000 - 5400 "	370
5500 - 5900 "	215
6000 - 6400 "	317
6500 - 6900 "	154
7000 - 7400 "	138
7500 - 7900 "	99
8000 - 8400 "	113
8500 - 8900 "	32
9000 - 9400 "	65
9500 - 9900 "	24
10,000 - 14,000 "	249
15,000 - 19,000 "	71
20,000 - 24,000 "	41
25,000 & over	38
	4,040

Average total remuneration is $6320

Many in the last group of 38, who have total remuneration of $25,000 and over, are in the consulting field or are executives of companies or are engaged in contracting. Remuneration was taken to the nearest hundred dollars or, in the last four cases, to the nearest thousand dollars.

Level of University Training

Never attended university	415
Attended university but did not receive a degree	196
Received a bachelor's degree only	3,139
Received a bachelor's degree plus master standing	223
Received a bachelor's degree plus doctorate	17
	4,040

..... (4)

Present Address

Newfoundland	17
Prince Edward Island	9
Nova Scotia	146
New Brunswick	127
Quebec	985
Ontario	1,636
Manitoba	205
Saskatchewan	127
Alberta	271
British Columbia	441
Yukon and N.W. Territories	11
United States	43
United Kingdom	4
Other Commonwealth Countries	7
Asia	2
Latin America, Mexico & Central America	8
Continental Europe	1
	4,040

Those listed above as being in the United States are Canadian citizens. Persons who were Canadian born and are now residing in the United States and have become citizens of that country are not included in the breakdown.

Fields of Employment - (Where now employed)

Mining	27
Manufacturing	524
Construction (all types)	700
Transportation and Communication	277
Public Utilities (other than trans. & comm.)	286
Trade - retail or wholesale	24
Finance - Insurance and Real Estate	62
Education	99
Consulting	458
Government, Federal - Civilian	481
Government, Federal - Armed Forces	54
Government, Provincial	568
Government, Municipal	430
Various	7
Not recorded (some taking post-grad work)	43
	4,040

OTTAWA, June 30, 1952