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An analysis of the "social factor" in personnel rating

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AN ANALYSIS OF THE "SOCIAL FACTOR" IN PERSONNEL RATING

by
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Certificate of Approval

This thesis is accepted and approved in partial fulfillment of the requirements for the degree of Master of Science.

5-15-63
(date)

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Acknowledgement

I wish to take this opportunity to thank my thesis advisors for the time they have so willingly given me. Dean C.W. Brennan was most helpful in assisting me with the questionaires used in the study. Professor Sutton Monro provided much needed guidance with the statistical techniques used in "getting at" the problem.

I would also like to thank the staff of the Industrial Engineering Department and the seniors in the department for so willingly taking on the task of ranking each other. Without the enthusiastic co-operation of everyone involved, the process would have been much more painful than it was.

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AN ANALYSIS OF THE "SOCIAL FACTOR" IN PERSONNEL RATING

This thesis was undertaken to explore the possibility of discovering some statistical method that would reflect the effect of the social relationships that are felt to affect the ratings of subordinates by superiors in the typical merit rating system. It was felt that there are situations in which the two persons have other than professional reasons for rating as they do. The purpose is not to explore or explain these reasons, but simply to explore a method which might indicate which combinations of superiors and subordinates exhibit the presence of these "social factors" most markedly.

The main thesis may be approached through two minor objectives. The first of these is to determine the extent to which these "social factors" are transmitted between the subjects by evaluating the degree of agreement of their opinions of each other as compared with the general consensus of the groups questioned. The second purpose is to determine if the form of the question controls the influence of the "social factor" upon the rating.

Technique:

The data used in this experiment was gathered from the students and the faculty of the Industrial Engineering Department at Lehigh University. I feel that the department affords a social and professional environment much like that encountered in an industrial situation. This is especially true of the relationship of the senior students with the faculty.

Each member of the two groups was asked to fill out a questionaire in which he ranked each member of the other group in each of three categories. An overall ranking was also called for. Samples of the questionaires used are included in Appendix A. There were originally seven members in the faculty group and fifteen in the student group. During the course of the experiment, one member was dropped from each group because of lack of sufficient contact with the members of the other group.

More than one category was used in order to gain insight into the relation of the question type to the degree of influence exerted by the "social factor" upon the rankings.

A ranking system of evaluation was decided upon for two main reasons. In the first place, ranking

eliminates any systematic biases the ranker may have. Secondly, it provides a forced choice arrangement which minimizes the possibility of ties.

After the data had been collected, the information was codified and all reference to proper names was terminated.

The next problem was to get the raw data into a form that would be suitable for analysis. The first step in this procedure was to transform the rows (rankings by one person of all other persons) into normal scores which were designed so as to divide a unit normal distribution into equal segments. Next, all of the scores were transformed into standard unit normal deviates (within columns). This transformation was necessary to give weight to relative disagreements in ranking that were significant, but small in absolute size.

In cases where everyone but one person agreed an individual was first, and that one person said the individual was second, this deviation from the typical could be highly significant. One way to give the necessary weight to this type of deviation from the consensus of the group is to use standard unit normal deviates to indicate the relative agreement of each ranking with the average ranking by the peers of the

ranker with respect to their ranking of the rankee in question.

Being interested in the agreement of scores of corresponding superior-subordinate combinations, the product of their scores was used. This statistic was decided upon because of several useful qualities of products. In the first place, agreement in sign produces a positive product while disagreement produces a negative product. Agreement in sign indicates the agreement of the direction of action of the "social factor" upon the ranking of each by the other. In order to retain the maximum amount of useful information about the product, the signs were not combined in the usual manner at the outset. Instead, the associated signs of the ranking deviations were retained. This would tell whether agreement was on the negative side or on the positive side of the mean. It is for this reason that the double sign in the product matrices appears in Appendix B.

Secondly, the product is used because it gives equal weight to both terms.

The question still remained regarding what to expect if the rankings were indeed independent and the above transformations were made. In order to have some answers to that question, a computer program was

written to simulate the conditions desired.

The program filled two matrices. One matrix was six by fourteen, the other was fourteen by six. The rows of these matrices were filled by placing the score equivalents, corresponding to the rankings available within a row, in a random order. Both matrices were so filled and the transformations were performed. The whole process was repeated twenty times, giving 1680 products.

A copy of the program actually used is on file in the Industrial Engineering Department at Lehigh University.

Throughout the experiment, interest was directed to comparisons of the "Overall" ranking of the students by the faculty with the various rankings of the faculty by the students. In an industrial situation, the ultimate question would be one concerning the desirability of promotion for the particular individuals and is an overall-type evaluation.

Results:

The results of this experiment indicate that the degree of independence of the mutual rankings can be influenced by the type of question that is asked. This indicator of dependence is a shift in the average of the distributions toward the positive end of the scale, rather than in a marked increase in the number and size of the extreme values.

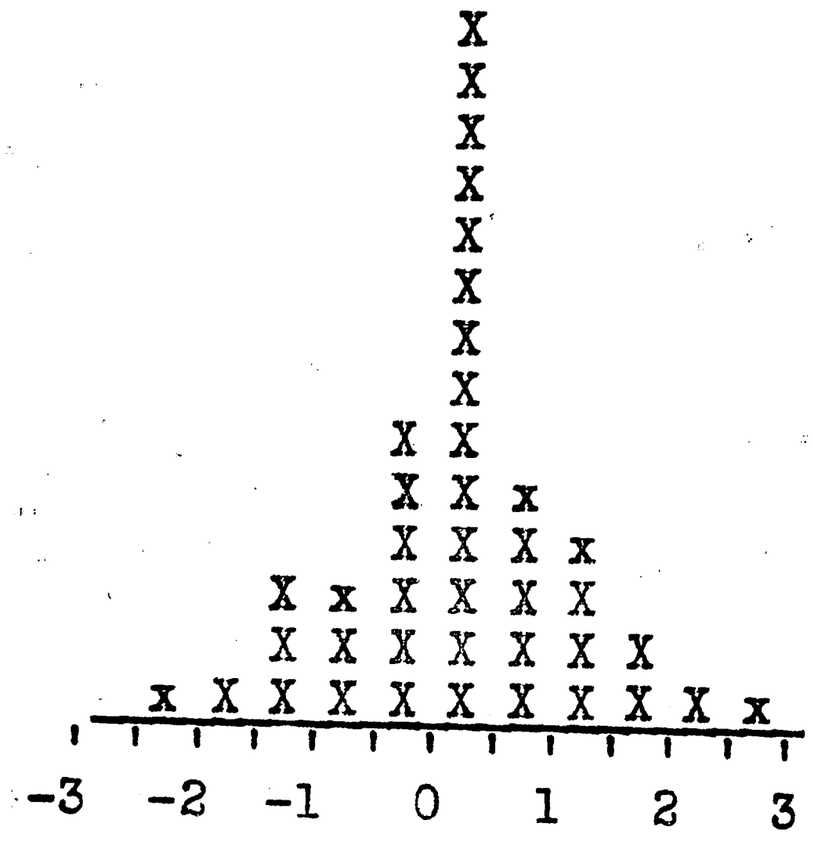
The shift in the average of the distribution is the result of equal increases in both types of positive products (++ and --).

The appearance of twice as many positive products as negative products in the case of the Overall vs. Overall indicates that the "social factor" is one that tends to be mutual. There are evidences, however, that some subjects are quite capable of hiding their feelings.

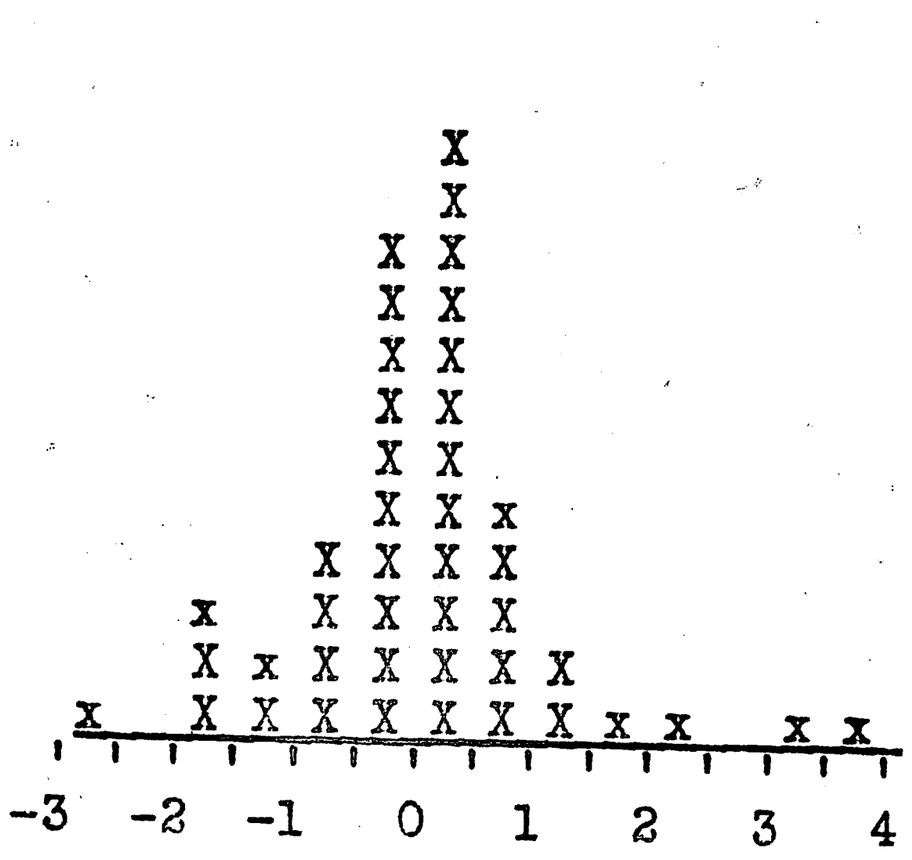
The effect of the question type on the distribution of products can be seen in the figures on the following page.

Key:

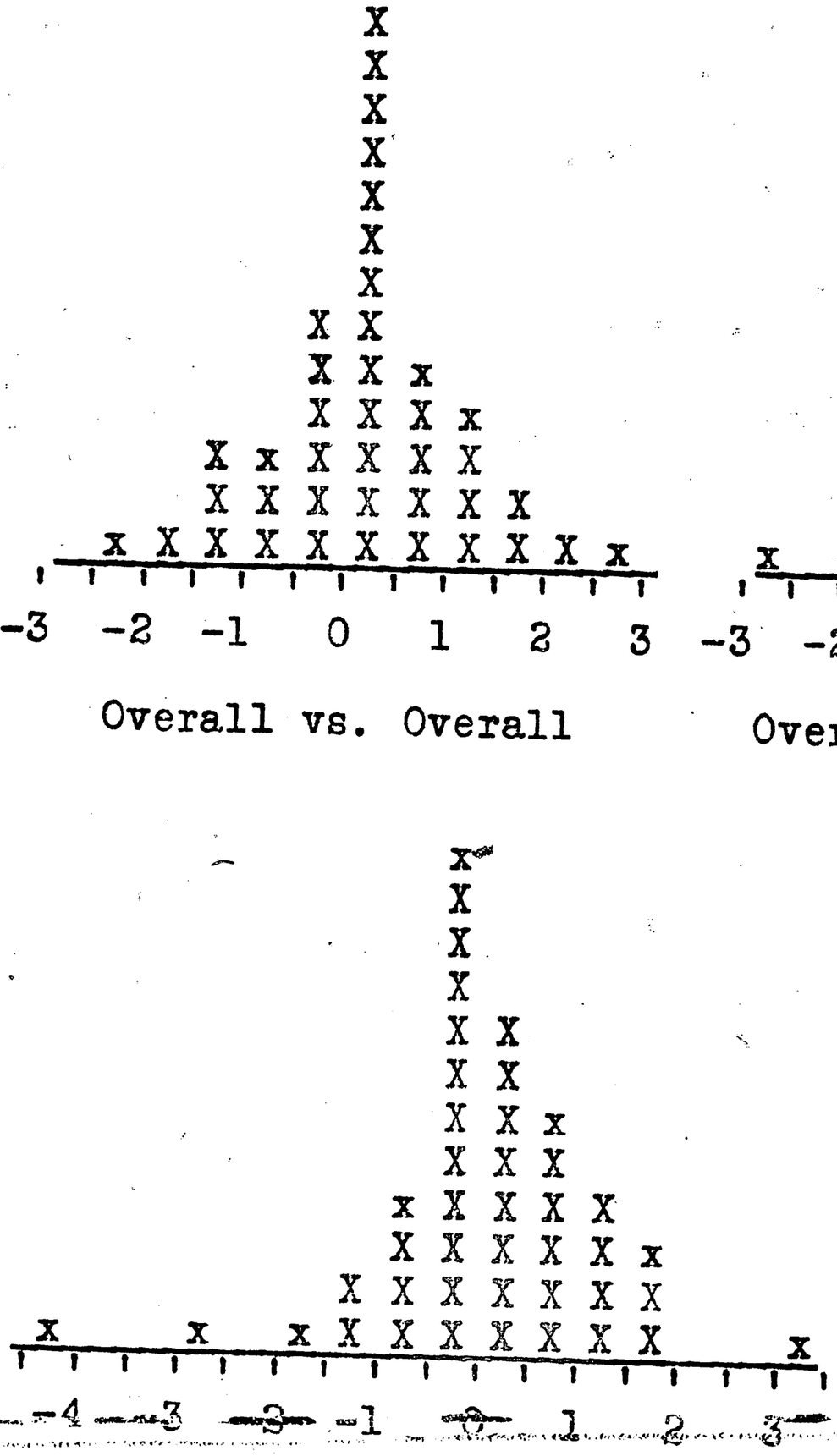
X = two observations
x = one observation



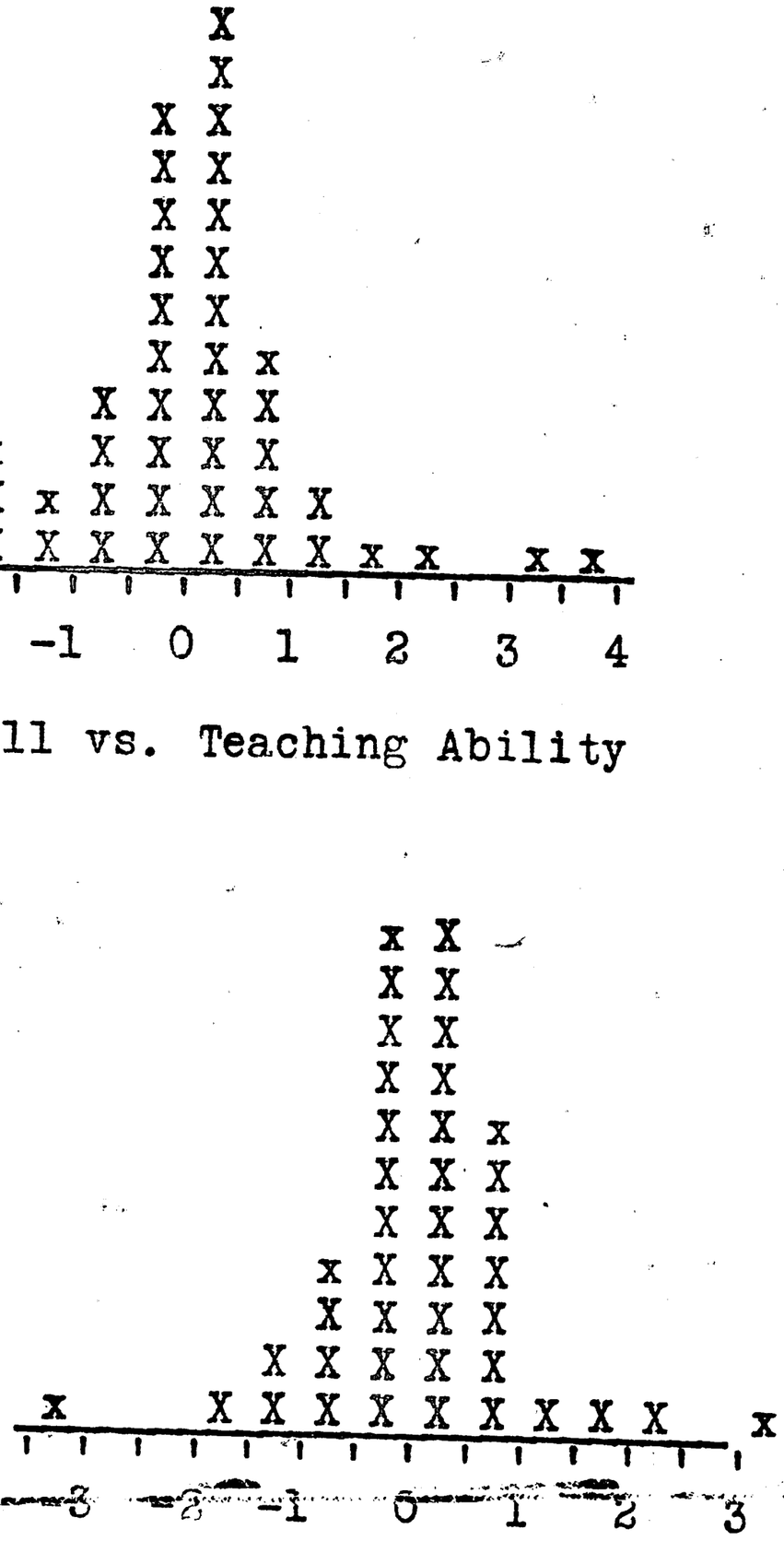
Overall vs. Overall



Overall vs. Teaching Ability



Overall vs. Command of Technical Material



Overall vs. Indication of Pradtical Experience

Closer observation of the data concerning the Overall vs. Overall products reveals the following distribution of products.

Absolute Cell Divisions	Negative Products (-+ or +-)	Positive Products (++)	Positive Products (--)
0.0 to 0.5	IIII IIII II	IIII IIII III	IIII IIII IIII I
0.5 to 1.0	IIII	IIII II	II
1.0 to 1.5	IIII I	III	IIII
1.5 to 2.0	II	II	II
2.0 to 2.5	I	I	I
2.5 to 3.0		I	

The actual distribution of the products of the Overall vs. Overall scores is exhibited in Figure 1. This figure shows the positive correlation between the rankings involved. Due to this correlation, the scatter takes on an elliptical shape. Due to this shape, the comparable level of significance for negative products may be lower than for positive products.

Table 1 shows the percentage of observations to be expected in the standard distribution with independence as compared with the distribution of the actual observations. It should be noted that the columns have been arranged so that the averages increase from left to right. The averages may be an indication of the amount of the influence of the "social factor".

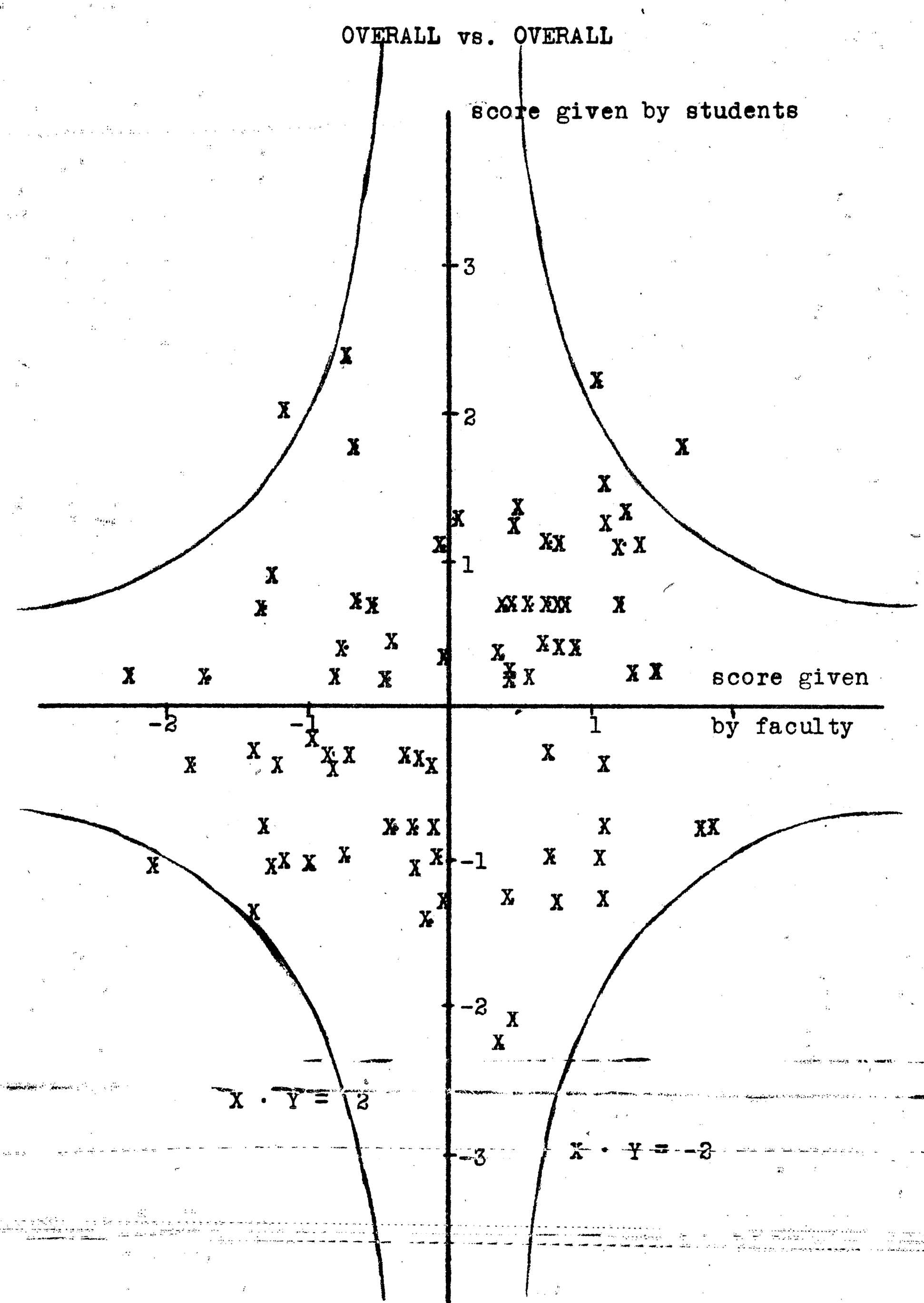

OVERALL vs. OVERALL
score given by students
score given
by faculty
3
2
1
-1
-2
-3
-2
-1
1
X · Y = 2
X · Y = -2

Figure 1

Table 1

Cell Units	Standard	Overall vs. Teaching Ability	Overall vs. Indctn of Practical Exper.	Overall vs. Command of Tech'l Mat'l.	Overall vs. Overall
less than -3.5	.2	.0	1.3	1.3	.0
-3.01 to -3.5	.5	.0	1.3	.0	.0
-2.51 to -3.0	.4	1.3	.0	1.3	.0
-2.01 to -2.5	1.8	.0	.0	.0	1.3
-1.51 to -2.0	4.0	6.4	2.6	1.3	2.5
-1.01 to -1.5	5.9	3.9	5.1	5.1	7.6
-0.51 to -1.0	11.4	10.3	9.0	9.0	6.3
-0.01 to -0.5	24.6	25.6	26.9	29.5	15.2
0.00 to 0.49	25.7	30.8	28.2	20.5	38.0
0.50 to 0.99	11.4	11.5	16.7	14.1	11.4
1.00 to 1.49	6.6	5.1	2.6	10.3	8.9
1.50 to 1.99	4.2	1.3	2.6	6.4	5.1
2.00 to 2.49	2.1	1.3	2.6	.0	2.5
2.50 to 2.99	.7	.0	.0	.0	1.3
3.00 to 3.49	.5	1.3	1.3	1.3	.0
3.5 and up	.1	1.3	.0	.0	.0
total:	100.1	100.1	99.9	100.1	100.1
average:	.01	.03	.04	.11	.20

Conclusions:

The results of this experiment can be generalized in several ways. In the first place, the data shows that there is a "social factor" which influences the rating of one person by another. This feeling has a tendency to be mutual and thereby affects both rankings in a similar manner. The effect on the product of the unit normal deviates is not as great in magnitude as may be expected, but the overall shift in the distribution as reflected in the averages is convincing.

In the educational environment, this tendency for mutual selection can be put to good use by allowing the student to choose the instructor under whose direction he wishes to take a multiple-section course. Under the commonly accepted psychological premise that a person performs more satisfactorily in an environment that is pleasing than in an unpleasant one, then both the enjoyment and value of the course should be greatly enhanced by allowing freedom of selection. The experiment indicates that such a choice by a student would generally concur with a similar choice by the instructor.

In an industrial setting, the products of the unit normal deviates would indicate those combinations of

personnel that may be most troublesome. It may be desirable to investigate those products with high positive (++) products as well as those with high positive products of the (--) type. High negative products should be watched to avoid placing a strain on relations necessitated by the possible covering up of feelings by one party or the other. The necessity of investigating high positive products of the (--) type is clearly evident.

There may be several reasons for the appearance of large negative products. These products may be the result of lack of information (contact) about the person being ranked, or the ranker may be responding in an irrational manner. Psychological study in this regard should yield valuable information.

I feel that one reason for the lack of a significant number of large products, either negative or positive, is the small size of the sample used in the study. In most real cases, however, the sample would most likely need to be small to allow the effect of the social contact to exhibit itself throughout the sample. A second reason for the small number of large products could be the temporaty nature of the relationship of faculty to student, the "social factor" may not be as pronounced as would be the case in the permanence of industry.

Questions:

This experiment has left me with several questions that as yet appear to be unanswered:

(1) What are the factors that contribute to the "social factor"?

(2) Is the "social factor" (bias) on a sub-conscious level, or is it well known to the ranker?

(3) What tool can be used to investigate the products within any row or column?

(4) What are the psychological reasons for the tendency of some rankers to have heavy negative or positive products?

(5) What is the statistical significance of the shift of the mean in the various classifications as compared with the standard?

(6) Is the mean of the distribution useable as some measure of the amount of subjectiveness inherent in the question asked?

(7) How could one devise a simple test procedure to be used in an industrial situation?

(8) How often would it be necessary to run such a procedure?

Appendix A

The questionaire given to the students consisted of the following pages:

Designation on Questionaire	Page
letter	15
2	16
3s	17
4s	18
5s	19

The questionaire given to the faculty consisted of the following pages:

Designation on Questionaire	Page
letter	15
2	16
3f	20
4f	21
5f	22

March 1, 1963

Thank you for agreeing to help me with my project. I hope there will be no problems of interpretation; but if there are, please do not hesitate to call me. My home phone number is 866-1242. I can also be reached at 867-4241 between 12:00 and 1:00 and between 5:30 and 7:00.

I have one more thing to ask of you. Please return the rankings at your earliest possible convenience, as I cannot proceed with my thesis until all of the rankings have been returned.

Thanks again for your time.

Sincerely,

Steve Roach

Steve Roach

Topic: Inter-relations in Supervisor-Subordinate Ranking Systems

Purpose: This experiment has as its objective the determination of the extent to which (if at all) a ranking of supervisors by subordinates can be used to predict the ranking of the same subordinates by the same supervisors.

In this case, I am substituting the student-teacher relationship for the worker-supervisor relationship, which would be of interest to industry. It is felt that the relationship of the senior year students in Industrial Engineering to the I.E. faculty closely approximates the desired situation both in familiarity with capabilities and in social relationship.

All of the ratings are to be of a ranking nature, with all of the rankings, from the first to the last, being designated by integers from one up. Each integer is to be used only once. In case of ties, indicate by assigning the same integer and omitting the next integer(s) from the ranking.

Due to the nature of the material, all results will remain confidential with respect to who ranked whom in what manner. For the purposes of the thesis, a letter code will be used to identify the participants. This code will not be disclosed. All references to individuals will be of the type "subordinate 'a'" or "supervisor 'c'" or "teacher 'a'" or "student 'c'".

I would appreciate careful rankings, as capricious answers will invalidate the conclusions. Do not consult with anyone in making your decisions.

If you feel that your exposure to any person being rated is insufficient, rate to the best of your ability but place an asterisk (*) next to his name.

To the Students:

Overall Ranking: In making this first ranking, include any considerations you feel relevant in answering the following:

With which instructor would you most like to work as his subordinate?

Rank from numeral one to "n" in order of decreasing preference. The instructor with rank "n" being the least desirable supervisor for you.

Instructor	Rank
C.W. Brennan.....	
A.F. Gould.....	
G.E. Kane.....	
S. Monro.....	
W.J. Richardson.....	
G.L. Smith.....	
W.A. Smith.....	

please return this sheet

_____

(name of ranker)

The three factors by which I am asking you to rank the instructors on the following page are not completely independent. As the rankings will be in no way combined, there will be no inherent double counting in the analysis.

Teaching Ability: ease with which the instructor conveys new ideas to you, the student.
Should be influenced by:
a. interest in teaching
b. interest in material being taught
c. organization of material being taught
d. personal traits or mannerisms

Command of Technical Material: scope and depth of knowledge of I.E. oriented material as demonstrated either in or out of the classroom.

If possible, disassociate this ranking from the effect of specific courses taught by the instructor in question. It is to reflect the technical knowledge of the instructor, not the demands made upon this knowledge by his course offerings.

Indication of Practical Experience: any evidence of a knowledge of the practical (as versus the academic) applications of the principles of Industrial Engineering.

Should be influenced by the ease with which a new idea is tied to the "real world."

Instructor	Rankings		
	Teaching Ability	Command of Technical Material	Indication of Practical Experience
C.W. Brennan.....	____	____	____
A.F. Gould.....	____	____	____
G.E. Kane.....	____	____	____
S. Monro.....	____	____	____
W.J. Richardson.....	____	____	____
G.L. Smith.....	____	____	____
W.A. Smith.....	____	____	____

Please return this sheet

_____

(name of ranker)

To the Faculty:

Overall Ranking: In making this ranking, include any consideration you feel relevant in answering the following:

Which student would you most likely recommend for advancement to a more responsible position?

Rank from one up in order of decreasing preference. The student with the highest digit being the least highly recommended for advancement.

Student	Rank
D.E. Benner.....	
T.H. Blackwood.....	
J.A. Cunitz.....	
M.P. Dunham.....	
W.B. Dunning.....	
R.J. Erkes.....	
L.C. Farish.....	
G.H. Johnson.....	
J.H. Minnich.....	
K. Petrime.....	
R.M. Rosenbaum.....	
H.M. Schwartz.....	
R.A. Stern.....	
R.D. Wayson.....	
A.H. Wilson.....	

Please return this sheet

20 _____

(name of ranker)

The three factors by which I am asking you to rate the students are not completely independent. As the rankings will be in no way combined, there will be no inherent double counting in the analysis.

Ability: ability to do work in Industrial Engineering.
This rank is not intended to reflect the total performance picture in I.E. material. It is intended to reflect the technical competence of the student in areas relating to Industrial Engineering. If possible, attitude should be discounted when making this ranking.

Achievement: performance in I.E. work.
This ranking is to include not only ability, but also the willingness of the student to do I.E. related work. It would be most easily noticed in individual projects.

Personality:
This factor is intended to reflect the ability of the student to work with others and includes both cooperation with his peers and supervisors. Also to be considered is the degree and manner in which the student contributes his own ideas for the solution of the problem.

Students	Rankings		
	Ability	Achievement	Personality
D.E. Benner.....	_____	_____	_____
T.H. Blackwood.....	_____	_____	_____
J.A. Cunitz.....	_____	_____	_____
M.P. Dunham.....	_____	_____	_____
W.B. Dunning.....	_____	_____	_____
R.J. Erkes.....	_____	_____	_____
L.C. Farish.....	_____	_____	_____
G.H. Johnson.....	_____	_____	_____
J.H. Minnich.....	_____	_____	_____
K. Petrime.....	_____	_____	_____
R.M. Rosenbaum.....	_____	_____	_____
H.M. Schwartz.....	_____	_____	_____
R.A. Stern.....	_____	_____	_____
R.D. Wayson.....	_____	_____	_____
A.H. Wilson.....	_____	_____	_____

Please return this sheet

_____

(name of ranker)

Appendix B

OVERALL

(Raw Data)

Ranker

Rankee

	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	s13	s14
f1	6	12	13	14	1	8	5	9	10	4	2	7	11	3
f2	*8	9	14	13	1	4	5	10	11	3	2	7	*12	*6
f3	4	11	13	14	1	8	9	6	12	2	7	3	10	5
f4	6	8	4		1				7	3	2		9	5
f5	10	9	14	13	1	6	7	8	12	3	2	4	11	5
f6	9	8	7	14	1	12	5	6	10	4	3	13	11	2

	f1	f2	f3	f4	f5	f6
s1	5	4	6	3	2	1
s2	4	2	5	6	1	3
s3	3	5	6	4	1.5	1.5
s4	4	2	5.5	5.5	1	3
s5	2	6	5	4	1	3
s6	4	2	6	5	1	3
s7	3	2	4	6	1	5
s8	1	4.5	3		2	4.5
s9	4	3	6	2	1	5
s10	3	3	6	1	3	5
s11	3	4	6	2	1	5
s12	5	2	3	*6	1	4
s13	5	4	2	6	1	3
s14	3	4	6	5	2	1

Ranker

Rankee

ABILITY

	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	s13	s14
f1	6	12	10	14	1	9	3	11	13	5	2	8	7	4
f2	6	10	9	14	1	8	3	12	13	2	5	7	11	4
f3	9	12	11	13	1	8	3	5	14	2	6	7	10	4
f4	6	9	4		1				7	2	3		8	5
f5	6	9	14	13	1	11	5	8	12	2	3	7	10	4
f6	5	9	8	14	1	11	4	7	12	3	6	10	13	2

ACHIEVEMENT

f1	5	12	13	14	1	6	11	8	10	4	2	9	7	3
f2	7	10	13	9	3	6	4	11	14	1	2	8	12	5
f3	8	13	10	14	2	5	4	11	12	1	3	6	9	7
f4	7	8	4		2				5	1	3		9	6
f5	10	7	14	13	1	6	5	8	11	3	2	4	12	9
f6	6	8	9	14	2	10	4	7	12	3	5	13	11	1

PERSONALITY

f1	4	13	12	14	1	8	10	7	9	5	2	6	11	3
f2	9	8	12	14	3	1	11	6	13	4	2	7	~~10~~	5
f3	7	10	14	13	1	4	3	2	12	5	11	6	9	8
f4	4	7	6		1				3	2	8		9	5
f5	10	6	14	13	2	5	9	8	12	4	3	1	11	7
f6	12	10	6	11	2	9	7	1	5	4	3	14	13	8

TEACHING ABILITY

Ranker	Rankee f1	f2	f3	f4	f5	f6
s1	3	4	6	5	2	1
s2	3	2	6	5	1	4
s3	2.5	4	5	6	1	2.5
s4	4	2	5.5	5.5	1	3
s5	3	5	4	-	1	2
s6	2	3	5	6*	1	4
s7	4	5	3	6	1	2
s8	2	4	5	-	1	3
s9	5	3	6	4	1	2
s10	4.5	2	6	4.5	1	3
s11	4	2	6	3	1	5
s12	3	2	4	6*	1	5
s13	5	3	4	6	1	2
s14	4	3	6	5	1	2

COMMAND OF TECH. MAT'L.

Ranker	Rankee f1	f2	f3	f4	f5	f6
s1	4	6	1	5	3	2
s2	2	6	3	5	1	4
s3	2	6	4	5	2	2
s4	2.5	5	4	6	1	2.5
s5	3.5	5	3.5	-	1	2
s6	3	5	2	6*	1	4
s7	4	5	2	6	1	3
s8	4	5	2	-	1	3
s9	2	5	4	6	3	1
s10	3	4.5	6	4.5	1	2
s11	1	4	3	5*	2	6
s12	5	4	2	6*	3	1
s13	1	5	2	6	3	4
s14	2	5	4	6	1	3

INDICATION OF PRACTICAL EXPERIENCE

s1	1	5	4	6	2	3
s2	2	6	4	5	3	1
s3	1	5.5	4	5.5	2	3
s4	1.5	4	5	6	3	1.5
s5	1	5	3.5	-	3.5	2
s6	1	4	3	6*	2	5
s7	1	4	5	6	3	2
s8	1	5	4	-	3	2
s9	1	5	4	6	3	2
s10	1	2	6	4	3	5
s11	1	5	4	6	2	3
s12	1	5	4	6*	3	2
s13	5	4	2	6	3	1
s14	1	5	3	6	2	4

OVERALL

Normalized Scores
(within row)

Ranker	Rankee f1	f2	f3	f4	f5	f6
s1	-0.64	-0.20	-1.27	∕0.20	∕0.64	∕1.27
s2	-0.20	∕0.64	-0.64	-1.27	∕1.27	∕0.20
s3	∕0.20	-0.64	-1.27	-0.20	∕0.95	∕0.95
s4	-0.20	∕0.64	-0.95	-0.95	∕1.27	∕0.20
s5	∕0.64	-1.27	-0.64	-0.20	∕1.27	∕0.20
s6	-0.20	∕0.64	-1.27	-0.64	∕1.27	∕0.20
s7	∕0.20	∕0.64	-0.20	-1.27	∕1.27	-0.64
s8	∕1.16	-0.83	0.00		∕0.50	-0.83
s9	-0.20	∕0.20	-1.27	∕0.64	∕1.27	-0.64
s10	∕0.20	∕0.20	-1.27	∕1.27	-0.20	-0.64
s11	∕0.20	-0.20	-1.27	∕0.64	∕1.27	-0.64
s12	-0.64	∕0.64	∕0.20	-1.27	∕1.27	-0.20
s13	-0.64	-0.20	∕0.64	-1.27	∕1.27	∕0.20
s14	∕0.20	-0.20	-1.27	-0.64	∕0.64	∕1.27
col. sum	∕0.08	∕0.06	-10.48	-4.96	∕14.36	∕0.90
col. avg.	∕0.006	∕0.004	-0.749	-0.382	∕1.026	∕0.064
sum x_{ij}^2	3.346	5.002	13.504	10.728	16.530	6.688
sum $x_{ij}^2 \div n$	0.239	0.357	0.965	0.825	1.181	0.478
(col. avg.)^2	0.000	0.000	0.561	0.146	1.051	0.004
variance	0.239	0.357	0.404	0.679	0.130	0.474
std. dev.	0.489	0.597	0.636	0.824	0.361	0.688
col. avg.	∕0.006	∕0.004	-0.749	-0.382	∕1.026	∕0.064

OVERALL

Normalized Scores (within row)

Ranker \ Rankee	s1	s2	s3	s4	s5	s6	s7
f1	+0.27	-0.90	-1.21	-1.70	+1.70	-0.09	+0.46
f2	-0.09	-0.27	-1.70	-1.21	+1.70	+0.66	+0.46
f3	+0.66	-0.66	-1.21	-1.70	+1.70	-0.09	-0.27
f4	-0.27	-0.93	+0.27		+1.49		
f5	-0.46	-0.27	-1.70	-1.21	+1.70	+0.27	+0.09
f6	-0.27	-0.09	+0.09	-1.70	+1.70	-0.90	+0.46
col. sum	-0.16	-3.12	-5.46	-7.52	+9.99	-0.15	+1.20
col. avg.	-0.027	-0.520	-0.910	-1.504	+1.665	-0.030	+0.240
sum x_{ij}^2	0.875	2.264	8.789	11.598	16.670	1.335	0.717
sum x_{ij}^2/n	0.146	0.377	1.465	2.319	2.778	0.267	0.143
$(\text{col. avg.})^2$	0.001	0.270	0.828	2.262	2.772	0.001	0.058
variance	0.145	0.107	0.637	0.057	0.006	0.266	0.085
std. dev.	0.381	0.327	0.798	0.239	0.077	0.516	0.292

OVERALL
(cont.)

Normalized Scores
(within row)

Ranker	Rankee						
	s8	s9	s10	s11	s12	s13	s14
f1	-0.27	-0.46	+0.66	+1.21	+0.09	-0.66	+0.90
f2	-0.46	-0.66	+0.90	+1.21	+0.09	-0.90	+0.27
f3	+0.27	-0.90	+1.21	+0.09	+0.90	-0.46	+0.46
f4		-0.57	+0.57	+0.93		-1.49	0.00
f5	-0.09	-0.90	+0.90	+1.21	+0.66	-0.66	+0.46
f6	+0.27	-0.46	+0.66	+0.90	-1.21	-0.66	+1.21
col. sum	-0.28	-3.95	+4.90	+5.55	+0.53	-4.83	+3.30
col. avg.	-0.056	-0.658	+0.817	+0.925	+0.106	-0.805	+0.550
sum x_{ij}^2	0.439	2.805	4.281	6.075	2.726	4.548	2.771
sum x_{ij}^2/n	0.088	0.468	0.714	1.013	0.545	0.758	0.462
$(\text{col. avg.})^2$	0.003	0.433	0.667	0.856	0.011	0.648	0.303
variance	0.085	0.035	0.047	0.157	0.534	0.110	0.159
std. dev.	0.292	0.187	0.217	0.396	0.731	0.332	0.399

Ranker	TEACHING ABILITY Normalized Scores (within row) Rankee					
	f1	f2	f3	f4	f5	f6
s1	∕0.20	-0.20	-1.27	-0.64	∕0.64	∕1.27
s2	∕0.20	∕0.64	-1.27	-0.64	∕1.27	-0.20
s3	∕0.42	-0.20	-0.64	-1.27	∕1.27	∕0.42
s4	-0.20	-0.95	∕0.64	-0.95	∕1.27	∕0.20
s5	0.00	-1.16	-0.50	-	∕1.16	∕0.50
s6	∕0.64	∕0.20	-0.64	-1.27	∕1.27	-0.20
s7	-0.20	-0.64	∕0.20	-1.27	∕1.27	∕0.64
s8	∕0.50	-0.50	-1.16	-	∕1.16	0.00
s9	-0.64	∕0.20	-1.27	-0.20	∕1.27	∕0.64
s10	-0.42	∕0.64	-1.27	-0.42	∕1.27	∕0.20
s11	-0.20	∕0.64	-1.27	∕0.20	∕1.27	-0.64
s12	∕0.20	∕0.64	-0.20	-1.27	∕1.27	-0.64
s13	-0.64	∕0.20	-0.20	-1.27	∕1.27	∕0.64
s14	-0.20	∕0.20	-1.27	-0.64	∕1.27	∕0.64
col. sum	-0.34	-0.29	-10.12	-9.64	∕16.93	∕3.47
col. avg.	-0.024	-0.021	-0.723	-0.803	∕1.209	∕0.248
sum x_{ij}^2	2.112	4.789	12.624	10.454	20.845	4.659
sum $x_{ij}^2 \div n_2$	0.151	0.342	0.902	0.871	1.489	0.333
$(\text{col. avg.})^2$	0.001	0.000	0.523	0.645	1.462	0.062
variance	0.150	0.342	0.379	0.226	0.027	0.271
std. dev.	0.387	0.585	0.616	0.475	0.164	0.521

col. avg. -0.024 -0.021 -0.723 -0.803 ∕1.209 ∕0.248

COMMAND OF TECHNICAL MATERIAL

Ranker

Normalized Scores
(within row)

Rankee

	f1	f2	f3	f4	f5	f6
s1	-0.20	-1.27	+1.27	-0.64	+0.20	+0.64
s2	+0.64	-1.27	+0.20	-0.64	+1.27	-0.20
s3	+0.70	-1.27	-0.20	-0.64	+0.70	+0.70
s4	+0.42	-0.64	-0.20	-1.27	+1.27	+0.42
s5	-0.25	-1.16	-0.25		+1.16	+0.50
s6	+0.20	-0.64	+0.64	-1.27	+1.27	-0.20
s7	-0.20	-0.64	+0.64	-1.27	+1.27	+0.20
s8	-0.50	-1.16	+0.50		+1.16	0.00
s9	+0.64	-0.64	-0.20	-1.27	+0.20	+1.27
s10	+0.20	-0.42	-1.27	-0.42	+1.27	+0.64
s11	+1.27	-0.20	+0.20	-0.64	+0.64	-1.27
s12	-0.64	-0.20	+0.64	-1.27	+0.20	+1.27
s13	+1.27	-0.64	+0.64	-1.27	+0.20	-0.20
s14	+0.64	-0.64	-0.20	-1.27	+1.27	+0.20
col. sum	+4.19	-10.79	+2.41	-11.87	+12.08	+3.97
col. avg.	+0.299	-0.771	+0.172	-0.989	+0.863	+0.284
sum x_{ij}^2	6.005	10.247	5.419	13.107	13.430	6.775
sum $x_{ij}^2 \div n$	0.429	0.732	0.387	1.092	0.959	0.484
$(\text{col. avg.})^2$	0.089	0.594	0.030	0.978	0.745	0.081
variance	0.340	0.138	0.357	0.114	0.214	0.403
std. dev.	0.583	0.371	0.597	0.338	0.463	0.635
col. avg.	+0.299	-0.771	+0.172	-0.989	+0.863	+0.284

INDICATION OF PRACTICAL EXPERIENCE

Normalized Scores
(within row)

Ranker

Rankee

	f1	f2	f3	f4	f5	f6
s1	∕1.27	-0.64	-0.20	-1.27	∕0.64	∕0.20
s2	∕0.64	-1.27	-0.20	-0.64	∕0.20	∕1.27
s3	∕1.27	-0.95	-0.20	-0.95	∕0.64	∕0.20
s4	∕0.95	-0.20	-0.64	-1.27	∕0.20	∕0.95
s5	∕1.16	-1.16	-0.25		-0.25	∕0.50
s6	∕1.27	-0.20	∕0.20	-1.27	∕0.64	-0.64
s7	∕1.27	-0.20	-0.64	-1.27	∕0.20	∕0.64
s8	∕1.16	-1.16	-0.50		0.00	∕0.50
s9	∕1.27	-0.64	-0.20	-1.27	∕0.20	∕0.64
s10	∕1.27	∕0.64	-1.27	-0.20	∕0.20	-0.64
s11	∕1.27	-0.64	-0.20	-1.27	∕0.64	∕0.20
s12	∕1.27	-0.64	-0.20	-1.27	∕0.20	∕0.64
s13	-0.64	-0.20	∕0.64	-1.27	∕0.20	∕1.27
s14	∕1.27	-0.64	∕0.20	-1.27	∕0.64	-0.20
col. sum	∕14.70	-7.90	-3.46	-15.22	∕4.35	∕5.53
col. avg.	∕1.050	-0.564	-0.247	-1.102	∕0.311	∕0.395
sum x_{ij}^2	18.932	7.828	3.476	15.870	2.393	6.839
sum $x_{ij}^2 \div n$	1.352	0.559	0.248	1.323	0.171	0.489
$(\text{col. avg.})^2$	1.103	0.318	0.061	1.214	0.097	0.156
variance	0.249	0.241	0.187	0.109	0.074	0.333
std. dev.	0.499	0.491	0.432	0.330	0.272	0.577
col. avg.	∕1.050	-0.564	-0.247	-1.102	∕0.311	∕0.395

OVERALL

Standard Unit Deviates (Normal)

Ranker

$$x_{ij}' = \frac{x_{ij} - \bar{x}_j}{s_j}$$

Ranke

	f1	f2	f3	f4	f5	f6
s1	-1.32	-0.34	-0.82	∕0.71	-1.07	∕1.75
s2	-0.42	∕1.07	∕0.17	-1.08	∕0.68	∕0.20
s3	∕0.40	-1.08	-0.82	∕0.22	-0.21	∕1.29
s4	-0.42	∕1.07	-0.32	-0.69	∕0.68	∕0.20
s5	∕1.30	-2.13	∕0.17	∕0.22	∕0.68	∕0.20
s6	-0.42	∕1.07	-0.82	-0.31	∕0.68	∕0.20
s7	∕0.40	∕1.07	∕0.86	-1.08	∕0.68	-1.02
s8	∕2.36	-1.40	∕1.18		-1.46	-1.30
s9	-0.42	∕0.33	-0.82	∕1.24	∕0.68	-1.02
s10	∕0.40	∕0.33	-0.82	∕2.00	-2.29	-1.02
s11	∕0.40	-0.34	-0.82	∕1.24	∕0.68	-1.02
s12	-1.32	∕1.07	∕1.49	-1.08	∕0.68	-0.38
s13	-1.32	-0.34	∕2.18	-1.08	∕0.68	∕0.20
s14	∕0.40	-0.34	-0.82	-0.31	-1.07	∕1.75

OVERALL

Standard Unit
Normal Deviates

$$x_{ij}' = \frac{x_{ij} - \bar{x}_j}{s_j}$$

Ranker

Rankee

Ranker	s1	s2	s3	s4	s5	s6	s7
f1	∕0.78	-1.16	-0.38	-0.82	∕0.45	-0.12	∕0.75
f2	-0.17	∕0.76	-0.99	∕1.23	∕0.45	∕1.34	∕0.75
f3	∕1.80	-0.43	-0.38	-0.82	∕0.45	-0.12	-1.75
f4	-0.64	-1.25	∕1.48		-2.27		
f5	-1.14	∕0.76	-0.99	∕1.23	∕0.45	∕0.58	-0.51
f6	-0.64	∕1.32	∕1.25	-0.82	∕0.45	-1.69	∕0.75

Ranker	s8	s9	s10	s11	s12	s13	s14
f1	-0.73	∕1.06	-0.72	∕0.72	-0.02	∕0.44	∕0.88
f2	-1.38	-0.01	∕0.38	∕0.72	-0.02	-0.29	-0.70
f3	∕1.12	-1.29	∕1.81	-2.11	∕1.09	∕1.04	-0.23
f4		∕0.47	-1.14	∕0.01		-2.06	-1.38
f5	-0.12	-1.29	∕0.38	∕0.72	∕0.76	∕0.44	-0.23
f6	∕1.12	∕1.06	-0.72	-0.06	-1.80	∕0.44	∕1.65

TEACHING ABILITY

Standard Unit
Normal Deviates

Ranker	Rankee					
	f1	f2	f3	f4	f5	f6
s1	≠0.58	-0.31	-0.89	≠0.34	-3.41	≠1.96
s2	≠0.58	≠1.13	-0.89	≠0.34	≠0.37	-0.86
s3	≠1.15	-0.31	≠0.13	-0.98	≠0.37	≠0.33
s4	-0.46	-1.59	≠2.21	-0.31	≠0.37	-0.09
s5	≠0.06	-1.95	≠0.36		-0.30	≠0.48
s6	≠1.72	≠0.38	≠0.13	-0.98	≠0.37	-0.86
s7	-0.46	-1.06	≠1.50	-0.98	≠0.37	≠0.75
s8	≠1.35	-0.82	-0.71		-0.30	-0.48
s9	-1.59	≠0.38	-0.89	≠1.27	≠0.37	≠0.75
s10	-1.02	≠1.13	-0.89	≠0.81	≠0.37	-0.09
s11	-0.46	≠1.13	-0.89	≠2.11	≠0.37	-1.70
s12	≠0.58	≠1.13	≠0.85	-0.98	≠0.37	-1.70
s13	-1.59	≠0.38	≠0.85	-0.98	≠0.37	≠0.75
s14	-0.46	≠0.38	-0.89	≠0.34	≠0.37	≠0.75

COMMAND OF TECHNICAL MATERIAL

Standard Unit
Normal Deviates

Ranker

Rankee

	f1	f2	f3	f4	f5	f6
s1	-0.86	-1.35	≠1.84	≠1.03	-1.43	≠0.56
s2	≠0.58	-1.35	≠0.05	≠1.03	≠0.88	-0.76
s3	≠0.69	-1.35	-0.62	≠1.03	-0.35	≠0.66
s4	≠0.21	≠0.35	-0.62	-0.83	≠0.88	≠0.21
s5	-0.94	-1.05	-0.71		≠0.64	≠0.34
s6	-0.17	≠0.35	≠0.78	-0.83	≠0.88	-0.76
s7	-0.86	≠0.35	≠0.78	-0.83	≠0.88	-0.13
s8	-1.37	-1.05	≠0.55		≠0.64	-0.45
s9	≠0.58	≠0.35	-0.62	-0.83	-1.43	≠1.55
s10	-0.17	≠0.92	-2.42	≠1.68	≠0.88	≠0.56
s11	≠1.67	≠1.54	≠0.05	≠1.03	-0.48	-2.45
s12	-1.61	≠1.54	≠0.78	-0.83	-1.43	≠1.55
s13	≠1.67	≠0.35	≠0.78	-0.83	-1.43	-0.76
s14	≠0.58	≠0.35	-0.62	-0.83	≠0.88	≠0.13

INDICATION OF PRACTICAL EXPERIENCE

Standard Unit
Normal Deviates

Ranker

Rankee

	f1	f2	f3	f4	f5	f6
s1	∕0.44	-0.15	∕0.11	-0.51	∕1.21	-0.34
s2	-0.82	-1.44	∕0.11	∕1.40	-0.41	∕1.52
s3	∕0.44	-0.79	∕0.11	∕0.46	∕1.21	-0.34
s4	-0.20	∕0.74	-0.91	-0.51	-0.41	∕0.96
s5	∕0.22	-1.22	-0.01		-2.06	∕0.18
s6	∕0.44	∕0.74	∕1.03	-0.51	∕1.21	-1.79
s7	∕0.44	∕0.74	-0.91	-0.51	-0.41	∕0.42
s8	∕0.22	-1.22	-0.59		-1.14	∕0.18
s9	∕0.44	-0.15	∕0.11	-0.51	-0.41	∕0.42
s10	∕0.44	∕2.45	-2.37	∕2.73	-0.41	-1.79
s11	∕0.44	-0.15	∕0.11	-0.51	∕1.21	-0.34
s12	∕0.44	-0.15	∕0.11	-0.51	-0.41	∕0.42
s13	-3.39	∕0.74	∕2.05	-0.51	-0.41	∕1.52
s14	∕0.44	-0.15	∕1.03	-0.51	∕1.21	-1.03

OVERALL vs. OVERALL

Ranker

Product of Corresponding
Standard Unit
Normal Deviates

Rankee

	f1	f2	f3	f4	f5	f6
s1	+-1.029	--0.058	+-1.476	-+0.454	--1.220	-+1.120
s2	--0.487	++0.813	-+0.073	--1.350	++0.517	++0.264
s3	-+0.512	--1.069	--0.312	++0.326	--0.208	++1.613
s4	--0.344	++1.316	--0.262		++0.836	-+0.164
s5	++0.585	+-0.959	++0.077	-+0.499	++0.306	++0.090
s6	--0.050	++1.434	--0.098		++0.394	-+0.338
s7	++0.300	++0.803	-+1.505		-+0.347	+-0.765
s8	-+1.723	--1.932	++1.322		--0.175	+-1.456
s9	+-0.445	-+0.003	--1.058	++0.583	-+0.877	+-1.081
s10	-+0.288	++0.125	+-1.484	-+2.280	+-0.870	--0.734
s11	++0.288	+-0.245	--1.730	++0.012	++0.490	--0.061
s12	--0.026	-+0.021	++1.624		++0.517	--0.684
s13	+-0.581	--0.099	++2.267	--2.225	++0.299	++0.088
s14	++0.352	--0.238	--0.189	--0.428	--0.246	++2.888

sum ; +15.577 avg. ; +0.1972
observations ; 79

First sign:
faculty appraisal
of student

Negative Products
(+- or -+)

s1	1.029		1.476	0.454		1.120
s2			0.073			
s3	0.152					
s4						0.164
s5		0.959		0.499		
s6						0.338
s7			1.505		0.347	0.765
s8	1.723					1.456
s9	0.445	0.003			0.877	1.081
s10	0.288		1.484	2.280	0.870	
s11		0.245				
s12		0.021				
s13	0.581					
s14						
sums	4.218	1.228	4.538	3.233	2.094	4.924

sum ; 20.235 avg. ; 0.7783
observations ; 26

OVERALL vs. OVERALL

Positive Products (++)

Ranker \ Rankee	f1	f2	f3	f4	f5	f6
s1						
s2		0.813			0.517	0.264
s3				0.326		1.613
s4		1.316			0.836	
s5	0.585		0.077		0.306	0.090
s6		1.434			0.394	
s7	0.300	0.803				
s8			1.322			
s9				0.583		
s10		0.125				
s11	0.288			0.012	0.490	
s12			1.624		0.517	
s13			2.267		0.299	0.088
s14	0.352					2.888
sums	1.525	4.491	5.290	0.921	3.359	4.943

sum ; 20.529 avg. ; 0.7332
observations ; 28

Positive Products (--)

s1		0.058				1.220
s2	0.487			1.350		0.208
s3		1.069	0.312			
s4	0.344		0.262			
s5						
s6	0.050		0.098			
s7						
s8		1.932			0.175	
s9			1.058			
s10						0.734
s11			1.730			0.061
s12	0.026					0.684
s13		0.099		2.225		
s14		0.238	0.189	0.428	0.246	
sums	0.907	3.396	3.649	4.003	1.849	1.479

sum ; 15.283 avg. ; 0.6113
observations ; 25

OVERALL vs. TEACHING ABILITY

Ranker

Product of Corresponding Standard Unit Normal Deviates

Rankee

	f1	f2	f3	f4	f5	f6
s1	+0.452	-0.053	+1.602	+0.218	-3.887	+1.254
s2	+0.673	+0.859	-0.383	+0.425	+0.281	+1.135
s3	+0.437	-0.307	+0.049	+1.450	+0.366	+0.413
s4	-0.377	+1.956	+1.812		+0.455	-0.074
s5	+0.027	+0.878	+0.162		+0.135	+0.216
s6	+0.206	+0.509	+0.016		+0.215	-1.453
s7	+0.345	+0.795	+2.625		+0.189	+0.563
s8	+0.986	-1.132	+0.795		-0.036	+0.538
s9	+1.685	+0.004	-1.148	+0.597	+0.477	+0.795
s10	-0.734	+0.429	+1.611	+0.923	+0.141	-0.065
s11	+0.331	+0.814	-1.878	+0.021	+0.266	-0.102
s12	+0.012	+0.023	+0.927		+0.281	-3.060
s13	+0.700	+0.110	+0.884	-2.019	+0.163	+0.330
s14	+0.405	+0.266	-0.205	+0.469	+0.085	+1.238

sum ; +1.965 avg. ; +0.0252
observations ; 78

First sign:
faculty appraisal of student

Negative Products
(+- or -+)

s1			1.602	0.218		1.254
s2	0.673			0.425		1.135
s3	0.437		0.049	1.450	0.366	
s4		1.956	1.812			
s5		0.878			0.135	
s6	0.206		0.016			
s7	0.345	0.795	2.625		0.189	
s8	0.986		0.795			0.538
s9	1.685	0.004			0.477	
s10			1.611	0.923		
s11	0.331					
s12	0.012	0.023				
s13	0.700	0.110				
s14	0.405	0.266		0.469	0.085	
sums	5.780	4.032	8.510	3.485	1.252	3.927

sum ; 25.986 avg. ; 0.7023
observations ; 37

OVERALL vs. TEACHING ABILITY

Positive Products (++)

R a n k e e

R a n k e r

	f1	f2	f3	f4	f5	f6
s1	0.452					
s2		0.859			0.281	
s3						0.413
s4					0.455	
s5	0.027		0.162			0.216
s6		0.509			0.215	
s7						0.563
s8						
s9				0.597		0.795
s10		0.429			0.141	
s11		0.814		0.021	0.266	
s12			0.927		0.281	
s13			0.884		0.163	0.330
s14						1.238
sums	0.479	2.611	1.973	0.618	1.802	3.555

sum ; 11.038 avg. ; 0.4599
observations ; 24

Positive Products (--)

s1		0.053			3.887	
s2			0.383			
s3		0.307				
s4	0.377					0.074
s5						
s6						1.453
s7						
s8		1.132			0.036	
s9			1.148			
s10	0.734					0.065
s11			1.878			0.102
s12						3.060
s13				2.019		
s14			0.205			
sums	1.111	1.492	3.614	2.019	3.923	4.754

sum ; 16.913 avg. ; 0.9949
observations ; 17

OVERALL vs. COMMAND OF TECHNICAL MATERIAL

Ranker

Product of Corresponding Standard Unit Normal Deviates

Rankee

	f1	f2	f3	f4	f5	f6
s1	+-0.67.	--0.230	++3.312	-+0.659	--1.630	-+0.358
s2	-+0.673	+-1.026	-+0.022	-+1.288	++0.669	+-1.003
s3	-+0.262	--1.337	--0.236	++1.524	--0.347	++0.825
s4	-+0.172	++0.431	--0.508		++1.082	-+0.172
s5	+-0.423	+-0.473	+-0.320		++0.288	++0.153
s6	--0.020	++0.469	-+0.094		++0.510	--1.284
s7	+-0.645	++0.263	-+1.365		-+0.449	+-0.098
s8	--1.000	--1.449	++0.616		-+0.077	+-0.504
s9	++0.615	-+0.004	--0.800	+-0.390	--1.845	++1.643
s10	--0.122	++0.350	+-4.380	-+1.915	++0.334	-+0.403
s11	++1.202	++1.109	-+0.106	++0.010	+-0.346	--0.147
s12	--0.032	-+0.030	++0.850		+-1.087	-+2.790
s13	++0.735	-+0.102	++0.811	--1.710	+-0.629	+-0.334
s14	++0.510	-+0.245	--0.143	--1.145	-+0.202	+-0.215

sum ; +8.364 avg. ; +0.1072
observations ; 78

First sign:
faculty appraisal
of student

Negative Products
(+- or -+)

s1	0.671			0.659		0.358
s2	0.673	1.026	0.022	1.288		1.003
s3	0.262					
s4	0.172					0.172
s5	0.423	0.473	0.320			
s6			0.094			
s7	0.645		1.365		0.449	0.098
s8					3.077	0.504
s9		0.004		0.390		
s10			4.380	1.915		0.403
s11			0.106		0.346	
s12		0.030			1.087	2.790
s13		0.102			0.629	0.334
s14		0.245			0.202	0.215
sums	2.846	1.880	6.287	4.252	2.790	5.877

sum ; 23.932 avg. ; 0.6468
observations ; 37

OVERALL vs. COMMAND OF TECHNICAL MATERIAL

Ranker

Positive Products (++)

Rankee

	f1	f2	f3	f4	f5	f6
s1			3.312			
s2					0.669	
s3				1.524		0.825
s4		0.431			1.082	
s5					0.288	0.153
s6		0.469			0.510	
s7		0.263				
s8			0.616			
s9	0.615					1.643
s10		0.350			0.334	
s11	1.202	1.109		0.010		
s12			0.850			
s13	0.735		0.811			
s14	0.510					
sums	3.062	2.622	5.589	1.534	2.883	2.621

sum ; 18.311 avg. ; 0.7961
observations ; 23

Positive Products (--)

s1		0.230			1.630	
s2						
s3		1.337	0.236		0.347	
s4			0.508			
s5						
s6	0.020					1.284
s7						
s8	1.000	1.449				
s9			0.800		1.845	
s10	0.122					
s11						0.147
s12	0.032					
s13				1.710		
s14			0.143	1.145		
sums	1.174	3.016	1.687	2.855	3.822	1.431

sum ; 13.985 avg. ; 0.7769
observations ; 18

OVERALL vs. INDICATION OF PRACTICAL EXPERIENCE

Ranker

Product of Corresponding Standard Unit Normal Deviates

Rankee

	f1	f2	f3	f4	f5	f6
s1	++0.343	--0.026	++0.198	--0.326	-+1.380	--0.218
s2	--0.951	+-1.094	-+0.047	-+1.750	+-0.312	++2.006
s3	-+0.167	--0.782	-+0.042	++0.681	-+1.198	+-0.425
s4	--0.164	++0.910	--0.746		+-0.504	-+0.787
s5	++0.099	+-0.549	+-0.005		+-0.927	++0.081
s6	-+0.053	++0.992	-+0.124		++0.702	--3.025
s7	++0.330	++0.555	--1.593		--0.209	++0.315
s8	-+0.161	--1.684	+-0.661		--0.137	++0.202
s9	++0.466	--0.002	-+0.142	+-0.240	--0.529	++0.445
s10	-+0.317	++0.931	+-4.290	-+3.112	+-0.156	--1.289
s11	++0.317	+-0.108	-+0.232	+-0.005	++0.871	--0.020
s12	-+0.009	--0.003	++0.120		+-0.312	-+0.756
s13	+-1.492	-+0.215	++2.132	--1.051	+-0.180	++0.669
s14	++0.387	--0.105	-+0.237	--0.704	-+0.278	+-1.700

sum ; +-2.899 avg. ; +-0.0372
observations ; 78

First sign:
faculty appraisal
of student

Negative Products
(+- or -+)

s1					1.380	
s2		1.094	0.047	1.750	0.312	
s3	0.167		0.042		1.198	0.425
s4					0.504	0.787
s5		0.549	0.005		0.927	
s6	0.503		0.124			
s7						
s8	0.161		0.661			
s9			0.142	0.240		
s10	0.317		4.290	3.112	0.156	
s11		0.108	0.232	0.005		
s12	0.009				0.312	0.756
s13	1.492	0.215			0.180	
s14			0.237		0.278	1.700
sums	2.649	1.966	5.780	5.107	5.247	3.668

sum ; 24.417 avg. ; 0.6783
observations ; 36

OVERALL vs. INDICATION OF PRACTICAL EXPERIENCE

Positive Products (++)

Ranker \ Rankee	f1	f2	f3	f4	f5	f6
s1	0.343		0.198			
s2						2.006
s3				0.681		
s4		0.910				
s5	0.099					0.081
s6		0.992			0.702	
s7	0.330	0.555				0.315
s8						0.202
s9	0.466					0.445
s10		0.931				
s11	0.317				0.871	
s12			0.120			
s13			2.132			0.669
s14	0.387					
sums	1.942	3.388	2.450	0.681	1.573	3.718

sum ; 13.752 avg. ; 0.6251
observations ; 22

Positive Products (--)

s1		0.026		0.326		0.218
s2	0.951					
s3		0.782				
s4	0.164		0.746			
s5						
s6						3.025
s7			1.593		0.209	
s8		1.684			0.137	
s9		0.002			0.529	
s10						1.289
s11						0.020
s12		0.003				
s13				1.051		
s14		0.105		0.704		
sums	1.115	2.602	2.339	2.081	0.875	4.552

sum ; 13.564 avg. ; 0.6782
observations ; 20

Appendix C

Biography

Place of Birth:	Baltimore, Maryland
Date of Birth:	October 5, 1940
Father:	William H. Roach
Mother:	Ruth Lloyd Roach
College:	Lehigh University
Degree:	B.S. in Industrial Engineering
Honoraries:	Tau Beta Pi
	Alpha Pi Mu
	Cyanide (Junior Honorary)