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ABSTRACT

A sample of 82 engineers and 82 supervisors rated the importance of 10 job performance criteria in relation to the successful performance of the engineer's job. Supervisors also rated the engineer's performance on each of the 10 specific criteria and two global measures. The ratings were intercorrelated and factor analyzed; the extracted factors were rotated using Kaiser's varimax method. The importance ratings by supervisors were found to be highly similar to the importance ratings by engineers, with three factors emerging from the ratings by each group: (1) administrative skill, (2) technical competence, and (3) design skill. The factor analysis of the performance ratings by supervisors revealed two factors: (1) interpersonal relations ability and (2) technical ability. It appears that supervisors appraise performance by criteria similar to those they perceive as being critical to the type of work performed by engineers. (Author)

Working Paper 1974-03

SUPERVISOR RATINGS AND THE PERCEIVED IMPORTANCE OF ENGINEERING JOB PERFORMANCE CRITERIA

by

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Supervisor Ratings and the Perceived Importance of Engineering Job Performance Criteria

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Ghiselli (1956) was one of the first to explicate the multidimensional nature of job performance. Studies by McQuitty, Wrigley, and Gaier (1954), Seashore, Indik, and Georgopoulos (1960) and Turner (1960) served to validate the notion of multidimensional job performance criteria by identifying and isolating different dimensions of behavior related to job performance. While certain dimensions of job performance criteria have emerged from such studies, a second issue revolves around the extent to which differing functional work units within an organization perceive these dimensions to be the same.

Meyer (1959) studied how foreman and general foreman differed in their perceptions of the foreman's job responsibilities. A relatively large amount of disagreement was found between the average individual foreman and his own general foreman regarding the degree of responsibility the foreman had for different job specifications. Postulating that such disparate perceptions were in part a function of differing status levels in the organizational hierarchy, Lahiri (1965) and Lahiri and Choudhuri (1966) studied two groups of employees (clerical and technical) who had the same job levels and salary grades. No overall differences were found between the perceptions of technical and clerical employees in regard to the relative importance of different job factors. Finally, Prien and

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Liske (1962) explored the relationship between supervisor ratings of job performance and incumbent ratings of job performance. Perceptions of performance criteria were found to vary consistently, with greater agreement on intellectual elements of performance, but less with the social aspects of job performance. Prien and Liske concluded that, "Perceptions of performance criteria are in some way a function of status, or of proximity to the actual performance being evaluated" (1962, p. 192).

The purpose of the present study is to examine the perceptions of a sample of engineers and their supervisors regarding the importance of certain job performance criteria relating to the engineer's job. Supervisor ratings of the engineer's performance are also related to the perceived importance of the job performance criteria.

METHOD

Subjects

The Ss were 82 male bachelor level engineering graduates and 82 supervisors. None of the engineers had advanced academic degrees and all had 5-10 years of post college working experience. The sample of engineers had all graduated from the College of Engineering of Kansas State University, and contained graduates of eight engineering departments (agricultural, architectural, chemical, civil, electrical, industrial, mechanical, and nuclear). The sample is assumed to be representative of bachelor-level engineering graduates who have 5-10 years of post college working experience.

Procedure

In consultation with College of Engineering officials, a list of ten criteria relevant to the successful performance of any engineering-related job was devised. These were: (1) Scientific-Technical Knowledge; (2) Understanding of Engineering Problem-Solving Methodology; (3) Creativity-Originality; (4) Persuasiveness; (5) Interpersonal Competence; (6) Managerial Skill; (7) Written Communication; (8) Oral Communication; (9) Precision-Care; and (10) Practical Judgment. Both the engineer and his supervisor were asked to rate the importance of each criterion to the successful performance of the engineer's job. A four-point scale was used: Essential (scored 4); Very Important (3); Important (2); Of Minor or No Importance (1).

Supervisors were also asked to rate the engineer's performance on each of the ten criteria. Five point rating scales were developed, with a different descriptive phrase defining the behavioral meaning of each point. The supervisor also was given the option to check "No Opportunity to Observe" for each criterion. For each scale, the most favorable rating was scored 5, the least favorable rating 1. In addition to these ten specific measures, two global measures were included in the supervisor's rating. These were his rating of the overall quality and quantity of the engineer's work; again a five point rating scale was used.

Analysis

The Spearman rank order correlation was computed between the mean importance ratings of the ten job performance criteria for the two rating groups. The importance ratings by both groups and the performance ratings by supervisors were intercorrelated and factor analyzed; the extracted factors were rotated using Kaiser's (1958) varimax method.

RESULTS AND DISCUSSION

Table 1 presents the means and standard deviations for the perceived importance ratings of the ten job performance criteria by both the supervisors and engineers. In general, the two groups were in substantial agreement as to the importance of the ten job performance criteria. The Spearman rank order correlation between the two sets of means in Table 1 was .69

Insert Table 1 About Here

($p < .03$). Engineers as a group gave a statistically significant ($p < .05$) lower rating to Precision-Care than did supervisors. None of the other pairs of means differed significantly. Practical Judgment, Interpersonal Competence, and Oral Communication received respectively the highest mean ratings by both collective groups. However, examining the interrater reliability across each engineer-supervisor pair revealed the least amount of agreement (.03) on the importance of Practical Judgment, as can be seen in Table 2.

Table 2 presents the intercorrelations between the rated importance of the ten job performance criteria, with the intercorrelation of the engineers' ratings below the diagonal, the intercorrelation of the supervisors' ratings above the diagonal, and the interrater reliability on the diagonal. Thus collectively, both engineers and supervisors rated Practical Judgment to be the most important criterion. However, there was virtually

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Insert Table 2 About Here

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no interrater agreement on this measure across pairs of raters. The greatest interrater reliability was for Scientific-Technical Knowledge (.47), which supports the findings of Prien and Liske (1962) regarding greater agreement on intellectual measures of job performance. The modest size of the correlations between job performance criteria (Table 2) indicates a lack of dependence in importance between these measures.

Both sets of importance ratings were factor analyzed and the rotated loadings are shown in Table 3. For the supervisors, the first factor has

Insert Table 3 About Here

strong positive loadings on Oral Communication, Persuasiveness, Written Communication, Managerial Skill, and Interpersonal Competence. These performance measures clearly reflect the importance of administrative ability; the ability to plan, organize, communicate, etc. This factor is called "Administrative Skill." The second factor has strong positive loadings on Scientific-Technical Knowledge, Understanding of Problem-Solving Methodology, and Precision-Care.

These performance measures reflect the importance of those skills that are typically engendered by formal academic training in engineering (see Hoyt and Muchinsky, 1970); factual knowledge, precise reasoning, tight thinking, etc. This second factor is called "Technical Competence." The third factor has strong positive loadings on Practical Judgment, Precision-Care, and Creativity-Originality. These performance measures reflect the importance of ability in the functional, operative aspects of engineering work, i.e., exercising sound judgment in the design and development of engineering projects. This third factor is called "Design Skill."

For the engineers, the first factor has strong positive loadings on Oral Communication, Managerial Skill, Interpersonal Competence, Persuasiveness, and Written Communication. These performance measures are the same as those in the first factor for supervisors, reflecting the importance of "Administrative Skill." The second factor has strong positive loadings on Creativity-Originality, Understanding of Problem-Solving Methodology, and

Practical Judgment. Similar to the third factor for the supervisors, this factor is called "Design Skill." The third factor has strong positive loadings on Scientific-Technical Knowledge, Precision-Care, and Written Communication. These performance criteria reflect the importance of engineering expertise. This factor is thus called "Technical Competence."

In comparing the two factor structures it is evident that both supervisors and engineers have close common perceptions regarding the importance of the engineer's job performance criteria. The predominant factor in the ratings of both groups is the importance of administrative responsibilities. This factor for both groups has similar loadings on the same five job performance criteria. This factor, however, seemingly relates more to the job responsibilities of supervisors than engineers, as it reflects the importance of managerial duties. However, both supervisors and engineers also perceived the importance of Technical Competence and Design Skill, factors which seemingly would relate more to the job responsibilities of engineers than the Administrative Skill factor. While the Technical Competence and Design Skill factors collectively accounted for more of the variance in the ratings than did the Administrative Skill factor, the latter emerged as the largest factor in both sets of ratings.

These results do not support the findings of Meyer (1959), who found considerable disagreement in perceptions of job responsibility between foreman and general foreman. The discrepancy between the findings of this study and Meyer's study may be due to differences in the working relationship between the two rating groups. Hoyt and Muchinsky (1970) reported that frequently supervisors direct the work of engineers who are involved in team design projects, serving in both a supervisory and consultative capacity. As Prien and Liske (1962) stated, if perceptions of performance criteria are a function of proximity to the actual performance being evaluated, it may well be that the supervisors in this study had a closer working relationship with their subordinates than did the general foremen in Meyer's study. Therefore, the substantial degree of agreement between the two sets of importance ratings may be reflective of the fact that supervisors interact directly with engineers in performing their daily work operations. Such close proximity between the engineer and his supervisor may eventuate in the evolution of common perceptions regarding the importance of certain job performance criteria.

The emergence of an Administrative Skills factor in the engineer's job may be a function of the type of work performed by engineers. Engineers involved in team design projects are frequently called upon to communicate and "sell" their ideas to others, and to organize their individual talents into a cohesive design team (Hoyt and Muchinsky, 1970). The importance of those skills is reflected in the high positive loadings on those performance criteria that comprise the Administrative Skills factor. Thus, while skill in administrative duties seemingly is more descriptive of a supervisory position, the particular nature of team design work may also engender the importance of these skills in the engineer's own position.

The amount of variance in the importance ratings unaccounted for in the factor analyses is due probably, in part, to the unreliability of the rating instruments. Greater refinement of the importance rating scale would be desirable for future research, as the interrater agreement coefficients suggest somewhat of a ceiling effect in the importance ratings. However, it is clear from Table 3 that the three factors do emerge from the importance ratings in the specific way shown.

Table 4 shows the intercorrelations of the engineer's performance ratings by supervisors. All of the intercorrelations are positive and

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Insert Table 4 About Here

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most are only modest in size, suggesting that these performance criteria reflect relatively independent aspects of an engineer's performance. Since only .01% of the performance ratings were marked "No Opportunity to Observe," the intercorrelations are not biased by frequent ratings of unobserved behavior.

The performance ratings were factor analyzed and the rotated loadings are presented in Table 5. The first factor has strong positive loadings on

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Insert Table 4 About Here

Interpersonal Competence, Oral Communication, Managerial Skill, Practical Judgment, and Persuasiveness. These loadings suggest the supervisors are evaluating the engineers' ability to work with the people-oriented problems associated with their job. Having the highest loading (.85) on Interpersonal Competence and manifesting a similar pattern to the Administrative Skills factor from the importance ratings, this factor is called "Interpersonal Relations Ability." The second factor has strong positive loadings on Creativity-Originality, Understanding Problem-Solving Methodology, Scientific-Technical Knowledge, Overall Quality, and Overall Quantity. These loadings suggest the supervisors are evaluating the technical and design merits of the engineer's performance, and is called "Technical Ability."

In reviewing the performance ratings, it appears that supervisors appraise the performance of engineers along similar lines to those by which they perceive the importance of job performance criteria. While there was not a homomorphic relationship between the importance and performance ratings, it seems the Administrative, Design, and Technical Skill factors of the importance ratings have their analog in the Interpersonal Relations and Technical Ability factors of the performance ratings.

While both engineers and supervisors perceived the importance of three dimensions to the engineer's job performance criteria, the actual performance ratings by supervisors reflected appraisal on two dimensions. The importance of Administrative Skills in the engineer's job accounted for the greatest percent of the variance in the ratings; likewise the corresponding Interpersonal Relations Ability factor accounted for the greatest percent of variance in the performance ratings. While both supervisors and engineers could discriminate between the importance of technical and design skill, supervisors were apparently unable to make this discrimination in their performance ratings. Perhaps this stems from the difficulty of identifying and assessing creativity, as reflected in design projects (Taylor, 1964). In general, however, supervisors appraised performance by criteria similar to those they perceived as being critical to the type of work performed by engineers.

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Table 1

Rated Importance of Job Performance Criteria

For Performing Engineer's Job

	Rating Groups			
	Supervisors (N=82)		Engineers (N=82)	
	Mean	S.D.	Mean	S.D.
Practical Judgment	3.51	.61	3.50	.67
Interpersonal Competence	3.28	.63	3.43	.61
Oral Communication	3.17	.68	3.28	.67
Precision-Care	3.15	.65	2.87	.75
Managerial Skill	3.11	.74	3.21	.77
Understanding of Prob.-Solv. Methods	3.02	.85	3.04	.92
Written Communication	3.01	.73	3.07	.78
Scientific-Technical Knowledge	2.94	.88	3.05	.93
Creativity-Originality	2.91	.72	2.72	.82
Persuasiveness	2.90	.82	3.06	.82

Table 2

Intercorrelation of Importance Ratings by Engineers and Supervisors

Supervisors (N=82)

	I	II	III	IV	V	VI	VII	VIII	IX	X
I	(.47)	.57	.07	-.20	-.26	-.05	.02	-.06	.23	.02
II	.40	(.26)	.18	-.05	-.13	.00	.04	-.07	.28	-.13
III	.24	.31	(.13)	.26	.03	.23	.26	.23	.24	.32
IV	-.18	-.05	.08	(.09)	.42	.41	.20	.44	-.02	.19
V	-.10	-.09	-.03	.38	(.29)	.33	-.01	.32	-.04	.17
VI	-.08	.01	.19	.39	.32	(.44)	.14	.31	-.03	.26
VII	.15	.01	-.04	.22	.22	.26	(.15)	.37	.07	.06
VIII	.00	-.08	.08	.46	.58	.58	.45	(.14)	.08	.15
IX	.22	.20	.18	.05	.14	.18	.16	.32	(.05)	.26
X	.06	.27	.19	.26	.05	.32	.26	.23	.26	(.03)

I Scientific Technical Knowledge
II Understanding of Problem-Solving Methods
III Creativity-Originality
IV Persuasiveness
V Interpersonal Competence
VI Managerial Skill
VII Written Communication
VIII Oral Communication
IX Precision-Care
X Practical Judgment

Table 3

Rotated Loadings from Factor Analysis of Supervisors' and Engineers' Importance Ratings

	Supervisors				Engineers			
	Cumulative % of Variance				Cumulative % of Variance			
	22.3	41.3	56.2		27.5	43.4	58.4	
	I	II	III	h^2	I	II	III	h^2
Scientific-Technical Knowledge	-.10	.78	.12	.63	-.23	.21	.77	.69
Understanding of Problem-Solving Methods	.04	.80	.05	.64	-.20	.62	.43	.61
Creativity-Originality	.41	.27	.49	.48	.00	.62	.43	.60
Persuasiveness	.72	-.23	.15	.59	.69	.21	-.25	.58
Interpersonal Competence	.45	-.46	.19	.45	.70	-.16	.07	.57
Managerial Skill	.57	-.16	.27	.42	.71	.32	-.06	.61
Written Communication	.63	.29	-.16	.51	.52	-.18	.52	.57
Oral Communication	.77	-.02	.03	.59	.86	.00	.23	.79
Precision-Care	-.04	.41	.61	.54	.25	.22	.56	.42
Practical Judgment	.11	-.17	.84	.75	.35	.57	.13	.46

Table 4

Intercorrelation of Engineers' Performance Ratings by Supervisors

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
(I) Scientific-Technical											
(II) Understanding of Prob.-Solv. Methods	.46										
(III) Creativity-Originality	.31	.37									
(IV) Persuasiveness	.25	.29	.48								
(V) Interpersonal Competence	.14	.24	.04	.46							
(VI) Managerial Skill	.27	.51	.43	.54	.44						
(VII) Written Communication	.27	.32	.13	.31	.37	.46					
(VIII) Oral Communication	.29	.36	.25	.51	.51	.49	.39				
(IX) Precision-Care	.38	.45	.32	.46	.37	.58	.43	.38			
(X) Practical Judgment	.34	.44	.42	.52	.49	.62	.28	.47	.56		
(XI) Overall Quality	.43	.53	.54	.50	.29	.57	.47	.46	.58	.53	
(XII) Overall Quantity	.37	.43	.44	.38	.28	.54	.31	.23	.35	.34	.44

Table 5

Rotated Loadings from Factor Analysis of Engineer's

Performance Ratings by Supervisors

	Cumulative % of Variance		
	32.1	57.4	
	I	II	h^2
Scientific-Technical Knowledge	.12	.65	.44
Understanding of Problem-Solving Methods	.28	.67	.53
Creativity-Originality	.06	.78	.61
Persuasiveness	.61	.39	.53
Interpersonal Competence	.85	-.06	.73
Managerial Skill	.63	.52	.67
Written Communication	.59	.22	.40
Oral Communication	.74	.19	.58
Precision-Care	.55	.49	.54
Practical Judgment	.62	.45	.58
Overall Quality	.44	.69	.67
Overall Quantity	.24	.65	.48