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ABSTRACT

Reported is a validation study of the Dubin technical updating model, one which identifies variables that may be combined with expectancy theory to predict whether or not engineers will need technical updating. The basic hypothesis is that the likelihood of engaging in updating activities is a function of individual motivation and characteristics of the work environment. To obtain information about work environments, researchers developed the Work Description Questionnaire for Engineers (WDQE). A factor analysis of data provided by over 400 practicing engineers and supervisors led to the development of a final version of the WDQE, which was then administered to an additional 500 engineers. Results generally validated the Dubin model and indicated that valence-instrumentality-expectancy theory can be a useful framework for understanding individual motivation and its impact upon technical updating. It is suggested that the WDQE can provide an organization with information that can facilitate technical updating by its employees. (Author/WB)

Relationships Among Individual Motivation, Work Environment, and Updating in Engineers

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Abstract

A set of questionnaire instruments was developed to measure the various components of the Dubin technical updating model. This model hypothesizes that the likelihood of an engineer engaging in technical updating activities is a function of individual motivation and characteristics of the work environment. Individual motivation measures are based upon a general valence-instrumentality-expectancy (VIE) theory of work motivation. The work environment measures are concerned with five general factors: supervisory actions and attitudes; peer-colleague interactions; job activities and work assignments; management and organizational policies; and organizational climate. Items concerned with these general work environment factors were collected into a single questionnaire labeled the Work Description Questionnaire for Engineers. Data gathered from over 400 engineers and technical supervisors served as input for the development of the WDQE.

The WDQE was completed by over 500 additional engineers. Thirteen more specific subscales were identified by factor analysis of these data. These subscales can serve as more detailed measures of work environment characteristics than the five general factors. An organization would use the WDQE and its subscales to gather information about how its engineering staff and various levels of management view the organization's support or nonsupport of technical updating. The WDQE responses could serve as diagnostic aids to help eliminate organizational barriers to updating and to help reinforce those organizational characteristics facilitating the updating of its engineers.

It is suggested that future research be conducted using the WDQE and the individual motivation measures to learn more about the nature of technical updating and to understand better the relationships among the various factors affecting updating. The technical updating and job performance of engineers remains a critical issue in the overall effectiveness of organizations and is worthy of more research.

Relationships Among Individual Motivation,

Work Environment and Updating in Engineers

Within the past two decades, technically-based organizations have become increasingly aware of the problem of technical obsolescence among its engineering personnel. Technical obsolescence refers to an individual's lack of knowledge concerning current technological and scientific knowledge and methods which would allow the individual to perform his or her job more efficiently. Technical obsolescence results from several factors, including technological change, the growth of specialized bodies of knowledge, and the state of environmental flux in contemporary organizations. According to Hinrichs (1973), environmental flux is evident in the increasing complexity of current technologies and organizations, the changes taking place in society, and the many ambiguities faced by decision makers. High levels of skills, broad perspectives, flexibility, and competence in the leading edges of relevant technologies are the hallmarks of a successful contemporary organization. These factors imply the need for continual technical updating on the part of organizational personnel, especially those in engineering disciplines.

Although the need for technical updating exists, not all engineers attempt to remain or to become up-to-date in their professions. The present project was generally focused upon the question of the determinants of technical updating. Our perspective for viewing this problem area was that of individual motivation; that is, the attempt, or lack of attempt, to become technically up-to-date was viewed as a decision made by the individual engineer to expend or not to expend effort and time. It was believed that approaching technical updating issues from the motivational perspective offered a great deal of potential insight into the problem.

Motivation to Engage in Updating Activity

The problem of motivating updating behavior may be seen as two-fold. First, the organization itself must recognize the problem of obsolescence and be committed to encourage and promote updating activity. Second, individuals must be motivated to take advantage of updating programs. For the moment we shall assume that the first condition is satisfied. Motivating people to update may be seen as simply a special case of motivation in general. Although work motivation is generally conceived as resulting from some combination of individual and environmental (organizational) factors, individual factors are usually seen as peripheral or boundary influences (cf. Vroom, 1964; Porter & Lawler, 1968). Similarly, while individual factors are undoubtedly related to obsolescence (Kaufman, 1973), the preponderance of evidence is associated with organizational factors.

Expectancy theories of work motivation (cf. Vroom, 1964; Porter & Lawler, 1968; Lawler, 1971) maintain that organizational rewards are contingent upon performance. Behavioristically based theories concur (cf. Nord, 1969; Jablonsky & DeVries, 1972; Hamner, 1974). Pay, promotions, etc. are relevant extrinsic outcomes. Expectancy theories also regard intrinsic rewards derived from properties of the task itself as contributing to motivation. Theories of job or task design (e.g., Hackman & Oldham, 1976; Hackman & Lawler, 1971) provide support for the same position. They argue that task properties of autonomy, task identity, task variety, task significance, and feedback contribute to intrinsic motivation.

Several specific organizational aspects, which are related to these conceptualizations of extrinsic and intrinsic outcomes, have been linked to impacts on motivation or upon the updating activity of engineers by previous research. Broadly speaking, the aspects which have been identified are: recognition for good performance (verbal, financial, promotional), participation in decision-making, responsibility for jobs or projects, feedback and communication with superiors, challenging job assignments, support for professional activities, and support for continuing education activities.

These extrinsic and intrinsic outcomes are, for the most part, determined by organizational factors. While numerous organizational factors have been hypothesized to impact on motivation, Dubin (1972, 1977, 1978) has proposed a multidimensional model of updating which includes five work environment variables that influence engineers' motivation to update. These five work environment or organizational factors may essentially be regarded as creating boundaries within which an individual motivational model of behavioral choice operates. The factors identified by Dubin included the following: 1) management policy, 2) supervisory behavior, 3) peer or colleague interactions, 4) work assignments, and 5) organizational climate.

The model is presented in Figure 1. The literature which relates these five factors to updating activity, when such literature exists, or to work motivation in a more general sense, is reviewed for each factor below.

Literature Review of Organizational Factors

Management Policy

McCarrey and Edwards (1973) found that such organizational features as ease of communication with management, degree of work group autonomy, management priorities, time pressures, and degree of skill utilization were

Figure 1

Dubin's Model of Technical Updating

$P(U) = f\ (M,\ W.E.),$

where:

$P(U)$ = probability of updating,

M = individual motivation, and

$W.E.$ = work environment.

$$W.E. = W_1\ (O.C.) + W_2\ (J.C.) + W_3\ (S.S.) + W_4\ (C.I.) + W_5\ (M.P.),$$

such that:

$W_1 \ldots W_5$ = weight assigned to each variable,

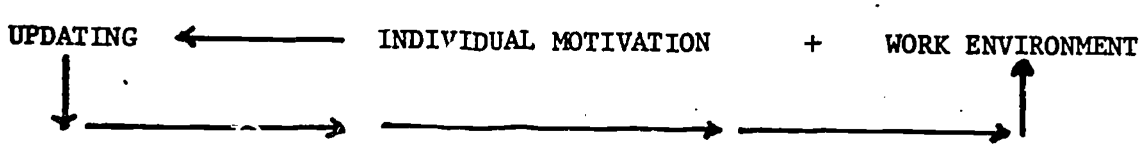
O.C. = organizational climate,

J.C. = job characteristics,

S.S. = supervisor-subordinate relationships,

C.I. = colleague interactions, and

M.P. = management policy.



related to the effective performance of R & D scientists. Miller (1977) maintained that the organization must have an explicit policy to reward updating behavior if it expects personnel to engage in those activities. He put the responsibility for the prevention of obsolescence squarely on management's shoulders by insisting that organizations must provide challenging projects/goals, must resist the temptation to exploit employee skills for the short term without refurbishment, must be aware of work priorities which can interfere with updating attempts, and must plan ahead for technical change; that is, insure that present technical talent is continually developed to meet future challenges. Kaufman (1974) made similar arguments. He stated that organizations must allow technical professionals to have influence in decision-making which directly affects them, that they must reward self-development and that dual career ladders must result in commensurate status (otherwise, technical advancement may be perceived as a failure to be recognized as management material) if the organization hopes to motivate updating behaviors.

Supervisory Behavior

Supervision becomes important in this schema since it is the most visible source of policy. It is supervisory actions which translate actual policy into the basis for individuals' perceptions of policy, and it is perceptions of policy which will ultimately influence behavior. Thus, virtually all of the policy features are linked to technical supervision. Kaufman (1974) asserted that supervision motivates updating if it is perceived as technically competent and participatory, if it provides feedback, if it emphasizes technical competence and innovation rather than deadlines, and if it provides recognition and rewards. Others have echoed the importance of recognition for updating activities (Wernimont, Toren, & Kapell, 1970; Misshauk, 1970). Miller (1972) noted that supervisors must concentrate on developing rather than exploiting their employees' talent. Thus, it is important that they support continuing educational activities (Miller, 1977).

Supervisory actions have also been linked to effects upon work motivation within an expectancy framework. For example, James et al. (1977), Sims et al. (1976), and Turney and Cohen (1976) have found positive relationships between leader support and outcome expectations. Arvey, DeWherst, and Boling (1976) obtained significant positive relationships between changes in perceived supervisory behavior and job satisfaction. Increases in the clarity of work goals, participation in goal setting, and increased subordinate feedback, freedom, and evaluation were associated with increases in intrinsic and extrinsic job satisfaction (Arvey, DeWherst, & Brown, 1978).

Hence, supervisory execution of management policies which emphasizes technical competence, participatory decision-making, autonomy, goal clarity, recognition, and rewards will tend to influence behavior in desired directions. If organizational concern for updating activity is clarified at the supervisory level, expectations that updating activity will lead to desired outcomes will increase, and appropriate behavior should follow.

Peer Interactions

The effects of peers upon the motivation of individuals to engage in updating activity is virtually undocumented in the literature. There is, however, a good deal of evidence concerning group influences upon individual perceptions of work environment factors which in turn affect motivation, the motivation to update presumably being one potential facet of this process.

Group processes such as norms for appropriate levels of work effort and proper performance have been extensively documented since the late 1920's (cf. Roethlisberger & Dickson, 1939; Whyte, 1955; Porter, Lawler, & Hackman, 1975). It is not unlikely that such norms could also regulate updating activity. Less directly, however, coworker groups can regulate information and its interpretation concerning, for example, the relationship of effort and performance to rewards or the perception of supervisory style, management policy, etc. (Hackman, 1976). The structuring of such individual perceptions would have a profound impact upon motivation within an expectancy framework.

There is, in addition, some research concerning the use of peers as sources of technical knowledge. Gerstberger and Allen (1968) reported that the engineer's choice of technical information channels was largely determined by the ease of accessibility. This was later reaffirmed by Allen (1977) who indicated that of such information sources as technical literature, vendors, customers, consultants, staff, and in-house research, colleague contacts within the organization were the most widely employed information sources. Colleagues outside of the immediate organization, in addition to customers and vendors, were also identified as important, albeit less frequently used, sources. The usage of technical literature was reported to be very low. Even when it was utilized, it was primarily trade journals or textbooks which were consulted; professional journals were seldom used.

Work Assignments

Misshauk (1970) provided evidence which related work assignments to motivation. Similarly, Arvey and Neel (1976) indicated that assignments must provide challenge to be motivating. Kaufman (1974) asserted that early work challenge was related to continuing knowledge contributions and professional competence in later years. Pelz and Andrews (1966) determined that effectiveness and sustained performance in later years was dependent upon the breadth and diversity of assignments. Similarly, Mali (1969) indicated that obsolescence was related to overspecialization, lack of diversity, and low levels of utilization. Miller (1977) concurred and suggested job rotation as a potential solution.

In addition, there is an extensive body of job design literature (cf. Lawler & Hall, 1970; Hackman & Lawler, 1971; Hackman & Oldham, 1976) which link five job factors--task identity, skill variety, task significance, autonomy, and feedback--to intrinsic motivation. This literature also supports the assertions made above.

Organizational Climate

Although the notion of organizational climate is a controversial one (Guion, 1973), i.e., disagreements about its composition, definition, and role in determining organizational performance, some consensus emerges upon inspection. Organizational climate is generally conceived as perceived characteristics of the work environment, whether they result from conscious or unconscious organizational actions, which affect employee behavior (Steers, 1977). This view of organizational climate may thus be seen as encompassing the other organizational factors under consideration--management policy, supervisory behavior, peer interactions, and work assignments--into a global attitude on the part of the individual as to the "favorableness" or "unfavorableness" of the organization. This perception of climate in turn serves as a basis for individuals to interpret and understand their surroundings, and hence will influence their behavior on the job (Forehand & Gilmer, 1964; Pritchard & Karasick, 1973).

The extent to which organizational structure is rigid, formal, and centralized, the more threatening the perceived climate. The key variable seems to be the perception of the degree of individual autonomy, especially in terms of discretionary decision-making with respect to the individual's job. The more discretion, the more favorable the perceived climate (Dieterly & Schneider, 1974; Lawler, Hall, & Oldham, 1974; Likert, 1961; Litwin & Stringer, 1968). Likewise, job technology or the extent to which tasks are seen as routine as opposed to challenging impact upon climate perceptions (Burns & Stalker, 1961; Litwin & Stringer, 1968).

It should be clear that the elements of each organizational factor affect not only that factor, but also perceptions of organizational climate. Research has indicated a clear positive relationship between climate and job satisfaction (Friedlander & Margulies, 1969; Kazcka & Kirk, 1968; LaFollette & Sims, 1975), however, its relationship to job performance is problematic. Unfavorable climates are linked to low satisfaction and performance. Favorable climates are associated with higher satisfaction, but not necessarily higher performance. Only in favorable climates which also possess an achievement orientation is performance likely to improve (Steers, 1975, 1976).

<u>Summary</u>

Examination of the literature reveals the emergence of a pattern of variables which cut across the organizational factors, but which find their expression somewhat differently within each factor. The notion is that such variables as discretionary decision-making, autonomy, responsibility for projects, goal clarity, feedback and evaluation, challenging assignments, and recognition and rewards for performance affect the direction and intensity of behaviors. Management policy determines the levels of these variables; supervisory behaviors implement policy, or fail to do so; peers assist in the structure of perceptions; work assignments provide the individual with the actual experience of these variables; and climate is the individual's overall interpretation of the situation.

VIE Theory as a Motivational Framework

The literature review suggests that each of the five organizational factors can influence employee behavior. What is required is a theory of motivation which can incorporate these factors within a coherent explanatory framework. Valence, instrumentality, and expectancy (VIE) theory (Vroom, 1964; Porter & Lawler, 1968) is a dynamic process model of individual work motivation. As such, it possesses the flexibility to incorporate these factors into a model which would be suitable for specifically examining updating behavior. First, the theory and its support will be briefly reviewed, then its potential for providing a framework for understanding the motivation to update will be clarified.

Basic VIE Theory

Essentially, VIE theory is based upon the prosaic notion that man attempts to maximize his pleasure. Hedonism is hardly a new idea; it can be traced back to the early Greek philosophers and was popular with the English utilitarians (e.g., Mill). Very simply, behavior is seen to be a function of the probability that it will lead to certain outcomes and the attractiveness of those outcomes.

This concept was rediscovered in psychology with the early work of Lewin (1938) and Tolman (1932). Both figured prominently in the original statement and development of the theory, Lewin's contribution focusing particularly on the cognitive aspects of behavior. Motivation was postulated to arise from the multiplicative relationship between expectancies, which are anticipations or subjective probabilities concerning future events, and valences, or hedonic preferences among behavioral outcomes. This notion has undergone considerable evolution and expansion since its original proposal. Additional development by other theorists, particularly Atkinson (1964), Edwards (1954) Peak (1955), and Rotter (1955), provided the basis for Vroom's (1964) statement of the theory as it related to work motivation. Briefly, the central concept of Vroom's expectancy theory is that the force of a person to exert a certain amount of effort is a function of his expectations that the effort will result in a specific outcome, and the sum of the valences that he expects to derive from the outcome. Thus, a person chooses the particular behavior and the level of effort he will exert on the basis of the valences he perceives to be associated with the outcomes of the behavior in question, and his expectation that his behavior will indeed result in those outcomes.

Since Vroom first proposed his model, it has undergone several major developments: first and second level outcomes have been distinguished (Galbraith & Cummings, 1967; Graen, 1969; House, 1971; Porter & Lawler, 1968); sources of intrinsic motivation have been noted (Galbraith & Cummings, 1967; Hackman & Lawler, 1971; Lawler, 1970; Porter & Lawler, 1968); a distinction has been identified between effort to performance expectancies and performance to reward expectancies (Campbell, Dunnette, Lawler, & Weick, 1970; Graen, 1969; Lawler & Porter, 1967; Mitchell & Knudsen, 1973; Porter & Lawler, 1968) and the model has been elaborated to include the effects of abilities and role perceptions (Porter & Lawler, 1968). The Porter and Lawler expectancy theory (1968) incorporates all of these developments and, therefore, represents a reasonable statement of current thinking within the paradigm.

Rather extensive research and critiques have served to clarify the methodological and theoretical issues of the theory. Prior to 1975, most studies of expectancy theory employed a between-subjects design, which is clearly inappropriate for a model where outcomes and behavioral choices are ipsative (Mitchell, 1979). This faulty methodology was duly criticized (Mitchell, 1974); Wahba & House, 1974) and is generally no longer used. Subsequent research employing ideographic methodologies has found improved predictions of performance with the model (Oldham, 1976; Muchinsky, 1977; Kopleman, 1977a). There have been additional methodological refinements. Ivancevich (1976) reported that predictions of engineers' performance were better when they were allowed to generate their own list of outcomes, while Dyer & Parker (1976) indicated that predictions of reenlistment by naval officers were more accurate when the list of outcomes was kept small. Moreover, accounting for initial levels of criterion behavior (Kopelman & Thompson, 1976) and refining the criterion measures (Andrisani & Nistel, 1976) have also led to improved prediction with the model.

There are many studies, too numerous to mention, which provide support for VIE theory (e.g., Mitchell & Nebeker, 1973; Mitchell & Beach, 1976; Kopleman, 1977b; Kopleman & Thompson, 1976, etc.). However, it is more succinct to cite a comprehensive review by Mitchell (1979) who noted that most research has been supportive of the hypothesized process--people make behavioral choices which they believe are likely to lead to desired organizational rewards. This does not presuppose that the theory lacks difficulties. Mitchell (1979), following March and Simon's (1958) conclusions, noted that certain assumptions of rationality, i.e., that people have conscious and perfect knowledge of all behavioral alternatives, outcomes, behavior $\longrightarrow$ outcome relationships, and their feelings about all these relationships, are untenable. So, also, is the notion that people use complex reasoning processes to select an optimal course of action. People do not seem to have access to this information, nor do they appear to use complex reasoning processes (Behling et al., 1975). Hence, VIE theory should not be regarded as a perfect representation of the cognitive process, but rather, a good approximation of it. It is useful for identifying salient variables and for suggesting how they might combine to influence behavioral choice. This is, in fact, exactly how the model is to be used for understanding updating behavior.

The Model

The Porter and Lawler VIE model is described briefly below. Given a certain level of performance, certain outcomes will result. The relationship between performance and extrinsic outcomes or rewards is usually tenuous. Nonetheless, the model assumes that the organization attempts to make the link salient by using a "differential reward policy": (a) that the organization can discern individual differences in performance; (b) that the organization has the capability to administer differential rewards; and (c) that the organization has the desire to reward superior performance. The relationship between performance and intrinsic rewards and outcomes is much stronger, i.e., that, given a task structured to promote intrinsic motivation, individuals will be their own source of intrinsic rewards. There will be virtually no delay period and sufficient amounts of intrinsic rewards can be administered.

Satisfaction is conceptualized primarily as a dependent variable which arises from an individual's comparison of his notion of "proper" rewards, given his level of performance and his actual rewards, both intrinsic and extrinsic. If actual rewards exceed or match perceived equitable rewards, the individual experiences satisfaction. Should actual rewards fail to meet the level of perceived equitable rewards, the individual experiences dissatisfaction.

The satisfaction variable is linked to the value of reward variable via a feedback loop. Porter and Lawler hypothesize that satisfaction of lower order needs will reduce the value of outcomes, satisfying those needs for some time period, during which they will not motivate behavior. Dissatisfaction, however, may lead to further behavior in order to satisfy those needs. On the other hand, the satisfaction of higher order needs is seen as enhancing the value of reward variable, which may lead to more behavior rather than its termination.

This theoretical model of personal motivation sees an individual as behaving primarily as a function of the rational forces within him. Applied to work motivation, it conceptualizes man as one who chooses to behave in a way which maximizes his chances of acquiring future desired rewards. Individuals see this behavior as "instrumental" in gaining valued rewards. The crucial element in the theory is the expectation or anticipation of an individual. As a process theory it attempts to explain relationships among variables in a dynamic state. The theory does not specify the important variables which impinge on an individual to create what is called "work motivation." Rather it provides a theoretical structure to describe any cognitively controlled behavior--within any set of individuals-- not just professionals. The most important characteristic of expectancy theory is its flexibility--the result of its process nature.

It is this flexibility which makes VIE theory ideal as a motivational model for this problem. It attempts to define the relationships among process variables which combine to yield motivational force. The organizational factors identified by Dubin and other researchers provide the content that is likely to inhibit or facilitate updating behavior. Porter (1971) used the model much in this way to explain how professionals evaluate different kinds of potential rewards and select those rewards which are attractive. If valent rewards are provided for updating activities, updating attempts would be hypothesized to occur. McIntyre (1977) explains how expectancy theory can be applied to updating in three ways. First, the theory dictates that an individual's goals should be elicited from the person himself. The same set of goals should never be assumed to be had by all. If management discovers that a professional is not aware of certain potential goals of the organization, it can intervene and make the goals known to him. Second, the organization must determine the importance of a set of goals and the perceived likelihood (expectancy) of the occurrence of a set of goals by probing at the level of the individual professional. Once again the organization may intervene to try to influence an individual's valence or expectancy of a particular goal. Third, because it is a process theory, it allows the organization to be flexible in its outlook towards its professionals. There is no need to establish a specified set of goals and outcomes for all. At the same time, the theory does not invalidate the existence of a set of common goals. Finally, the organization can use expectancy theory as a tool with which to diagnose the individual's obsolescence. The theory provides the organization with a means of asking the important questions aimed at the following logical sequence of theoretical concepts: ultimate goals, instrumentality, valence, expectancies, and behaviors. This is the most valuable aspect of expectancy theory-- its ability to stimulate the appropriate set of questions.

The Dubin (1972,1977,1978) model for technical updating (see Figure 1) suggests some of the content variables which can be combined with the processes suggested by expectancy theory to make fairly specific predictions about the technical updating of engineers. The work environment or organizational factors of the Dubin model could be expected to affect, either favorably or unfavorably, an engineer's perceptions of the likely outcomes of technical up-to-dateness as well as the degree of favorability of the various possible outcomes. Thus, the combination of the general expectancy theory paradigm and the specific factors suggested by the Dubin model represents an approach to the understanding and prediction of technical updating that has strong potential for success.

Need for Instruments to Measure the Components of the Dubin Model

The Dubin (1972,1977,1978) model of technical updating has been indirectly supported by the various studies cited in earlier sections of this report. The support is only indirect because none of the existing studies has directly attempted to validate the Dubin model. One obstacle to testing the Dubin updating model is the lack of instruments that could be used to obtain operational measures of the components of the model. At a conceptual level, the Dubin model appears useful in the understanding of technical updating, but its direct empirical support is limited.

Components of the updating model do not have obvious measures already in existence. While it makes good sense logically to state that the supervisor has an effect on the updating activities of subordinate engineers, it is not obvious exactly how to measure what the supervisor does or does not do that causes updating differences. The same circumstances exist for all other components of the model. The major purpose of the present project was to develop instruments which would be used to test the validity of the Dubin updating model.

An initial decision that must be made concerning the development of these measurement instruments is whether the resulting instruments will measure the objective work environment or the perceived work environment. The VIE model of motivation presented earlier makes a strong case for perceptual measures, rather than objective measures. The VIE model hypothesizes that an individual's work behavior is affected by the individual's <u>perceptions</u> of the work environment. While it is presumed that the objective work environment affects the individual's perception of it, each individual responds somewhat differently to the objective environment. Thus, the individual's perception of the work environment is likely to be a better predictor of behavior than the objective environment.

A perceptual orientation to the measurement of the components of the updating model suggests that a series of questionnaire measurement scales would be desirable. In order to test adequately the Dubin model, it would be necessary to have scales which measure the five general work environment factors (supervision, peers, policies, work assignments, and organizational climate), the work-related outcomes and rewards sought by the engineer, and the perception of the relationship between technical updating and obtaining desired outcomes and rewards.

It would be desirable to develop measurement instruments that could be useful in a variety of organizations and with a variety of engineering disciplines. In order to be more likely to achieve these outcomes, the present project attempted to sample widely among engineering disciplines, individuals, and organizations. No single organization or engineering discipline was primarily involved in the development of the instruments. Also, different individuals were involved at the different stages of instrument development so that as many viewpoints as possible were obtained.

Method

Proposed Sampling Procedure

In order to identify work environment factors which influence an engineer to keep up-to-date, it was originally proposed that fifteen workshops be conducted. Of the fifteen workshops, ten were to be composed of engineers and engineering supervisors from private industry and five composed of the same types of individuals from governmental organizations. Table 1 gives the proposed workshop composition. A sample of industrial and governmental organizations was to be drawn from the states of Pennsylvania, New York, New Jersey, Massachusetts and Ohio. The industrial organizations were to be medium (500 - 5000 employees) or large (over 5000 employees) in size.

Table 1

Proposed Composition of Workshops

Unit	Number of Workshops	Number of Supervisors per Workshop	Total Number of Supervisors	Number of Engineers per Workshop	Total Number of Engineers	Total Number of Participants
Industry	10	3-4	30-40	7-8	70-80	100-120
Government	5	3-4	15-20	7-8	35-40	50-60
Total	15	---	45-60	---	105-120	150-180

For the purpose of this study, a supervisor was defined as a person who is in charge of a minimum of five practicing engineers, who deals with day-to-day problems within the organization, and who holds an engineering degree. A practicing engineer was defined as having completed a Bachelor of Science degreee in engineering from an accredited college of engineering and having had five years' work experience.

Ten locations were selected for the ten industry workshops and five for the government workshops. The fifteen locations were selected so that each of the five states would be represented at least once, and that each location would have an adequate population of industrial and/or governmental organizations from which to draw the sample.

For each industry workshop location, a sample of 20 companies was selected, using various industrial directories (see Reference List). A similar process, using different sources (see Reference List), was carried out in selecting agencies to be contacted for government workshops.

A letter which requested participation in the project was mailed to each organization identified in the samples. Table 2 summarizes the results of the mailing. Of the 200 industrial organizations contacted, 29 (14.5%) replied "yes" or "maybe" as to their willingness to participate. (Of this group, 23 (11.5%) organizations actually participated later in a workshop.) The results of the mailing to 115 governmental organizations were much better, with 44 (38.3%) "yes" or "maybe" replies. (The actual workshop participation was higher also with 34 (29.6%) organizations later participating in a workshop.)

The positive response level of the governmental organizations was sufficient to conduct six workshops. An additional mailing to industrial

Table 2

Results of Work Motivation Project Mailing

Desired Workshop Location	Number Mailed	Results					Participated in Workshop
		Not Delivered	No Reply	Replied			
				No	Maybe	Yes	
Industry Workshops							
New York City	20	0	14	3	0	3	3
Area		(0.0)*	(70.0)	(15.0)	(0.0)	(15.0)	(15.0)
Bergen County, NJ	20	0	14	3	0	3	2
Area		(0.0)	(70.0)	(15.0)	(0.0)	(15.0)	(10.0)
Scranton/Wilkes-	20	0	16	4	0	0	0
Barre, PA Area		(0.0)	(80.0)	(20.0)	(0.0)	(0.0)	(0.0)
Cleveland Area	20	2	12	2	1	3	2
		(10.0)	(60.0)	(10.0)	(5.0)	(15.0)	(10.0)
Buffalo Area	20	2	17	1	0	0	0
		(10.0)	(85.0)	(5.0)	(0.0)	(0.0)	(0.0)
Allentown, PA	20	0	12	4	1	3	3
Area		(0.0)	(60.0)	(20.0)	(5.0)	(15.0)	(15.0)
Rochester, NY	20	0	13	5	0	2	2
Area		(0.0)	(65.0)	(25.0)	(0.0)	(10.0)	(10.0)
Erie, PA	20	0	8	4	4	4	8
Area		(0.0)	(40.0)	(20.0)	(20.0)	(20.0)	(40.0)
Trenton, NJ	20	1	17	2	0	0	0
Area		(5.0)	(85.0)	(10.0)	(0.0)	(0.0)	(0.0)
Lewisburg/Williams-	20	0	12	3	0	5	3
port, PA Area		(0.0)	(60.0)	(15.0)	(0.0)	(25.0)	(15.0)
Industry Subtotals	200	5	135	31	6	23	23
		(2.5)	(67.5)	(15.5)	(3.0)	(11.5)	(11.5)

Table 2 (cont'd)

Results of Work Motivation Project Mailing

Desired Workshop Location	Number Mailed	Results: Not Delivered	Results: No Reply	Replied: No	Replied: Maybe	Replied: Yes	Participated in Workshop
Government Workshops							
Philadelphia Area	19	0 (0.0)	7 (36.8)	2 (10.5)	4 (21.1)	6 (31.6)	9 (47.4)
Harrisburg Area	36	0 (0.0)	10 (27.8)	12 (33.3)	4 (11.1)	10 (27.8)	10 (27.8)
Pittsburgh Area	14	0 (0.0)	6 (42.9)	3 (21.4)	0 (0.0)	5 (35.7)	4 (28.6)
Washington, DC Area	20	0 (0.0)	4 (20.0)	8 (40.0)	4 (20.0)	4 (20.0)	5 (25.0)
Boston Area	26	0 (0.0)	12 (46.2)	7 (26.9)	3 (11.5)	4 (15.4)	6 (23.1)
Government Subtotals	115	0 (0.0)	39 (33.9)	32 (27.8)	15 (13.1)	29 (25.2)	34 (29.6)
TOTALS	315	5 (1.6)	174 (55.2)	63 (20.0)	21 (6.7)	52 (16.5)	57 (18.1)

*The numbers in parentheses are the percentages of total mailed.

organizations was ruled out because of time constraints. The procedure for obtaining participants for the industry workshops was modified as is discussed in the next section.

Modified Procedure for Identifying Industry Workshop Participants

During the same time frame as this project, the research team was involved with a related National Science Foundation project entitled, "Behavior Anchored Scales - A Method of Identifying Continuing Education Needs of Engineers" (Grant No. SED78-21940). In the conduct of this project, workshops with engineers and supervisors from industry were also required. The primary difference in the workshops for the two projects was the size of the industrial organizations contacted. The Behavior Anchored Scales (BAS) project required small (less than 500 employees) and medium (500 - 5000 employees) sized industries. Table 3 contains the results of the BAS project mailing. The results were not as positive as the Work Motivation* results, with only eighteen out of 220 (8.2%) replying "maybe" or "yes" and only 12 (5.5%) actually participating in a workshop.

It was decided to combine some of the workshops of the two projects. The fact that there would be participants from small industry at some of the Work Motivation workshops was not considered to be critical. (Of the 61 different industrial organizations which actually participated, only 9 were small.)

This combination of workshops was only a partial solution to the problem of obtaining enough participants. In order to obtain the remaining

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*Work Motivation is used as an abbreviated name for the present project, "Relationships Among Work Motivation, Work Environment and Updating in Engineers."

Table 3

Results of BAS Mailing

Phase-Workshop Number	Desired Workshop Location	Number Mailed		Results					Participated in Workshop
						Replied			
		First Mailing	Second Mailing	Not Delivered	No Reply	No	Maybe	Yes	
I - 1	Philadelphia Area	20	11	4 (12.9)*	22 (71.0)	3 (9.7)	0 (0.0)	2 (6.4)	1 (3.2)
I - 2	New York City Area	20	10	1 (3.3)	20 (66.7)	6 (20.0)	3 (10.0)	0 (0.0)	0 (0.0)
I - 3	Boston Area	20	13	2 (6.1)	24 (72.7)	6 (18.2)	1 (3.0)	0 (0.0)	0 (0.0)
II - 1	Cleveland Area	20	11	1 (3.2)	22 (71.0)	6 (19.4)	0 (0.0)	2 (6.4)	2 (6.4)
II - 2	Pittsburgh Area	20	11	3 (9.7)	20 (64.5)	3 (9.7)	3 (9.7)	2 (6.4)	4 (12.9)
III - 1	Newark, NJ Area	20	14	1 (2.9)	26 (76.5)	4 (11.8)	1 (2.9)	2 (5.9)	3 (8.8)
III - 2	Harrisburg Area	20	10	0 (0.0)	26 (86.7)	2 (6.7)	1 (3.3)	1 (3.3)	2 (6.7)
TOTALS		140	80	12 (5.5)	160 (72.7)	30 (13.6)	9 (4.1)	9 (4.1)	12 (5.5)

*The numbers in parentheses are the percentages of total mailed.

workshop participants, personal contacts were used to obtain cooperation from a number of industrial organizations. In some cases, a single organization was willing to furnish enough participants for a workshop. In other cases, the organization would furnish from one to five participants to attend a workshop made up of participants from more than one organization. The personal contacts resulted in 27 industrial organizations participating in Work Motivation workshops by sending a total of 186 engineers and supervisors.

Even though the combining of workshops and the use of personal contacts represented deviation from the original proposal, the results were worthwhile. Table 4 gives the actual breakdown of workshops held for the Work Motivation project (Appendix A lists the participating organizations by workshop). In comparing Table 4 with Table 1, the improvements become apparent. The number of workshops increased from a proposed 15 to an actual 32 and the number of participants from a range of 150-180 to 289.

In the next section, some additional modifications to the proposed data collection process are explained. Again, these modifications resulted in an increased sample size of engineer and supervisor input to the project.

<u>The Five Phases of Data Collection</u>

The collecting of data for the Work Motivation project was divided into five phases. Each is described below.

<u>Phase 1</u>. Six questionnaires which were used for mailing in Phase II were developed. The questionnaires dealt with the five work environment factors of the Dubin updating model and with work-related outcomes and rewards that might serve to motivate an engineer. A single workshop was used to obtain engineers' input as to the ease of using the questionnaires, various editorial comments and reaction to the six factors selected.

TABLE 4

SUMMARY OF WORKSHOPS HELD FOR WORK MOTIVATION PROJECT

	Single Organizations	Multi-Organizations	Total Workshops	Total Organizations	Total Participants
Phase I					
Industrial Workshops	1	0	1	1	11
Government Workshops	0	0	0	0	0
Totals	1	0	1	1	11
Phase III					
Industrial Workshops	9	7	16	54	139
Government Workshops	0	6	6	30	51
Totals	9	13	22	84	190
Phase IV					
Industrial Workshops	9	0	9	9	88
Government Workshops	0	0	0	0	0
Totals	9	0	9	9	88
TOTALS	19	13	32	94*	289

*Included in this number are three industrial organizations which participated in two different workshops. ...us, the number of <u>different</u> organizations is 91.

Phase II. A sample of 387 names was selected from the American Society for Engineering Education roster for the mailing of the questionnaires. University employees were not selected. Names of persons belonging to ASEE were selected because of the organization's concern for the continuing education of the practicing engineer. Each of the six questionnaires was mailed to approximately 65 persons. The results of the mailing are given in Table 5. Each respondent was asked to generate examples of work behavior, pertaining to one of the six factors, which might motivate or inhibit an engineer in terms of keeping technically up-to-date. The examples were collected, edited, and grouped by factor as motivators or inhibitors. As a result of the editing process, each factor had from 17 to 40 examples. These results led to the development of a questionnaire for each factor which would be used for scaling the examples in Phase III. (Appendix B contains these questionnaires.)

Phase III. The six questionnaires shown in Appendix B were taken to the 22 workshops which were conducted during this phase. At various workshops, 190 engineers completed from one to six of the factor questionnaires. In this way, each factor was scaled by approximately 100 engineers. The exact sample size for each factor is given in Table 6.

Means and standard deviations were calculated for each example of each work environment factor in order to identify examples which were generally agreed upon by the workshop participants as being important facilitators or inhibitors of technical updating. If an example received a mean rating of less than 3.00 on the seven point scale, it was retained as a possible inhibitor of updating. If an example received a mean rating of greater than 5.00, it was retained as a possible facilitator of updating. Items with

Table 5

Results of Questionnaire Mailing - Phase II

Factor	Completed Questionnaires Returned
Work-related Rewards and Outcomes	15
Perceptional Attitudes (Organizational Climate)	24
Job Activities	21
Supervisory Actions and Attitudes	24
Peer-Colleague Interaction	20
Management Policies	28
TOTAL	132

Table 6

Sample Size for each Factor - Phase III Data

Factor	Sample Size
Perceptions & Attitudes (Organizational Climate)	95
Supervisory Actions & Attitudes	100
Job Activities	101
Peer-Colleague Interaction	100
Management Policies	104
Work-related Outcomes and Rewards	96

mean ratings between 3.00 and 5.00 were discarded as their rating indicated no strong effect upon updating. The means and standard deviations for all examples of the five work environment factors appear also in Appendix B.

The items meeting the item mean criterion were examined for redundancy and some items were discarded on the basis of overlapping content with other items. The resulting set of 100 examples were collected into a single questionnaire designated as the Work Description Questionnaire for Engineers (WDQE). The WDQE is presented in Appendix C. Each of the 100 items is designated in terms of the work environment factor which it represents. This factor designation did not appear on the questionnaire which was distributed in later phases of the project.

The means and standard deviations of the ratings of the rewards and outcomes related to an engineer's job are also shown in Appendix B. Items that were judged to be at least moderately important to engineers in general, personally desirable or undesirable (but not neutral), and either facilitating or inhibiting updating were retained for future use. The retained rewards and outcomes are shown in Appendix D.

Phase IV. The WDQE was completed by the 88 participants of the nine workshops conducted during this phase. Each participant was asked to describe his or her job, organization, supervisor, and peers on the various WDQE items by use of a six-point rating scale. This phase of the project was intended to ascertain if engineers could reasonably use the WDQE to describe their work environment and to gather preliminary psychometric data on the various items and scales.

Phase V. In order to achieve a larger sample size on the WDQE for purposes of more extensive data analyses, mailing lists were obtained from the American Society of Civil Engineers, the Institute of Electrical and Electronic Engineers, the American Institute of Industrial Engineers, and the American Society of Mechanical Engineers. Lists of members from the states of Pennsylvania, Ohio, New York and New Jersey were used. A total of 2068 WDQEs and cover letters were mailed, approximately 500 to members of each of the four organizations. There were 561 (27.1%) returns, of which 510 (24.7%) were acceptable. Details of the analysis of these returns are discussed in a later section.

Summary of Sampling Strategy

A comparison of the proposed sampling strategy with the actual strategy, reveals one will find a number of deviations. These deviations resulted in input from some 961 engineers and supervisors instead of the proposed 150-180, an increase of at least 534%. Since no attempt was made to identify the organizations of participants taking part in Phases II and V, the total number of organizations represented cannot be given. However, in Phases I, III, and IV, there were 91 different organizations represented. It is felt that these numbers represent the justification for the deviations made.

Results

Many of the preliminary results of the instrument development procedure have already been given in the Method section. The present section will focus primarily upon results of Phases IV and V of the project.

In Phase IV, the WDQE was administered in nine separate workshops. Each workshop was comprised of individuals employed by a single organization. Thus, information was obtained on the usability of the WDQE in terms of its understandability, meaningfulness, and comprehensiveness via group interviews with the participants following its administration. Preliminary psychometric data were also obtained. Of most importance was the degree of agreement among various organizational members in terms of the way they described their work organization. Scores on each of the five work environment scales of the WDQE were computed for each respondent by summing the individual's scores for the various items comprising each scale. Individual item scores were determined by the rating given the item on the six-point response scale. Items which described a favorable aspect of the organization were scored with a response of "very inaccurate" receiving a score of 1 and a response of "very accurate" receiving a score of 6. Items which described an unfavorable aspect of the organization were scored in the reverse with a response of "very inaccurate" receiving a score of 6 and a response of "very accurate" receiving a score of 1. The degree of agreement was calculated by obtaining an inverse correlation matrix of the responses to the various work environment factor items. An inverse correlation matrix examines the respondent by respondent covariation instead of the more usual variable by variable covariation. Thus, for each of the five work environment factors, the correlation between each possible pair of respondents within each organization was calculated. In Table 7 are presented the median inverse correlations for each factor scale in each organization. The overall median correlations across the nine organizations are also shown. The general level of agreement was moderate, but this should be viewed as encouraging since the individuals in each organization were from several different work groups and functions within the organization. Thus, strong agreement would not be expected due to work group and functional differences.

Table 7

Median Inverse Correlations for
the Five WDQE Work Environment Factors

Organization	WDQE Factor				
	Policies	Job Activities	Perceptions	Supervisor	Peer
1 (N= 9)	.36	.26	.21	.55	.56
2 (N= 7)	.18	.46	.43	.46	.00
3 (N=12)	.45	.45	.43	.59	.71
4 (N=12)	.61	.42	.32	.56	.71
5 (N= 8)	.46	.35	.40	.54	.62
6 (N= 7)	.25	.43	.42	.49	.45
7 (N=15)	.41	.34	.42	.52	.60
8 (N= 9)	.40	.19	.27	.44	.41
9 (N= 9)	.39	.44	.38	.54	.52
Overall Median	.40	.42	.40	.54	.56

The Phase IV results were sufficiently positive to warrant the gathering of more data on the WDQE. This was accomplished in the Phase V mailout to engineers who were members of various professional societies. The 510 usable responses were randomly divided into two groups for purposes of further data analyses. Group A was composed of 297 individuals and Group B of 213. Group A's data were used to determine possible subscales of items drawn from the five factor scale of the WDQE. Group B's data were used to examine the generalizability of the subscales found in Group A.

It was hypothesized that there might exist more specific subscales of the WDQE which would be more informative and useful than the five general factor scales previously described. A principal components factor analysis (Nunnally, 1967) was conducted on the 100 items from the WDQE using the data of the 297 individuals in Group A. The resulting factor solution was rotated using an oblimin oblique procedure. This analysis and rotation yielded a solution of 24 factors meeting the Kaiser (1958) criterion of an eigenvalue exceeding 1.00. Inspection of the 24 factor solution revealed a number of factors accounting for only small portions of the total variance. A decision was made to consider only the first 12 factors in the solution which accounted for a cumulative 54% of the total variance. None of the second 12 factors accounted for as much as 2% of the total variance. The inclusion of these additional factors would have made more difficult the interpretation of the factors.

The 12 factor solution to the 100 item WDQE was, in fact, very complex with many items loading .40 or greater on more than two factors. This was an excessive amount of item redundancy across factors. In order to alleviate this redundancy, an item analysis was conducted of the 100 WDQE items for Group A's data, in which the correlation between the item score and the total WDQE score was examined for each item, derived from summing the scores on the remaining 99 items. This item score-total score correlation served as a measure of the degree to which the responses to an item reflected a general perception of or attitude toward the organization as measured by the overall favorability of the sum of the WDQE item responses. Any item which correlated .60 or more with the total WDQE score was defined as a general attitude measure. There were 27 such items in the total of 100 WDQE items. It was decided to conduct a factor analysis of the Group A data with these 27 items deleted.

A principal components factor analysis of the remaining 73 items followed by an oblique rotation (delta=.00) was conducted on the Group A data. This yielded a 12 factor solution accounting for 53% of the total variance. Only five items loaded over .40 on as many as three factors in this solution. Forty-nine of the items loaded greater than .40 on only a single factor and eighteen items loaded over .40 on two factors. One item failed to load in excess of .40 on any of the 12 factors. This solution was deemed sufficiently "clean" to attempt factor interpretation and subscale construction. The question of assignment of those items loading in excess of .40 on more than one factor was approached by considering both the magnitude of an items loading on the various factors and the content of the item. Generally an item which had loaded on two or three factors was assigned to a factor if its loading on that factor was substantially greater than that for the one or two other factors. If there were no substantial differences among the two or three factor loadings for an item, then the item was assigned to that factor with which its content seemed most similar.

Five items could not be assigned to any factor (item numbers 13, 29, 34, 41, and 57 on the WDQE).

Table 8 presents the 12 factors and the items from the WDQE which were assigned to each. The factor loading for each item on the factor to which it was assigned is also shown. Each factor is also named on the basis of the item content represented.

The 27 items which had been found to correlate highly with the WDQE total score were considered to have potential usefulness as an overall organizational attitudinal measure. These items were treated as a subscale of the WDQE and are shown in Table 9. Subscale scores were calculated as the sum of the scores of all items assigned to the factor.

The data on the 210 individuals in Group B were used to obtain reliability estimates of the subscales identified in the factor analysis of the Group A data. The intercorrelations among the subscales were also computed on the Group B data. This procedure yielded a better estimate of the subscale reliabilities and intercorrelations than would occur with the use of the Group A data for these analyses because the Group A data had been used to create the subscales and, thus, would yield biased reliability and intercorrelation data. Table 10 presents coefficient alpha (Cronbach ,1951) estimates of subscale reliability. No such estimate can be calculated for subscale 11 since it was comprised of only a single item. Although the subscales with relatively few items have generally only moderate reliability, all of the subscales appear to have sufficient reliability for future research use, although further development work with subscales 3, 8, 9, and 10 appears warranted since each of their reliability estimates is less than .60.

Table 8

Items Loading on Factors Identified in the WDQE

WDQE Item Number	Factor Name	Factor Loading
	Factor 1. Supervisor Feedback and Communication	
16.	My supervisor's performance reviews point our the engineer's strengths and weaknesses and offer suggestions for improvement.	.64
42.	My supervisor does not recognize and reward an engineer's efforts to keep technically up-to-date.	-.61
45.	My supervisor provides career counseling for the engineer.	.74
50.	The organization provides career counseling for engineers.	.68
58.	My supervisor matches the engineer's need for professional development with opportunities to attend courses and technical meetings.	.48
71.	My supervisor encourages engineers to present papers at technical meetings.	.41
87.	There is a clear statement of the organization's technological goals available to all engineers.	.58
88.	My supervisor solicits ideas from the engineers regarding technical problems.	.52
90.	My supervisor holds periodic staff meetings to discuss technical problems and developments.	.67
93.	My supervisor involves the engineer in establishing performance goals by which the engineer will be evaluated.	.65
	Factor 2. Organization Policies Encouraging Updating	
15.	The organization has a patent award program.	.50
27.	There is competition among engineers for promotions and choice assignments.	.75
37.	The organization has a performance appraisal system which ties financial gain to technical competence.	.56
52.	The organization has a systematic rotational program to give its engineers diversified job assignments during the first years of employment.	.42

Table 8 (cont'd)

WDQE Item Number	Factor Name	Factor Loading
68.	The organization provides in-house technical seminars.	.47
74.	There exists a competitive atmosphere among fellow engineers which maintains pressure toward high levels of job performance.	.72
	Factor 3. Project and Work Management	
2.	Project plans are often changed, resulting in new deadlines and work schedules.	.43
56.	The organization keeps its engineering staff small, relying on overtime to get the work done.	.77
75.	The job requires extensive overtime.	.73
	Factor 4. Technological Orientation of Organization	
4.	The organization is involved in technically stagnant fields.	.74
7.	The organization provides its engineers with current technical equipment and facilities.	-.49
8.	People in technical disciplines view the organization as an innovator.	-.51
10.	Work assignments include state-of-the-art technology and advanced instrumentation.	-.51
23.	Job assignments are frequently made to a product or area in which little or no technological change is occurring.	.71
54.	The organization attempts to be better technically than its competition.	-.46
	Factor 5. Work Assignments Encouraging Updating	
25.	All of the engineer's time must be charged to project budgets with no allowance for general technical updating.	-.65
59.	The organization pays for subscriptions to technical and trade journals for the engineer.	.68
82.	My supervisor encourages the reading of technical journals and trade magazines during working hours.	.61
86.	The organization does not provide financial support for attending professional meetings.	-.58

Table 8 (cont'd)

WDQE Item Number	Factor Name	Factor Loading
99.	Job allows free time to explore new, advanced ideas.	.62
	Factor 6. Technical Expertise of Peers	
28.	Peers are able to provide reliable information about current technical developments.	.59
35.	Peers usually draw one's attention to useful new journal articles and technical papers.	.59
73.	Peers are able to catch logical and analytical errors in designs and ideas.	.62
78.	Peers are willing to act as sounding boards for new ideas.	.48
91.	Peers often react negatively to new technical ideas.	-.45
100.	The organization does not have a tuition refund policy for continuing education.	-.59
	Factor 7. Engineers' Participation in Decisions	
6.	The engineers have a sense of personal involvement in the organization's future	.41
22.	There are open lines of communication between the engineering staff and organization management.	.62
30.	Engineers who receive advanced training and degrees receive little formal recognition in the organization.	-.45
31.	The engineer participates in technical decisions relevant to assignments.	.40
47.	My supervisor restricts the participation of the engineers in professional activities to a minimum.	-.45
48.	Challenging work is often assigned only to newer engineers.	-.65
49.	The organization's concern for the protection of proprietary information restricts interactions with other engineers in the organization.	-.70
51.	My supervisor does not allow any engineer to understand the total project by withholding pertinent information and discouraging communication among the engineers.	-.60
60.	The engineer lacks the authority to make technical decisions about a project.	-.61

Table 8 (cont'd)

WDQE Item Number	Factor Name	Factor Loading
61.	Other engineers in the organization prefer to keep new ideas to themselves.	-.62
96.	Information exchange is restricted by excessive competition among the engineers in the organization.	-.65
	<u>Factor 8.</u> Technical Support within the Organization	
3.	The recruitment practices of the organization bring competent young engineers into the organization.	.55
19.	Peers are able to suggest new approaches to technical problems based upon their own experience.	.53
26.	Other engineers can identify the people to consult about problems in unfamiliar technical areas.	.42
55.	There is a lack of competent support technicians and clerical personnel	-.48
	<u>Factor 9.</u> Organizational Policies Discouraging Updating	
32.	The organization provides limited funds for internal research and development.	.65
62.	The organization has no policy of administrative leave with pay to work on advanced engineering degrees.	.48
64.	The organization has a limited training budget for its engineering staff.	.58
	<u>Factor 10.</u> Comprehensive Project Assignments	
14.	Job assignments have no identifiable end product which represents project completion.	-.53
44.	Job assignments require contacts with vendors, manufacturers, and customers.	.53
81.	Assignments require system and concept development.	.47
94.	The engineer is allowed to see a project through from initial design to implementation.	.54

Table 8 (cont'd)

WDQE Item Number	Factor Name	Factor Loading
	<u>Factor 11.</u> Availability of Technical Courses	
1.	Technical courses are available for engineers after work hours.	.45
	<u>Factor 12.</u> Assignments to Nontechnical and Repetitive Work	
5.	My supervisor bases salary and promotion recommendations on technical performance.	-.59
18.	Job assignments are frequently repetitious and formatted.	.43
20.	Engineers are not always hired for engineering jobs.	.75
36.	Assignments are made in the area of the engineer's personal interest.	-.43
38.	Engineers are often assigned to non-technical tasks.	.75
53.	My supervisor is not technically up-to-date or abreast of recent technical developments.	.42
66.	Job assignments are challenges which stretch the engineer's technical knowledge to the limit.	-.41

Table 9

Items on the Overall Organizational Attitude Subscale

WDQE No.	Item
11	The organization's work is usually of less than average quality.
12	My supervisor overemphasizes short-term results at the expense of long-term technical excellence.
17	There is a discouraging and indifferent attitude toward technological innovation and excellence.
21	Organizational management lacks technical sophistication.
24	There is little leadership in the organization regarding professional standards.
33	Personal creativity and growth are stifled by the organization.
39	My supervisor does not give credit for an engineer's idea, but promotes it as his own.
40	Low value is placed on the development of human resources to achieve organizational excellence.
43	Organizational members seek to maintain the status quo.
46	The organization is concerned with the professional growth of its engineers.
63	My supervisor fails to delegate responsibility and authority to the engineer.
65	My supervisor does not support attendance at company and industry training courses.
67	My supervisor does not assign to the engineer work which is technically challenging.
69	The organization is dedicated to staying at the cutting edge of technology.
70	There is a limited opportunity for engineers in the organization to use their technical knowledge.
72	The organization has a progressive atmosphere.
76	My supervisor stands behind the engineers and supports them with high management.
77	The engineer is given the responsibility to implement new ideas.
79	The organization recognizes the technical contributions of its engineers.
83	Innovation is enthusiastically received within the organization.
84	The organization provides little opportunity for advancement within the technical professional ranks.
85	My supervisor provides recognition and credit for good technical work.
89	The organization stresses high professional standards

WDQE No.	Item
92	The organization underutilizes its technical talent.
95	My supervisor reacts negatively to innovative ideas of the engineers.
97	My supervisor maintains open and two-way communication with the engineers.
98	Organizational rewards are given to those engineers with technical competence.

Table 10

Subscale Reliabilities Estimated by Coefficient Alpha

Subscale	Number of Items	Reliability
1. Supervisor Feedback and Communication	10	.84
2. Organization Policies Encouraging Updating	6	.61
3. Project and Work Management	3	.56
4. Technological Orientation of Organization	7	.80
5. Work Assignments Encouraging Updating	5	.65
6. Technical Expertise of Peers	6	.63
7. Engineer's Participation in Organizational Decisions	11	.81
8. Technical Support within the Organization	4	.52
9. Organizational Policies Discouraging Updating	3	.38
10. Comprehensive Project Assignments	4	.48
11. Availability of Technical Course	1	Not Calculable
12. Assignments to Nontechnical and Repetitive Work	7	.66
13. Overall Organizational Attitude	27	.95

Note. N=210.

Table 11 presents the subscale intercorrelations based upon Group B's data. Subscale 11 is not included in this analysis since it is comprised of only a single item. The median intercorrelation among the twelve subscales (eleven specific subscales and the overall attitude subscale) is .40. The median intercorrelation among the eleven specific subscales is .35. The various subscales appear to be on the average sufficiently independent of each other to be useful as separate measures. It should be noted that the intercorrelations are generally positive because of the scoring procedure used. One might expect, for example, for Organization Policies Encouraging Updating (subscale 2) and Organization Policies Discouraging Updating (Subscale 9) to be negatively correlated, but they correlate .27. This is due to the scoring procedure in which high scores always reflect the favorable end of the scale continuum. Thus, for example, a high score on the Organization Policies Encouraging Updating subscale reflects a judgment that the organizational policies encourage an engineer to be technically up-to-date. A high score on the Organization Policies Discouraging Updating subscale reflects the judgment that policies which might discourage updating are <u>not</u> characteristic of the organization.

The various subscales of the WDQE described above measure the work environment factors of the Dubin updating model. Measures of the components of the individual motivation aspect of the Dubin model are also necessary. These measures are derived from the VIE theory of work motivation described in an earlier section of this report. Examples of the measures of valence, expectancy, and instrumentality are shown in Table 12. A specific valence measure and instrumentality measure would be needed for each of the 25 work-related outcomes and rewards presented in Appendix D. An expectancy measure

Table 11

Subscale Intercorrelations

Subscale Number	2	3	4	5	6	7	8	9	10	12	13
1	.58	.24	.52	.55	.56	.50	.43	.26	.37	.56	.73
2	–	.18	.48	.29	.47	.24	.37	.24	.22	.34	.46
3		–	.25	.24	.36	.25	.32	.29	–.07	.30	.31
4			–	.44	.58	.60	.42	.31	.37	.58	.73
5				–	.40	.51	.35	.27	.34	.40	.57
6					–	.58	.47	.22	.37	.56	.69
7						–	.47	.24	.45	.59	.82
8							–	.30	.20	.50	.58
9								–	.01	.15	.25
10									–	.39	.49
12										–	.70
13											–

Note: Subscale 11 contains only one item and is not included in this analysis. N=210.

Table 12

Examples of Measures of Valence, Expectancy, and Instrumentality

Motivation Component	Example of Specific Measure						
Valence	Being recognized for accomplishments and technical success would be ____.						
	-3	-2	-1	0	+1	+2	+3
	highly dissatisfying	moderately dissatisfying	slightly dissatisfying	neither satisfying nor dissatisfying	slightly satisfying	moderately satisfying	highly satisfying
Expectancy	If I pursue an advanced engineering degree, the chances that I will become more technically up-to-date are ____.						
	1	2	3	4	5	6	7
	very unlikely			moderately likely			very likely
Instrumentality	If I become more technically up-to-date, the chances that I will be recognized for my accomplishments and technical success will ____.						
	-3	-2	-1	0	+1	+2	+3
	strongly decrease	moderately decrease	slightly decrease	not change	slightly increase	moderately increase	strongly increase

is needed for each activity likely to increase technical up-to-dateness identified in the work of National Science Foundation Grant No. SED78-21940 (Farr, Enscore, Dubin, Cleveland, and Kozlowski, 1980). These specific measures would all take the form of the examples shown in Table 12 but are not presented in complete detail in interests of space limitations.

Discussion

The various measurement instruments described in the previous section appear to be useful measures of the components of the Dubin (1972, 1977, 1978) model of technical updating. The existence of these measures will permit the gathering of empirical data to test the Dubin model and to learn more about the factors affecting the technical updating of engineers. The importance of the technical updating and job performance of engineers to the overall efficiency and productivity of an organization justifies more research in the updating of engineers' technical knowledge and skills.

An organization could use the subscales comprising the WDQE to conduct an analysis of its facilitative and inhibitory properties in regard to the updating of its engineers. The perceptions and descriptions of the organization that are held by its engineers can provide valuable information about why the engineering staff is or is not involved in technical updating. It may be informative for an organization to obtain WDQE responses from different portions of the organization, especially at different levels in the management hierarchy. A comparison of responses from different functional areas or levels of the organization may serve as a point of departure for organizational change or modification. Many organizations suffer from less than perfect communication across organizational levels and functional areas, and this can contribute to less than optimal organizational performance and productivity. The WDQE can serve to aid in understanding the extent of current communication effectiveness.

The subscales of the WDQE identified in the factor analysis reflect many of the variables suggested by research reviewed in the introduction to this report to be important in affecting the job performance, motivation, and satisfaction of employees. These subscales can serve as standardized measures of what have often been concepts not well operationalized. All of the five general work environment factors suggested by Dubin's technical updating model are represented by at least one subscale developed from the factor analysis. Some of these subscales are not ideal from the standpoint of reliability but can probably be improved without much difficulty with some additional data and subsequent analyses. In general, however, the subscales show acceptable psychometric properties.

The methodology employed in this research project should insure the usefulness of the WDQE to a wide variety of organizations and engineering disciplines. The input of several hundred individuals and many organizations prevents the idiosyncratic views of only a few individuals or organizations from biasing the results.

Valence-instrumentality-expectancy (VIE) theory appears to be a useful framework for understanding individual motivation and its impact on technical updating. There would appear to be little incentive or reason for an engineer to expend effort to become technically up-to-date unless he or she believes that the effort of engaging in an updating activity will result in greater technical competence (an expectancy belief) and that being technically up-to-date and competent will increase the likelihood of receiving valued rewards and outcomes (instrumentality belief about receiving positively valent outcomes). Thus, the basic tenets of VIE theory seem to apply to the updating process. This would suggest that updating be considered as a special instance of motivated behavior that perhaps can be better understood from the perspectives of organizational behavior and industrial/organizational psychology. The theoretical framework of VIE theory and its associated methodologies are likely to be a more productive way of approaching the technical updating process than the atheoretical methods of merely assessing beliefs about needs for continuing education that have characterized much of the earlier work in this area.

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Industrial Organizations

Air Products & Chemicals, Inc., Allentown, PA

American Sterilizer Co., Erie, PA

Applied Research Laboratory, University Park, PA

Armstrong Cork Corporation, Lancaster, PA

Babcock & Wilcox Research Center, Alliance, OH

Bethlehem Steel Corporation, Bethlehem, PA

Bloom Engineering Co., Inc., Pittsburgh, PA

Bucyrus Erie Co., Erie, PA

Canrad-Hanovia, Inc., Newark, NJ

Cleveland Twist Drill Company, Cleveland, OH

Consolidated Rail Corporation, Philadelphia, PA

Copes-Vulcan, Inc., Lake City, PA

Corry Jamestown Corporation, Corry, PA

Eastman Kodak Co., Rochester, NY

Fuller Co., Bethlehem, PA

General Electric Co., Allentown, PA

Geosource, Inc., Erie, PA

General Electric Co., Erie, PA

Grumman Aerospace Corporation, Bethpage, NY

H R B-Singer, Inc., State College, PA

Hamilton Technology, Lancaster, PA

Hershey Chocolate Company, Hershey, PA

Hoke, Inc., Cresskill, NJ

Ingersoll-Rand Co., Allentown, PA

International Signal & Control, Lancaster, PA

J & L Steel, Aliquippa, PA

Joy Manufacturing Company, Bedford Gear Division, Solon, OH

Kawneer Company, Bloomsburg, PA

Koppers Co., Inc., Pittsburgh, PA

Leviton Mfg. Co., Inc., Little Neck, NY

Mack Trucks, Inc., Allentown, PA

Marathon Carey McFall Co., Montoursville, PA

Matthews International Corporation, Pittsburgh, PA

Merck, Sharp & Dohme, West Point, PA

Neville Chemical Co., Pittsburgh, PA

New Cumberland Army Depot, New Cumberland, PA

New Jersey Zinc, Palmerton, PA

Packard Electric, Warren, OH

Parker Hannifin Corporation, Cleveland, OH

Pennsylvania House Furniture Co., Lewisburg, PA

Pennsylvania Power & Light Co., Allentown, PA

RCA, Moorestown, NJ

Republic Steel Corporation, Cleveland, OH

Rockwell International, Newark, OH

Schramm, Inc., West Chester, PA

Scott & Fetzer Co., Stahl Division, Cleveland, OH

Shop-Vac Corp., Williamsport, PA

Sperry Division Headquarters, Great Neck, NY

Sperry New Holland, Belleville, PA

Sperry New Holland, New Holland, PA

Standard Steel Division, TMCA, Burnham, PA

TRW, Inc., Danville, PA

Teledyne Penn Union, Edinboro, PA

Thomas J. Lipton, Inc., Englewood Cliffs, NJ

Universal-Cyclops Specialty Steel Division, Bridgeville, PA

Vicks Health Care Division, Hatboro, PA

Weis Markets, Inc., Sunbury, PA

Weston Instruments, Division of Sangamo Weston, Inc., Newark, NJ

Wilbur B. Driver Co., Newark, NJ

Xerox Corporation, Rochester, NY

Zenith Audio Division, Watsontown, PA

Zurn Industries, Erie, PA

Government Agencies

Federal Aviation Administration, Washington, DC

Massachusetts Bureau of Building Construction, Boston, MA

Massachusetts Dept. of Labor & Industries, Division of Occupational Hygiene, Boston, MA

Massachusetts Dept. of Public Works, Boston, MA

Massachusetts Division of Air & Hazardous Materials, Boston, MA

Massachusetts Division of Water Pollution Control, Boston, MA

Northern Division Naval Facilities Engineering Command, Philadelphia, PA

Naval Ship Engineering Center, Philadelphia Naval Base, Philadelphia, PA

Pennsylvania Dept. of Environmental Resources, Pittsburgh, PA

Pennsylvania Dept. of Environmental Resources, Bureau of Air Quality Control, Norristown, PA

Pennsylvania Dept. of Environmental Resources, Bureau of Water Quality Management, Harrisburg, PA

Pennsylvania Dept. of General Services, Harrisburg, PA

Pennsylvania Dept. of Transportation, Harrisburg, PA

Pennsylvania Dept. of Transportation, Pittsburgh, PA

Pennsylvania Turnpike Commission, Harrisburg, PA

Pennsylvania Public Utility Commission, Bureau of Rates Harrisburg, PA

Philadelphia Department of Licenses & Inspections, Philadelphia, PA

U.S. Army Corps of Engineers, Pittsburgh, PA

U.S. Army Corps of Engineers, Philadelphia, PA

U.S. Defense Nuclear Agency, Washington, DC

U.S. Department of Energy, Germantown, MD

U.S. Department of Housing & Urban Development, Pittsburgh, PA

U.S. Dept. of Labor, Occupational Safety & Health Administration, Philadelphia, PA

U.S. Dept. of Transportation, Research & Special Programs Administration, Washington, DC

U.S. Dept. of Transportation, Transportation Systems Center, Cambridge, MA

U.S. Dept. of Transportation, Urban Mass Transportation Administration, Philadelphia, PA

U.S. Dept. of Transportation, Urban Mass Transportation Administration, Washington, DC

U.S. Environmental Protection Agency, Philadelphia, PA

U.S. Nuclear Regulatory Commission, King of Prussia, PA

APPENDIX A

Organizations Participating in Each Project Workshop

WORKSHOP ID AND LOCATION	ORGANIZATIONS PARTICIPATING	NUMBER OF ENGINEERS PARTICIPATING
I - 1 State College, PA 3-12-79	Applied Research Laboratory	2
	Cerro Metal Products	1
	Centre Engineering, Inc.	1
	H R B - Singer, Inc.	2
	Management Engineering The Pennsylvania State University	1
	Sutton Engineering Company	3
I - 2 State College, PA 3-14-79	H R B - Singer, Inc.	1
	C. H. Masland and Son	2
	Corning Glass Works	1
	Piper Aircraft, Inc.	2
	Sperry New Holland	2
	Sprout Waldron Koppers	1
	Standard Steel Division, TMCA	2
I - 3 Altoona, PA 3-22-79	Consolidated Rail Corporation	8
I - 4 New Holland, PA 4-23-79	Sperry New Holland	7
I - 5 Lancaster, PA 4-24-79	Armstrong Cork Corporation	6
I - 6 Hershey, PA 4-24-79	Hershey Chocolate Company	8
I - 7 West Point, PA 4-30-79	Merck, Sharp & Dohme	7
I - 8 Moorestown, NJ 5-1-79	RCA	9

WORKSHOP ID AND LOCATION	ORGANIZATIONS PARTICIPATING	NUMBER OF ENGINEERS PARTICIPATING
II - 1 Cleveland, OH 5-3-79	Cleveland Twist Drill Company	2
	Joy Manufacturing Company	1
	Parker Hannifin Corporation	2
	Scott & Fetzer Company	1
II - 2 Cleveland, OH 5-4-79	Republic Steel Corporation	6
II - 3 Warren, OH 5-4-79	Packard Electric	7
II - 4 Rochester, NY 5-9-79	Xerox Corporation	7
II - 5 Rochester, NY 5-9-79	Eastman Kodak Co.	11
II - 6 Pittsburgh, PA 5-24-79	Bloom Engineering Co., Inc.	1
	Pennsylvania Dept. of Environmental Resources	1
	Pennsylvania Dept. of Transportation	2
	U.S. Army Corps of Engineers	2
	U.S. Department of Housing & Urban Urban Development	1

WORKSHOP ID AND LOCATION	ORGANIZATIONS PARTICIPATING	NUMBER OF ENGINEERS PARTICIPATING
II - 7 Pittsburgh, PA 5-25-79	Koppers Co., Inc.	2
	Matthews International Corporation	1
	Neville Chemical Co.	1
	Universal-Cyclops Specialty Steel Division	2
II - 8 Boston, MA 6-4-79	Massachusetts Bureau of Building Construction	2
	Massachusetts Dept. of Labor & Industries Division of Occupational Hygiene	2
	Massachusetts Dept. of Public Works	1
	Massachusetts Division of Air & Hazardous Materials	1
	Massachusetts Division of Water Pollution Control	1
	U.S. Department of Transportation Transportation Systems Center	2
II - 9 New York, NY 6-5-79	Canrad-Hanovia, Inc.	2
	Grumman Aerospace Corporation	1
	Hoke, Inc.	2
	Leviton Mfg. Co., Inc.	2
	Sperry Division Headquarters	2
	Thomas J. Lipton, Inc.	3
	Weston Instruments	1
	Wilbur B. Driver Co.	1
II - 10 Williamsport, PA 6-7-79	Kawneer Company	1
	Marathon Carey McFall Co.	1
	Pennsylvania House Furniture Co.	1
	Shop-Vac Corporation	2
	TRW, Inc.	1
	Weis Markets, Inc.	1
	Zenith Audio Division	1

WORKSHOP ID AND LOCATION	ORGANIZATIONS PARTICIPATING	NUMBER OF ENGINEERS PARTICIPATING
II - 11 Allentown, PA 6-11-79	Air Products & Chemicals, Inc.	5
	Fuller Co.	1
	General Electric Co.	2
	Ingersoll - Rand Co.	2
	Mack Trucks, Inc.	1
	New Jersey Zinc	1
	Pennsylvania Power & Light Co.	2
II - 12 Harrisburg, PA 6-12-79	International Signal & Control	2
	New Cumberland Army Depot	2
	Pennsylvania Dept. of Environmental Resources, Bur. of Water Quality Mgt.	1
	Pennsylvania Dept. of Transportation	3
	Pennsylvania Public Utility Commission	2
	Pennsylvania Turnpike Commission	2
II - 13 Harrisburg, PA 6-12-79	Pennsylvania Dept. of General Services	1
	Hamilton Technology	1
	Pennsylvania Dept. of Transportation	5
II - 14 Erie, PA 6-15-79	American Sterilizer Co.	2
	Copes-Vulcan, Inc.	1
	Corry Jamestown Corporation	1
	Geosource, Inc.	2
	Bucyrus Erie Co.	2
	General Electric Co.	2
	Teledyne Penn Union	1
	Zurn Industries	1
II - 15 Washington, DC 6-19-79	Federal Aviation Administration	2
	U.S. Department of Energy	1
	U.S. Department of Transportation Research & Special Programs Admin.	1
	U.S. Department of Transportation Urban Mass Transportation Admin.	1
	U.S. Defense Nuclear Agency	2

WORKSHOP ID AND LOCATION	ORGANIZATIONS PARTICIPATING	NUMBER OF ENGINEERS PARTICIPATING
III - 1 Belleville, PA 8-9-79	Sperry New Holland	12
III - 2 Burnham, PA 8-9-79	Standard Steel Division, TMCA	8
III - 3 Aliquippa, PA 8-13-79	J & L Steel	7
III - 4 Warren, OH 8-13-79	Packard Electric	9
III - 5 Alliance, OH 8-14-79	Babcock & Wilcox Research Center	12
III - 6 Bethlehem, PA 8-20-79	Bethlehem Steel Corporation	15
III - 7 Allentown, PA 8-20-79	Air Products & Chemicals, Inc.	7
III - 8 Newark, OH	Rockwell International	9
III - 9 State College, PA	H R B-Singer, Inc.	9

APPENDIX B

Questionnaires for Phase III of the Project and Item Means and Standard Deviations Resulting from the Phase III Scaling

Job Activities and Work Assignments

The following statements describe various job activities and assignments on which an engineer might be required to work. We are interested in how you think that these activities and assignments would influence the likelihood that an engineer would be technically up-to-date. Use the scale below to indicate your judgment about each statement. Please do not omit any statements. Place the number indicating your judgment in the space to the left of each statement.

1	2	3	4	5	6	7
This would greatly decrease the likelihood that an engineer would be technically up-to-date			This would have no effect upon the likelihood that an engineer would be technically up-to-date			This would greatly increase the likelihood that an engineer would be technically up-to-date

Mean
S.D.

6.44 (0.73) 1. Job assignments are challenges which stretch the engineer's technical knowledge to the limit.

5.79 (0.93) 2. Job rotation exposes the engineer to new technical disciplines.

6.11 (0.94 3. Work assignments include state-of-the-art technology and advanced instrumentation.

5.33 (1.10) 4. Job requires design of new cost-effective and reliable product.

2.84 (1.04) 5. Too frequent assignment changes prevent seeing projects to completion.

3.06 (1.36) 6. Engineers are given assignments only within their specialty.

5.47 (1.04 7. Job allows free time to explore new, advanced ideas.

5.87 (0.91) 8. The engineer is given the responsibility to implement new ideas.

3.76 (1.14) 9. Job assignments require frequent travel.

2.04 (0.94) 10. Job assignments are frequently repetitions and formatted.

2.72 (0.95) 11. There is a lack of competent support technicans and clerical personnel.

2.14 (0.87) 12. Challenging work is often assigned only to newer engineers.

5.44 (0.74) 13. Job assignments require the evaluation of alternative solutions to technical problems.

2.60 (1.03) 14. Assignments require a lot of paperwork and accounting.

Note: N=101

5.38 (1.06) 15. The engineer is given complete freedom to solve a problem.

5.63 (0.85) 16. The engineer participates in technical decisions relevant to assignments.

3.51 (1.17) 17. Assignments have tight time deadlines.

2.59 (1.15) 18. Engineers are often assigned to non-technical tasks.

2.97 (1.12) 19. Project plans are often changed, resulting in new deadlines and work schedules.

2.87 (1.09) 20. The job requires extensive overtime.

2.55 (0.92 21. The engineer lacks the authority to make technical decisions about a project.

5.07 (1.04) 22. Job assignments require contacts with vendors, manufacturers, and customers.

5.08 (1.12) 23. Technicians and other support personnel are assigned the routine and non-technical jobs.

5.58 (1.03) 24. The engineer is allowed to see a project through from initial design to implementation.

2.93 (1.09) 25. Insufficient technical work exists to keep the engineer busy.

2.82 (0.95) 26. Job assignments have no identifiable end product which represents project completion.

2.05 (0.81) 27. Assignments rarely require the use of current technical knowledge and procedures.

3.34 (1.42) 28. The engineer is frequently assigned to new areas or projects without sufficient time to become proficient in the area.

5.55 (0.79) 29. Assignments require system and concept development.

4.27 (1.11) 30. Duties include managerial and administrative tasks.

5.39 (1.13) 31. The engineer is sometimes assigned a project which no one else has been able to complete successfully.

2.76 (1.00) 32. Job assignments are frequently made to a product or area in which little or no technological change is occurring.

5.52 (1.14) 33. Assignments are made in the area of the engineer's personal interest.

4.39 (1.08) 34. The engineer's duties often include adding components to existing systems.

Supervisory Actions and Attitudes

The following statements describe various actions and attitudes which might characterize the supervisor of an engineer in an organization. We are interested in how you think that these actions and attitudes would influence the likelihood that an engineer would be technically up-to-date. Use the scale below to indicate your judgment about each statement. Please do not omit any statements. Place the number indicating your judgment in the space to the left of each statement.

1	2	3	4	5	6	7
This would greatly decrease the likelihood that an engineer would be technically up-to-date			This would have no effect upon the likelihood that an engineer would be technically up-to-date			This would greatly increase the likelihood that an engineer would be technically up-to-date

2.97 (1.09) 1. The supervisor does not clearly define work objectives and responsibilities.

6.29 (0.70) 2. The supervisor provides recognition and credit for good technical work.

5.91 (0.89) 3. The supervisor's performance reviews points out the engineer's strengths and weaknesses and offer suggestions for improvement.

2.17 (1.37) 4. Only new hires are given the tough technical jobs by the supervisor.

2.74 (1.20) 5. The supervisor does not rotate the engineers' assignments to projects in various technical disciplines.

4.31 (1.08) 6. The supervisor allows the engineer to make an occasional mistake without punishment.

5.87 (0.87) 7. The supervisor demands excellence through the setting of challenging performance goals.

2.64 (1.23) 8. The supervisor overemphasizes short-term results at the expense of long-term technical excellence.

3.37 (1.04) 9. The supervisor does not consistently apply company policies.

5.41 (0.85) 10. The supervisor maintains open and two-way communication with the engineers.

6.20 (0.67) 11. Independent and innovative thinking are encouraged by the supervisor.

6.12 (0.77) 12. The supervisor solicits ideas from the engineers regarding technical problems.

2.24 (1.19) 13. The supervisor does not assign to the engineer work which is technically challenging.

2.66 (1.19) 14. The supervisor is not technically up-to-date or abreast of recent technical developments.

Note: N=100

Mean
).

2.38 15. The supervisor restricts the participation of the engineers in professional
(1.09) activities to a minimum.

2.18 16. The supervisor does not allow any engineer to understand the total project
(1.08) by withholding pertinent information and discouraging communication among the engineers.

5.50 17. The supervisor stands behind the engineers and supports them with higher
(0.96) management.

6.24 18. The supervisor bases salary and promotion recommendations on technical
(0.79) performance.

2.34 19. The supervisor does not support attendance at company and industry training
(1.07) courses.

2.62 20. The supervisor tends to dwell on an engineer's past mistakes.
(1.21)

2.89 21. Outside department technical advice is not sought by the supervisor.
(1.13)

5.48 22. The supervisor holds periodic staff meetings to discuss technical problems
(1.02) and developments.

6.20 23. The supervisor matches the engineer's need for professional development with
(0.80) opportunities to attend courses and technical meetings.

2.21 24. The supervisor does not recognize and reward an engineer's efforts to keep
(1.28) technically up-to-date.

2.03 25. The supervisor does not give credit for an engineer's idea, but promotes it
(1.08) as his own.

2.43 26. The supervisor fails to delegate responsibility and authority to the engineer.
(0.98)

5.92 27. The supervisor provides continuing education seminars on technological
(0.81) developments.

2.87 28. The supervisor encourages engineers to present papers at technical meetings.
(1.03)

5.36 29. The supervisor provides career counseling for the engineer.
(0.96)

5.44 30. The supervisor develops the younger engineers by giving a senior engineer
(0.98) responsibility for coaching the younger one.

3.03 31. The supervisor assigns too much work to the engineer.
(1.11)

5.16 32. The supervisors encourages the reading of technical journals and trade
(0.94) magazines during working hours.

2.16 33. The supervisor reacts negatively to innovative ideas of the engineer.
(0.86)

5.40 34. The supervisor involves the engineer in establishing performance goals by
(0.95) which the engineer will be evaluated.

4.96 35. The supervisor does not "play favorites," but treats all of the engineers
(1.26) in an equitable manner.

Management and Organizational Policies

The following statements describe various management and organizational policies which might characterize an organization for which an engineer works. We are interested in how you think that these policies would influence the likelihood that an engineer would be technically up-to-date. Use the scale below to indicate your judgment about each statement. Please do not omit any statements. Place the number indicating your judgment in the space to the left of each statement.

1	2	3	4	5	6	7
This would greatly decrease the likelihood that an engineer would be technically up-to-date			This would have no effect upon the likelihood that an engineer would be technically up-to-date			This would greatly increase the likelihood that an engineer would be technically up-to-date

Mean (S.D.)		Statement
6.[illegible] (1.[illegible])	[illegible]	The organization has a performance appraisal system which ties financial gain to technical competence.
2.3[illegible] (1.35)	2.	The organization does not have a tuition refund policy for continuing education.
2.11 (1.23)	3.	The organization provides little opportunity for advancement within the technical professional ranks.
5.29 (1.32)	4.	The organization has a patent award program.
5.25 (1.21)	5.	The organization provides career counseling for engineers.
2.75 (1.24)	6.	The organization does not provide financial support for attending professional meetings.
2.65 (1.21)	7.	The organization does not have the latest technical equipment for its engineers.
2.74 (1.16)	8.	The organization has a limited training budget for its engineering staff.
5.10 (1.23)	9.	There is a clear statement of the organization's technological goals available to all engineers.
5.70 (1.25)	10.	The organization provides in-house technical seminars.
5.45 (1.38)	11.	The organization maintains a current technical library.
2.35 (1.22)	12.	There is a fixed salary schedule which is independent of the engineer's accomplishment.
2.87 (1.17)	13.	The organization has a no administrative leave with pay to work on advanced engineering degrees.

Note: N=104

5.31 (1.45) 14. The organization rewards professional registration by salary increases.

4.17 (1.92) 15. The organization maintains equity in the salary of new and experienced engineers.

5.27 (1.18) 16. Technical courses are available for engineers after work hours.

2.45 (1.30) 17. Technically competent engineers are not given sufficient financial rewards by the organization.

2.[illegible] (1.13) 18. Engineers who receive advanced training and degrees receive little formal recognition in the organization.

5.06 (1.16) 19. The organization pays for subscriptions to technical and trade journals for the engineer.

3.13 (1.44) 20. Engineers must move into management positions in order to advance in the organization.

2.99 (1.23) 21. The organization provides limited funds for internal research and development.

2.85 (1.41) 22. The organization is frequently reorganized.

2.52 (1.23) 23. Engineers are not always hired for engineering jobs.

5.20 (1.54) 24. The organization has parallel avenues of advancement via technical and managerial paths.

4.90 (1.30) 25. The organization maintains a computerized information system regarding the professional development needs of its engineers.

5.70 (1.10) 26. The organization provides its engineers with current technical equipment and facilities.

5.48 (1.23) 27. The organization has a systematic rotational program to give its engineers diversified job assignments during the first years of employment.

2.71 (1.17) 28. The organization keeps its engineering staff small, relying on overtime to get the work done.

2.39 (1.27) 29. The organization does not have a competitive salary structure.

4.79 (1.26) 30. The organization provides clerical assistance for the preparation of articles for technical journals.

2.56 (1.07) 31. All of the engineer's time must be charged to project budgets with no allowance for general technical updating.

4.65 (1.16) 32. The organization maintains attractive and comfortable working conditions.

Peer-Colleague Interactions

The following statements describe various interactions an engineer might have with his or her fellow engineers or peers in the organization. We are interested in how you think that these peer interactions would influence the likelihood that an engineer would be technically up-to-date. Use the scale below to indicate your judgment about each statement. Please do not omit any statements. Place the number indicating your judgment in the space to the left of each statement.

1	2	3	4	5	6	7
This would greatly decrease the likelihood that an engineer would be technically up-to-date			This would have no effect upon the likelihood that an engineer would be technically up-to-date			This would greatly increase the likelihood that an engineer would be technically up-to-date

Mean (S.D.)		Statement
5.75 (0.91)	1.	Peers are able to provide reliable information about current technical developments.
5.59 (0.95)	2.	Peers are able to suggest new approaches to technical problems based upon their own experience.
2.36 (1.05)	3.	Fellow engineers discourage attempts to remain technically current.
2.76 (1.14)	4.	Other engineers in the organization prefer to keep new ideas to themselves.
5.31 (0.89)	5.	Other engineers can identify the people to consult about problems in unfamiliar technical areas.
5.71 (0.67)	6.	Peers usually draw one's attention to useful new journal articles and technical papers.
2.52 (0.96)	7.	Peers often react negatively to new technical ideas.
2.75 (0.70)	8.	Information exchange is restricted by excessive competition among the engineers in the organization.
5.50 (0.95)	9.	Peers are willing to act as sounding boards for new ideas.
5.46 (1.21	10.	There exists a competitive atmosphere among fellow engineers which maintains pressure toward high levels of job performance.
4.38 (0.86)	11.	Peers provide information about how the "organizational system" operates.
3.77 (1.15)	12.	Fellow engineers in the organization have narrow ranges of specialization

Note: N=100

2.87 (0.92) 13. The organization's concern for the protection of proprietary information restricts interactions with other engineers in the organization.

5.09 (1.43) 14. Each engineer's promotional opportunity is competitive with that of other engineers in the organization.

3.21 (1.32) 15. Peers pretend to know about certain technical areas and thus give incorrect information.

3.01 (1.40) 16. Fellow engineers are unwilling to make an extra effort to help a colleague with a technical problem.

5.07 (1.15) 17. Peers are able to catch logical and analytical errors in designs and ideas.

Perceptions and Attitudes of Organizational Members

The following statements describe various perceptions and attitudes which organizational members, including engineers, might have about the organization for which they work. We are interested in how you think that these perceptions and attitudes would influence the likelihood that an engineer would be technically up-to-date. Use the scale below to indicate your judgment about each statement. Please do not omit any statements. Place the number indicating your judgment in the space to the left of each statement.

1	2	3	4	5	6	7
This would greatly decrease the likelihood that an engineer would be technically up-to-date			This would have no effect upon the likelihood that an engineer would be technically up-to-date			This would greatly increase the likelihood that an engineer would be technically up-to-date

Mean (S.D.)	No.	Statement
6.25 (0.67)	1.	The organization expects continuing technical excellence and competence.
6.08 (0.63)	2.	The organization has a progressive atmosphere.
2.97 (1.09)	3.	The organization has a conservative, "no-risk" climate.
2.71 (1.10)	4.	There is a lack of openness in organizational communication.
5.01 (1.12)	5.	An effort is make to create an entrepreneurial environment.
6.07 (0.64)	6.	The organization attempts to be better technically than its competition.
1.67 (0.64)	7.	Personal creativity and growth are stifled by the organization.
2.47 (0.92)	8.	Organizational members seek to maintain the status quo.
4.89 (0.86)	9.	Organizational and subunit goals are clearly defined.
5.83 (0.72)	10.	The organization emphasizes problem solving and achievement rather than short-term profits.
6.35 (0.93)	11.	The organization is dedicated to staying at the cutting edge of technology.
3.15 (1.43)	12.	Organizational members have a fear of failure.
2.34 (0.69)	13.	The organization underutilizes its technical talent.
5.78 (0.76)	14.	The organization is concerned with the professional growth of its engineers.

Note: N=95

Mean (S.D.)	Item	Statement
5.25 (0.90)	15.	Reasonable risk taking is an accepted practice within the organization.
6.32 (0.64)	16.	Innovation is enthusiastically received within the organization.
2.06 (0.85)	17.	Low value is placed on the development of human resources to achieve organizational excellence.
2.23 (0.83)	18.	The organization is overstructured and inflexible.
2.67 (0.81)	19.	Traditional procedures and techniques are favored within the organization.
5.73 (0.61)	20.	The engineers have a sense of personal involvement in the organization's future.
5.91 (0.81)	21.	Technical growth is stimulated by seminars and presentations.
6.26 (0.70)	22.	Organizational rewards are given to those engineers with technical competence.
1.76 (0.83)	23.	There is a discouraging and indifferent attitude toward technological innovation and excellence.
3.23 (1.33)	24.	The organization is paternalistic in its view of the engineering staff.
5.23 (0.89)	25.	Engineers are matched well with work assignments.
6.22 (0.67)	26.	The organization is a leader in technical development.
5.80 (0.93)	27.	Engineers are encouraged to be autonomous and take responsibility for projects.
5.51 (1.10)	28.	There is competition among engineers for promotions and choice assignments.
5.86 (0.81)	29.	People in technical disciplines view the organization as an innovator.
2.69 (0.75)	30.	There is little leadership in the organization regarding professional standards.
4.13 (1.40)	31.	The organization tends to divert top technical people into administrative positions.
2.33 (0.88)	32.	The organization is involved in technically stagnant fields.
5.[illegible] (0.69)	33.	The organization recognize the technical contributions of its engineers.

5.34 (0.97	34.	There are open lines of communication between the engineering staff and organization management.
2.99 (0.93)	35.	Organizational management lacks technical sophistication.
2.21 (1.39)	36.	Engineers are more likely to be fired when projects end rather than be reassigned to other parts of the organization.
5.85 (0.90)	37.	The organization stresses high professional standards.
5.65 (1.01	38.	The recruitment practices of the organization bring competent young engineers into the organization.
2.47 (0.73)	39.	The organization's work is usually of less than average quality
1.89 (0.83)	40.	There is a limited opportunity for engineers in the organization to use their technical knowledge.

REWARDS AND OUTCOMES RELATED TO AN ENGINEER'S JOB

A. Attached is a list of items which describe possible rewards or outcomes related to work. Many of these concern your organization and your job; others are more related to your feelings and perceptions. Indicate how important you think each of these items is for engineers in general. Use the scale below to make these judgments. Place the number indicating your judgment in the space to the left of each item. Please do not skip any items.

1	2	3	4	5	6	7
not at all important to engineers			moderately important to engineers			very important to engineers

B. The same items are listed again. Now, please indicate how desirable each of these items is for <u>you personally</u>. Use the scale below to make these judgments. Place the number indicating your judgment in the space to the left of each item. Please do not skip any items.

1	2	3	4	5	6	7
This would be very undesirable for me			This would be neither desirable nor undesirable for me			This would be very desirable for me

Mean	S.D.		
6.3	1.1	1.	recognition for accomplishments and technical success
6.0	1.3	2.	opportunity for advancement based on quality of work performance
5.2	1.9	3.	lack of recognition for accomplishment and well-done job
6.0	1.2	4.	salary and merit increases, based on performance
5.2	1.8	5.	lack of opportunity for advancement
4.8	1.5	6.	immediate feedback with regard to success of assignment
5.5	1.7	7.	less then adequate salary
5.8	1.2	8.	feeling of achievement resulting from work assignment
5.0	1.6	9.	limited promotional opportunity for those who maintain technical competence
5.4	1.3	10.	desire for excellence in work assignment
4.8	1.7	11.	failure to reward individuals for well-done job
4.9	1.3	12.	opportunity for professional development
5.0	1.3	13.	orga ational reward for those who maintain and expand technical skills
5.6	1.2	14.	being assigned challenging work
5.0	1.7	15.	lack of opportunity to grow technically and professionally
4.9	1.4	16.	seeing how one's assignments fit into the overall project
5.2	1.5	17.	having time for family activities
4.1	2.1	18.	being assigned routine and technician-type work
4.8	1.5	19.	having time for recreational and leisure activities
4.7	1.4	20.	having assignments in the forefront of technology
4.6	1.5	21.	recognition of the rapid change in technology
4.4	1.5	22.	company reputation for technological leadership and excellence
5.2	1.4	23.	having job security
5.4	1.3	24.	opportunity to be creative and innovative
5.7	1.2	25.	opportunity to exercise personal initiative in assignment
4.9	1.3	26.	getting along with supervisor
5.0	1.3	27.	having major responsibility for a project
4.0	1.5	28.	availability of technical library
3.4	1.5	29.	opportunity to publish technical articles and books
3.8	1.5	30.	opportunity to join professional societies, attend professional meetings and present technical papers
5.1	1.4	31.	good relations with co-workers

Note: N=96

Mean	S. D.		
6.0	1.2	1.	recognition for accomplishments and technical success
6.2	1.2	2.	opportunity for advancement based on quality of work performance
4.2	2.2	3.	lack of recognition for accomplishment and well-done job
6.0	1.3	4.	salary and merit increases, based on performance
4.3	2.3	5.	lack of opportunity for advancement
4.9	1.5	6.	immediate feedback with regard to success of assignment
4.6	2.4	7.	less then adequate salary
6.2	1.2	8.	feeling of achievement resulting from work assignment
4.1	1.9	9.	limited promotional opportunity for those who maintain technical competence
6.0	1.2	10.	desire for excellence in work assignment
4.3	2.1	11.	failure to reward individuals for well-done job
5.2	1.3	12.	opportunity for professional development
5.0	1.3	13.	organizational reward for those who maintain and expand technical skills
6.1	1.2	14.	being assigned challenging work
4.2	2.0	15.	lack of opportunity to grow technically and professionally
5.4	1.4	16.	seeing how one's assignments fit into the overall project
5.6	1.6	17.	having time for family activities
3.4	2.3	18.	being assigned routine and technician-type work
5.1	1.5	19.	having time for recreational and leisure activities
4.8	1.4	20.	having assignments in the forefront of technology
5.0	1.6	21.	recognition of the rapid change in technology
4.9	1.5	22.	company reputation for technological leadership and excellence
5.3	1.4	23.	having job security
5.9	1.2	24.	opportunity to be creative and innovative
6.2	1.1	25.	opportunity to exercise personal initiative in assignment
5.5	1.3	26.	getting along with supervisor
5.9	1.3	27.	having major responsibility for a project
4.2	1.7	28.	availability of technical library
3.5	1.6	29.	opportunity to publish technical articles and books
3.9	1.7	30.	opportunity to join professional societies, attend professional meetings and present technical papers
5.6	1.3	31.	good relations with co-workers

Note. N=95

C. The same items are again listed. In your organization, what effect would being technically up-to-date and competent have upon the likelihood that an engineer would obtain each of the rewards or outcomes? Use the scale below to make these judgments. Place the number indicating your judgment in the space to the left of each item. Please do not skip any items.

1	2	3	4	5	6	7
Being up-to-date would greatly decrease the chances of obtaining this item			Being up-to-date would have no effect upon the chances of obtaining this item			Being up-to-date would greatly increase the chances of obtaining this item

Mean	S. D.		
5.3	1.3	1.	recognition for accomplishments and technical success
5.2	1.4	2.	opportunity for advancement based on quality of work performance
3.1	1.6	3.	lack of recognition for accomplishment and well-done job
5.2	1.3	4.	salary and merit increases, based on performance
3.1	1.6	5.	lack of opportunity for advancement
3.9	1.3	6.	immediate feedback with regard to success of assignment
3.1	1.7	7.	less then adequate salary
4.9	1.6	8.	feeling of achievement resulting from work assignment
3.7	1.7	9.	limited promotional opportunity for those who maintain technical competence
5.3	1.4	10.	desire for excellence in work assignment
3.4	1.5	11.	failure to reward individuals for well-done job
5.0	1.6	12.	opportunity for professional development
4.9	1.7	13.	organizational reward for those who maintain and expand technical skills
5.4	1.6	14.	being assigned challenging work
3.1	1.7	15.	lack of opportunity to grow technically and professionally
4.2	1.5	16.	seeing how one's assignments fit into the overall project
3.7	1.4	17.	having time for family activities
3.0	1.8	18.	being assigned routine and technician-type work
3.6	1.4	19.	having time for recreational and leisure activities
5.3	1.9	20.	having assignments in the forefront of technology
5.4	1.8	21.	recognition of the rapid change in technology
5.1	1.8	22.	company reputation for technological leadership and excellence
4.7	1.7	23.	having job security
5.3	1.6	24.	opportunity to be creative and innovative
5.1	1.7	25.	opportunity to exercise personal initiative in assignment
4.2	1.6	26.	getting along with supervisor
5.1	1.7	27.	having major responsibility for a project
4.0	1.5	28.	availability of technical library
5.0	1.9	29.	opportunity to publish technical articles and books
4.5	1.7	30.	opportunity to join professional societies, attend professional meetings and present technical papers
4.2	1.5	31.	good relations with co-workers

Note N=96.

APPENDIX C

The Work Description Questionnaire for Engineers (WDQE) with Factor Designation for Each Item

Note:
Policy = Management and Organizational Policies;
Job Act. = Job Activities and Work Assignments;
Percept. = Perceptions and Attitudes of Organizational Members (Climate);
Superv. = Supervisory Actions and Attitudes;
Peer = Peer-Colleague Interactions.

Work Description Questionnaire for Engineers

The following statements are concerned with the nature of your work assignments, the actions and attitudes of your peers and supervisor, the policies of your organization, and other characteristics of the organization which employs you. We are interested in how well you think that each of these statements describes your job, organization, supervisor, or peers. Use the scale below to indicate your judgment about each statement. Write the number indicating your judgment in the space to the left of each statement. Please do not omit any statements.

1	2	3	4	5	6
a very inaccurate statement	a generally inaccurate statement	a more inaccurate than accurate statement	a more accurate than inaccurate statement	a generally accurate statement	a very accurate statement

Policy 1. Technical courses are available for engineers after work hours.

Job Act. 2. Project plans are often changed, resulting in new deadlines and work schedules.

Percept. 3. The recruitment practices of the organization bring competent young engineers into the organization.

Percept. 4. The organization is involved in technically stagnant fields.

Superv. 5. My supervisor bases salary and promotion recommendations on technical performance.

Percept. 6. The engineers have a sense of personal involvement in the organization's future.

Policy 7. The organization provides its engineers with current technical equipment and facilities.

Percept. 8. People in technical disciplines view the organization as an innovator.

Peer 9. Fellow engineers discourage attempts to remain technically current.

Job Act. 10. Work assignments include state-of-the-art technology and advanced instrumentation.

Percept. 11. The organization's work is usually of less than average quality.

Superv. 12. My supervisor overemphasizes short-term results at the expense of long-term technical excellence.

Percept. 13. The organization emphasizes problem solving and achievement rather than short-term profits.

Job Act. 14. Job assignments have no identifiable end product which represents project completion.

Policy 15. The organization has a patent award program.

Superv. 16. My supervisor's performance reviews point out the engineer's strengths and weaknesses and offer suggestions for improvement.

Percept. 17. There is a discouraging and indifferent attitude toward technological innovation and excellence.

Job Act. 18. Job assignments are frequently repetitious and formatted.

Peer 19. Peers are able to suggest new approaches to technical problems based upon their own experience.

Policy 20. Engineers are not always hired for engineering jobs.

Percept. 21. Organization management lacks technical sophistication.

Percept. 22. There are open lines of communication between the engineering staff and organization management.

Job Act. 23. Job assignments are frequently made to a product or area in which little or no technological change is occurring.

Percept. 24. There is little leadership in the organization regarding professional standards.

Policy 25. All of the engineer's time must be charged to project budgets with no allowance for general technical updating.

Peer 26. Other engineers can identify the people to consult about problems in unfamiliar technical areas.

Percept. 27. There is competition among engineers for promotions and choice assignments.

Peer 28. Peers are able to provide reliable information about current technical developments.

Job Act. 29. Assignments require a lot of paperwork and accounting.

Policy 30. Engineers who receive advanced training and degrees receive little formal recognition in the organization.

Job Act. 31. The engineer participates in technical decisions relevant to assignments.

Policy 32. The organization provides limited funds for internal research and development.

Percept. 33. Personal creativity and growth are stifled by the organization.

Percept. 34. The organization is overstructured and inflexible.

Peer 35. Peers usually draw one's attention to useful new journal articles and technical papers.

Job Act. 36. Assignments are made in the area of the engineer's personal interest.

Policy 37. The organization has a performance appraisal system which ties financial gain to technical competence.

Job Act. 38. Engineers are often assigned to non-technical tasks.

Superv. 39. My supervisor does not give credit for an engineer's idea, but promotes it as his own.

Percept. 40. Low value is placed on the development of human resources to achieve organizational excellence.

Job Act. 41. Job assignments require the evaluation of alternative solutions to technical problems.

Superv. 42. My supervisor does not recognize and reward an engineer's efforts to keep technically up-to-date.

Percept. 43. Organizational members seek to maintain the status quo.

Job Act. 44. Job assignments require contacts with vendors, manufacturers, and customers.

Superv. 45. My supervisor provides career counseling for the engineer.

Percept. 46. The organization is concerned with the professional growth of its engineers.

Superv. 47. My supervisor restricts the participation of the engineers in professional activities to a minimum.

Job Act. 48. Challenging work is often assigned only to newer engineers.

Peer 49. The organization's concern for the protection of proprietary information restricts interactions with other engineers in the organization.

Policy 50. The organization provides career counseling for engineers.

Superv. 51. My supervisor does not allow any engineer to understand the total project by withholding pertinent information and discouraging communication among the engineers.

Policy 52. The organization has a systematic rotational program to give its engineers diversified job assignments during the first years of employment.

Superv. 53. My supervisor is not technically up-to-date or abreast of recent technical developments.

Percept. 54. The organization attempts to be better technically than its competition.

Job Act. 55. There is a lack of competent support technicians and clerical personnel.

Policy 56. The organization keeps its engineering staff [illegible] relying on overtime to get the work done.

Policy 57. Technically competent engineers are not given s[illegible]t financial rewards by the organization.

Superv. 58. My supervisor matches the engineer's need for professional development with opportunities to attend courses and technical meetings.

Policy 59. The organization pays for subscriptions to technical and trade journals for the engineer.

Job Act. 60. The engineer lacks the authority to make technical decisions about a project.

Peer 61. Other engineers in the organization prefer to keep new ideas to themselves.

Policy 62. The organization has a no administrative leave with pay to work on advanced engineering degrees.

Superv. 63. My supervisor fails to delegate responsibility and authority to the engineer.

Policy 64. The organization has a limited training budget for its engineering staff.

Superv. 65. My supervisor does not support attendance at company and industry training courses.

Job Act. 66. Job assignments are challenges which stretch the engineer's technical knowledge to the limit.

Superv. 67. My supervisor does not assign to the engineer work which is technically challenging.

Policy 68. The organization provides in-house technical seminars.

Percept. 69. The organization is dedicated to staying at the cutting edge of technology.

Percept. 70. There is a limited opportunity for engineers in the organization to use their technical knowledge.

Superv. 71. My supervisor encourages engineers to present papers at technical meetings.

Percept. 72. The organization has a progressive atmosphere.

Peer 73. Peers are able to catch logical and analytical errors in designs and ideas.

Peer 74. There exists a competitive atmosphere among fellow engineers which maintains pressure toward high levels of job performance.

Job Act. 75. The job requires extensive overtime.

Superv. 76. My supervisor stands behind the engineers and supports them with higher management.

Job Act. 77. The engineer is given the responsibility to implement new ideas.

Peer 78. Peers are willing to act as sounding boards for new ideas.

Percept. 79. The organization recognizes the technical contributions of its engineers.

Percept. 80. Reasonable risk taking is an accepted practice within the organization.

Job Act. 81. Assignments require system and concept development.

Superv. 82. My supervisor encourages the reading of technical journals and trade magazines during working hours.

Percept. 83. Innovation is enthusiastically received within the organization.

Policy 84. The organization provides little opportunity for advancement within the technical professional ranks.

Superv. 85. My supervisor provides recognition and credit for good technical work.

Policy 86. The organization does not provide financial support for attending professional meetings.

Policy 87. There is a clear statement of the organization's technological goals available to all engineers.

Superv. 88. My supervisor solicits ideas from the engineers regarding technical problems.

Percept. 89. The organization stresses high professional standards.

Superv. 90. My supervisor holds periodic staff meetings to discuss technical problems and developments.

Peer 91. Peers often react negatively to new technical ideas.

Percept. 92. The organization underutilizes its technical talent.

Superv. 93. My supervisor involves the engineer in establishing performance goals by which the engineer will be evaluated.

Job Act. 94. The engineer is allowed to see a project through from initial design to implementation.

Superv. 95. My supervisor reacts negatively to innovative ideas of the engineers.

Peer 96. Information exchange is restricted by excessive competition among the engineers in the organization.

Superv. 97. My supervisor maintains open and two-way communication with the engineers.

Percept. 98. Organizational rewardc are given to those engineers with technical competence.

Job Act. 99. Job allows free time to explore new, advanced ideas.

Policy 100. The organization does not have a tuition refund policy for continuing education.

APPENDIX D

Work-Related Outcomes and Rewards Retained for Future Use

__*__ 1. recognition for accomplishments and technical success

__*__ 2. opportunity for advancement based on quality of work performance

__*__ 3. lack of recognition for accomplishment and well-done job

__*__ 4. salary and merit increases, based on performance

__*__ 5. lack of opportunity for advancement

_____ 6. immediate feedback with regard to success of assignment

__*__ 7. less then adequate salary

__*__ 8. feeling of achievement resulting from work assignment

_____ 9. limited promotional opportunity for those who maintain technical competence

__*__ 10. desire for excellence in work assignment

_____ 11. failure to reward individuals for well-done job

__*__ 12. opportunity for professional development

__*__ 13. organizational reward for those who maintain and expand technical skills

__*__ 14. being assigned challenging work

__*__ 15. lack of opportunity to grow technically and professionally

__*__ 16. seeing how one's assignments fit into the overall project

__*__ 17. having time for family activities

__*__ 18. being assigned routine and technician-type work

__*__ 19. having time for recreational and leisure activities

__*__ 20. having assignments in the forefront of technology

__*__ 21. recognition of the rapid change in technology

__*__ 22. company reputation for technological leadership and excellence

__*__ 23. having job security

__*__ 24. opportunity to be creative and innovative

__*__ 25. opportunity to exercise personal initiative in assignment

__*__ 26. getting along with supervisor

__*__ 27. having major responsibility for a project

_____ 28. availability of technical library

_____ 29. opportunity to publish technical articles and books

_____ 30. opportunity to join professional societies, attend professional meetings and present technical papers

__*__ 31. good relations with co-workers

* = Item retained for future use.