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Validation of the Human Factors Satisfaction Questionnaire

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VALIDATION OF THE HUMAN FACTORS SATISFACTION QUESTIONNAIRE

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Abstract

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In order to predict behavior in organizations, it is important to understand and to consider both the individual employee and his/her interaction with the physical work environment. The main purpose of this research was to gather evidence of the validity of the Human Factors Satisfaction Questionnaire (HFSQ) in order to provide a tool with which employees' perceptions of several elements of their physical work environments can be measured. The physical work environment and its relationship to both organization theory and motivation theory is discussed. Evidence of the construct validity of the HFSQ was sought through the administration of the HFSQ to 641 employees of 8 organizations, along with established measures of job satisfaction, organization commitment, turnover intentions, participation in goal setting, feedback in goal effort, perceived crowding, task privacy, and communications privacy. Hypotheses 1 and 2 stated that the HFSQ would converge with measures of peoples' perceptions of their objective physical work environment and discriminate from other measures. These expectations were contradicted by the correlational data. However, when the HFSQ was considered to be a measure of the "physical work environment satisfaction" construct, it was seen to converge with other measures of job satisfaction and to be less strongly related to non-satisfaction measures. Hypothesis 3 stated that the HFSQ would be a significant contributor to the model illustrating the

relationships between the job satisfaction, organization commitment, and turnover intention constructs, and that the model would "fit" better with the HFSQ than without it. The investigation of the job satisfaction construct measurement model provided evidence of the validity of the "physical work environment satisfaction" construct and of the HFSQ as a measure of that construct, while the data provided support for Hypothesis 3. Finally, it was expected (Hypothesis 4) that groups of people who worked in distinct physical environments would report significantly different HFSQ scores. This hypothesis received no support. Therefore, the study provided mixed evidence for the construct validity of the HFSQ and for the "physical work environment satisfaction" construct.

DEDICATION

This work is dedicated to Phoebe and Cassandra Carlopio, and to the children of our future. You are my motivation; you are my life.

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VALIDATION OF THE HUMAN FACTORS SATISFACTION QUESTIONNAIRE

Chapter One
Introduction

Current conceptualization and measurement of work systems fail to adequately consider the effects of the physical environment on people at work. Whether they focus mainly on the characteristics of jobs (e.g., Hackman & Oldham, 1980, Job Diagnostic Survey), on the behavioral aspects of jobs (e.g., Van de Ven & Ferry, 1980, Organization Assessment Instrument), or try to explain a wider range of variables (e.g., Seashore, Lawler, Mirvis, & Camman, 1983, Michigan Organization Assessment Questionnaire) theories of work systems overlook the physical work environment. Disregarding the well-documented (e.g., Beck, 1987; Oborne & Gruneberg, 1983; Walker & Guest, 1952) effects of the physical work environment on people's behavior leaves behavioral variance unexplained, and the relationships between environmental variables and measures of interest to organizational researchers (e.g., turnover intention, satisfaction, and commitment) unexplored. Several authors have addressed the physical work environment and discussed it theoretically and/or attempted to incorporate in it measures of workers' satisfaction (e.g., Moos, 1973; Weiss, Dawis, England, & Lofquist, 1967). However, these treatments of the physical work environment have been somewhat superficial. This research describes (1) how the physical work environment has been neglected; (2) why the physical work environment should not be overlooked; (3) the inadequacies of existing theories and measures of employee satisfaction with respect to the

physical work environment; and (4) the development of a short, yet comprehensive, questionnaire that assesses satisfaction with elements of the physical work environment.

Organization Theory and the Physical Work Environment

Although early research in industrial psychology (e.g., Taylor, 1911) considered the importance of work conditions, modern organizational theory fails to take into account sufficiently the effects of the physical setting of work on organizational behavior (Becker, 1981; Carlopio, 1986a). For example, March and Simon (1958) suggested that the major problem with classical physiological organization theory (cf. Taylor, 1911) is that it takes the form of engineering principles and lacks "an explicit underlying theory of the human mechanism" (p. 21). March and Simon (1958) then go on to develop a complex, comprehensive theory of the human mechanism at work that failed to consider the effects, constraints, and limitations of human physiology and of the physical work environment on the "human mechanism." This typifies the bias in modern organization theory toward ignoring elements of the physical work environment. Whether writing about organizations from a social (e.g., Katz & Kahn, 1978) or a technical (e.g., Thompson, 1967) perspective, the physical work environment is typically overlooked by organization theorists.

One of the few modern organization theories that considers the physical work environment is Socio-Technical Systems (STS) theory (cf. Pasmore & Sherwood, 1978). STS theory approached its goal of optimizing the fit between the social-work organization and the technical organization (including equipment and process layout) by adapting the social-psychological and technical structures to maximize the performance of both systems. Variations

on this theme have been employed throughout the world; good examples are the "Swedish Experiments" conducted by Saab and Volvo in which the work organization was reconfigured away from the traditional assembly line toward more group-oriented "parallel group" and "work team" layouts. As part of their evaluation of 10 years at the Kalmar facility (1974 to 1984), the Volvo Kalmar Plant research team of Aguren and associates (Aguren, Hansson, & Karlsson, 1976; Aguren, Bredbacka, Hansson, Lhregren, & Karlsson, 1984) queried employees regarding changes in work organization, participation, quality, wages, training, and development. Since the effects of equipment and layout were considered significant in this model, the attitude survey also included questions about workers' satisfaction with 12 aspects of the physical work environment: physical burden, working positions, noise, lighting, windows/contact with nature, climate/ventilation, safety issues, facilities, accident risk, health care, pace, and working areas/workplaces. As evidence of the success of their organization redesign efforts, the authors reported that most of the elements measured showed more workers were more satisfied in 1984 than they were in 1974. Satisfaction with the 12 aspects of the physical work environment was evaluated with 12 single-item questions.

Motivation Theory and the Physical Work Environment

Although the conceptual link between organization behavior and the physical work environment is yet to be established, a connection between physical working conditions and motivation theory can be found in the work of Herzberg and his associates (Herzberg, 1966; Herzberg, Mausner, & Snyderman, 1967). Herzberg's two-factor theory suggested that there are two distinct, independent dimensions of satisfaction. Elements such as responsibility,

recognition, and achievement were considered higher-order motivators while those like pay, job security, and working conditions were considered as lower-level hygiene factors.

Herzberg's research found that when workers related incidents that they associated with being satisfied on the job, they more frequently mentioned achievement, recognition, work itself, responsibility, and advancement. When workers related incidents associated with their dissatisfaction, they more often mentioned interpersonal relations, supervision, company policy, working conditions, and personal life. Thus, two-factor theory postulated that satisfiers increase job satisfaction beyond the neutral point when present and drop satisfaction back to the neutral point when absent. The theory suggested that dissatisfiers have a complementary negative affect. Herzberg et al. (1967) did state that the support for the unidirectional effects of these dimensions in their own data was truer for dissatisfiers than for satisfiers (p. 112). The presence of hygiene factors was considered necessary to reduce workers' dissatisfaction. The presence of motivating factors was considered important to fulfill workers' higher-order needs for self actualization. This distinction rests heavily on the work of Maslow (1943) and his stated hierarchy of needs. Maslow's theory suggests that when lower-order needs are satisfied (or at least partially satisfied), individuals begin to consider higher-order needs more important. Most modern-day workers have some money, a place to live, adequate food, and relationships. The basic physiological, safety, and belonging needs (i.e., hygiene factors) at least partially seem to be satisfied. Therefore, according to two-factor theory, members of the modern labor force should consider the esteem and self-actualization needs (i.e., motivating factors) as more important than the lower-order needs.

According to Whitehill (1976), Herzberg and associates gave academicians

and corporate management a bias from which they have never recovered. Both management and the behavioral sciences have ignored the lowly hygiene factors while efforts have been concentrated mostly on the motivators. Herzberg's two-factor dichotomy seems to have encouraged managers and researchers to concentrate on higher-order needs; for example, the popular and academic literature is full of examples of job enrichment, participative schemes, and ways to satisfy workers' needs for autonomy, responsibility, and variety. Concern with issues such as good physical working conditions, health and safety, work pace, and physical burdens clearly has been secondary.

The Physical Work Environment

Steele (1973) proposed six functions of the physical work environment: (1) shelter and security, (2) social contact, (3) symbolic identification, (4) task instrumentality, (5) pleasure, and (6) growth. He did not propose that these dimensions were independent or all-inclusive. Rather, he suggested that they capture the major elements of peoples' experiences in the physical work environment in terms of the environment's ability to satisfy basic human needs. Steele expected, therefore, that physical work environments would be satisfying if they were pleasant, safe, comfortable, promoted social contact (not isolation), and provided the "circumstances" necessary for critical tasks and functions.

Becker (1981) suggested that the physical environment has both first- and second-order effects at work. First, the environment provides the requisite support to engage in one's job or to carry out an activity effectively and comfortably. Second, the environment acts as a catalyst setting in motion linked events impacting variables such as satisfaction, communication, and trust. Thus, both Steele (1973) and Becker (1981) conceptualized the physical

work environment in psycho-social terms of comfort, functionality, and individual interaction. In fact Locke (1976), in his review of the satisfaction concept in the professional literature, suggested that the two basic principles that underlie workers' preferences for pleasant working conditions were (1) the desire for physical comfort and (2) the desire for conditions that facilitate goal attainment. The physical work environment, however, includes more than what is typically considered the psycho-social task environment. Attributes that could be considered include the size, overall pleasantness, and color of the work environment, the cafeteria, the restrooms, along with health and safety issues.

Murphy and Fraser's (1978) article on intuitive-theoretical scales of content and context satisfaction continued the distinction between content/intrinsic factors of jobs (as opportunities for self-actualization) and context factors of jobs (as the social and technical environment). They stated that "white-collar workers rate content factors as significantly more important, and context factors as significantly less important than do blue-collar workers" (p. 485). This seems to support the Herzberg et al. (1967) statement that when the job offers little opportunity for the motivating factors to appear (e.g., the blue-collar as compared with the white-collar job), hygiene factors must be stronger to make the work tolerable (p. 115).

Whitehill (1976) related the results of interviews with 173 production workers from three engine plants of major U.S. automobile manufacturers in the Midwest. The results of the survey showed that overall, the employees were generally satisfied with their work. Over all job types, the answer to the question "All in all, how satisfied are you with your job?" produced 86 percent satisfied responses. However, on closer examination several problems were revealed. Six job facets were examined specifically, three were motivating factors (variety, independence, and responsibility) and three were hygiene

factors (physical working conditions, safety and health, and hours of work). The importance of these factors to the individual was ascertained, as well as the extent to which they were provided on the job. Dissatisfaction was defined as when the facet was considered both important to the worker and not provided by the job. The percentages of workers rating the specific job factors as unsatisfactory were: 67 percent - physical conditions; 49 percent - safe and healthy work place; 35 percent - convenient hours of work (the three hygiene factors); followed by 31 percent - variety; 24 percent - independence; and 19 percent - responsibility (the three motivators). Regardless of employee age, education, seniority, or pay group, the lower-level hygiene factors were found to be the principal sources of discontent (Whitehill, 1976). These results also provide evidence for the contention of Herzberg's two-factor theory that hygiene factors are associated with dissatisfaction. The research of Murphy and Frazer (1978) and Whitehill (1976) illustrate that whether they are labeled "extrinsic," "contextual," or "hygiene" factors, elements of the physical work environment are important to many employees and should be taken seriously.

Oldham and associates (Oldham, 1988; Oldham & Brass, 1979; Oldham & Fried, 1987; Oldham & Rotchford, 1983) more recently have begun to investigate the effects of objective office work space characteristics (e.g., openness, density, darkness) on what they call employee reactions (e.g., satisfaction, behavior during discretionary periods, spacial markers, turnover). They have conceptualized the physical environment of offices in terms of openness (i.e., number of interior boundaries), density (i.e., number of square feet per employee), architectural accessibility or number of enclosures (i.e., workspace accessibility to external intrusions), darkness (i.e., overall illumination and coloring), and interpersonal distance. These factors were expected to influence the amount of interpersonal contact, feedback, and

autonomy among employees, ultimately affecting outcomes such as turnover and work satisfaction. Work satisfaction, interpersonal satisfaction, and internal motivation all decreased for a group of employees who moved from a conventional office to an open office setting (Oldham & Brass, 1979). Objective office characteristics (e.g., density) were found to be related to employee reactions (e.g., job satisfaction) (Oldham & Rotchford, 1983). Oldham and Fried (1987) again found evidence that the physical characteristics of office work environments can have an impact on the behavior and attitudes of office employees. Most recently, Oldham (1988) found that objective elements of the physical environment at work (e.g., partitions and spatial density) affect employee perceptions of task privacy, communication privacy, perceived crowing, and office satisfaction. Taken as a group, the studies done by Oldham and associates lend substantial support to the contention that objective physical characteristics of an office work environment can have an impact on the behavior and attitudes of employees.

The effects of perceived characteristics of the work environment on worker attitudes were investigated by Newman (1975). He conceptualized the work environment as having six general aspects: tasks, people, interpersonal relationships, organizational norms, physical setting, and opportunities-rewards-incentives. Newman reviewed existing work environment measures and found them to be lacking in two areas -- task characteristics and physical setting (work space) characteristics. Thus, he developed questions to tap perceptions of task characteristics (e.g., autonomy, variety, wholeness, feedback) and questions to assess perceptions of the work environment such as crowdedness, equipment-people arrangements, and privacy. Newman's research found that employees in distinct parts of "organizational space" (i.e., different places within the organizational chart) had varying perceptions of the work environment that

were associated with variations in their job attitudes. Furthermore, his results provided evidence supporting the importance of the interaction of people/personalities and the environment when investigating behavior in organizations.

Theorists may choose to look at behavior as a function of the "person," as a function of the "environment," or as a function of the "person-and-environment" system. Sociotechnical systems theorists and environmental psychologists argue in favor of this latter interactionist perspective (cf. Sells, 1963; Davis and Associates, 1986). However, many modern theories of behavior at work fail to consider the affects of the physical work environment on employees' behavior. They are predominantly psychological theories that concentrate on the person in isolation and miss the systemic interaction of the person-and-environment. The present research advocates the interactionist and systems perspectives and hopes to provide a rational for considering the physical work environment in psychological organization theory and a tool with which perceptions of several elements of the physical work environment can be measured.

Human Performance and the Physical Work Environment

If the physical work environment factors discussed above are important, two questions then arise; first, "To what are they related?", and second, "Do they affect productivity or performance?" The traditional variables of concern regarding the physical work environment and human performance are the environmental ambients (e.g., climate, noise, illumination). Although these topics are of immense practical value to engineers and designers, they have received virtually no attention in the industrial and organizational psychology

literature.

Human factors and ergonomic studies that have been conducted generally are inconclusive regarding the effects of environmental ambients on performance. For example, Kobrick and Fine (1983) reviewed 96 articles examining the effects of heat and cold on performance and concluded that generalizations about the effects of heat or cold on performance are almost impossible to make based on the available data. First, 42 of the 96 studies that they examined were found to be methodologically deficient (e.g., too few subjects, invalid design or inappropriate statistical analysis). Second, both improvements and decrements in performance were noted for similar exposure conditions, and there were numerous instances of unchanged performance reported as well. The effects of illumination at work were reviewed by Megaw and Bellamy (1983). After examining studies of reading, inspection, color judgment, glare, and visual fatigue, they stated that "... the standards of correct lighting practices are inadequate and this is reflected in the frequent complaints that refer to lighting as a cause of discomfort and annoyance" (p 138). They concluded, however, that lighting plays only a minor role in influencing performance and productivity. Michael and Bienvenue (1983) examined noise and its effects on speech and warning signals, cognitive task performance, annoyance, relaxation and sleep. From their review, it is clear that noise can produce hearing impairment; between 5 and 15 million U. S. workers are exposed to potentially hazardous noise. It is also clear that noise can interfere with speech and warning signal recognition. What is less clear and less well established, however, are the effects of noise on cognitive task performance. No consistent pattern of effects of noise on task performance has been delineated. Megaw and Bellamy (1983) concluded that the effects of noise on short-term task performance are not severe in most cases.

These studies illustrate that the physical surroundings (within the "normal" ranges encountered in U.S. business and industry today) frequently do not directly affect performance. However, considering the importance many employees attach to them, elements of the physical work environment might better be considered intervening variables about which people form opinions and attitudes, which in turn affect behavior. For example, Canter (1983) suggested that satisfaction, turnover, communication, symbolic identification, adaptability, growth, competence, and safety all may be aspects of organizational life that are related to, but not necessarily directly influenced by, the physical surroundings. At this time, there are virtually no available data on the topic.

With so little research having been done in this area, many questions remain to be answered. What does it mean to workers to have to work in dust and oil clouds as compared with environments where there are clean and open spaces, with ample eating and rest facilities? What do variations in the quality and nature of equipment, furnishings, floor and wall surfaces, and other environmental elements communicate to employees? Are workers' perceptions of different elements of the physical environment related to their levels of commitment to the organization, to their levels of job satisfaction, or to their intentions to leave the organization? None of these questions can now be answered definitively.

The Need to Develop a Human Factors Satisfaction Questionnaire (HFSQ)

Concurrent with this absence of theory and research is the paucity of measurement instruments that include adequate consideration of physical

working conditions (Carlopio, 1986a & b; Cook, Hepworth, Wall, & Warr 1981; Goodman & Argote, 1984; Wilson & Grey 1986). Some do exist. Cook et al. (1981) examined about 4000 articles in 15 major psychology and business journals (e.g., *Journal of Applied Psychology, Academy of Management Journal, Administrative Science Quarterly, Journal of Occupational Psychology*). The review provided detailed information regarding the 249 measures of work attitudes, values, and perceptions that were found. Cook et al. covered the period from 1974 to the middle of 1980. Of the 31 measures of "specific satisfactions" identified, six included some mention of the physical working conditions. In general, these measures are vague (i.e., generally refer to "working conditions"), simplistic (i.e., view the physical work environment simply in terms of worker comfort), and have few items (i.e., use from one to five items). These six measures are now discussed in more detail.

The Index of Organizational Reactions (Smith, Roberts, & Hulin, 1976) includes four questions regarding the amount of work and six questions about how the physical environment affects workers. The questions are general; the wording generally refers to "the physical working conditions." The Facet-Specific Job Satisfaction (Quinn & Staines, 1979) has only four relevant "comfort" items. They are concerned with the time to get the job done, the hours of work, the pleasantness of the physical surroundings, and the amount of work. The Existence, Relatedness and Growth Satisfaction Scale (Alderfer, 1972) is composed of 35 items in seven subscales (e.g., pay, respect, growth). The only relevant subscale, "physical danger," contains two items. The Minnesota Satisfaction Questionnaire (MSQ) (Weiss et al., 1967) uses only five items of the 100-item long-form questionnaire, and one item of the 20-item short-form, to assesses workers' perceptions of their working conditions. The Job Satisfaction Scale (Warr, Cook, & Wall, 1979) devotes only one of 15 items

to "satisfaction with the physical environment." The Morale Scales (Scott, 1967; Scott & Rowland, 1970) are 299 bipolar, semantic differential ratings of nine facets of morale (e.g., me at work, my job, my supervisor, my pay). The Moral Scales generate three main factors regarding the physical work environment: (1) function, (2) safety, and (3) attractiveness. Although this approach to possible facets of workers' perceptions of their work environment seems promising, it lacks specificity and did not yield consistent dimensions across the two studies.

The present author reviewed the last ten years (1980 - 1989) of nine journals (*Journal of Applied Psychology, Academy of Management Journal, Academy of Management Review, Human Factors, Ergonomics, Work and Environment, Environment and Behavior, Organization Dynamics,* and *American Psychologist*) searching for the most recent articles that had employed instruments related to physical working conditions or had included a consideration of physical working conditions. Eleven references were identified, nine of which will be discussed below while the work done by Newman and by Oldham and associates was discussed previously. Two types of measures were found. The first type were observational tools used by job analysts. These tools are much more comprehensive in scope of coverage than the questionnaires reviewed by Cook et al. (1981). The Position Analysis Questionnaire (PAQ) (McCormick, Jeanneret, & Mecham, 1972) and the Job Structure Profile (JSP) (Patrick & Moore, 1985) consider the physical working conditions, work scheduling, general body activities and postures, and the use of physical devices. Similarly, Campion and Thayer (1985) have developed the Multimethod Job Design Questionnaire (MJDQ). The MJDQ considers the following methods: (1) motivational (e.g., autonomy, feedback, promotion, pay adequacy), (2) mechanistic (e.g., task and skill simplification and fractionalization, motion

economy), (3) biological (e.g., anthropomorphic and work environment ambients), and (4) perceptual and motor (e.g., physical work place, control, and cognitive) variables. Although these instruments address many important physical work environment variables, they are mainly observational tools used by job analysts to reflect their perceptions of the physical work environment. They do not reflect job incumbents' perceptions of, or attitudes toward, the physical work environment.

The second group of measures identified are questionnaires designed to examine employees' perceptions of various elements of their physical environment at work. Unfortunately, they suffer from the same shortcomings as those reviewed by Cook et al. (1981). Portigal (1976) identified a comfort scale that added to predictions of job satisfaction. This scale contains seven relevant items assessing perceptions of hours, schedule, overtime, dangerous or unhealthy working conditions, having enough time to do the job, pleasantness and comfort of the physical conditions, and working too fast or too hard. The Work Environment Scale (WES) (Insel & Moos, 1974; Moos, 1986) was designed to measure the social environment of hospital work settings. One of the 10 WES subscales is "physical comfort." Questionnaire items are concerned with temperature, lighting, space, appearance, furniture, and ventilation. Adler, Skov and Salvemini (1985) looked at job and task characteristics. They used two standard instruments, the Job Diagnostic Survey (JDS) (Hackman & Oldham, 1980) and the Job Descriptive Index (JDI) (Smith, Kendal, & Hulin, 1969). Additionally, they examined five characteristics (performance level, performance satisfaction, pay equity, physical environment, and time provided for the task) not measured by the JDS or JDI. The physical environment scale has only "four items concerning the appropriateness of the room in which the group met, the seating assignment of the group, the amount of light in the

room, and the size of the room for performing the task" (p. 272-273).

Manhardt (1972) had 666 college graduates from a life insurance company rate the importance of 25 typical job characteristics. Factor analysis revealed 21 items that loaded .40 or above on one of the rotated factors. "Advancement" and "supervising others" led the first factor, "work conditions" and "work routine/variety" led the second, and "using own methods" and "intellectually stimulating" led the third. Bartol and Manhardt (1979) used the same 25 items as Manhardt (1972) and gave them to 648 newly hired personnel in a major insurance company. She found three similar factors: the first, now labeled "long-term career objectives" (advancement and responsibility); the second, "working environment and interpersonal relationships" (working conditions and associates); and the third, "intrinsic job aspects" (creativity and intellectual stimulation). Unfortunately, "working conditions" were represented as a single item regarding the importance of comfortable working conditions. Berkowitz, Fraser, Treasure and Cochran (1987) asked 92 questions, mostly concerned with respondents' perceptions of and attitudes toward work and income. Eight factors were generated: social comparison frequency, intrinsic job satisfaction, current inequity, total household income, non-pay economic benefits, satisfaction with work environment and coworkers, future equity, and quality of life. The "satisfaction with the work environment" factor was comprised of two items: (1) pleasantness of coworkers and (2) pleasantness of the physical surroundings. Popp and Belohav (1982) used a measure of job satisfaction with an "over-all" question and several facet items: for example, amount of work, pay, supervision, working conditions, coworkers, equipment, treatment of absenteeism by supervisors. Working conditions were measured with a single, five-point, Likert-type satisfaction item. In general, the questionnaires described above

either resulted from simple conceptualizations of the physical work environment (in terms of general pleasantness or comfort), have few items to examine the dimensions, or were not developed for use in both office and manufacturing settings (e.g., the WES).

Considering the inadequacies of the above assessment instruments, the development of the Human Factor Satisfaction Questionnaire (HFSQ) was begun in 1986 (Carlopio, 1986a). Several criteria were considered important during its conception: the HFSQ (1) was to be quick and easy to use, (2) was to be written in plain, understandable language, and (3) was to tap the major components of the physical environment at work.

The human factors/ergonomics conceptualization of the physical work environment typically considered environmental ambients (e.g., climate, noise, illumination), work schedules and assignments, dimensioning and arrangement (e.g., seating, work surfaces), workload and postures, and hazards and safety issues (Huchingson, 1981; Salvendy, 1987; Woodson, 1981). Human factors/ergonomic theories are too frequently overlooked by industrial and organizational psychologists because of their technical and engineering nature. The physical environment ambients, workload and system characteristics, and health and safety issues were included in the HFSQ because of their centrality to many conceptualizations of the physical work environment.

Portigal (1976), Moos (Insel & Moos, 1974; Moos, 1986), and Adler, Skov and Salvemini (1985) all considered similar "facets" of the physical work environment. Plant facilities have almost totally been neglected in the literature (Canter, 1983). Because of the inherently social nature of most activities that take place in plant facilities (e.g., talking during lunch and breaks), plant facilities were considered likely to be related to attitudes and social behavior. This facet, therefore, was included. Equipment design was

included because it was considered essential to task performance and is one of the major points of interaction between the individual and the physical environment.

The HFSQ currently is a self-report questionnaire designed to enable the measurement of people's perceptions of their physical work environment. The HFSQ addresses workers' satisfaction with the following areas: design of the physical environment (e.g., lighting, air quality, work surfaces); plant facilities (e.g., restrooms, recreation and eating facilities' cleanliness, pleasantness and size); workload and work system characteristics (e.g., information availability and work pace); equipment design (i.e., machines, tools, and materials); and health and safety (e.g., training, hazard exposure, and control).

Initial Development of the HFSQ

According to Anastasi (1986), basic steps for test development include (1) formulation of construct(s), (2) item preparation for the construct(s), (3) empirical item analysis, (4) factor analysis or other appropriate internal analyses, and (5) validation and cross-validation. She also maintains that information gathered during the developmental process of a test that increases our understanding of what the test measures is relevant to its validity. Therefore, internal consistency reliability as well as normative data are important (Anastasi, 1986).

Several different scale development strategies are discussed and compared by Hase and Goldberg (1967). When using a factor analytic strategy, one administers items to a large number of subjects. The internal structure of the initial item pool determines selection. An empirical strategy attempts to align scales with some external criterion. For example, the test may be given to two

distinct groups that are considered to differ on the trait being measured or that fail at opposite ends of the continuum of the trait. The intuitive-theoretical strategy uses formal psychological theory to guide test construction. In the intuitive-rational strategy (1) the investigator has some dimensions or traits in mind, (2) items are created that are believed to be related to the dimensions, and (3) the scales are refined by selecting items with high internal consistency (e.g., highest item-total correlations after initial administration). Hase and Goldberg (1967) found that all four scale development strategies were equivalent in their validity across 13 diverse criteria.

A human factors/ergonomic conceptualization of the physical work environment provided dimensions from which to derive scale items. The intuitive-rational strategy, therefore, was employed in the initial development of the HFSQ. Six dimensions were identified that were related to individual-level, physical environment issues. One hundred and ten items were generated that were thought to tap these dimensions. The dimensions were: (1) environmental design/ambients, (2) plant facilities, (3) workload characteristics, (4) work systems design, (5) equipment design, and (6) health and safety. In order to assess the face validity of the items and scales a "retranslation process" was employed. Three judges were asked to match the items to the proposed dimensions. The items generated for the environmental design/ambients, plant facilities, equipment design, and health and safety dimensions were successfully matched with the scales. The items generated for the workload characteristics and systems design dimensions, however, were not distinguished. They were, therefore, combined into a single workload/system characteristics dimension. The initial administration of the scales was conducted with 229 undergraduate students in March 1986. High internal consistency estimates (coefficient alpha) were obtained. They ranged from .89 (environmental design) to .95 (health and

safety), with the overall scale reliability being .97. The item-total correlations were examined and used in an attempt to reduce the number of items per scale, while preserving the internal consistency reliability estimates. The original pool of 110 items was reduced to 42. The items and scales are shown in Figure 1.

The 42-item HFSQ was administered to 60 men (in three groups) employed as optical technicians. These men worked in a single room (7100 square feet) containing over 100 machines and machine banks performing the operations necessary for the production of prescription eyeglasses (e.g., edging, blocking, scoping, mounting, grinding, inspection). The results of this administration again showed adequate internal consistency estimates for the HFSQ, ranging from .74 (facilities) to .87 (equipment design) for the subscales, and .89 overall.

Owing to the success of the initial administration of the HFSQ and the results from the manufacturing sample, the HFSQ was considered sufficiently reliable to warrant its comparison to several other related measures. The HFSQ was sent via internal mail to 129 employees of a contract research and consulting firm. Following the HFSQ in the questionnaire packet were the short form of the Minnesota Satisfaction Questionnaire (MSQ) and the MSQ working conditions subscale (Weiss et al., 1967), the Organization Commitment Questionnaire (OCQ) (Mowday, Porter, & Steers, 1982), and three questions assessing intent-to-turnover. The HFSQ again exhibited high internal consistency estimates for the subscales ranging from .71 (environmental design) to .93 (equipment design) and .94 overall.[1]

[1]These high reliability figures could suggest potential method bias and the need for examining the discriminant validity of the scales. This is discussed in the next section.

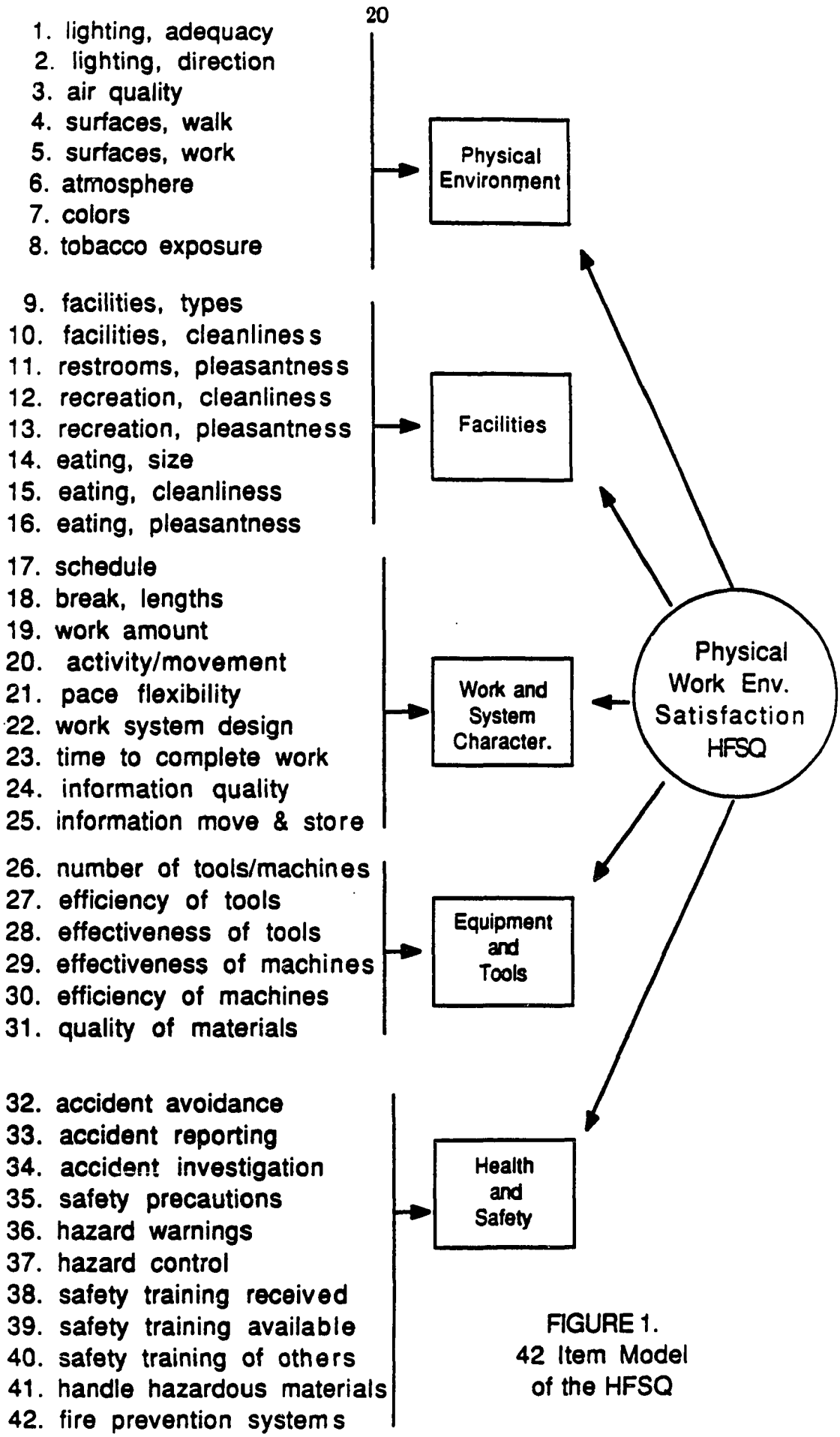

FIGURE 1.
42 Item Model
of the HFSQ

Comparisons of the HFSQ with other scales were also possible. High correlations between the HFSQ and theoretically similar or related measures would provide initial evidence of its convergent validity. Correlations between the HFSQ and the MSQ revealed it to be significantly related to both the MSQ short-form (r= .648)[2] and the MSQ working conditions subscale (r= .759). Further evidence of the validity of the HFSQ was illustrated by correlations between the HFSQ and the OCQ (r= .542) as well as the HFSQ and the intent to turnover measure (r= -.447).

Although the HFSQ seems to be consistently reliable, and comparisons of the HFSQ, MSQ, OCQ, and intent-to-turnover scales revealed relationships that make basic theoretical sense, no other evidence of the validity of the HFSQ has systematically been generated. The next step in the development of the HFSQ, therefore, requires the conduct of a study designed to address the issue of its validity. The following section outlines a strategy designed to examine the validity of the HFSQ.

Validation Strategies

Definitions of Validity

There are many definitions and conceptualizations of validity and its various forms.

1. Criterion-related validity is at issue when an instrument's purpose is to estimate some important form of behavior that is external to the measurement instrument itself (i.e., the criterion) (Nunnally, 1978, p. 87).

    a. Predictive validity is demonstrated by the ability of the questionnaire to predict a criterion at some future point in

[2]All correlations here reported are significant, $p < .05$.

time (Nunnally, 1978; Weiss, Dawis, England & Lofquist, 1964).

b. Concurrent validity is demonstrated by the relationship of the dimensions of a questionnaire to a criterion that is measured at the same time as the questionnaire measurements were taken. (Nunnally, 1978; Weiss et al., 1964).

2. Content validity depends primarily on the adequacy with which a specified domain of content is sampled (Nunnally, 1978). A demonstration that the items in a questionnaire sample the dimensions that the questionnaire is presumably measuring would provide evidence of its content validity (Weiss et al., 1964).

3. Construct validity is the degree to which a set of measurement operations measures hypothesized constructs (Ghiselli, Campbell & Zedeck, 1981). Construct validity is demonstrated by the ability of the questionnaire to support predictions made from a theoretical framework (Weiss et al., 1964). Construct validity is based on the degree of convergent validity and discriminant validity (Campbell & Fisk, 1959; Ghiselli et al., 1981). Convergent validity is shown by correlations among measures of the same or similar constructs. Discriminant validity is shown by no or little correlation with unrelated constructs. Construct validity may also be investigated by examining group differences. Cronbach and Meehl (1955) state that "if our understanding of a construct leads us to expect two groups to differ on the test, this expectation may be tested directly" (p 286).

Validity and the HFSQ

The content validity of the HFSQ can be inferred from repeated demonstrations of its internal consistency reliability (Weiss et al., 1964) and the retranslation process mentioned earlier.

The criterion-related validities of the HFSQ can be demonstrated by "predicting" some criterion collected at the same time (concurrent validity) or at a future time (predictive validity). If HFSQ scores were found to predict future turnover, absenteeism levels, or future health and safety problems, for

example, this would demonstrate the HFSQ's predictive validity. The HFSQ's ability to predict employees' current absenteeism levels, for example, would provide evidence of its concurrent validity. Because of practical considerations (e.g., the additional effort and "time-lag" inherent when collecting turnover data and plants' unwillingness to give me access to information), however, data concerning the criterion-related validities of the HFSQ were not collected at this time.

The construct validity of the HFSQ can be demonstrated in several ways: (1) by its convergent and discriminant validities, (2) by its ability to reflect group differences across respondents that work in distinct physical work environments, and (3) by its ability to support predictions made from a theoretical framework. Construct-valid scales converge more with (i.e., are more strongly related to) similar measures of the same constructs than with measures of substantively different constructs. The choice of the scales for discriminant and convergent validity was based on the expectation that HFSQ scores would reflect people's satisfaction with their objective physical work environment. That is to say, it was expected that the major construct underlying the HFSQ was that of "respondents' reactions to their objective physical work environments." Therefore, it was hypothesised that HFSQ scores would correlate more strongly with other physical work environment-related measures (i.e., the MSQ working conditions subscale and Oldham's 1988 measures of perceived crowding, task privacy, and communication privacy) than with measures of constructs such as the Participation in Goal-Setting (PGS) and Feedback on Goal Effort (FdBk) measures from Steers (1973), and the facet-specific subscales from the Job Descriptive Index (JDI; Smith, Kendall, & Hulin, 1969).

Additional evidence of the construct validity of the HFSQ would be

provided if respondents who worked in distinctly different physical work environments reported significantly different HFSQ scores.

Further evidence of the construct validity of the HFSQ would be provided if respondents' scores truly represented a construct that was related in hypothesized ways to constructs that have established relations in the literature such as job satisfaction, organization commitment, and turnover propensity (i.e., intention to turnover). A model illustrating the relationship among these variables will be discussed next.

A Model of Job Satisfaction, Organization Commitment, and Turnover Intention

One of the most robust findings in the literature is that of commitment being causally related and antecedent to intent to turnover (Steers, 1977; Kotch & Steers, 1978; Bluedorn, 1982; Michaels & Spector, 1982; Williams & Haser, 1986; Meyer, Paunonen, Gellathy, Goffin, & Jackson, 1989). This is not surprising since intent to turnover is an underlying dimension of the commitment concept. The literature is less clear regarding where job satisfaction fits into the model. Although most of the data point toward job satisfaction as a causal factor of commitment (Bluedorn, 1982; Reichers, 1985; Williams & Haser, 1986), there is at least one study that showed the reverse relationship to be significant (Bateman & Strasser, 1984) and three that showed no significant causal relation between the two constructs (Bluedorn, 1982; Michaels & Spector, 1982; Curry, Wakefield, Price & Mueller, 1986). A reason for this may be that job satisfaction is measured by any one of a number of different scales that could include from one to one-hundred items. Also, job satisfaction is considered to be "general" or "over-all," in which case questions are asked regarding the employees' job and their satisfaction "in general" or

"over-all." Job satisfaction may also be considered to be "facet-specific" and derived from the summation of any number of different facets such as pay, supervision, coworkers, the work itself, and promotion. These two measurement strategies of job satisfaction have been shown to be non-equivalent (Brayfield, Wells, & Strate, 1957), although they are used interchangeably in the literature. In spite of these problems, the overwhelming evidence points toward job satisfaction as a cause of commitment. Therefore, the proposed model specifies that job satisfaction is causally related and antecedent to commitment, that in turn is causally related to turnover intention (please see Figure 2, pg. 34). Further, it is expected that respondents' HFSQ scores will reflect a portion of the Job Satisfaction construct and will be consistent with, and a contribution to, this model.

Study Design and Hypotheses

The construct validity of the HFSQ was first examined by collecting evidence of both the convergent validity and the discriminant validity of the HFSQ. Convergent validity was assessed by comparing the HFSQ scores to the MSQ Work Environment subscale and Oldham's (1988) measures of perceived crowding, task privacy, and communication privacy. Discriminant validity was assessed by comparing the HFSQ scores to the "participation in goal-setting" (PGS) and "feedback in goal-effort" (FdBk) scales (Steers, 1973), and to the five, facet-specific JDI subscales (work, pay, promotion, coworkers, and supervision; this excludes the work in general subscale; Smith et al., 1969).

It was hypothesized that, H1a, the HFSQ total score and MSQ working conditions scale scores would be highly correlated; that, H1b, the HFSQ total score and the measures of perceived crowding, task privacy, and communication

privacy would be correlated; and that, H1c, these correlations would be larger than the correlations between the HFSQ total score and the measures to be considered for discriminant validity. These findings would provide evidence of the HFSQ's convergent validity.

It was also hypothesized that, H2a, the HFSQ total score and PGS scale scores would not be significantly correlated; that, H2b, the HFSQ total score and FdBk scale scores would not be significantly correlated; that, H2c, the HFSQ total score and the JDI subscales would not be significantly correlated; and that, H2d, these correlations would be smaller than the correlations between the HFSQ total score and the measures considered above for convergent validity. These findings would provide evidence of the HFSQ's discriminant validity.

Construct validity would also be assessed by comparing the HFSQ total score, as a measure of job satisfaction, to "established" measures of job satisfaction (i.e., the JDI & MSQ) and to measures of intention to turnover and organization commitment in a test of the model illustrated in Figure 2.

The diagram in Figure 2 is a structural equation model based on the hypothesized relationships between the constructs of job satisfaction, organization commitment, and turnover intention found in, and supported by, the literature. The concepts and relationships of theoretical interest are depicted in the model. The latent variables (i.e., postulated psychological constructs) are within the circles. A one-way arrow between the circles represents a hypothesized causal, directional relationship. A bi-directional arrow (seen in Figure 7) represents a hypothesized non-causal association (i.e., correlation) between variables. This constitutes the structural portion of the model. The measurement portion of the model consists of the indicators or measures (within the boxes) and their hypothesized linkages to the related

underlying constructs. The Greek letters in the models correspond to the entries in the matrices of the general structural equation model used by the LISREL analysis program for the analysis of the models.

As further evidence of the HFSQ's construct validity, it was expected that, H3a, the HFSQ would be a significant contributer to the model (see Figure 2), and that, H3b, the model would "fit" better with the HFSQ (i.e., correspond better to the relationships found in the data) than without it. Simultaneous estimations of the predictive contributions of the various elements of the "full" model in Figure 2 were examined. Additionally, an examination of the measurement model addressing the question of how well the measurement instruments/questionnaires (i.e., the MSQ, JDI, & HFSQ) measured the hypothesized psychological construct (i.e., satisfaction). Several measurement models were examined. The examination of these models provides further evidence of the construct validity of the HFSQ.

Additional evidence of the construct validity of the HFSQ would be provided if the HFSQ's ability to distinguish between respondents who worked in physical environments that vary along the dimensions covered by the HFSQ could be demonstrated. Therefore, it was expected (Hypothesis 4) that groups of people who work in distinct physical environments would report significantly different HFSQ scores.

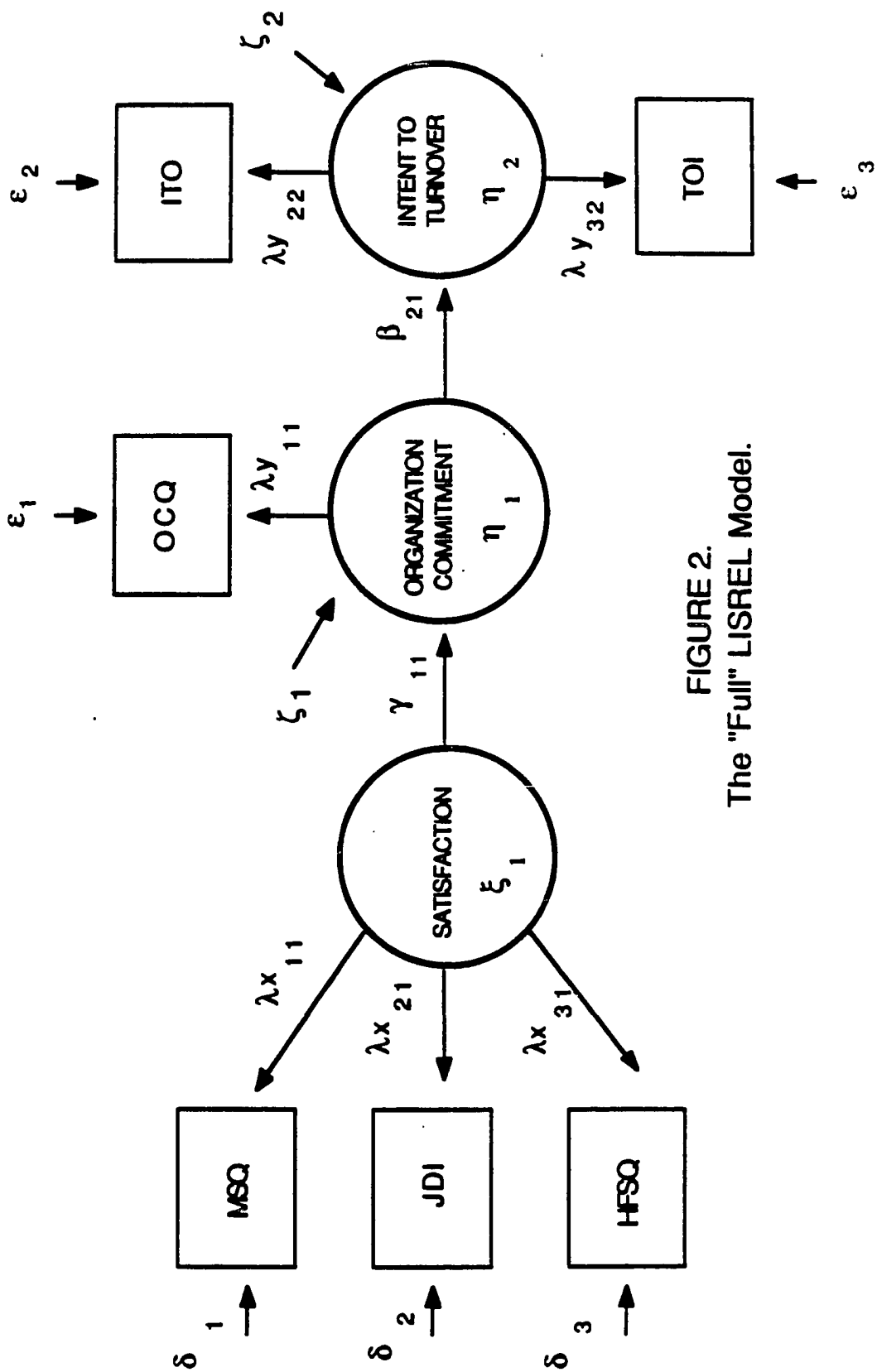

FIGURE 2.
The "Full" LISREL Model.

Chapter Two
Method

Sample

The sample consisted of 641 respondents from eight firms (please see Table 1). Five of the eight firms were durable goods manufacturers or suppliers to that industry, one was a manufacturer of medical filtration devices, one a computer systems developer and assembler, and one the administrative and systems planning divisions of an international transportation organization. The mean age of respondents was 38 years, with a mean job tenure of 9 years[3]. Approximately 89% were in non-supervisory positions, 62% in blue collar jobs, and 58% male.

Table 1
Sample Demographics by Organization.

Demographic Variables	Organization 1	2	3	4	5	6	7	8	Tot
Total N	84	52	94	91	73	59	67	115	641
Supervisor	0	2	6	16	23	9	9	2	67
Non-sup.	82	52	86	64	37	42	52	104	519
Female	14	2	84	37	34	2	4	62	239
Male	69	52	9	42	26	47	53	39	337
Blue Collar	84	50	88	12	0	34	36	95	399
White Collar	0	2	6	79	73	25	31	20	242
Mean Tenure	22.1	20.0	5.6	8.8	2.3	4.6	9.1	4.6	9.0
Mean Age	44.7	50.9	34.4	37.2	33.5	35.7	36.8	31.3	38.0

[3]The age distribution was symmetrical, while the tenure distribution was highly negatively skewed with a median of 4 years and a mode of 3 years.

Cohen and Cohen (1975) suggest that a convention for minimally adequate estimates of experimental power (i.e., the ability to detect "real" differences if they exist) should be .80. Here, with $\alpha = .05$, eight independent variables, and over 600 subjects, power (in the case of multiple correlations) is estimated to be over .95.

Procedures

Organizations were contacted from a list of available sites generated by the Industrial Technology Institute's Status Report on Great Lakes Manufacturing (Wiarda, 1987) and from personal contacts of the author. A firm was randomly chosen from the list and contacted. The purpose of the study was explained and their participation was requested. If the firm declined to participate, they were removed from the list and a new name was randomly chosen. If the organization agreed to participate, the author then ascertained the likely number of available subjects and arranged meetings, plant visits and evaluations, and questionnaire administration dates. Both blue-collar and white-collar employees were included in the sample.

Distinguishing Among Distinct Physical Work Environments

An assessment was made regarding whether different groups of employees shared the same physical work environment. Four distinct types of physical work environments were represented in the sample (please see Table 2): (1) office environments, either traditional walled offices or more "open" offices/cubes with partitions; (2) industrial clean rooms, where employees worked in "controlled" environments and were required to wear hair and shoe coverings, and protective lab coats; (3) assembly environments, industrial environments where employees were assembling parts and machinery; and (4)

machining environments, industrial environments where employees performed drilling, milling, lathe, or other machining tasks.

Table 2
Sample Sizes of Environmental Types by Organization.

Environmental Type	Organization 1	2	3	4	5	6	7	8	Tot
Office	0	6	0	63	73	16	22	18	198
Industrial Clean Room	6	0	0	0	0	0	0	10	16
Industrial Assembly	41	0	57	15	0	10	23	71	217
Industrial Machining	37	46	36	0	0	16	21	0	156

Questionnaire Administration Procedures

The questionnaire (see Appendix A) was administered to groups of employees who were gathered in meeting, lunch, or conference rooms. The following instructions were given to all groups:

> Thank you for participating in this study that is designed to test the adequacy and usefulness of a new questionnaire. The Human Factors Satisfaction Questionnaire is designed to assess how satisfied you are with several different aspects of your physical work environment. Your individual responses will be kept totally confidential. This is the first questionnaire you will see in the packet. It is followed by additional questionnaires that look at how satisfied you are with your work in general and how committed you are to this organization. Your answers to these questionnaires will be used to evaluate the first questionnaire.
>
> Please answer all the questions directly on the questionnaire sheets.
>
> Please remember, your responses will be kept totally confidential. You do not have to put your name anywhere on these sheets. If you have any questions, please let me know. Please read and follow all the directions on the forms. When you are done, please hand the

packet in to me on your way out.

Thank you.

The questionnaire packets and pencils were distributed. Employees were instructed to determine in which of the plant's physical environments they most frequently worked. This information was coded on the questionnaires along with job tenure, status, supervisor, gender, and age information (These data were used for initial normative establishment and are displayed in Appendix B).

Measures

The Job Descriptive Index (Smith, Kendall, & Hulin, 1969) is a widely used measure of job satisfaction designed to measure six facets (a sixth facet was added in the 1985 update of the JDI) of satisfaction. The facets are: work on present job (work itself), supervision (sup), present pay (pay), opportunities for promotion (promo), coworkers (cowk), job in general (gen).

The Minnesota Satisfaction Questionnaire (Weiss et al., 1967) is another popular measure of job satisfaction. The MSQ 20 question short-form and the 5 item MSQ work environment subscale were used.

The Participation in Goal Setting (PGS) and Feedback in Goal Effort (FdBk) scales from Steers (1973) were used. The four item PGS scale measures the level of influence and control employees perceive they have over their work objectives and goals. The four item FdBk scale assesses the amount of feedback and guidance employees receive regarding the quality and quantity of their work.

The Perceived Crowding (PC), Task Privacy (TP), and Communications Privacy (CP) scales were used. Oldham (1988) developed these three-item measures to assess the degree to which employees feel crowded (PC), the degree

to which employees can focus attention on their work (TP), and the degree to which employees can hold personal and private conversations with coworkers (CP).

The Organizational Commitment Questionnaire (Mowday et al., 1982) is a 15-item measure of the strength of an individual's identification with, and involvement in an organization. Organizational commitment is considered to be a more stable construct (less variation day-to-day), and a more global construct as compared to job satisfaction (Cook et al., 1981).

Two measures of propensity to turnover were used. A four-item measure (here named Turnover Intentions or TOI) addressing employees' thinking of quitting, probability of finding an acceptable alternative, intention to search, and intention to quit was used. The measure is based on Mobley's model of the intermediate linkages in the turnover decision process (Mobley, 1977; Mobley, Horner, & Hollingsworth, 1978). Another four-item measure (Intention to Turnover or ITO) was developed for this study. It is similar to the Mobley-based measure. The ITO measure addresses employees' desire to leave the company, their interest in finding another job, and additionally asks about their desire to transfer to another department, and to another job within their current department.

Chapter Three
Results

Since the data were collected from respondents in eight different organizations, possible mean differences in the data due to respondents' organization had to be explored. The HFSQ subscales and total score were computed and an analysis of variance was conducted on these scores looking for mean differences across organizations. A significant difference was found on all six variables. Therefore, in order to combine these data across the eight organizations, these mean differences had to be accounted for, or controlled. The raw scores for each subjects' data within each organization were converted into Z scores (also known as standardized scores). This transformed the distribution of scores within each organization to one having a mean of 0 and a standard deviation of 1, thus eliminating the mean differences across the organizations. The data were then combined across all eight organizations and the scale scores were computed using the Z scores. All further analyses were conducted on either the standardized scores or on the scales created from these standardized scores.

Before proceeding to test the research hypotheses, factor analysis was conducted to examine the factor structure of the HFSQ. Principal-components analysis was conducted with Varimax rotation on the total sample of 641 subjects with list-wise deletion of missing data dropping the number of subjects to 547[4]. The results of this analysis are shown in Table 3. The first factor accounted for 29.9% of the variance, the second for 6.9%, the third for 6.1%, the fourth for 5.1%, and the fifth for 4.3%, for a total of 52.3%.

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[4]The reported factor solution is the result of forcing a five-factor solution. When the number of factors was left open, the program generated a nine-factor solution, the first five of which were the five proposed factors.

Table 3
Factor Analysis of the 42 Item HFSQ.

Item #	FACTOR 1 Health & Safety	FACTOR 2 Work & Systems	FACTOR 3 Environment Design	FACTOR 4 Equipment & Tools	FACTOR 5 Facilities
1	.150	.064	.726	.144	-.058
2	.264	.131	.488	.107	.116
3	.120	.162	.560	.079	.083
4	.183	.093	.686	.171	-.024
5	.108	.293	.571	.122	.144
6	.141	.328	.607	.107	.158
7	.226	.207	.433	.187	.155
8	.149	.050	.373	-.004	.190
9	.120	.145	.499	.084	.298
10	.138	.213	.494	.264	.340
11	.090	.207	.350	.069	.435
12	.198	.080	.184	.090	.649
13	.257	.087	.200	.062	.635
14	.081	.100	.041	.062	.737
15	.070	.048	.131	.092	.802
16	.143	.085	.061	.071	.803
17	.101	.617	.089	.038	.195
18	.225	.441	.034	.117	.236
19	.104	.712	.221	.020	.047
20	.146	.687	.183	.081	.004
21	.183	.598	.186	.155	.009
22	.161	.628	.260	.215	.063
23	.084	.691	.147	.144	-.013
24	.281	.526	.084	.171	.142
25	.276	.508	.134	.190	.173
26	.200	.231	.156	.684	.100
27	.118	.077	.242	.760	.063
28	.143	.057	.230	.770	.070
29	.182	.201	.064	.829	.129
30	.175	.230	.073	.805	.106
31	.174	.371	.178	.450	.044
32	.570	.200	.270	.095	.138
33	.659	.222	.273	.070	.165
34	.740	.192	.193	.111	.033
35	.769	.179	.099	.096	.133
36	.755	.162	.222	.123	.062
37	.793	.134	.130	.096	.146
38	.690	.150	.152	.093	.111
39	.759	.151	.091	.153	.091
40	.676	.119	.085	.094	.083
41	.697	.133	.075	.135	.109
42	.540	.030	.213	.168	.147
Eigen-values	12.57	2.91	2.58	2.14	1.79

Seven of the 42 items fell below a .5 factor loading cut off. Two of those five were item 9 (.499) and item 10 (.494) which seem to load on the Environmental Design factor, rather than as predicted on the Facilities dimension. I chose to keep these two items and decided to drop the remaining five items (i.e., items 7, 8, 11, 18, and 31) whose loadings were .433, .373, .350, .441, and .450 on the predicted factors.

Table 4 shows the factor loadings for the final 37 variables used for all further analyses. All factor loadings are above .5 except items 9 and 10. There are no variables which load on more than one factor. Figure 3 illustrates the model of the final version of the HFSQ.

The scale reliabilities (Cronbach's Alpha) for the HFSQ total and five subscales, along with each of the scales used in the analyses to follow, are listed in Table 5. The reliability estimate for the total HFSQ is .94. The reliabilities for the five subscales range from .82 (for environmental design) to .92 (for health and safety). The reliability estimates of all other scales are good, ranging from .90, for the MSQ short-form, to .46, for the three-item communications privacy scale.

Hypothesis 1 states that (a) the HFSQ and MSQ working conditions scale scores will be highly correlated, (b) the HFSQ and the measures of perceived crowding, task privacy, and communication privacy will be correlated, and that (c) these correlations will be larger than the correlations between the HFSQ and the measures to be considered for discriminant validity. The correlations between the HFSQ subscales and total and the measures used for convergent and discriminant validity are listed in Table 6. The correlation between the HFSQ total and MSQ working conditions subscale was high ($r = .70$) as

predicted. The correlations between the HFSQ total and the perceived crowding ($r = .29$), task privacy ($r = .22$), and communication privacy ($r = .24$) scales, although significant ($p < .01$), were much lower than expected.

Table 4
Factor Analysis of the 37 Item HFSQ.

Item #	FACTOR 1 Health & Safety	FACTOR 2 Work & Systems	FACTOR 3 Environment Design	FACTOR 4 Equipment & Tools	FACTOR 5 Facilities
1	.160	.060	.117	.761	-.033
2	.270	.119	.096	.502	.128
3	.116	.190	.080	.549	.105
4	.188	.081	.151	.719	.005
5	.115	.292	.108	.587	.171
6	.153	.337	.101	.580	.178
9	.145	.156	.097	.443	.292
10	.151	.219	.272	.470	.345
12	.200	.070	.092	.169	.657
13	.254	.081	.084	.194	.655
14	.075	.097	.059	.044	.753
15	.076	.051	.080	.127	.805
16	.148	.092	.059	.042	.809
17	.116	.614	.050	.068	.178
19	.109	.708	.028	.228	.038
20	.154	.684	.085	.182	.000
21	.186	.610	.163	.166	.010
22	.170	.634	.196	.251	.082
23	.093	.689	.132	.146	-.010
24	.287	.561	.156	.018	.145
25	.281	.540	.173	.088	.178
26	.199	.226	.686	.158	.099
27	.125	.099	.778	.221	.052
28	.150	.080	.785	.206	.059
29	.183	.195	.828	.077	.123
30	.181	.227	.804	.076	.099
32	.580	.204	.095	.249	.128
33	.665	.239	.077	.233	.156
34	.743	.191	.108	.187	.036
35	.770	.170	.105	.079	.133
36	.757	.149	.101	.233	.076
37	.795	.125	.101	.110	.145
38	.693	.132	.077	.151	.116
39	.760	.143	.161	.063	.088
40	.682	.127	.086	.062	.071
41	.702	.148	.133	.047	.094
42	.543	.021	.149	.217	.158
Eigen-values	11.42	2.83	2.48	2.12	1.71

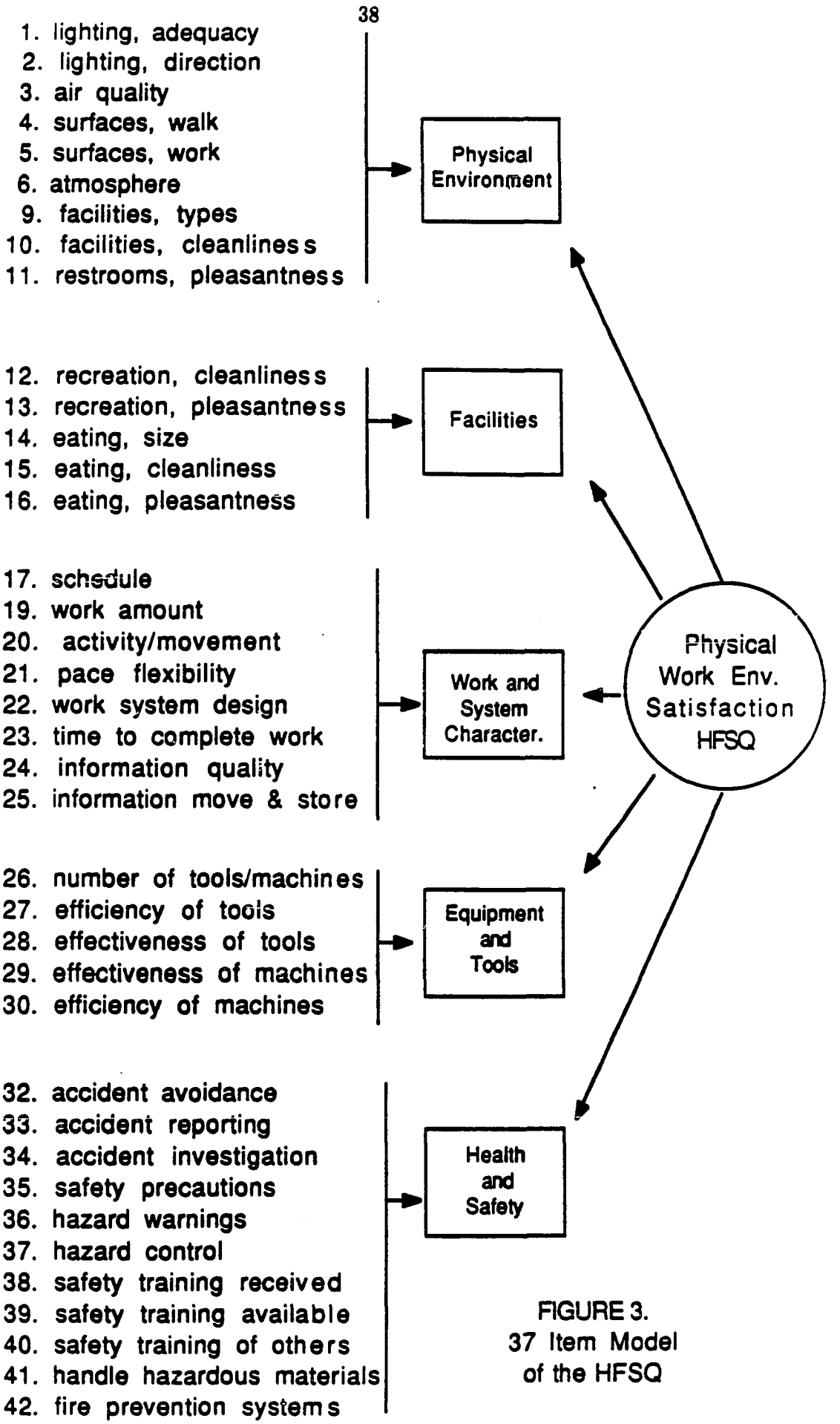

FIGURE 3.
37 Item Model
of the HFSQ

Table 5
Scale Reliabilities

Scale	N	# Items	Alpha
HFSQ Total (HFSQ)	548	37	.963
Environment (Env)	629	8	.819
Facilities (Fac)	583	5	.836
Work Char. (Wk&S)	620	8	.843
Equipment (Eqp)	628	5	.890
Health & Safety (H&S)	612	11	.924
MSQ-short form (MSQ-sf)	622	20	.904
MSQ-work subscale (MSQ-wk)	637	5	.863
JDI - 5 facets[a]	614	5	.744
JDI - 6 facets[b]	613	6	.800
Participation in Goal Setting (PGS)	627	4	.734
Feedback in Goal Effort (FdBk)	636	3	.675
Perceived Crowding (PC)	635	3	.816
Task Privacy (TP)	630	3	.499
Communications Privacy (CP)	630	3	.460
Organizational Commitment Questionnaire (OCQ)	612	15	.883
Turnover Intention (TOI)	627	4	.721
Intention to Turnover (ITO)	632	4	.759

a - The facets are pay, promotion, work, coworkers, supervision.
b - The "job in general" facet was added in the 1985 update.

Table 6
Scale Intercorrelations

Scales	HFSQ	Env	Fac	Wk&S	Eqp	H&S
MSQ-short form	.62	.49	.28	.61	.39	.50
MSQ-work subscale	.70	.71	.37	.53	.43	.55
JDI total	.55	.45	.28	.53	.33	.42
work	.43	.35	.22	.42	.28	.32
promotion	.38	.32	.22	.34	.19	.33
supervisor	.35	.27	.15	.41	.20	.28
coworkers	.31	.26	.16	.27	.22	.22
pay	.35	.32	.22	.31	.22	.24
general	.48	.38	.23	.50	.30	.36
Participation in Goal Setting	.33	.28	.12	.36	.19	.28
Feedback in Goal Effort	.30	.17	.16	.33	.15	.19
Perceived Crowding	.29	.26	.16	.27	.16	.20
Task Privacy	.22	.17	.09#	.23	.16	.16
Communications Privacy	.24	.21	.15	.26	.11	.18

N = 499
Correlations significant p < .01, one-tailed, unless noted.
# denotes nonsignificant correlation.

Hypothesis 2 states that (a) - the HFSQ and PGS scale scores will not be significantly related, that (b) the HFSQ and FdBk scale scores will not be significantly related, that (c) the HFSQ and the JDI pay, promotion, coworkers, and supervision subscales will not be significantly related, and that (d) these correlations will be smaller than the correlations between the HFSQ and the measures of convergent validity. The correlations between the HFSQ and the PGS ($r = .33$), FdBk ($r = .30$), and JDI pay ($r = .35$), promotion ($r = .38$), coworkers ($r = .31$), and supervision ($r = .35$) subscales, clearly do not

support this hypothesis. These constructs are all significantly related to the HFSQ and are more strongly related to it than the Perceived Crowding, Task Privacy, and Communications Privacy scales. It seems, then, that the HFSQ is more highly related to other satisfaction measures, regardless of content (i.e., MSQ & JDI), than to any non-satisfaction measures of the environment.

It was also hypothesized that (Hypothesis 3) (a) the HFSQ would be a significant contributer to the model (see Figure 2) illustrating the relationships between the satisfaction, commitment, and turnover intention constructs, and that (b) the model would "fit" better with the HFSQ in the model than without it. The LISREL 7 (Linear Structural Relationships) data analysis program (Joreskog & Sorbom, 1988) was employed to examine these hypotheses.

The LISREL 7 program is specifically designed to assess the fit of existing data with specified "models for latent variables and structural equation models for directly observed variables" (Joreskog & Sorbom, 1988, p. 3). There are three measures of overall fit between the model and the data that are provided as output: (1) a chi-square measure, (2) the goodness-of-fit index (GFI) and the adjusted goodness-of-fit index (AGFI), and (3) the root mean squared residual (RMR). The chi-square measure should be regarded "as a goodness (or badness)-of-fit measure in the same sense that large chi-square values correspond to a bad fit and small chi-square values to good fit. The degrees of freedom serve as a standard by which to judge whether chi-square is large or small" (Joreskog & Sorbom, 1988, p. 42). The GFI indices are comparisons of the minimum of the fit function after the model has been fitted (the numerator) with the fit function before any model has been fitted (the denominator). The GFI adjusted for degrees of freedom is the adjusted goodness-of-fit index (AGFI). "This corresponds to using mean squares instead of total sums of squares in the numerator and denominator of 1 - GFI" (Joreskog & Sorbom,

1988, p. 43). Unlike the chi-square measure, the goodness-of-fit indices are independent of sample size and robust against departures from normality. The values of these indices should be between zero and one. Their statistical distribution is unknown, however, even under idealized assumptions. Therefore, there is no standard with which to compare it (Joreskog & Sorbom, 1988). According to Bentler & Bonett (1980), however, models that produce overall fit indices with values of less than .90 can usually be substantially improved. Therefore, GFI and AGFI values of greater than .90 can be considered indicators of good fit (Bagozzi & Yi, 1988). The root mean squared residual is a measure of the average of the fitted residuals and can only be interpreted in relation to the sizes of the observed variances and covariances in the sample covariance matrix (Joreskog & Sorbom, 1988, p. 43). This measure is frequently used to compare the fit of different models to the same data. According to Bagozzi and Yi (1988), RMR values need to be "low," (< 0.1) to be considered evidence of good fit between the model and the data.

A fourth measure of goodness-of-fit is the number of cases necessary for the fitted residuals to be considered statistically significant. Hoelter's (1983) critical number (critical N or CN) of cases considers the chi-square value, the degrees of freedom, and is additionally sensitive to sample size[5]. The CN calculations produce a value corresponding to the number of cases necessary for the residuals to be significant. Therefore, the higher the CN, the smaller the residuals, and the better the fit of the model to the data. Hoelter (1983, p. 331) suggested that calculated CNs with values greater than 200 (per group being

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[5]The greatest value of this goodness-of-fit index is that it is sensitive to sample size. According to Hoelter (1983, p. 330), "...one may obtain a chi-square/df of 12 for a particular model and set of data when examining a sample of 3000 respondents. When considering an identical model (and an identical observed covariance structure) with a sample size of 300, however, the chi-square/df yielded would be 1.2. Thus, one would reject the model when N=3000, while retaining the same model ... when N=300."

analyzed), are evidence of good fit. It is important to remember that these indices are measures of the overall fit of the model to the data. They do not express the quality or practical importance of the model judged by any other internal or external criteria (Bentler & Bonett, 1980; Joreskog & Sorbom, 1988).

The LISREL 7 program allowed the examination of the question "how well do the measurement instruments/questionnaires measure the hypothesized psychological construct" (i.e., satisfaction). Several measurement models were examined. First, the model in Figure 4 was examined. This model shows the five JDI facets, the five HFSQ facets, and the MSQ-sf all loading on a single Job Satisfaction construct. This model did not fit the data well: AGFI = .65, RMR = .067, chi square/df = 6.36, and CN = 113. An alternative measurement model for Job Satisfaction (see Figure 5) shows the five JDI facets loading on one JDI-Job Satisfaction construct, the five HFSQ facets loading on one HFSQ-Job Satisfaction construct, and the MSQ-sf loading on one MSQ-Job Satisfaction construct. This model fits the data well and suggests that the three measures of Job Satisfaction are distinct: AGFI = .91, RMR = .035, chi square/df = 2.11, CN = 344. In order to explore the relationship between these three measures, a second-order factor analysis was conducted. This analysis explores the possibility that although the 11 facets do not all load on to a single Job Satisfaction construct (as seen in Figure 4), the three constructs which are formed by the 11 facets (as seen in Figure 5) might all load on the Job Satisfaction construct. This model (see Figure 6) fits the data well and shows that there is a construct which accounts for the variance in common across the three Satisfaction sub-constructs: AGFI = .91, RMR = .035, chi square/df = 2.11, CN = 344.

Similar results are obtained when traditional principle components factor analysis is conducted on the HFSQ, JDI and MSQ total scores. This analysis

produced a one factor solution accounting for 76.1% of the variance. The factor loadings are listed in Table 7.

Figure 7 illustrated the following related questions: Do the hypothesized factors of the HFSQ measure what is being proposed as "physical work environment satisfaction?" Similarly, "do the five JDI subscales measure 'non-physical work environment satisfaction'?" Finally, "what is the relationship between the two constructs?" Confirmatory factor analysis was conducted on the five HFSQ subscales and the five specific facets of the JDI. The results show a good fit for the model with the data: AGFI = .93, RMR = .036, chi squared/df = 2.0, and CN = 380.

These results provide some support regarding the convergent and discriminant validities of the HFSQ. Although the HFSQ scores were highly correlated to respondents' JDI scores, this analysis illustrated that when all 10 of the HFSQ and JDI specific facets were considered simultaneously, they produced two distinct dimensions corresponding to "physical work environment satisfaction" (HFSQ) and "non-physical work environment satisfaction" (JDI). Again, principle components factor analysis (with Varimax rotation) produced similar results (see Table 8) and illustrated that the HFSQ accounted for 40% of the variance while the JDI accounted for 12.6%.

Table 7
Factor Analysis of the HFSQ, the JDI, and the MSQ

	FACTOR 1
HFSQ	.818
JDI-6	.883
MSQ-sf	.913

Table 8
Factor Analysis of the JDI and HFSQ Facets

	Factor 1	Factor 2
JDI		
Work	.244	.721
Supervision	.111	.774
Pay	.318	.434
Promotion	.223	.685
Coworkers	.089	.700
HFSQ		
Environment	.767	.250
Facilities	.664	.047
Work Char.	.647	.408
Equipment	.682	.143
Health/Safety	.732	.222

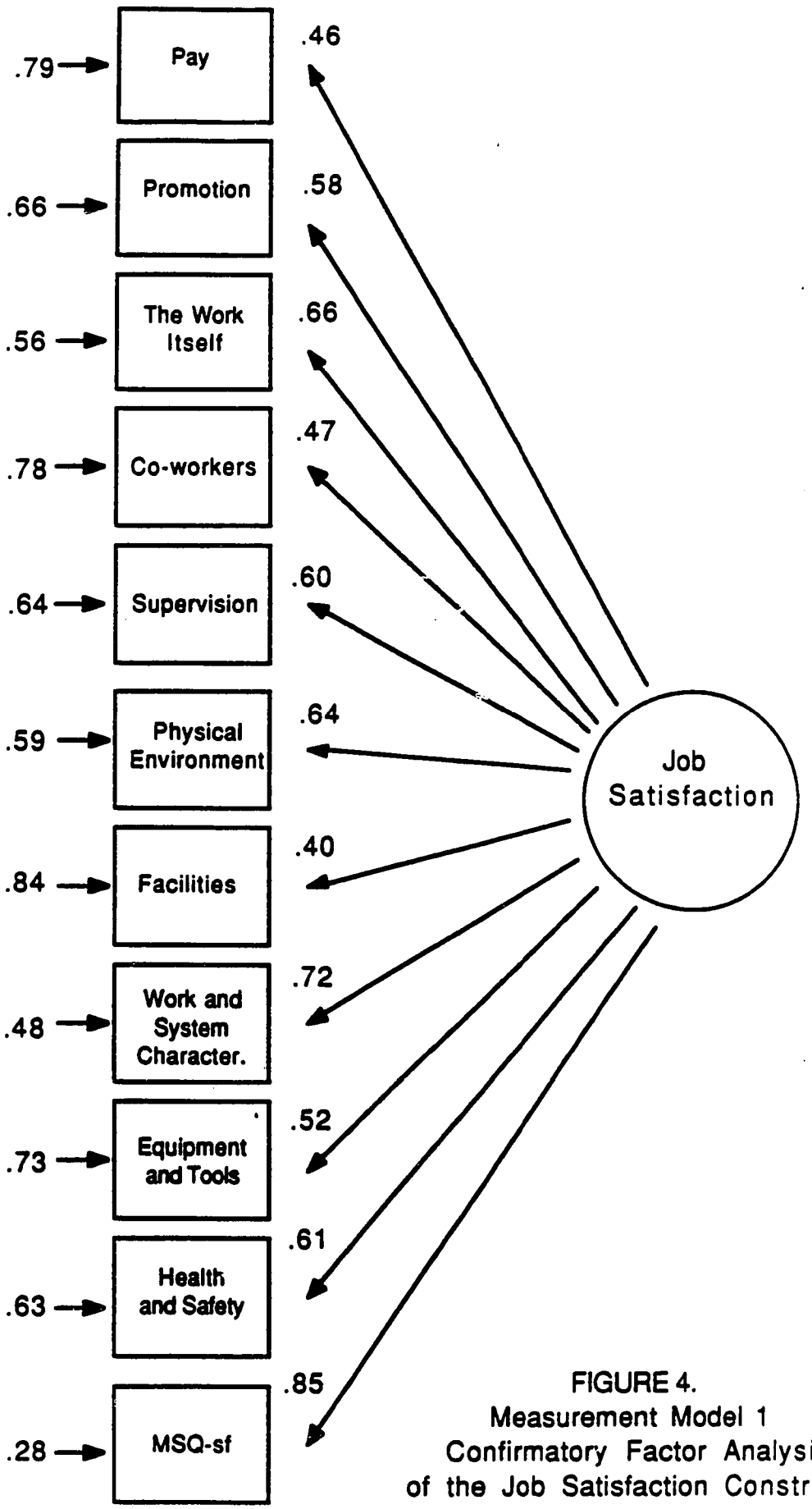

FIGURE 4.
Measurement Model 1
Confirmatory Factor Analysis
of the Job Satisfaction Construct

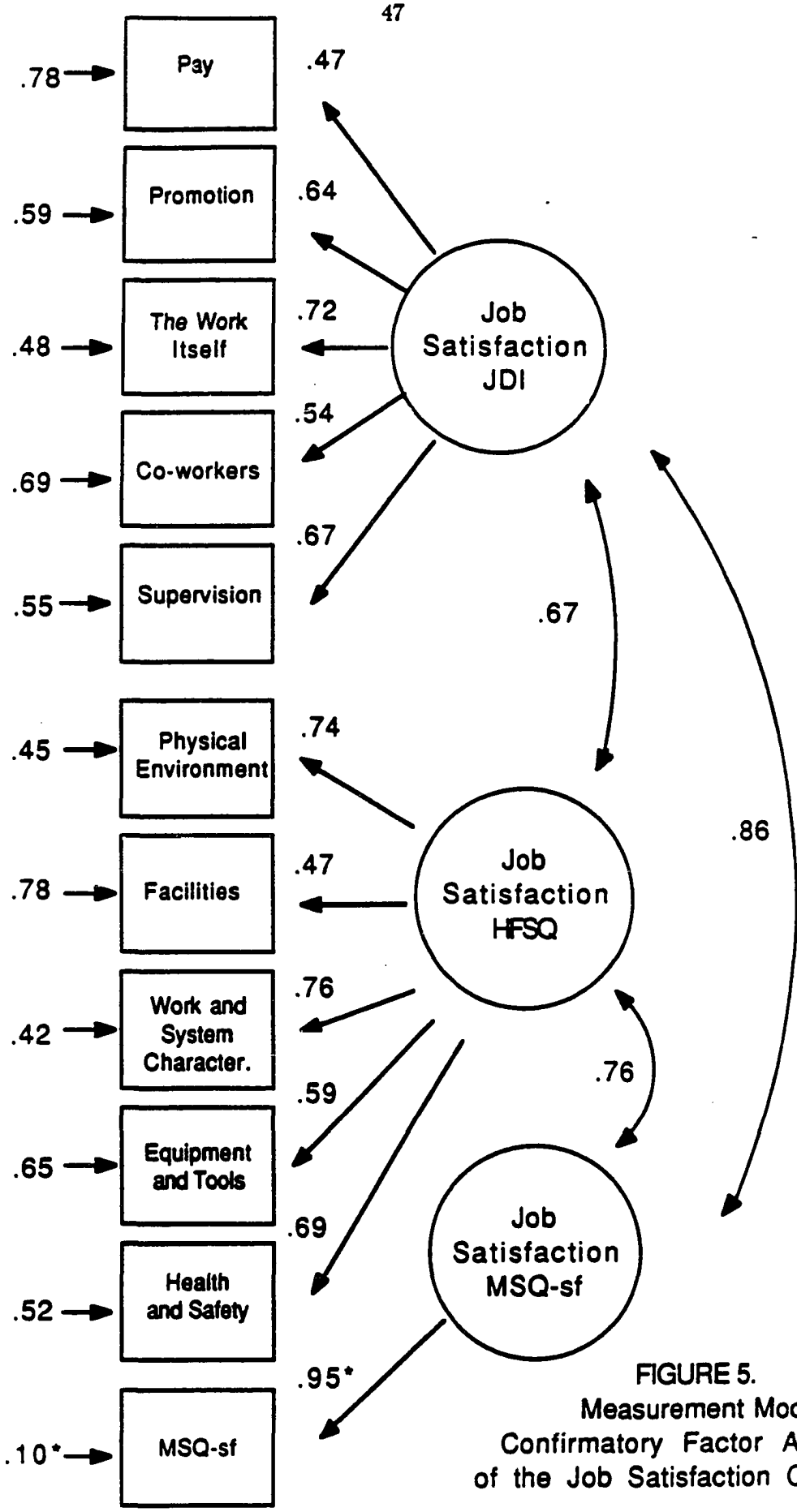

FIGURE 5.
Measurement Model 2
Confirmatory Factor Analysis
of the Job Satisfaction Construct

* Fixed value for a single indicator.

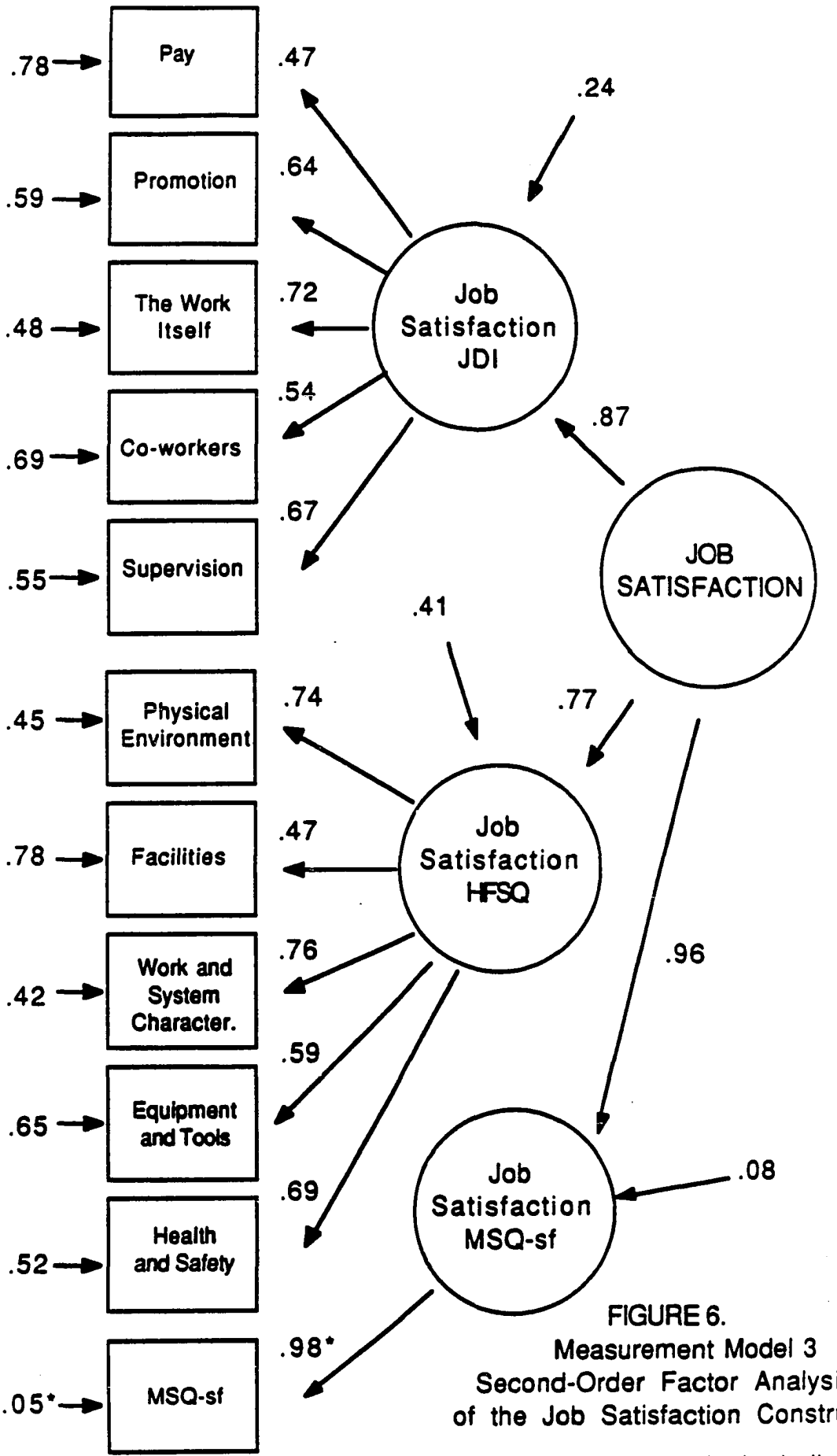

FIGURE 6.
Measurement Model 3
Second-Order Factor Analysis
of the Job Satisfaction Construct

* Fixed value for a single indicator.

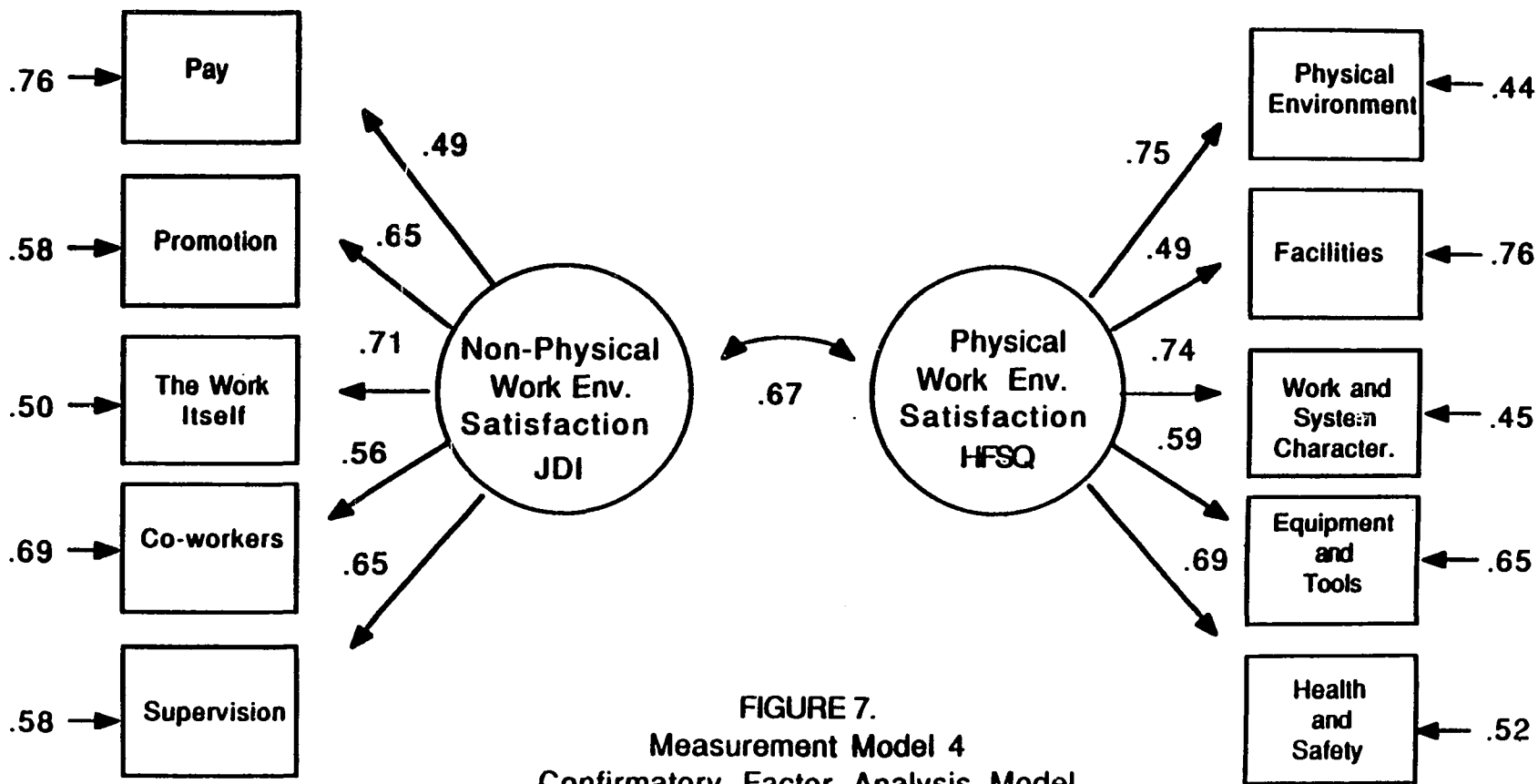

FIGURE 7.
Measurement Model 4
Confirmatory Factor Analysis Model
for Ten Satisfaction Facets.

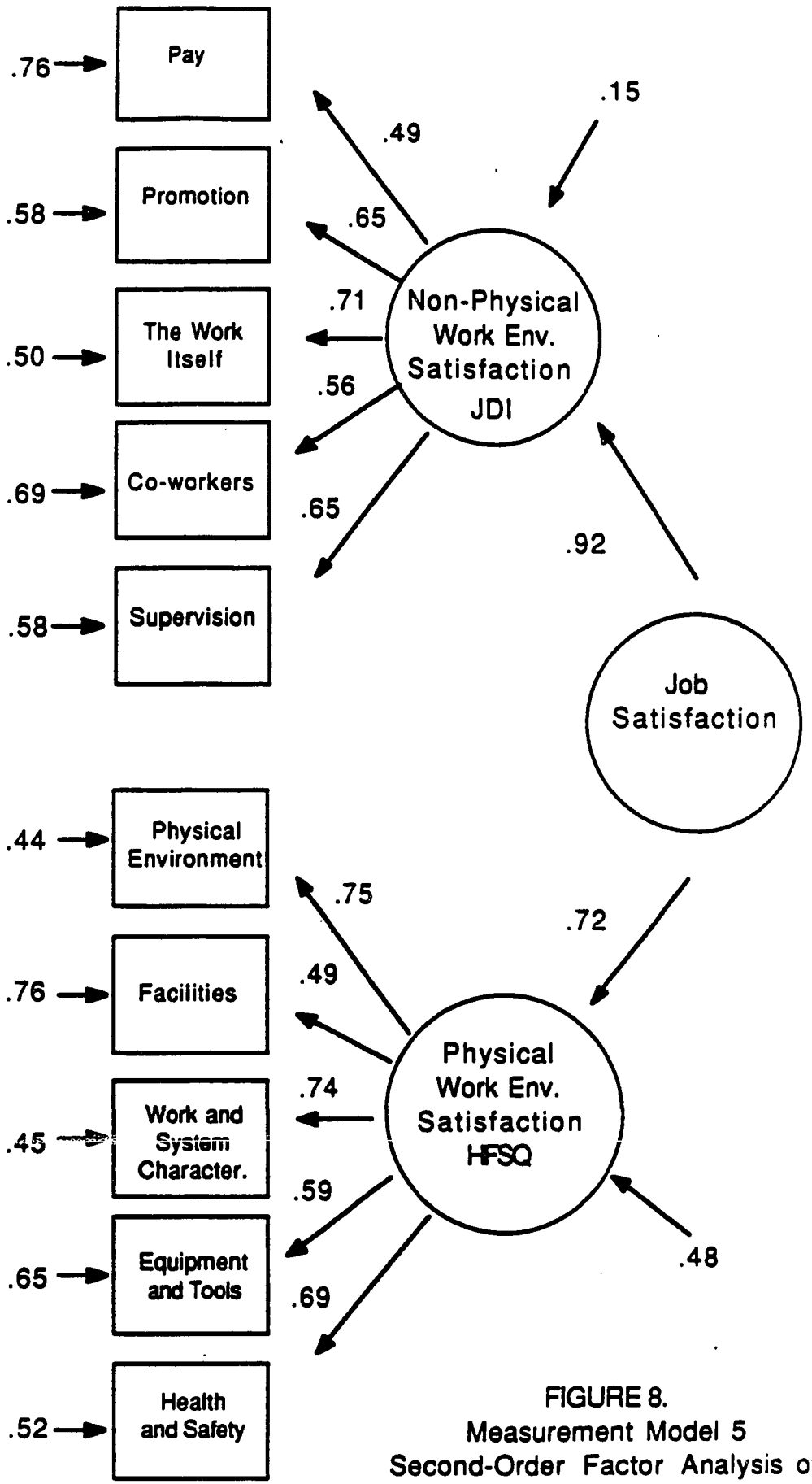

FIGURE 8.
Measurement Model 5
Second-Order Factor Analysis of
the Model for Ten Satisfaction Facets.

Figure 8 subsumed the questions asked in relation to Figure 7 and asked an additional question regarding the "physical work environment satisfaction" and the "non-physical work environment satisfaction" constructs in terms of their relationship to a higher-order factor of job satisfaction. The results suggested that there is a construct/factor, that I have labeled "job satisfaction," that accounts for the variance in common between the "non-physical work environment satisfaction" (as measured by the five specific JDI facets) and the "physical work environment satisfaction" construct (as measured by the five HFSQ facets). The model fits the data well: AGFI = .94, RMR = .036, chi-square/df = 2.0, and CN = 370. When comparing the two models (please see Table 9) in figures 5 and 6 to the two models in figures 7 and 8 we see that the later pair (identical to the earlier pair with the MSQ removed from the model) fit slightly better with the data.

Table 9
Modifications Made to the Measurement Model for the Job Satisfaction Construct.

Figure #	Measurement Model #	Modifications to Previous Model	AGFI	RMR	Chi-Sq/ df	CN
4	1		.65	.067	6.36	113
5	2	Added 3 Job Sat sub-constructs.	.91	.035	2.11	344
6	3	Added 2nd order Job Sat construct.	.91	.035	2.11	344
7	4	Dropped MSQ & 2nd order Job Sat construct.	.93	.036	2.00	380
8	5	Added 2nd order Job Sat construct.	.94	.036	2.00	370

LISREL 7 also allowed simultaneous estimations of the predictive contributions of various elements of the full model in Figure 2. This model (see Figure 9) shows marginal fit to the data. Although the AGFI = .95 and the RMR = .06, which may be considered evidence of adequate fit, the chi-square/df = 7.35 and the CN = 151, which are considered evidence of a less than adequate fit. This suggests an alternative model may exhibit better fit with the data which was expected, considering the results from the examination of the measurement model for the job satisfaction construct. This will be explored further below as the study hypotheses are examined.

It was expected that the HFSQ would be a significant contributer to the model in Figure 2 (Hypothesis 3a), and that the model would "fit" better with the HFSQ (i.e., correspond better to the relationships found in the data) than without it (Hypothesis 3b). Hypothesis 3a was supported as the T value for the HFSQ's contribution to the model was significant ($\underline{T}$ = 17.421). According to Joreskog & Sorbom (1988), "Parameters whose T-values are larger than two in magnitude are normally judged to be different from zero."

In order to examine Hypothesis 3b, the full model in Figure 2 was run without the HFSQ. This model (see Figure 10) yields an improved, yet inadequate fit with the data: AGFI = .99, RMR = .01, chi-square/df = 3.07, and a CN = 475. Although the values for the AGFI, the RMR, and the CN are all good, the chi-square/df is quite high. Thus, without the HFSQ, the model seems to fit better with the data, but still does not fit very well with the data. Considering that the job satisfaction measurement model was slightly better without the MSQ, considering that in both Figures 4 and 9 the MSQ loads very strongly on the satisfaction construct (i.e., .85 in Figure 4 and .92 in Figure 9), and given that the MSQ correlates so highly with all the other variables in the model, it was suspected that the MSQ may be virtually defining

the satisfaction construct and possibly masking the contribution of the HFSQ and the JDI. The full model (Figure 9) was run without the MSQ. The resulting model (see Figure 11), with the JDI and HFSQ as measures of satisfaction, fits almost perfectly with the data: AGFI = .99, RMR = .01, chi squared/df = 1.78, and CN = 820. This model fits better with the data than does the model without the HFSQ (i.e., Figure 10). The new model (Figure 11) has a substantially lower chi squared/df and higher CN while it accounts for almost as much variance in commitment (i.e., 63% compared to 70%) and more variance in turnover intentions (i.e., 80% compared to 76%) than the previous model without the HFSQ (i.e., Figure 10). Therefore, Hypothesis 3b is supported.

After investigating the normalized residuals and the modification indices of the models in Figures 9, 10, and 11, and trying several alternative models (given the hypothesized causal ordering of the job satisfaction and organization commitment constructs) no model could be produced which fit the data better than the model presented in Figure 11. When the causal ordering of the satisfaction and commitment constructs was reversed, however, a model was found which fit the data slightly better (see Figure 12). In this model, commitment is causally antecedent to satisfaction (as measured by the JDI and HFSQ), which in turn affects turnover intentions, while commitment also has a direct affect on turnover intentions. This model (Figure 12) fits the data as well as the model in Figure 11 (please see Table 10). The fit indices for this model in Figure 12 are: AGFI = .99, RMR = .02, chi squared/df = 1.51, and CN = 885. This model accounts for 41% of the variance in satisfaction and 62% of the variance in turnover intentions.

Table 10
Modifications Made to the Full LISREL Model.

Figure #	Modifications to Previous Model	AGFI	RMR	Chi-Sq/ df	CN
9		.95	.06	7.35	151
10	The HFSQ was dropped.	.99	.01	3.07	475
11	The MSQ was dropped and the HFSQ was added.	.99	.01	1.78	820
12	Causal ordering of Job Sat and commitment was reversed.	.99	.02	1.51	885

Finally, it was expected that (Hypothesis 4) groups of people who worked in distinct physical environments would report significantly different HFSQ scores. This hypothesis received no support. When the standardized HFSQ subscale and total scores from employees who worked in offices, clean rooms, assembly environments, and machining environments were compared, there were no significant differences found due to type of environment. When the first two and last two groups are combined (comparing "clean" environments, i.e., office and clean rooms, to more "dirty" industrial environments, i.e., assembly and machining), respondents' HFSQ scores were still not found to be significantly different. An alternative way to examine this hypothesis is to conceive of the non-standardized data within the model of environmental types nested within organizations. The scale scores based on the non-standardized raw scores were used and differences due to organizations, and environmental types with organizations, were tested. When this was done, however, no significant differences were found. Therefore, Hypothesis 4 must be rejected.

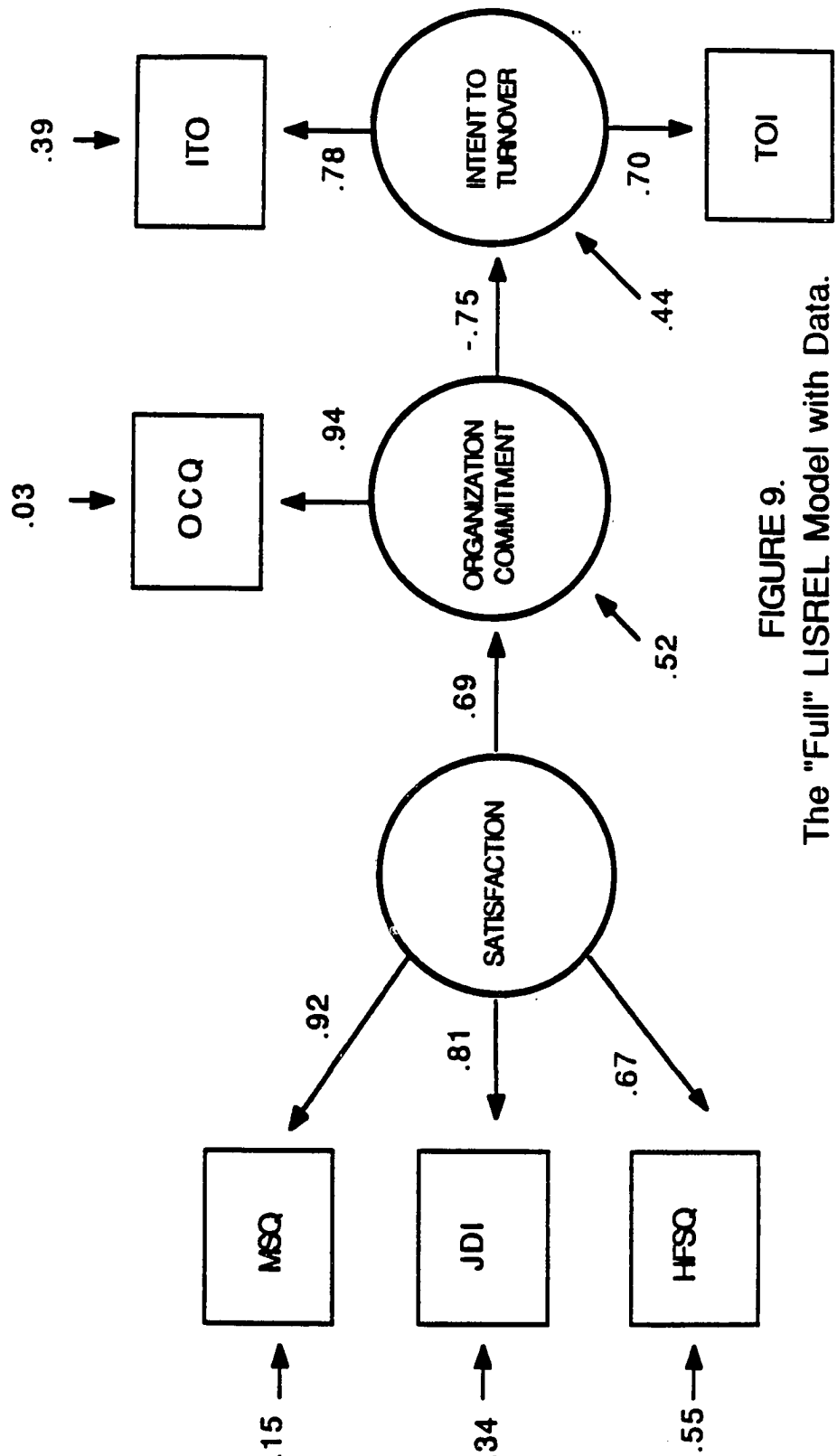

FIGURE 9.
The "Full" LISREL Model with Data.

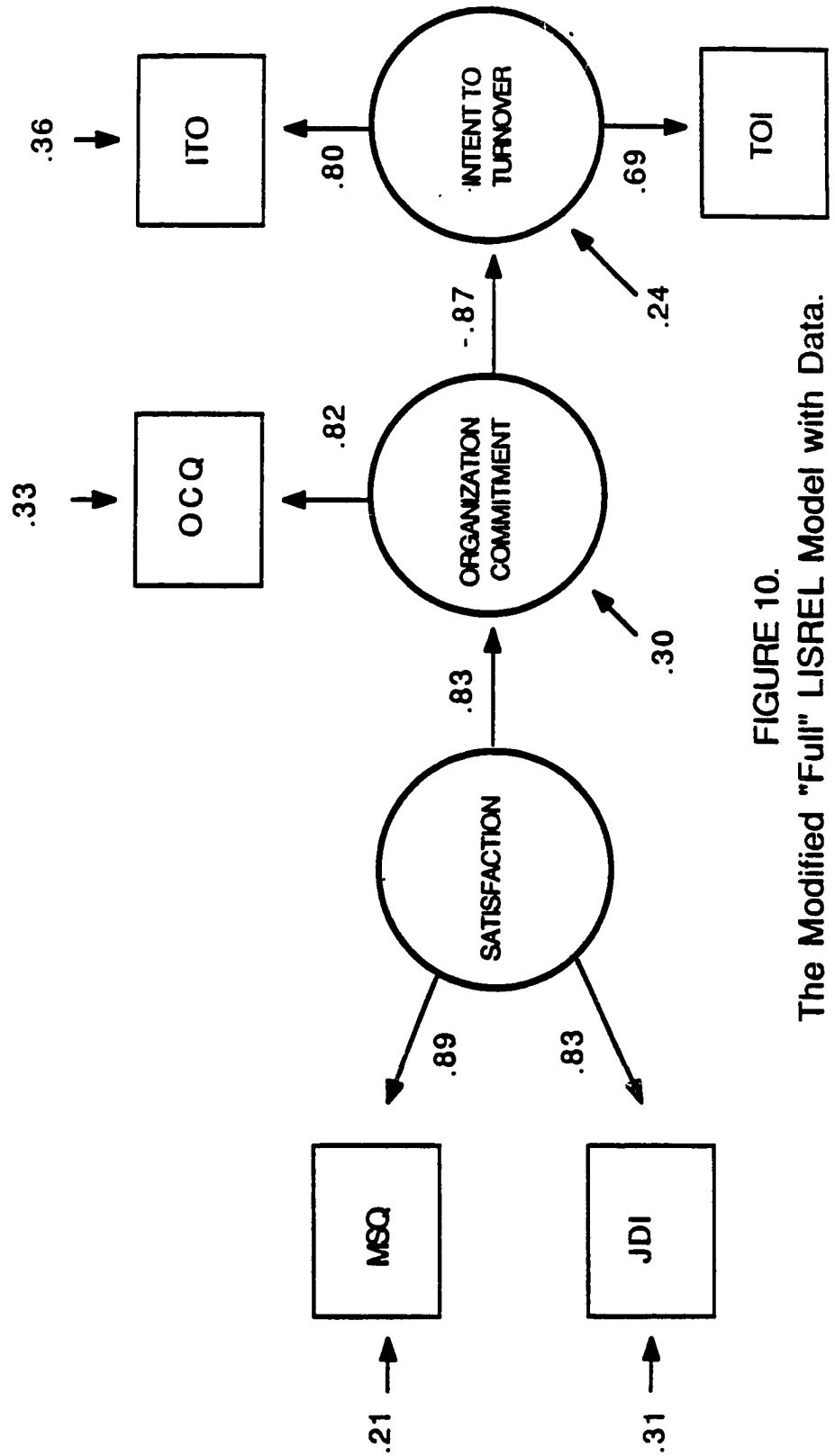

FIGURE 10.
The Modified "Full" LISREL Model with Data.

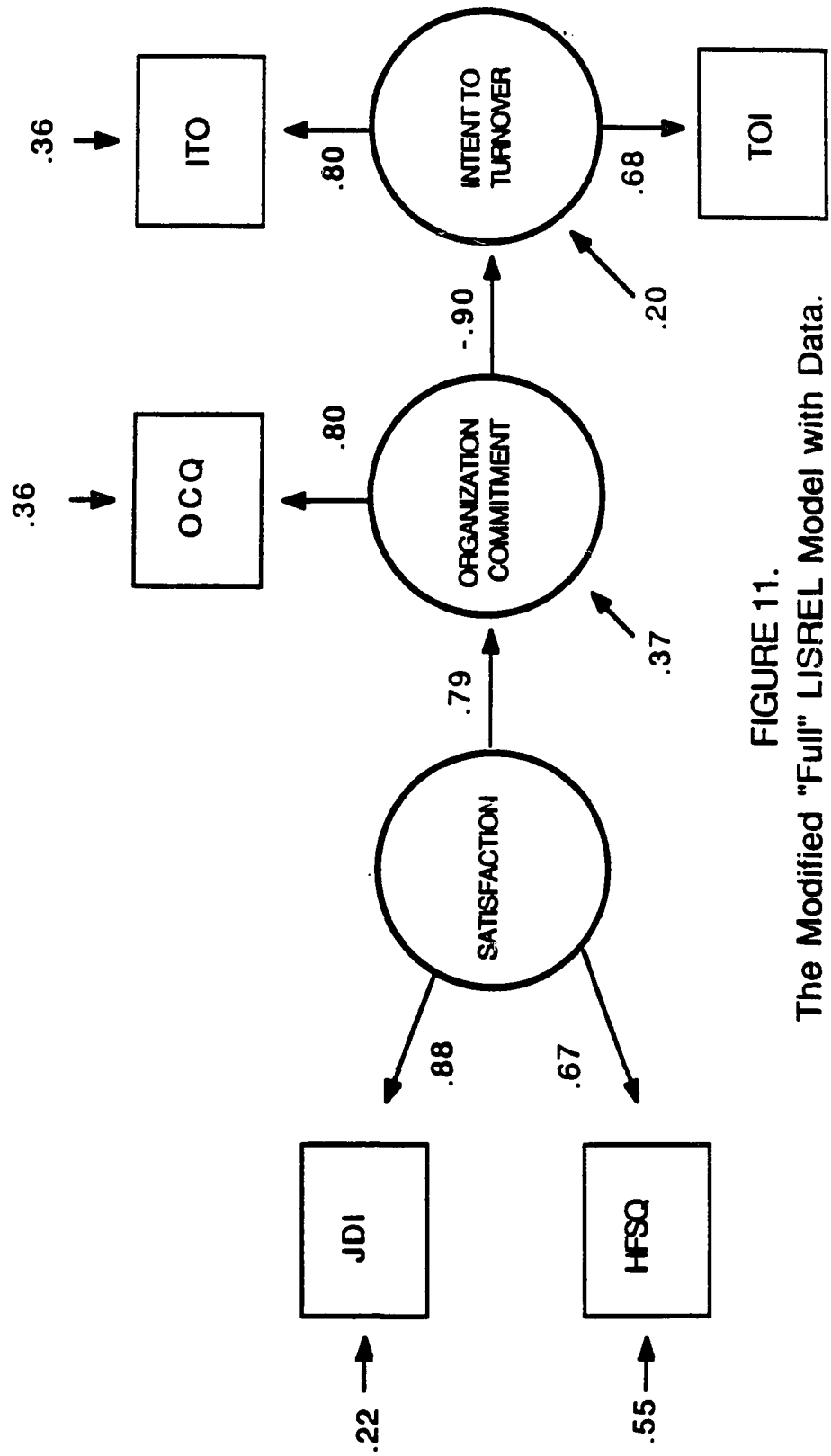

FIGURE 11.
The Modified "Full" LISREL Model with Data.

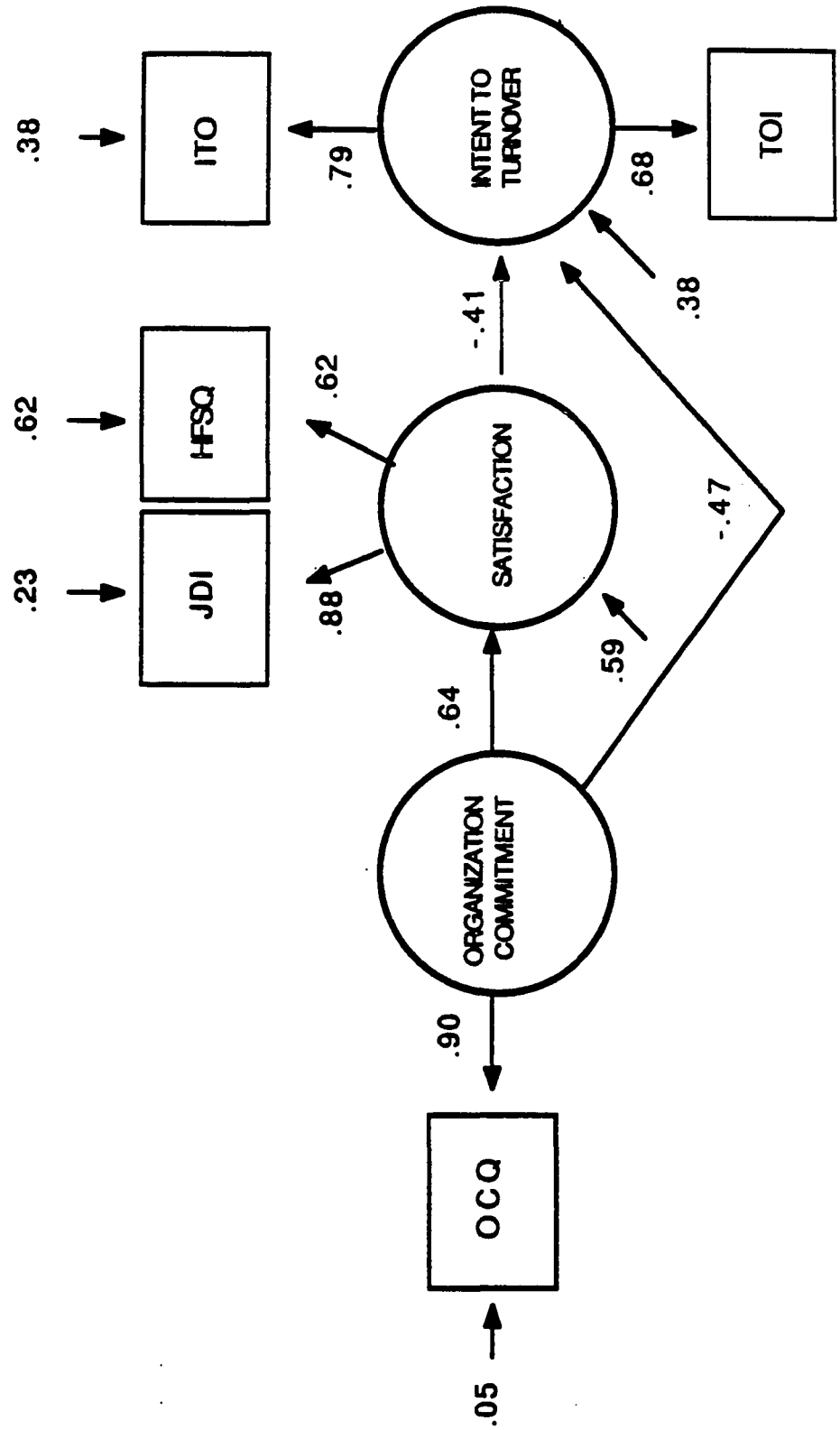

FIGURE 12.
The Modified "Full" LISREL Model. with Data

Chapter Four
Discussion

The purpose of this research was to provide evidence for the construct validity of the Human Factors Satisfaction Questionnaire (HFSQ). Mixed evidence for the construct validity of the HFSQ was found. Although the HFSQ scores of people who worked in different physical environments were not significantly different from each other, HFSQ scores were related in hypothesized ways to constructs that have established relations in the literature. This provided evidence for the validity of the HFSQ as a measure of the "physical work environment satisfaction" portion of the larger job satisfaction construct.

The Physical Work Environment

The results of the factor analyses provided evidence supportive of the HFSQ's five hypothesized dimensions of the physical work environment. The Health and Safety dimension accounted for almost 30% of the variance while the total questionnaire accounted for over 50%. All the factors held together well, with items loading at or above a value of .6, except for the Environment Design factor which seems to need some modification. These results support the contention that the physical work environment includes more than what is typically considered as the psycho-social task environment. Steele (1973), Becker (1981), and Locke (1976) all conceptualized the physical work environment in psycho-social terms of comfort, functionality, and individual interaction. These results illustrate that employees perceive at least the five dimensions of physical environment ambients, facilities, work and system characteristics, equipment and tools, and health and safety as part of the physical work environment, as well.

Validity of the HFSQ

Convergent and discriminant validity hypotheses were originally based on the expectation that the major construct underlying the HFSQ was that of "respondents' reactions to their objective physical work environments." Therefore, it was expected that the HFSQ would converge with measures of peoples' perceptions of their objective physical work environment (e.g., Perceived Crowding, Task and Communications Privacy) and discriminate from other measures (e.g., Participation in Goal-Setting, Satisfaction with Pay, Promotion). These expectations were contradicted by the correlational data. However, when the HFSQ was considered to be a measure of the "physical work environment satisfaction" construct, it is seen to converge with other measures of job satisfaction (e.g., the MSQ and JDI) and to be less strongly related to non-satisfaction measures (e.g., Perceived Crowding, Task and Communications Privacy, Participation in Goal-Setting). Although the attitude statements used in this research were both positively and negatively worded, and response scales and formats were varied as suggested by Cook and Campbell (1979), a portion of the generally high correlations among all the measures in this study could be explained by response or method bias resulting from the use of all paper-and-pencil measures given to respondents at the same time.

It was expected that people who worked in distinct physical environments that varied along the dimensions measured by the HFSQ would report significantly different HFSQ scores. These expectations were not supported by the data. The group differences hypothesis, however, was based on the expectation that the major construct underlying the HFSQ was that of "respondents' reactions to their objective physical work environments." As with the convergent and discriminant validity hypotheses, however, the HFSQ

may be better considered to be a measure of the "physical work environment satisfaction" construct. HFSQ scores could then be expected to be the result of the differences between employees' expectations of what their physical work environment should be, and what they actually was. For example, according to Lawler (1981), the determinant of pay satisfaction is considered to be the relationship between the perceived amount of pay that should be received (i.e., peoples' expectations of what their pay should be) and the perceived amount received (i.e., peoples' perceptions of what their pay actually is). An explanation for the lack of group differences in HFSQ scores would therefore be that people who work in industrial manufacturing environments have a very low expectation of what their physical work environments should be, relative to the office employees from the same samples. This would result in the discrepancy between their expectations and their perceived reality being just as small as the discrepancy between the office employees greater expectations and their more positive physical work environments. There are no data available from this study able to provide evidence for or against this hypothesis. A more parsimonious explanation for the lack of significant group differences is that that the physical work environments sampled in this study, although they may have varied across some dimensions, did not actually vary along dimensions relevant to the HFSQ.

The results from the examination of the confirmatory factor analyses of the job satisfaction construct measurement model (Figures 4, 5, & 7) and the second-order factor analyses (Figures 6 & 8) all provide evidence for the "physical work environment satisfaction" construct and for the HFSQ as a measure of the construct. The results of the confirmatory and second-order factor analyses suggest that the best measurement model for the job satisfaction construct includes the 5 HFSQ and the 5 JDI facets loading on to the related,

yet distinct sub-constructs of "physical work environment satisfaction" (i.e., the HFSQ facets) and "non-physical work environment satisfaction" (i.e., the JDI facets). The results of the second-order factor analyses show that there is variance common to the HFSQ and JDI measures of job satisfaction which can be accounted for by a single (job satisfaction) construct.

If the HFSQ was related in predicted ways to measures and constructs which have established relationships in the literature, that would provide evidence of the construct validity of the HFSQ. The full model (Figure 2) relating the constructs of turnover intentions, organization commitment, and job satisfaction (using the MSQ, JDI, and HFSQ as measures of job satisfaction) did not fit the data well. Although the original model fit the data better without the HFSQ, the best fit to the data came from the model which included the HFSQ and the JDI as the measures of job satisfaction. The model shows that the HFSQ and the JDI load .67 and .88 on the job satisfaction construct. Job satisfaction accounts for 63% of the variance in organization commitment scores with a loading of .79, while organization commitment loads -.90 on turnover intentions and accounts for 80% of the variance in the construct. This provides support for the validity of the "non-physical work environment" and "physical work environment" satisfaction constructs as measured by the JDI and the HFSQ.

Interestingly, when the causal ordering of the satisfaction and commitment constructs is reversed, the model fit the data slightly better. This model shows organization commitment to be causally antecedent to job satisfaction and accounting for 41% of the variance in the satisfaction construct with a .64 loading. Job satisfaction and organization commitment both load on intent to turnover, with values of -.41 and -.47, and together account for 67% of the variance. We are not able to determine the order of the causal

relationship between the commitment and satisfaction constructs based on these results. In either case, the best fit to the data in this study was produced when the HFSQ and JDI were used in combination as the measures of the job satisfaction construct.

Limitations of this Study

There are some problems with this study and its design. First, all measures used in this study were paper-and-pencil measures of psychological constructs. Although different response categories, different response formats, and negatively worded attitudes were used, some "response bias" was likely. Second, all constructs in this study were attitudinal. Measurement of behavioral outcomes, such as performance, accident or health and safety data, or actual turnover would have greatly added to the validity and generalizability of this study. Third, compared to the effort that was invested in the development and validation of questionnaires such as the MSQ and the JDI, the sample size (N = 641) used in this study was small. This may limit the generalizability of the results.

Theoretical Implications

The results of this study have several theoretic implications. First, it seems that although the MSQ short form was a powerful measure of the job satisfaction construct, it was not as good a measure of job satisfaction, either alone or in combination with the HFSQ and/or the JDI, as the JDI-HFSQ combination. In one sense, that is not a fair comparison, since the MSQ short form uses single-item measures of twenty facets and the HFSQ-JDI combination uses over one-hundred items to measure ten facets. However, the data showed that the five HFSQ and five JDI facets are distinct, and that the variance common to both can be accounted for by a second-order factor which is shown

to provide the best fit with the existing data as a measure of the job satisfaction construct that predicts the variance in organization commitment scores (and in turnover intention scores when the causal ordering is reversed). Second, it seems that motivation theory and modern organization theory, including most current conceptualizations of the facets of job satisfaction and their measurement, need to consider the "physical work environment" as a construct which affects peoples' attitudes and behavioral intentions, and as an important part of peoples' lives at work.

The results of this study also are relevant to a discussion of the relation between the constructs of job satisfaction and organizational commitment. Commitment and satisfaction are considered distinct, yet related constructs (cf. Mowday, Porter, & Steers 1982). The distinction rests on the contention that the construct of organizational commitment is more global than the job satisfaction construct. Organizational commitment reflects a general affective response to the organization as a whole, rather than to one's job or to certain aspects of one's job as does job satisfaction. Therefore, commitment emphasizes longer-term, more stable attachment to the employing organization, while satisfaction emphasizes a more transitory, quickly forming reaction to the specific task environment (Mowday, Porter, & Steers 1982, p. 28). The theorized instability and more rapid formation of satisfaction suggest it as a cause of commitment, rather than vice versa (cf. Williams & Hazer, 1986). Although the validity of this contention has not been established as noted earlier. The results of this study cast further doubt on the validity of the argument that one or the other of the constructs is definitively causally antecedent to the other. The models presented in Figures 11 and 12 both fit the data extremely well, and both account for respectable portions of the variance in the modeled constructs.

Some of the problem in establishing one of the constructs as the determinant of the other may come from the frequent conceptualization of organizational commitment as an attitude. In this study, as in most others, commitment is conceptualized as an attitude characterized by at least three factors: (1) a strong belief in and acceptance of the organization's goals and values; (2) a willingness to exert considerable effort on behalf on the organization; and (3) a strong desire to maintain membership in the organization (Steers, 1977 p. 46), and is measured by the Organizational Commitment Questionnaire that was designed to tap these three aspects of commitment. Organizational commitment may also be conceptualized in terms of behavioral, overt indicators. For example, if an employee works late at night or on weekends, this behavior exceeds role expectations and may be considered evidence of organizational commitment. Mowday, Porter, & Steers (1982) clearly distinguish between attitudinal and behavioral commitment and argue that "the assertion that one approach is superior to the other is questionable" and "that both concepts are useful" (p. 26). The behavioral conceptualization and measurement of organizational commitment may be more distinguishable from the attitudinal construct of job satisfaction. An examination of these two variables may be able to shed a more definitive light on the relation between the satisfaction and commitment constructs.

Practical Implications

Based on the results of this study, it seems that the HFSQ could be used to highlight major problems in the physical work environment as perceived by employees. The HFSQ results collected during this study were fed back to each participating organization. Anecdotal evidence from recipients of these reports suggested that the data have been useful and have pointed out areas in need of attention.

In terms of more academic and research usefulness, the HFSQ results have provided a first look at how satisfaction with elements of the physical work environment relate to other facets of the job satisfaction construct, and the constructs of organization commitment and turnover intention. "Physical work environment satisfaction" seems to be a valid sub-construct or dimension within the broader job satisfaction construct and there is some evidence that the HFSQ is a valid measure of this construct.

There is much evidence in the literature that illustrate how the physical work environment and ergonomic issues have significance for job satisfaction (cf. Verhaegen, 1979). Social-psychological efforts to increase satisfaction and "quality of work life," therefore, should not proceed without taking into account the physical work environment, ergonomics, and other human factors principles. If peoples' lower-order needs must be fulfilled before it is possible for them to attain their higher-order needs (e.g., Maslow), and if the presence or absence of lower-order hygiene factors at work affects employees' dissatisfaction, while the presence or absence of the higher-order motivators affects employees' job satisfaction (e.g., Herzberg), then employers who fail to provide pleasant, healthy, safe physical work environments that are conducive to task performance will not receive maximal performance, motivation, or satisfaction from their employees regardless of management style, advancement opportunities, level of responsibility, or recognition. Therefore, before consultants recommend changes in the organization of work to increase the level of responsibility, autonomy, or task variety, or recommend changes toward more participative management and organization structures, they should implore organizations to start with the basics. By providing outstanding physical working conditions that are safe, comfortable, pleasant, conducive to task performance, and that promote physical and mental health, a solid base on

which to build efforts to achieve desired improvements in productivity, quality, satisfaction, and motivation will be in place.

Implications for Future Research

This research leaves several issues in need of further study. First, the discriminant validity of the HFSQ has not been clearly demonstrated. The generally high correlations among all the measures in this study illustrate the need for further validation research to include both measures of distinct psychological constructs (e.g., personality traits) and measures of actual behavioral outcomes (e.g., actual turnover, absenteeism, performance). Second, further validation research should attempt to provide evidence of criterion-related validities. This could be accomplished along with the investigations of discriminate validity. Third, more exploration of the specific sub-dimensions of the job satisfaction construct is needed. Although basic work has been done to determine the many facets of job satisfaction, very little work has been done grouping and relating these facets beyond the intrinsic and extrinsic distinction. Fourth, further research is needed in order to determine the exact nature of the relationship between the job satisfaction and organizational commitment constructs. A study employing a composite behavioral measure of organizational commitment that includes variables such as absenteeism, job tenure, the number of times an individual works late or on weekends, the level of voluntary participation in various activities, etc., and the JDI and HFSQ facets could shed a more definitive light on the relationship between the constructs. Also explorable in this context is the relationship between the construct of general job satisfaction, the behavioral conceptualization of the organization commitment construct, and the JDI and HFSQ facets. General job satisfaction is measured by questions asking about respondents' satisfaction with their jobs in general, and may be even more highly related to the organizational

commitment construct than the more specific job satisfaction facets. As suggested by (Brayfield, Wells, & Strate, 1957), these two job satisfaction measurement strategies have been shown to be non-equivalent although they are used interchangeably in the literature. Finally, a study is needed to test the hypothesized explanations for the lack of group differences in HFSQ scores. More work is required to identify physical work environments that vary greatly along dimensions relevant to the HFSQ. Also, potential group differences in peoples' ratings of the importance of the physical work environment and their expectations of the physical work environment should be examined.

Summary and Conclusion

In summary, although the HFSQ scores of people who worked in different physical environments were not significantly different from each other, substantial evidence for the construct validity of the HFSQ was found. The present study provides evidence that the "physical work environment satisfaction" is a valid sub-construct of the job satisfaction construct, and that the HFSQ is a valid measure of this construct.

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Appendix A

Questionnaire Used in this Study

Industrial Technology Institute

Human Factors Evaluation Survey

The purpose of this questionnaire is to get your views on issues relating to your physical work environment.

In this booklet you'll find questions about the work you do and about how satisfied you are with many aspects of your work. Please answer these questions to the best of your knowledge and ability.

WHAT YOU SAY IN THIS QUESTIONNAIRE IS CONFIDENTIAL.

Do not put your name on any of these forms. No one from your organization will see your individual answers, nor will it be possible to identify your individual responses once the data are analyzed. Your managers or union leaders will only see a report of summary data.

1. Please start at the beginning of the booklet and answer all questions in order. There are no right and wrong answers; this is an opinion survey.
2. All questions should be answered by circling the number of the alternative that best represents your choice. For our purposes your first reaction to a question is usually the best. Do not dwell on any one question.
3. If a question does not apply to you or you have no opinion, please select "Neutral" or "Neither Disagree or Agree."
4. Feel free to make comments on the questionnaire.

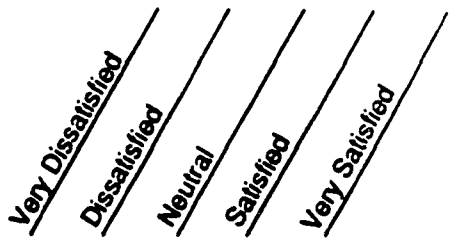
Upon completion, please return the form to the administrator.

Human Factors
Satisfaction Questionnaire

Section I:
The Physical Work Environment

Please think of your present job when answering the following questions. These questions are designed to examine what you think and feel about the physical surroundings in your work place.

Please use the following scale to answer the questions below. Record your answers by **circling** the number which corresponds to your answer in the selections provided next to each question.



How satisfied are you with:

The lighting in your work area.....	1	2	3	4	5
The air quality in your work area.....	1	2	3	4	5
The surfaces you usually walk on.....	1	2	3	4	5
The direction of the light which enters your work area.....	1	2	3	4	5
The surfaces you frequently work on.....	1	2	3	4	5
The generai atmosphere in your work area.....	1	2	3	4	5
The colors used in your work area (walls, furnishings, etc.).....	1	2	3	4	5
The amount of smoke (e.g., tobacco) to which you are exposed.	1	2	3	4	5

How satisfied are you with:	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
The cleanliness of the facilities at work.....	1	2	3	4	5
In general, the type of facilities provided at work.....	1	2	3	4	5
The pleasantness of the restrooms you use.....	1	2	3	4	5
The cleanliness of the recreation facilities you use.....	1	2	3	4	5
The pleasantness of the recreation facilities.....	1	2	3	4	5
The size of the eating facilities (e.g., lunch room) provided.....	1	2	3	4	5
The cleanliness of the eating facilities.....	1	2	3	4	5
The pleasantness of the eating facilities.....	1	2	3	4	5
How your time at work is scheduled.....	1	2	3	4	5
The length of the rest breaks you receive.....	1	2	3	4	5
The amount of work you are required to do.....	1	2	3	4	5
The amount of activity/movement needed to perform your job.....	1	2	3	4	5
The flexibility of your work place.....	1	2	3	4	5
The general design of your work system.....	1	2	3	4	5
The amount of time you are given to complete your work.....	1	2	3	4	5

How satsified are you with:	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
The quality of information you receive to do your work.....	1	2	3	4	5
How information is handled (e.g., moved & stored) at work.....	1	2	3	4	5
The number of tools with which you have to work.....	1	2	3	4	5
The effectiveness of the machines with which you work.....	1	2	3	4	5
The efficiency of the machines with which you work.....	1	2	3	4	5
The effectiveness of the tools with which you have to work.....	1	2	3	4	5
The efficiency of the tools with which you have to work.....	1	2	3	4	5
The quality of the materials you are given to do your job.....	1	2	3	4	5
How accidents are avoided at work.....	1	2	3	4	5
The safety precautions taken in your work place.....	1	2	3	4	5
The warnings you are given regarding work place hazards.....	1	2	3	4	5
The safety training you have received.....	1	2	3	4	5
How hazards are controlled in your work place.....	1	2	3	4	5
The safety training available to you through work.....	1	2	3	4	5
How hazardous materials or products are handled/moved at work.	1	2	3	4	5

How satisfied are you with:	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
The safety training other workers receive.....	1	2	3	4	5
The way accidents are reported at work.....	1	2	3	4	5
The way accidents are investigated at work.....	1	2	3	4	5
The fire prevention system(s) you have at work.....	1	2	3	4	5
The amount of privacy you have at work.....	1	2	3	4	5
The level of noise in your work area.....	1	2	3	4	5
The number of times you are distracted while you are working....	1	2	3	4	5
The amount of space in which you have to work.....	1	2	3	4	5
The size of your work area.....	1	2	3	4	5
Your ability to control your physical surroundings.....	1	2	3	4	5
Your ability to change (or rearrange) your physical surroundings.	1	2	3	4	5
The temperature in your work area.....	1	2	3	4	5

How satisfied are you with:	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
The amount of lifting you have to do	1	2	3	4	5
The weight of objects you have to lift	1	2	3	4	5
The amount of bending you have to do	1	2	3	4	5
The amount fo squatting you have to do	1	2	3	4	5
The amount of standing you have to do	1	2	3	4	5
The amount of walking you have to do	1	2	3	4	5
The number of time you repeat the same motions	1	2	3	4	5
The amount of reaching or stretching you have to do	1	2	3	4	5
The way your wrist (s) feel after a day of work	1	2	3	4	5
The way your elbo(s) feel after a day of work	1	2	3	4	5
The way your knee(s) feel after a day of work	1	2	3	4	5
The way your ankel(s) feel after a day of work	1	2	3	4	5

	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
How satisfied are you with:					
The way your upper back feels after a day of work	1	2	3	4	5
The way your lower back feels after a day of work	1	2	3	4	5
The way your neck feels after a day of work	1	2	3	4	5
The way your hip(s) feel after a day of work	1	2	3	4	5

Please use the following scale to answer the next four questions:

	Strongly Disagree	Disagree	Neither Disagree or Agree	Agree	Strongly Agree
If I could, I would gladly leave Manchester Plastics	1	2	3	4	5
I am currently interested in finding another job.....	1	2	3	4	5
If I could, I would gladly transfer to another department within Manchester Plastics.....	1	2	3	4	5
If I could, I would gladly transfer to another job within my department.....	1	2	3	4	5

Think of the work you do at present. How well does each of the following words or phrases describe your work? In the blank beside each word below, write "Y" for "yes" if it describes your work, "N" for "no" if it does NOT describe it, or "?" if you cannot decide.

WORK

_____ Fascinating
_____ Routine
_____ Satisfying
_____ Boring
_____ Good
_____ Creative
_____ Respected
_____ Uncomfortable
_____ Pleasant
_____ Useful
_____ Tiring
_____ Healthful
_____ Challenging
_____ To much to do
_____ Frustrating
_____ Simple
_____ Repetitive
_____ Gives sense of accomplishment

SUPERVISION

_____ Asks my advice
_____ Hard to please
_____ Impolite
_____ Praises good work
_____ Tactful
_____ Influential
_____ Up-to-date
_____ Doesn't supervise enough
_____ Has favorites
_____ Tells me where I stand
_____ Annoying
_____ Stubborn
_____ Knows job well
_____ Bad
_____ Intelligent
_____ Poor planner
_____ Around when needed
_____ Lazy

Think of the work you do at present. How well does each of the following words or phrases describe your work? In the blank beside each word below, write "Y" for "yes" if it describes your work, "N" for "no" if it does NOT describe it, or "?" if you cannot decide.

PAY

_____ Income adequate for normal expenses

_____ Fair

_____ Barely live on income

_____ Bad

_____ Income provides luxuries

_____ Insecure

_____ Less than I deserve

_____ Well paid

_____ Underpaid

PROMOTIONS

_____ Good opportunity for promotion

_____ Opportunity somewhat limited

_____ Promotion on ability

_____ Dead-end job

_____ Good chance for promotion

_____ Unfair promotion policy

_____ Infrequent promotions

_____ Regular promotions

_____ Fairly good chance for promotion

CO-WORKERS

_____ Stimulating

_____ Boring

_____ Slow

_____ Helpful

_____ Stupid

_____ Responsible

_____ Fast

_____ Intelligent

_____ Easy to make enemies

_____ Talk too much

_____ Smart

_____ Lazy

_____ Unpleasant

_____ Gossipy

_____ Active

_____ Narrow interests

_____ Loyal

_____ Stubborn

Think of the work you do at present. How well does each of the following words or phrases describe your work? In the blank beside each word below, write "Y" for "yes" if it describes your work, "N" for "no" if it does NOT describe it, or "?" if you cannot decide.

JOB IN GENERAL

_____ Pleasant

_____ Bad

_____ Ideal

_____ Waste of time

_____ Good

_____ Undesirable

_____ Worthwhile

_____ Worse than most

_____ Acceptable

JOB IN GENERAL

_____ Superior

_____ Better than most

_____ Disagreeable

_____ Makes me content

_____ Inadequate

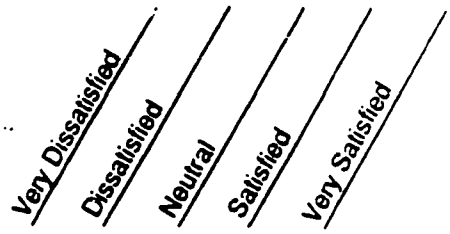
_____ Excellent

_____ Enjoyable

_____ Poor

Please use the following scales to answer the questions below:

	Never ---------- Constantly
How frequently do you think of quitting your job?	1 2 3 4 5
	Very Unlikely ---------- Certain
How probable is it that you could find an acceptable alternative to your current job?	1 2 3 4 5
	Unlikely ---------- Certain
How likely is it that you will search for a new job this year?	1 2 3 4 5
How likely is it that you will quit your job this year?	1 2 3 4 5



ON MY PRESENT JOB, THIS IS HOW I FEEL ABOUT:

The chance to do something that makes use of my abilities.....	1	2	3	4	5
The feeling of accomplishment I get from the job.....	1	2	3	4	5
The physical surroundings where I work.....	1	2	3	4	5
Being able to keep busy all the time.....	1	2	3	4	5
The chances for advancement on this job.....	1	2	3	4	5
The chance to tell other people what to do.....	1	2	3	4	5
The way company policies are put into practice.....	1	2	3	4	5
The pleasantness of the working conditions.....	1	2	3	4	5
My pay and the amount of work I do.....	1	2	3	4	5
The way my co-workers get along with each other.....	1	2	3	4	5
The chance to try my own methods of doing the job.....	1	2	3	4	5

ON MY PRESENT JOB, THIS IS HOW I FEEL ABOUT:

	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
The chance to work alone on the job	1	2	3	4	5
Being able to do things that don't go against my conscience	1	2	3	4	5
The working conditions (heating, lighting, etc.) on the job	1	2	3	4	5
The praise I get for doing a good job	1	2	3	4	5
The freedom to use my own judgement	1	2	3	4	5
The way my job provides for steady employment	1	2	3	4	5
The physical working conditions of the job	1	2	3	4	5
The chance to do things for other people	1	2	3	4	5
The chance to be "somebody" in the community	1	2	3	4	5
The way my boss handles his or her employees	1	2	3	4	5
The competence of my supervisor in making decisions	1	2	3	4	5
The chance to do different things from time to time	1	2	3	4	5
The working conditions	1	2	3	4	5

	Strongly Disagree	Disagree	Neither Disagree or Agree	Agree	Strongly Agree
GOALS					
I am allowed a high begree of influence in the determination of my work objectives.....	1	2	3	4	5
I really have little voice in the formulation of my work objectives..	1	2	3	4	5
The setting of my work goals is pretty much under my own control	1	2	3	4	5
My supervisor usually asks for my opinions and thoughts when determining my work objectives.....	1	2	3	4	5
FEEDBACK					
I receive a considerable amount of feedback concerning my quantity of output on the job.....	1	2	3	4	5
I am provided with a great deal of feedback and guidance on the quality of my work.....	1	2	3	4	5
My boss seldom lets me know how well I am doing on my work toward my work objectives.....	1	2	3	4	5

Listed below are a series of statements that represent possible feelings that individuals might have about the company or organization for which they work. With respect to your own feelings about working for Manchester Plastics, please indicate the degree of your agreement or disagreement with each statement by circling the number which best represents how much you agree with each statement in the space provided next to each question.

	Strongly Disagree	Disagree	Neither Disagree or Agree	Agree	Strongly Agree
I am willing to put in a great deal of effort beyond that normally expected in order to help this organization be successful.....	1	2	3	4	5
I talk up this organization to my friends as a great organization to work for.....	1	2	3	4	5
I feel very little loyalty to this organization.....	1	2	3	4	5
I would accept almost any type of job assignment in order t keep working for this organization.....	1	2	3	4	5
I find that my values and the organization's values are similar.....	1	2	3	4	5
I am proud to tell others that I am part of this organization.....	1	2	3	4	5
I could just as well be working for a different organization as long as the type of work were similar.....	1	2	3	4	5
This organization really inspires the very best in me in the way of job performance.....	1	2	3	4	5
It would take very little change in my present circumstances to cause me to leave this organization.....	1	2	3	4	5

	Strongly Disagree	Disagree	Neither Disagree or Agree	Agree	Strongly Agree
I am extremely glad that I chose this organization to work for over others I was considering at the time I joined	1	2	3	4	5
There's not much to be gained by sticking with this organization indefinitely	1	2	3	4	5
Often, I find it difficult to agree with this organization's policies on important matters relating to its employees	1	2	3	4	5
I really care about the fate of this organization	1	2	3	4	5
For me, this is the best of all possible organizations for which to work	1	2	3	4	5
Deciding to work for this organization was a definite mistake on my part	1	2	3	4	5

Please use the following scale to answer the remaining questions:

	Very inaccurate	Somewhat inaccurate	Inaccurate	Neutral	Accurate	Somewhat accurate	Very accurate
CROWDING							
I often feel "crowded" while at work	1	2	3	4	5	6	7
My work place does not have enough space for the number of employees currently working in it	1	2	3	4	5	6	7
Individual workstations are located too close to one another	1	2	3	4	5	6	7
TASK PRIVACY							
I am able to concentrate fully on my job while at work	1	2	3	4	5	6	7
While at my workstation, I can work with few distractions or interruptions	1	2	3	4	5	6	7
Interruptions at work often prevent me from giving my full attention to my job	1	2	3	4	5	6	7
COMMUNICATIONS PRIVACY							
I can talk with my co-workers in confidence while at my workstation	1	2	3	4	5	6	7
It's difficult to work at my station because I have to worry about disturbing others	1	2	3	4	5	6	7
I am unable to have a personal or private discussion while at work	1	2	3	4	5	6	7

PLEASE FILL IN THE FOLLOWING INFORMATION:

Brief Job Description: (What do you do?)_____

_____

_____

Job Tenure (months and years working at Company Name):_____

Are you a supervisor (please circle one)?: **yes** **no**

(optional) Gender (please circle one): **female** **male**

(optional) Age (how old are you now?): ____

Please circle one item below which best describes the area in which you work:

Other (please specify)_____

THANK YOU FOR YOUR TIME AND EFFORTS.

Appendix B

Normative Data

Table 11
HFSQ Means by Environmental Type

Scale	Total	Office	Clean Room	Assembly	Machining
Total	3.20	3.50	3.33	3.10	2.95
Environ. Design	3.29	3.72	3.41	3.22	2.84
Facilities	3.07	3.33	3.22	3.00	2.84
Work & Systems	3.36	3.53	3.59	3.32	3.16
Equipment	3.27	3.70	3.02	3.07	3.00
Health & Safety	3.10	3.28	3.19	3.04	2.95
N =	505	161	13	191	140

Table 12
HFSQ Means by Supervisor - Non-Supervisor

Scale	Total	Supervisors	Non-Supervisors
Total	3.19	3.48	3.16
Environ. Design	3.29	3.77	3.22
Facilities	3.06	3.21	3.04
Work & Systems	3.37	3.54	3.34
Equipment	3.26	3.67	3.21
Health & Safety	3.09	3.35	3.06
N =	504	54	450

Table 13
HFSQ Means by Gender

Scale	Total	Female	Male
Total	3.20	3.18	3.21
Environ. Design	3.28	3.27	3.29
Facilities	3.07	2.96	3.14
Work & Systems	3.37	3.44	3.32
Equipment	3.26	3.29	3.24
Health & Safety	3.09	3.00	3.15
N =	498	199	299

Table 14
HFSQ Means by Job Tenure

		Number of Years on the Job				
Scale	Total	<1	1-2	2-5	5-10	>10
Total	3.20	3.53	3.27	3.12	3.19	3.08
Environ. Design	3.32	3.68	3.49	3.25	3.35	3.13
Facilities	3.05	3.46	2.96	2.94	3.11	2.98
Work & Systems	3.37	3.72	3.39	3.36	3.34	3.21
Equipment	3.28	3.60	3.47	3.21	3.34	3.08
Health & Safety	3.10	3.25	3.13	2.96	3.04	3.14
N =	380	57	58	96	41	128

Table 15
HFSQ Means by Age

		Age in Years				
Scale	Total	18-30	31-40	41-50	51-60	61+
Environ. Design	3.30	3.41	3.29	3.21	3.15	3.32
Facilities	3.06	3.08	3.12	2.98	3.05	2.83
Work & Systems	3.37	3.37	3.33	3.40	3.42	3.51
Equipment	3.27	3.37	3.28	3.19	3.12	3.35
Health & Safety	3.10	3.04	3.17	3.15	3.08	2.98
N =	411	146	108	94	51	12