A STUDY OF THE EFFECTS OF TECHNOLOGY CHARACTERISTICS OF MANUFACTURING PRODUCTION SYSTEMS ON AN INDIVIDUAL'S PERCEPTION OF JOB CHARACTERISTICS AND SATISFACTION

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CHAPTER I

INTRODUCTION

The ability to develop and adopt a reasonable level of technological sophistication can be a crucial competitive advantage of manufacturing firms. Technology is the driving force to improve performance, (productivity, quality) and the overall quality of working life [47].

How technology is designed and used may substantially change the nature of the manufacturing workplace. However, a review of the literature reveals little agreement as to what is referred to when we use the term "technology." Terms such as "automation," "hi-tech," "advanced production systems," "integrated manufacturing systems," "flexible manufacturing systems," "typology of production systems," etc., reflect the difficulty in identifying and defining the technology phenomenon that exists in the manufacturing industry. The new thought variety and proliferation of technology --as defined by Holt [45, p. 239] ("the knowledge, tools, systems, work methods and human patterns of endeavor used collectively to transform inputs into outputs,")--have affected a wide range of organizational, contextual, social, and behavioral variables. Unfortunately assessing the feasibility of a new technology is usually narrowed to matters of technical competence [73]. Janet J. Turnage [81] and Ann Majckrzak [55] found that while the purchasing rate of sophisticated and advanced manufacturing technology by U.S. firms is remarkably higher than other countries, the implementation failure of new technologies is 50-75 percent. The factory in today's shifting competitive criteria (timely delivery of high quality customized goods) "stands at the crossroads of technology-and-human-centered production concepts" [13, p. 1]. However, many American companies "have not yet realized that they should have to make far-reaching changes in the ways of thinking about human resources" [5, p. 45].

Workers' satisfaction on the job and high morale are important to organizational success. Low satisfaction can lead to high stress, absenteeism, and turnover of valuable workers [14, 27, 36, 79]. To retain excellent performers in an organization, managers may need to understand how various factors contribute to an acceptable level of workers' satisfaction. This knowledge can help decision makers to manipulate those factors in improving their workforce's life quality as well as the effectiveness of the organization itself.

Previous research indicates that technology has emerged as an explicit variable that influences employee job satisfaction [20, 32, 52, 72, 87 etc.]. Furthermore, many studies have looked at the specific influence of technology in terms of division of labor on organizational structure [88], as well as alienation [46, 76, 77, etc.]. Some studies extended their scope to examine the impact of a specific technology (i.e., assembly line, FMS, etc.) on job characteristics [1, 7, 8]. However, not a single study has investigated the relationship between technological and job characteristics, individual differences and employees' satisfaction comprehensively using the predictor-mediator-moderator-outcome. Nelson and White [61] attempted to explore the relationship between organizational context variables, job characteristics and attitudes, but the scope of their study was limited.

Blumberg [7] and Kelvin [25] observe that the impact of different technology characteristics on the workplace, particularly on workers is often overlooked or discounted. Even the few studies conducted in flexible manufacturing systems (FMSs), as reviewed by Adler [1], show that there is much dispute about the impact of technology on workers' satisfaction as a result of the technology-human interface. Differences in technology characteristics of production systems may result in different perceptions of the changing characteristics of the job that may lead to different personal outcomes.

The purpose of this study is to examine empirically the relationships between the technology characteristics of manufacturing production systems, workers' perceptions of job characteristics and job satisfaction. The study uses a general conceptual framework that portrays the efforts of many researchers with respect to "the effect of the interaction of organizational contextual factors (Predictor)" [62], "job characteristics and individual differences (Mediator and Moderators, respectively) on personal outcomes" [3, 17, 37].

Succeeding sections will present the rationale for this study; statement of the problem; objectives of the study; the theoretical framework used, namely: the predictor-mediator-outcome conceptual model (Figure 1) and Hackman's-Oldham's model (Figure 2), and a summary of the study's hypotheses.

Rationale and Significance of the Study

An organization represents a complex set of variables that interact to determine the organization's eventual effectiveness. Technology, size, environment and goals are the most pertinent variables comprising the organization's contextual dimensions. It is important to understand and evaluate the contextual dimensions (variables) in order to describe the organizational setting that influences the structural dimensions [26]. Structure refers to how the efforts of people in a unit are segregated for specialization and coordinated for overall goal accomplishment. Jobs are the components of the structure that facilitate the activities people engage in while utilizing the technology to work on the task [67]. The management literature attempted to find the relationship between technology and organization structure. Research proposed the structural designs that accommodate production technologies and facilitate internal workflow [59, 61, 68, 89]. However, few studies have explored the antecedence of technology to individual attitudes. They only examined satisfaction and alienation with respect to technological categories [46, 68, 69, 76-78].

Reviewing Fry [33] it is evident that Woodward's [89] classification of technology marked an outstanding contribution to the study of manufacturing technology. Many studies categorized technology according to either a modified version of Woodward's [89], Thompson's [81], Perrow's [65], Emery's [28], Faunce's [30], or a combination of any two or more classification schemes. The drawback of the categorization is that researchers conceptualize technology differently in terms of both its meaning and dimensionality. Defining technology as a concept rather than as a specific characteristic creates confusion in the usage of the term [46]. Moreover, these categories are inaccurate to represent the emerged new information technology, e.g., the flexible manufacturing systems (FMSs) [48].

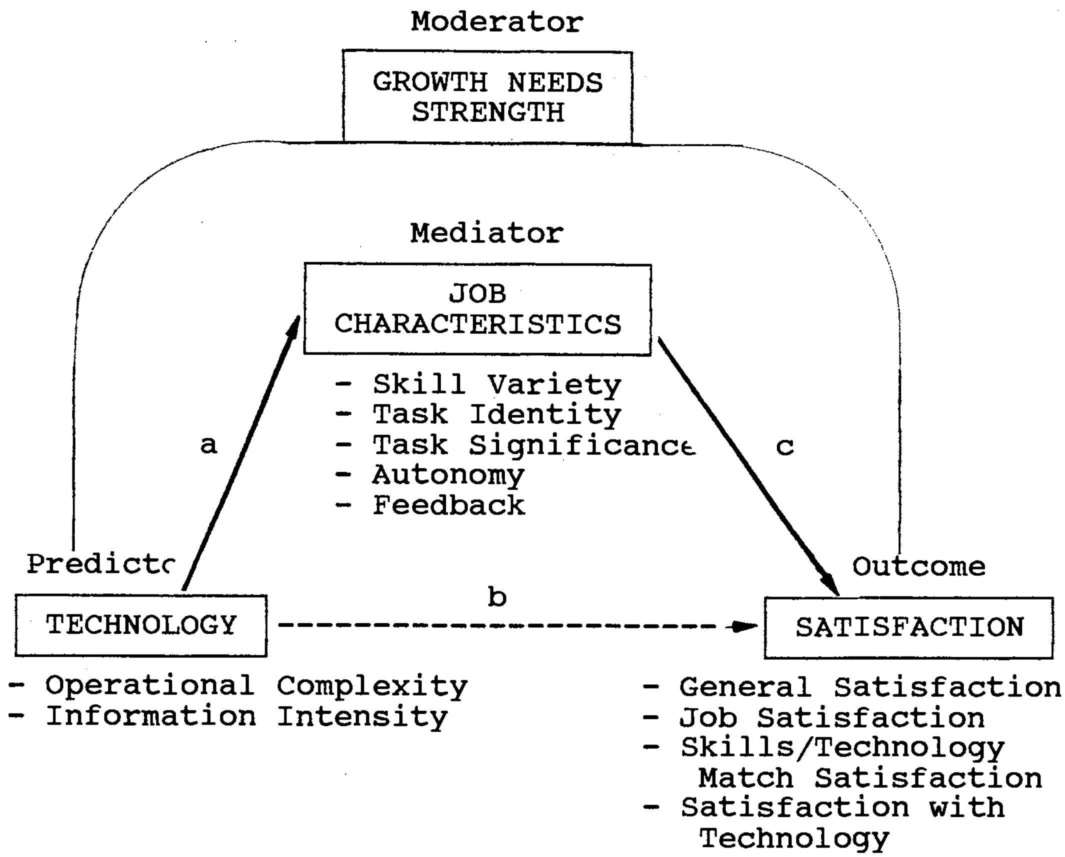
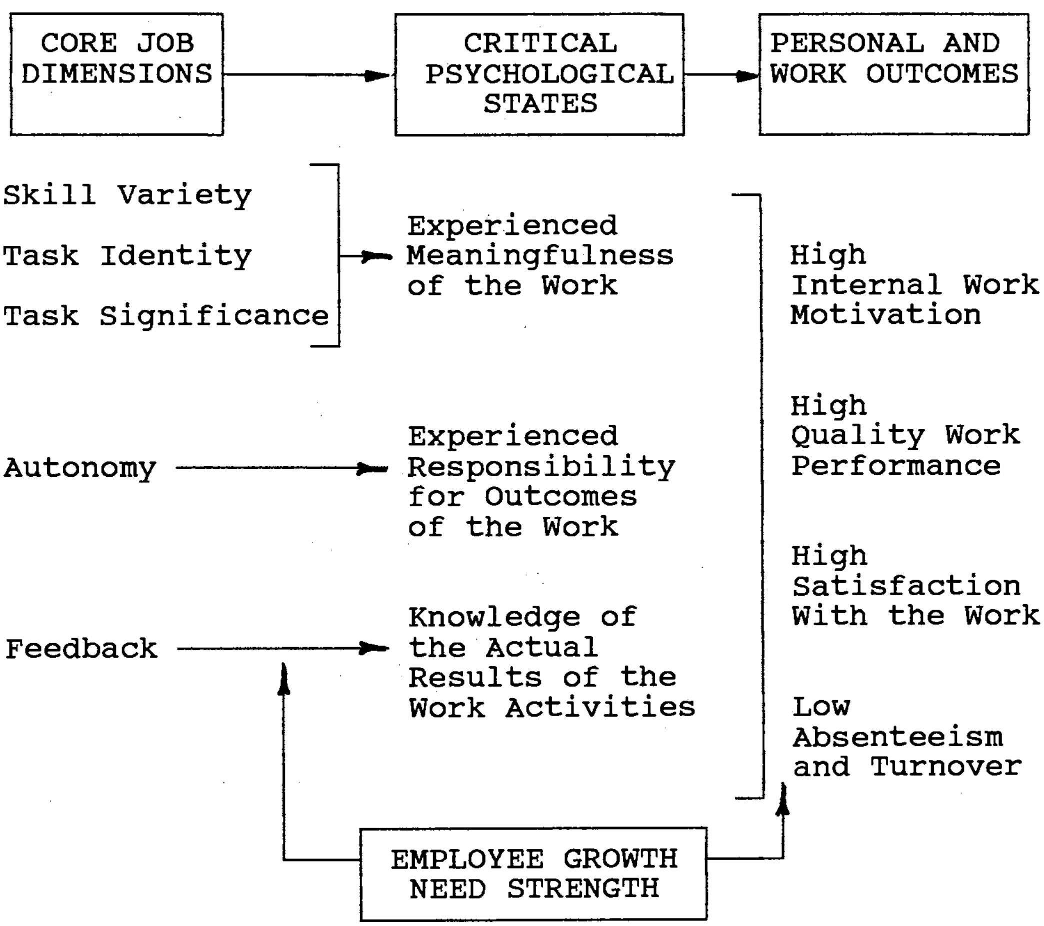


Figure 1. The Effect of the Interaction of Technology (Predictor), Job Characteristics (Mediator), and Growth-Need Strength (Moderator) on Satisfaction (Outcome)

A second drawback in technology-attitude studies is that only one attempt [61] was located treating technology, job characteristics, and attitudes as correlates. Nelson and White [61] attempted to correlate the relationship between organizational context variables, job characteristics, and attitudes. Nevertheless, they limited the scope of their study to the following: 1) a single mode of technology --the computer technology in a university library, 2) a specific innovation stage which was the initiation stage, 3) use of context variables which were structure-oriented, and 4) did not explore the role of individual differences as a possible moderating variable to the impact of computers on the outcomes.



Source: Hackman, J. R., and Oldham, G. R. (1974). The Job Diagnostic Survey: An Instrument for the Diagnosis of Jobs and the Evaluation of Job Redesign Projects [37].

Figure 2. Core Job Characteristics and Individual Outcomes: A Diagnostic Model of Job Enrichment

A proper mix of technology, structure, and human attitudes is necessary to achieve the organization's goals and accomplish its tasks [67]. The successful management of technology is no longer an optional matter but is vital to develop and maintain a firm's competitiveness in the present "new world order." Therefore, comprehensive studies on the interface of technology-structure-outcomes carry an immense importance in technology management. Extension of the sociotechnical and job design theories are attempts to manage the technology-structure-outcome relationships [75].

"While the sociotechnical system approach considers the whole system or organizational unit in planning organizational change, job design has traditionally focused upon interrelated job functions or jobs" [69, p. 21]. Thus, interventions which can be classified as job design studies [69] lack a coherent theory that incorporates technology/job characteristics and satisfaction relationships. The theory underlying this study as illustrated by the model presented in Figure 1 is an attempt to fill the gap of previous research, particularly, the use of technology categorization and the incomprehensiveness of contextual factors.

The predictor-mediator-moderator-outcome model might be a helpful tool to decision makers with regard to productivity improvement. A better understanding of the technology-human interface problem might help solve the dilemma of the American industry, specifically its 50-75 percent technology implementation failure. Components of the research model highlight the importance of identifying technology characteristics affecting the job characteristics which ultimately affect the employee's perceived satisfaction.

The model also recognizes the effect of individual differences on the entire relationship between the predictor, mediator, and the outcome (Figure 1). Thus, finding relationships and "identifying correlates of attitudes may help to identify factors which can be more easily manipulated than the attitudes themselves" [61, p. 3], since attempts to change attitudes through training programs have somewhat failed [61]. Therefore, it becomes important to include other elements assumed to be associated with individual attitudes, i.e., technology and job characteristics, and individual differences [62].

The importance of this research stems from the fact that it, i) mitigates the drawbacks of technology categorization, and ii) extends the scope of studies in the technology-attitude area by correlating the mediating effect of job characteristics and the moderating influence of individual differences on the impact of technology on satisfaction.

Statement of the Problem

This research identifies the relationships between production system technologies in manufacturing industries functioning at different levels of "operational complexity" and "information intensity" and workers' satisfaction. The research also determined whether the technology-satisfaction relation is mediated and/or moderated by workers' perceptions of job characteristics and growth-need strength, respectively.

Objectives of the Study

The objectives of this study are to identify the following relationships (as portrayed by the model depicted in Figure 1):

a. the perceived job characteristics and the production systems in terms of the technology's "operational complexity" and "information intensity;"

b. workers' perceptions of satisfaction and the characteristics of the employed technology of that production system.

c. workers' perceptions of satisfaction, and the constructs that mediate (the characteristics of their jobs) and moderate (individual differences --growth-need strength), respectively.

Theoretical Framework of the Study

The conceptual and theoretical framework of this study reflects a combination of Baron's and Kenny's [3] "mediation-moderation path diagram," Burns's [17] "moderator-mediator framework," Nelson's [62] "interactional model of individual adjustment," and Hackman's [37] "relationships among the core job dimensions, the critical psychological states, and on-the-job outcomes". Specifically however, a major part of the study is primarily based on Hackman's and Oldham's Job Diagnostic Survey model (JDS). Hackman-Oldham's JDS concept is used here to measure the employees' perceptions of technology and job characteristics, and satisfaction.

The Predictor-Mediator-Outcome Model

Figure 1 presents the conceptual model that guides this research. Worker perceptions regarding a production system reflect how the predictor (technology characteristics of that system) influences the components of the mediator (job characteristics embedded into the job the worker performs).

Thus, the model includes three interacting elements that affect individual satisfaction:

1. predictor - an organizational context factor defined in terms of operational complexity and information intensity. According to previous studies [23, 25, 26,

35, 44, etc.] these dimensions are defined as follows:

Operational Complexity is the outcome of three interacting concepts: skill complexity, process/operations interdependence and maintenance complexity.

Information Intensity is data which reinforce understanding, change the mental image and provide insight.

2. a mediator, job characteristic defined in terms of the amount of skill variety, task identity, task significance, autonomy, and feedback.
3. moderators (individual differences) as represented by "growth-need strength."

The model implies an analytical approach to moderator and mediator effects. The solid arrows connecting the independent variable (technology) to the mediator (job characteristics) and the latter to the dependent variable (satisfaction) are meant to signify the assumed presence of a mediator effect. This segment of the model (path "a" and "c") advocates the paradigm that the job design is affected by technology characteristics, albeit couched in terms of a mediator to satisfaction. The broken arrow connecting the independent variable (technology) and dependent variable (satisfac-tion), accordingly, signifies that this demonstrated direct path should diminish, ideally to zero, when the mediator is added to the equation. Finally, the moderator (a double-headed inverted-U curve) effects the entire independent-mediator-dependent system [16].

Generally speaking, the model is developed to measure the degree to which the specific technology characteristics (operational complexity, and information intensity) affect the job characteristics. The match between the two sets of variables may be an indicator of a specific criterion (satisfaction) or outcome. Nevertheless, a second route to satisfaction is possible; the direct predictor-satisfaction route.

Guided by this framework, a set of proposed hypotheses are presented in a later section. Details of the model arguments and discussion for the development of the hypotheses are presented in the literature review (Chapter II).

Job Diagnostic Survey (JDS) Theory

The theory developed by Hackman and Oldham [37] is illustrated by the model presented in Figure 2. The theory states that positive personal and work outcomes are obtained when three "critical psychological states," namely: --experienced meaningfulness of the work, responsibility, and knowledge of results-- are present (Figure 2). The three critical psychological states are created by the presence of five "core" job characteristics: skill variety, task identity, task significance, autonomy, and feedback. According to Hackman et al. [38, p. 161] these dimensions are defined as follows:

(1) skill variety -- the opportunity to use a number of

different skills on the job;

(2) task identity -- the opportunity to complete a whole and identifiable piece of work, i.e., doing a job from beginning to end with a visible outcome;

(3) task significance -- the opportunity to perform a job that affects the well-being of other people;

(4) autonomy -- the opportunity to make decisions relating to the work process, and;

(5) feedback -- the opportunity to learn how well one is performing the job.

Hackman's model actually focuses on the interaction among three variables: a) the psychological states of employees that must be present for internally motivated work behavior to develop; b) employee perception of job characteristics that can create these psychological states; and c) the growth-need strength. The theory suggests that experienced meaningfulness of the work is enhanced by skill variety, task identity, and task significance. Also experienced responsibility for work outcomes is increased when a job has high autonomy, and the knowledge of results is increased when a job is high on feedback. When tested, the model showed that the links between job characteristics and the psychological states, and between psychological states and outcomes, are moderated by individual growth-need strength.

It is important to note that Hackman and Oldham recommended that organization context variables (e.g.

size, and technology) must be integrated into the study of task design variables if meaningful proportions of outcome variance are to be explained [38]. Consequently, the theoretical framework of this study integrates technology into the JDS model as portrayed in Figure 1. Meanwhile, details of the arguments with regard to the integration of the technology into the JDS model (Figure 3) will be presented in Chapter II.

Hypotheses

Five hypotheses were proposed to test the relationships established by the model for this study. The research hypotheses are summarized as follows:

1- There is no relationship between workers' perceptions of job characteristics and the two technology characteristics of production systems.

2- There is no relationship between workers' perceptions of satisfaction and technology characteristics of production systems.

3- There is no relationship between workers' perceptions of job characteristics and satisfaction.

4- There is no mediating relationship (in terms of job characteristics) between workers' perceptions of technology characteristics and satisfaction.

5- There is no moderating relationship (in terms of growth-need strength) between workers' perceptions of technology/job characteristics and satisfaction.

Tests of the hypotheses provide a better understanding of the predictor-mediator-moderator-outcome process. Understanding the process of technology-human differences and the expected outcome of the interaction of technology-job characteristics and/or human differences -job characteristics will enable managers to prepare long-range plans before introducing new technologies. A planned series of managerial decisions could be initiated to integrate technological change into the existing human infrastructure. This can be done through education and training or improved selection of appropriate personnel or technologies as pre-adoption issues are already addressed.

Definition of Terms

The following definition of terms are presented to aid in the interpretation and clarification of this study:

Satisfaction is "the pleasurable emotional state resulting from the appraisal of one's job as achieving or facilitating the achievement of one's job values" [53, p. 310] . It includes intrinsic satisfiers such as pride in the work, self-actualization and identification with the organization, and extrinsic satisfiers, wage, security and social affiliation [43]. The notion satisfaction in this study means: 1) General Satisfaction, 2) Job Satisfaction (satisfaction with the job characteristics), 3) Skills/Technology Match Satisfaction, and 4) Satisfaction with Technology.

Growth-need Strength is "the attribute of an individual that determines how positively a person responds to a complex and challenging job" [37], i.e., it is the individual desire to achieve a sense of psychological growth in work --ego fulfillment and self-actualization.

Job characteristics refer to a set of attributes embedded into a job that are widely thought to be important causes of employee attitude and behavior [66].

Operational Complexity is the outcome of three interacting concepts: a) Collins's [23] skill complexity, b) Hickson's [44] and Thompson's [81] process/operations interdependence and c) maintenance complexity [22, 35].

Information Intensity is data which alter or reinforce understanding. It changes the mental image and provides insight" [26, p. 309].

Technology refers to the knowledge, know-how, strategies, equipment and techniques used in workflow activities to transform raw materials (inputs) into products (outputs) [26, 65, 70].

The arguments with regard to the selection of specific technology characteristics, and details of the operationalization of these terms as used in this study will be presented in Chapter II.

Synopsis of the Chapters

Chapter II is a review of the literature. It essentially presents the arguments for the development of the study's theoretical framework and hypotheses that guide the empirical research. Chapter III discusses the methodology; operationalization measurement of concepts; and the statistical techniques employed to analyze the data. Results of data analysis and overall findings are presented in chapter IV. The final chapter (V) examines the theoretical implications of the study's findings, and presents the summary, conclusions drawn and recommendations for further research.

CHAPTER II

REVIEW OF THE LITERATURE

Technology has brought profound and far reaching changes that have altered the way in which manufacturing organizations function. These changes in technology shape how people relate to their jobs and the satisfaction derived from their jobs.

Indicators point to the existence of a link between technology, job characteristics, individual differences and job satisfaction. But, opinions differ on how to identify the technology and the effect it has on these factors [20, 52, etc.]

This study attempts to relate the factors that interact in the technology-satisfaction process as depicted by the conceptual model in Figure 1 (Chapter I). Hence, the literature review culls previous opinions and research findings with regard to the model components, their definitions and relationships. The discussion is divided into the following sections:

- Technology and the Organization Design: The Techno-structural Approach to Organization Development
    - The Sociotechnical System
    - Job Design
    - The Theoretical Framework of the Study

- The Research Model:
  Integration of Technology into the JDS Model
- Predictor: Technology Characteristics
- Mediator: Job Characteristics
- The Moderator Effect
- Job Satisfaction

Technology And The Organization Design: The Techno-Structural Approach To Organization Development

Technostructural approach is the intervention intended to affect the work content and relationships of employees to their jobs and to each other through the introduction of changes in job characteristics. Paraphrasing Friedler and Brown, Rousseau [68] found two approaches to technostructural change, sociotechnical systems and job design.

The sociotechnical systems approach handles the inter-relationships of tasks within an organizational unit, e.g., a work group. The job design approach, on the other hand, focuses on the modification of specific jobs within an organizational unit but does not necessarily consider interrelationships between the modified jobs and other jobs or units [68]. Thus, the technostructural approach supports the technological imperative thesis. The concept of the technological imperative came into existence as a result of Woodward's and many other researchers' contributions such as

Bradley et al. [11]; Holt [45]; Mintzberg [59]; and Perrow [65] . It suggests that technology is a decisive factor in an organization's structure.

According to Woodward's [89] evolution process, the small batch system's evolution into mass production will be accompanied by expansion of middle management; and automation (continuous-process) will reduce middle managers thereby emphasizing more highly skilled supervision at all levels. Woodward also found that successful small-batch and continuous process plants had flexible structures, where their more rigidly structured counterparts were less successful. Nevertheless, successful mass-production plants were inflexibly structured.

Mintzberg [59] suggests that the more regulated the technical systems, the more formalized the operating work and the more bureaucratic the structure of the operating core. He also believes that automation of the operating core will shift the bureaucratic structure into an organic one accompanied by production employees' reduction and proliferation of more versatile highly qualified technical experts [45]. Daft [26], Mintzberg [59], and Woodward [89] advocate the contingent concept that structure depends on the nature of the adopted technology. They found that the more complex the technology (non-routine nature of the prevailing problems) the more organic the structure; and the less complex the technology the more mechanistic the structure.

Sociotechnical Systems

> Historically, the industrial system has been seen as imposing its own structure of relationships on the people who work for it, on their dependents, and, eventually, on all members of society who are, so to speak, "processed" by its needs for human resources
>
> (Burns and Stalker [18, p. xxi])

Based on the sociotechnical system theory, optimization of the social and technical subsystems occurs through analyzing and structuring of work content. The idea is to permit discretion on the use of methods and skill capabilities while preserving social harmony in the workplace in the process of achieving the organizational goals [68]. It has been suggested that the type of technology employed in an industrial organization acts as a major influence on its organizational structure, i.e., it affects decisions on the use of methods and skill capabilities and on the relationships of workers to their fellow workers (social harmony) [48, 59, 89]. Ever since, the technology-human interface has been an issue linked with the social aspects of work. The recognition of the impact of variations in technology characteristics on human roles and attitudes created the need for an adjustment theory. This study intends to disentangle the effects of production technology, per se, from the organizational, or workplace determinants of job satisfaction. Technology will be represented in terms of two variables, operational complexity and information intensity.

The sociotechnical theory provides technology management new dimensions and perspectives. The theory emphasizes the intimate interdependence of technology and human response; a blending of social and technical characteristics of the organization [8, 50, 65, 89]. As Hong-Joon Yoo [46, p. 2] quoted Broom and Selznick:

> A sociotechnical system means a system in which the rational, impersonal process of technology interacts with human factors and affects (1) worker behavior or attitudes, (2) informal group structure, and (3) formal organizational structure.

The sociotechnical components therefore include a production technology (machines, tools, and conveyances laid out over a geographic area), a process of transforming input (timely flow of raw materials and information), and a social structure. The social structure links the worker (attitudes, beliefs, and feelings) both with the technology and to each other (empathy and shared understanding) [68, 83].

Rousseau [68] paraphrased Katz and Khan [49] who found that a sociotechnical system could be represented by any unit of the organization formed out of technological and social subsystems having a common task or goal to accomplish. Thus, a sociotechnical system contains various jobs or functions which are interrelated through techniques inherent in the production process to facilitate the accomplishment of an organization's goals.

Goals are specifically accomplished through control mechanisms and joint optimization of the social and technical subsystems.

The control mechanism approach is exemplified by the work of Trist et al. concerning autonomous units in British [82] and American [83] coal mines. It assumes that the work group "must have at least as many possible behaviors in its repertoire to deal with unprogrammed events, as there are such events in the environment" [66, p. 20]. This means that the system design involves minimum specifications required to enhance autonomous production units. This approach contradicts Taylor's theories on scientific management, and Weber's bureaucracy in which they assumed that optimal work structure requires maximum specification [74].

Joint optimization states that a production unit will function best only if its two subsystems (social, technical) are designed to mutually satisfy their needs [26]. Organizing the production system to meet human needs while neglecting the technical aspects, or modifying technology to improve efficiency while ignoring human requirements, may eventually reduce performance.

Given the technical requirements of the production process, joint optimization of the social and technical subsystems leads to the involvement of the individual employee. Katz and Khan [49, p. 435] found that:

> Optimization requires technical aspects of the work ... organized in such a manner that the immediate work group would have a meaningful unit of activity, some degree of responsibility for its task, and a satisfactory set of interpersonal relationships.

Trist and Bamforth [82] found that when mechanical coal cutters were introduced in British mines, two adverse unexpected results occurred: productivity decreased and labor strife increased. The new technology failed because workers resented fragmented work groups which created lost opportunity for social interaction. In view of this finding, adjustments in the technology were made resulting in increased social satisfaction, higher productivity (95%), lower absenteeism (50%), and reduced conflicts and labor disputes.

Evidently jobs in an optimal sociotechnical system are conceptualized by theorists as those which provide variety in the tasks performed and skills used on the job, meaningful work, responsibility and control over the production process, feedback on performance and interaction with others (Adler [1]; Blumberg [7, 8]; Emery [28]; Hackman [41]; McWhinney [57]; Rousseau [68]; Shani [75]; Trist and Bamforth [82]; Trist, Susman, and Brown [83]).

Sociotechnical theorists predict that higher performance and satisfaction are ultimate consequences of restructuring work along the job characteristics mentioned earlier [68]. Technology is predicted to impose limitations on the type of change possible. However, no research has been carried out to evaluate the relationship of job characteristics shaped by different technological characteristics (i.e., operational complexity and information intensity), to satisfaction.

Job Design

Job design studies are traditionally concerned with interrelated job functions or single jobs to promote the factors influencing employees' effective and behavioral responses to their jobs [15, 69]. Thus, job designers have failed to incorporate linkages of jobs in the redesign of work processes [37]. "Interventions which can be classified as job design studies have lacked a coherent theory dealing with psychological process relevant to the behavioral and attitude changes associated with the restructuring of work" [68, p. 21].

Job design studies, however, have gained a profound place in the management thought due to a number of documented unfavorable behaviors and attitudes (e.g. job dissatisfaction, high rates of turnover and absenteeism) that often result from simple fragmented and repetitive jobs [6, 43]. As such, the quality of work life movement began as a reaction against Taylor's simplification of jobs. Consequently, the term "enrichment" was coined as an indicator of good jobs that involve variety, autonomy, etc., [9, 37].

Most of the current studies of job design have employed subsets of Hackman's "core" job characteristics to attain favorable behaviors and improve attitudes [1, 7, 61, 69]. Rousseau [69] found that research on job design supports Hackman's theory that specific types of job characteristics are related to employee behavior and attitudes. However, attitudes, absenteeism, and quality appeared to be improved as a result of job redesign although productivity is less often increased.

Moving toward the "information technology" phenomenon, pervasive changes have taken place in the work environment. Hackman's theory has been criticized by job designers who advocate that technological advancement dictates work design and therefore individuals must adjust to environmental conditions [45]. However, it is interesting to know that even Hackman's supporters have not found "a single definition of a job evolving separately from the particular work environment. Therefore, technology becomes subordinated as tools of work, not constraints to define job parameters" [45, p. 362].

Hymowitz, paraphrased by Holt [45], found that the sophistication of technology and methods constrains human resources such as the individual's control of tasks (e.g. robotic assembly). It is thus impractical today to define the individual's job pace when comprehensive technology systems rely on predictable behavior.

An examination of the two views necessitates a re-definition of the concept of a "job". An improved theory of redesigning jobs, under the technological imperative viewpoint, becomes essential to solve individual behavioral problems, helping workers to adapt to new technologies, and integrate technology in an enriched human resource system [45].

The Theoretical Framework of the Study

"The job characteristics employed in job design intervention appear to be congruent with the job dimensions characterizing an optimal sociotechnical system" [68, p. 23]. Both approaches strive for better meaningful work, control over the process, feedback, developing new skill, friendly relations with co-workers and supervisors in order to get favorable attitudes/ behaviors of organization members. The sociotechnical and job design theories however seem to converge in their use of the core job characteristics as the vehicle for desired organizational outcomes. Both hypothesize that certain aspects of work design are particularly relevant to the attitudes and behaviors of employees. Hackman's "core" job characteristics are not necessarily exhaustive, but do reflect the basic types of techno-structural change employed by these two approaches. Sociotechnical and job design proponents are therefore in consensus in the use of job characteristics as the core for techno-structural change. Antecedent to the development of job design techniques, sociotechnical systems provide a theoretical base for job redesign along with the emphasis on the role of the unit within the organization prior to developing change strategies. Sociotechnical theory also recognizes the impact of technology on change strategies [69].

Although sociotechnical and job design research has shifted their focus from routine, assembly-line production systems [28, 75, 82, 83] to fully automated --information technology--production systems (e.g. FMS) [1, 7, 8, 61, 62] there is little information on the variation of job characteristics across technology as defined in specific technology characteristics. Since relationships of technology characteristics to a set of job characteristics and satisfaction (direct, moderated and/or mediated) have not been previously examined, this study will particularly address this research gap.

The Research Model: Integration Of Technology Into The JDS Model

A modified version of Hackman's and Oldham's model guides this study. Hackman's and Oldham's findings [38] support this modification which is actually an integration of technology into the JDS model. The study by Griffin, Welsh and Moorhead [34] explained the concept of this integration. They think that outcome "is a function of a complex set of individual variables (e.g., motivation, experience, ability), group variables, and organizational variables (e.g., task design, structure, technology)" [34, p. 663].

Generally speaking, Hackman and Oldham [38] did not recommend that the JDS be used as "an instrument for a broad-based diagnostic tool of employee attitudes at work. Instead it is useful primarily for examining the characteristics of jobs per se and employee reactions to those jobs" [37, p. 7]. The Hackman-Oldham JDS concept could be an accurate reflection of the range of individual job characteristic perceptions across technologies, some of which did not exist at the time of the development of the survey; i.e., information technology. Using the general JDS concept, technology characteristics can be introduced into the model and can be reasonably assessed as direct correlates to job satisfaction.

Recently, a number of technology-attitude studies have begun to use JDS or modified versions of it. These studies have opened a new avenue to explore workers' reactions to the new information technology.

Adler [1], shows that there is much dispute about the impact of technology on workers' satisfaction when he replicated Blumberg's [7] study on flexible manufacturing systems (FMSs). In examining workers' (who were used to be working in stand-alone conventional machines and NC equipment) reactions to two FMSs, Adler found that: 1) the skill requirements of FMS jobs were perceived by workers as greater than those required by both stand-alone and NC equipment; thus defying Braverman's [12] de-skilling prognosis, and 2) workers in both FMS installations experienced high levels of satisfaction and motivation; thus also contradicting Blumberg et al. [7] who reported that workers in FMS were dissatisfied with their jobs because of the lack of autonomy and skill variety.

Most of the technology-attitude studies have shown incomprehension with regard to variables that should be included [62] and correlations to be considered [61]. Based on the expanded view of the "job-person" developed by Brousseau [15] outcomes depend on the job, the person, and the work situation. Nelson [62, p. 80] concluded that "the central tenet of organizational behavior is the notion that organizational context, work group attributes, job characteristics, and individual characteristics affect individual attitudes and behavior."

Nelson [62] evaluated more than thirty researches covering a wide variety of disciplines (industrial engineering, social psychology, human resource management, psychiatry, and information systems management) extended over an 11-year period (1978-1989). She found that the few researches having unambiguous connections between the technology and its social environment were unfortunately macro in focus, i.e., the research on attitudes toward computers used to be correlated with moderating variables such as experience, gender, etc. No studies investigating perceptions of the organizational context and job characteristics as correlates were located [61].

Although, the Adler [1], Blumberg [7], Brousseau [15], Hong-Yoo [46] Klopping [52], Nelson and White [61], Rousseau [69], etc., studies either covered a single type of technology or produced inappropriate correlates, they begin to provide insights with potentially far-reaching implications not only for job design but also for the design of organizational technology itself. Development of technical advancement must not be taken as a pure technical issue, but as a set of organizational context and social relations within which the system designers set the conditions under which the users feel comfortable. Considering only technology characteristics means giving technology only a little chance to be effective.

The modified model of Hackman and Oldham depicted in Figure 3 is an attempt to examine the effect of technology on job characteristics and job satisfaction. The figure represents technology design as being defined in terms of operational complexity, and information intensity that interact with Hackman's core job characteristics. The model indicates that technology characteristics affect job satisfaction either directly or through the individual's perceptions of the technology impact on his/her job characteristics (Chapter One, Figure 1) by paths "b" or "a" and "c", respectively.

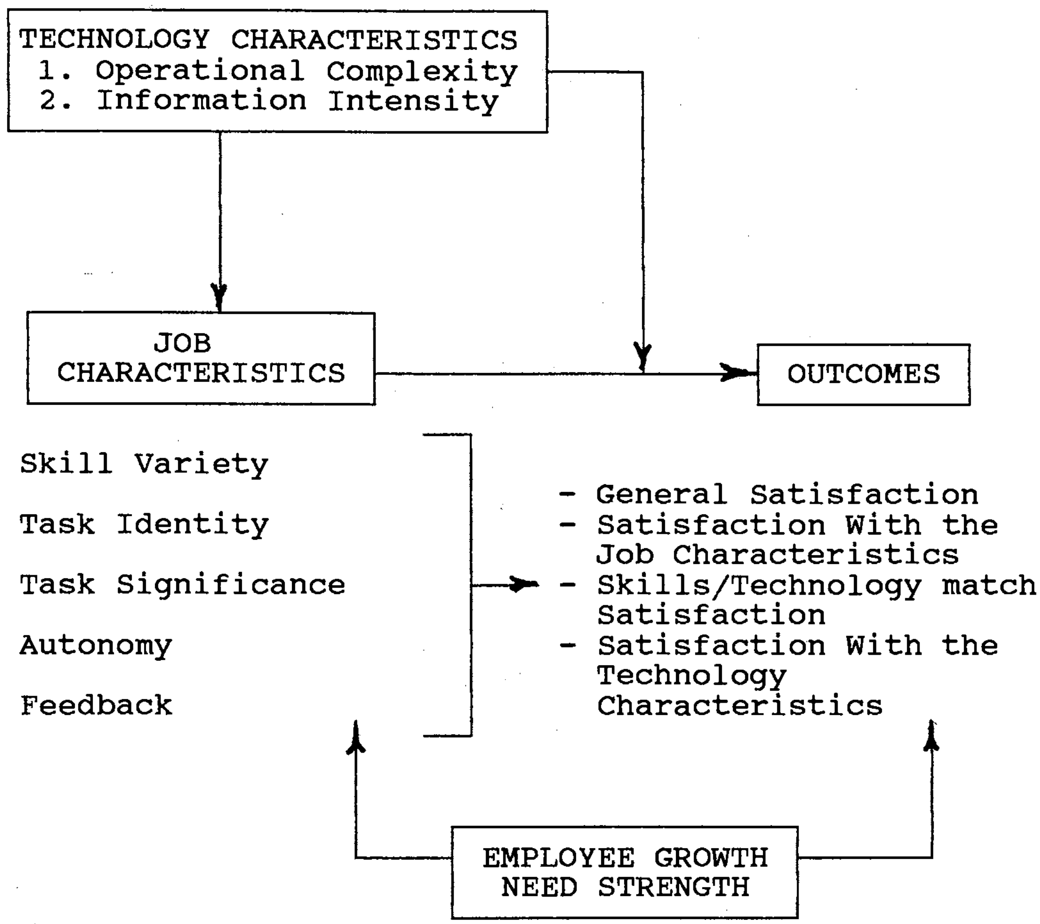


Figure 3. Integration of Technology into the JDS Model

Thus Figure 3 examines the relationship between manufacturing technologies and workers' perceptions of job characteristics and job satisfaction. The worker's perception regarding a technology system reflects how the technology characteristics of that system influence the amount of job variety, task identity, etc., embedded in the job the worker performs. Adopting Baron's and Kenny's [3] terms and Burns's [17] concept (Figure 1), the proposed model distinguishes between the properties of a predictor, moderator, mediator, and an outcome variable. The technology is the independent variable while satisfaction (outcome) is the dependent variable.

Reviewing Burns's [17] conceptual framework, it is appropriate, at this point of the research, to elaborate on the factors representing the terms "mediator" and "moderator" as related to the predictor-outcome model.

* Job characteristics are factors operating to accentuate the effects of the manipulated independent variable on a dependent variable (job satisfaction).
* Growth-need strength (GNS) affects the direction and strength of the relationship between the technology and job characteristics and satisfaction. Therefore, GNS is at the same level as the predictor (technology) with regards to its role as a variable antecedent to certain criterion effects.

Thus, mediators represent the generative mechanisms through which the focal independent variables are able to influence the dependent variables of interest [3]. Definitions of the model's components and their significance will be presented in the next section.

Predictor: Technology Characteristics

Definitions of technology abound, but most are either broad or narrow. The broad meaning of technology refers to the knowledge, know-how, and strategies involved in transforming inputs into outputs. In the stricter or narrower meaning, technology refers to the mechanical devices and techniques used in workflow activities to transform raw materials into products. Perrow [63], Rousseau [70], and many other researchers defined technology as the tools, techniques and actions used to transform organizational inputs into outputs. Subsequently they have operationalized the narrow concept of technology and have developed typologies of production technologies in manufacturing industry [46].

The first and most influential study of manufacturing technology was conducted by Joan Woodward [89]. She developed the first typology for classifying technology. Her model developed a scale of technical complexity. Accordingly, firms were categorized into batch, mass, and continuous-process production systems.

Hong [46] found that Woodward's classification has been elaborated by subsequent researchers according to different criteria, e.g., Mohr's consideration of the variability of work activities [60]; Rushing's typology with respect to raw materials flow [71], etc. The list is long and covers different evaluation criteria including: the use of mechanical aids, dependability of one task over the other, control systems, and the number of new products [26].

Considerable recognition was achieved by Thompson's [81] typology of technology which recently has been used by many researchers, e.g. Rousseau in her "Measures of Technology as Predictors of Employee Attitude" [69]. Thompson classified complex organizations by their operating technologies considered as a decisive factor to conceptualize the operation of complex organizations. Thompson's framework viewed the organization as entities rather than visualizing it as an entire body of knowledge at one time. He classified technology as long-linked; mediating and intensive. Long-linked technologies are similar to Woodward's mass production where there is a large number of narrowly specialized jobs and concrete specification of the tasks performed in a closely controlled sequence. Mediating systems, on the other hand, operate through a standardized process of sorting inputs into categories characterized by similarity so that well defined (tailored) procedures can be applied based on the categorization. Intensive technologies use a customized, combined variety of techniques and information for inputs, and provide the appropriate method of feedback. Thompson's scheme is most likely applicable to a diverse types of industries, even to service organizations, but is less likely to distinguish between different technologies in the manufacturing industry.

Perrow [65] developed a framework that has had a remarkable impact on departmental technologies. The model enhanced the ability to study diverse departmental activities. It is characterized by two dimensions of activities relevant to organizational structure and process, variety and analyzability.

Variety is the frequency of unexpected and novel activities occurring in the transformation process. Variety occupies a continuum with two extremes: high (numerous number of unexpected events/problems) and low (stable technology and repetitive jobs). Analyzability is the possibility of reducing the transformation process to mechanical steps where an objective computational procedure to solve problems. High analyzability means that standard procedures such as technical knowledge and operating manuals can be used to solve problems as they arise. Solving low analyzability problems requires accumulated experience, intuition, and judgment [26].

The two dimensions form the basis for four categories of technology: routine, craft, engineering, and non-routine technologies. Although Perrow's thesis seems to be applicable to various organizations, operationalization of his concepts tend to be difficult when applied to manufacturing firms [46].

Klopping [52] found that Emery et al. [29] distinguished five levels in the technology advancement process:

1. Mechanical manual production, where work is performed by manual labor with the aid of tools or machinery.
2. Mechanized production, where work is performed by powered machines, while the operation of equipment is partially manual.
3. Integrated mechanized production, where the whole cycle of the production process is performed by machinery, while a manual worker maintains the machines only.
4. Automated production, where some basic and ancillary operations are performed by machines without human intervention, while the worker regulates the equipment.
5. Integrated automated production, where no human intervention is involved in the production process.

Faunce [30] associates a characteristic form of division of labor according to the existence of a unique man-machine relationship in a three-type typological classification of production technological systems:

a. A craft production system is one in which workers are skilled and no highly differentiated division of labor exists.
b. A mechanized production system is one in which most workers are highly and narrowly specialized special purpose machine operators. Shepard [76] described these workers as making only a minute contribution to a product e.g. an assembly worker stationed in a fixed

post, watching a conveyor and adding one item to a thousand-component product (automobile). Hackman et al. [38] characterized such a job as insignificant. Shepard paraphrased Walker and Guest ("The Man on the Assembly Line") in describing mass (mechanized) production; "jobs are characterized by pacing of work, repetitive minute tasks, minimum skill requirements, predetermination in the use of tools and techniques, and surface mental attention," [76, p. 7].

c. An automated production system is one in which the operator monitors an integrated system, checking the functioning of the subsystems through dial readings. Job enlargement is the product of this system.

Hickson, Pugh, and Pheysey [44] conceptualized technology as multi-dimensional and classified it into operations technology, materials technology, and knowledge technology. Operations technology corresponds to Thompson's [81] long-linked technology, i.e., those workflow activities characterized by "serial interdependence". Yoo [46] viewed Hickson, Pugh's, and Pheysey's scheme as a re-interpretation of Woodward's classification into "the scale of production continuity." Materials technology, as Yoo quoted Perrow [63, p. 195], means "the characteristics of the object itself or raw materials," while Hickson et al [44, p. 380] defined knowledge technology as "the characteristics of the knowledge used in the workflow."

Examining the technology literature, Fry [33] realized that six specific technology criteria have categorized the production technology and consequently have guided empirical research. These are:

1. Technical complexity (Woodward [89])
2-3. Operation technology, and operation variability (Hickson, Pugh, and Pheysey [44])
4. Interdependence (Thompson [81])
5. Routine-nonroutine (Perrow [65])
6. Manageability of raw materials (Mohr [60])

In sum, the various studies that categorized technology have used two or more of the six general theoretical dimensions to arrive at a more comprehensive view of technology i.e., Mohr [60]. These classification schemes have been subsequently applied to investigate personal and work outcomes. The study by Rousseau [69], for instance, examined satisfaction across technologies in different industries using Thompson's [81] technology classification scheme. Modifying Woodward's typologies of production systems, Hong Yoo [46] classified the manufacturing industry into four levels: craft, machine-tending, assembly line, and continuous process to examine the impact of technology on alienation. Klopping [52] used Lieberman's classification of office automation (traditional, transitional, and transformational) to examine managers' satisfaction, etc. Robert Blauner [6] believed that automation presents a technological typology that is characterized by a less specialized division of labor which could lead to favorable attitudes toward work among production people. Walker [87] confirmed this in a study conducted in both semi-automated (transfer technology) and automated (continuous-process) work settings.

However, a review of the literature reveals little agreement as to what is referred to when we use the term "technology" as expressed in terms of the different typologies. Moreover, discrepancies have been reported in the findings of the studies due to the operationalization and measurement of the categorization criteria. For example Shepard [77] argued that various studies on the impact of technology are not comparable because different measures of the technology's aspects were used [46].

The preponderance of different technology categorization reflects the difficulty in identifying and defining the technology phenomenon existing in manufacturing industry. Assumptions on which the categorization criteria were based are usually criticized and debunked by others, e.g., the linearity assumption of Woodward's categorization was disputed by Harvey, as paraphrased by Yoo [46]. Harvey argued that Woodward's scale is non-linear because its first stage (small batch technology) is as complex as its final stage (continuous-flow). Moreover, the proliferation of information technologies has eventually rendered obsolete the old concept of the "small batch" classification [48]. Hull and Collins [48] to a large extent agreed with Woodward's model but questioned the absolute reality of the "batch" production system in the light of today's microelectronics advancements. With the emergence of CAD, CAM and FMS, the production of customized high-performance products became a reality. These technologies amended Woodward's model by sectioning the "batch production system" into two --technical and traditional (craft) batch systems, thereby creating a fourth class [48]. The subdivision of batch technology into traditional and technical categories not only updates Woodward's typology, but also:

> links it more closely with other basic variables associated with such characteristics of organizational design such as scale (Blau, Fable, McKinley, and Tracy) and complexity of knowledge (Collins and Hull; Perrow) as well as with current typologies of organizational design (Hage; Hull and Hage; Mintzberge) [48, p. 787]

Scale is referred to as the capacity of operations in terms of human activities and mechanical energy; while knowledge complexity means the technical expertise vested in human knowledge as well as the degree of computerization.

The literature survey indicates the following drawbacks of the various categorizations: first, researchers conceptualized technology differently in terms of both its meaning and its dimensionality [33]. Defining technology as a concept rather than as specific characteristics creates confusion in the usage of the terms [46]. "Often a study would use a different label for a technology dimension but cite another theorist as providing the conceptual underpinnings for the technology measure" [33, p. 538]. For example, one study used task scope to define technology but credited the task variability dimension [33].

Second, these categories are inadequate to represent the emerged new information technology, e.g., the flexible manufacturing systems (FMSs) [48]. Third, technologies vary across organizations to the point that definitions and analyses sometimes reflect differing parts of the production process or system characteristics. However, researchers measured technology as an aggregate at the level of the whole industry, e.g., Blauner [6]. As a result all respondents in a given industry (e.g. automobiles) were assigned to one technology type (assembly-line) whether they worked at maintenance, assembly, or even janitorial tasks. Respondents from a firm were therefore characterized by one "dominant" technology of that firm irrespective of their individual tasks [46]. This flaw ultimately biases data analysis and is likely to infer incorrect predictive impact of the technology. On account of this fact this study will assign each respondent to the actual characteristics of the production technology with which he/she directly works in examining the relationship between technology and satisfaction. Technology measured at the individual-level was found to be the best predictor of attitudes, whereas measurements based on interviews with management was the least predictive [69].

Broom and Selznick, as quoted by Yoo [46, p. 27] stated that "many sociotechnical systems in modern industry cannot be classified as strictly craft, assembly-line or continuous-process." Form [31] and Shepard [77], as summarized by Yoo [46], found that there are significant internal differences in the types of technology used within industries, even within the same factory. Paraphrased by Yoo, Blauner [6] corroborated that there was seldom technological homogeneity in any given industry or firm. The organization-level approach can produce distorted results in attitude studies because it samples employees who work at irrelevant work process, e.g., a janitor of an oil company as a continuous-process worker [46]. Based on cited methodological flaws this study defines technology in terms of its characteristics, i.e., operational complexity and information intensity.

Definition of the Technology Attributes

1) Operational Complexity is the outcome of three interacting concepts: a) Collins's [23] skill complexity, b) Thompson's [81] and Hickson's [44] process/ operations interdependence and c) maintenance complexity [22, 34]. Identification of these three concepts are as

follows:

a) One of the most popular methods of job evaluation is the point method. It divides jobs into specific factors that are believed, by personnel management (compensation schemes) [19], to be vital to an organization's satisfactory performance. Four interrelated compensable factors are considered to be important as skill's requirements (skill complexity): i) knowledge complexity, ii) training and experience, iii) complexity of duties, and iv) contacts with others.

Knowledge complexity refers to information concerning work duties which an individual should know for satisfactory technology performance. This knowledge could be acquired through different sources extended from formal schooling to equivalent experience in allied field [19]. Formal schooling knowledge corresponds to McCormick's [56] basic knowledge and aptitudes required for manufacturing operators, such as arithmetic reasoning, manual dexterity, etc., (Appendix C). Specific knowledge, on the other hand, relates to specific characteristics of the technology, e.g., the degree of computerization [48].

Training and experience are activities conducted under apprenticeship, introductory and continuous upgrading programs, and mentor attachment, to develop dexterity, managerial, and technical capabilities [19].

Complexity of duties appraises the kind and extent of judgment required in the making of decisions; analysis of problems; planning of procedures and determining methods of action; and the extent to which initiative and ingenuity are required to maintain the continuous effective/efficient operation of the technology and compliance with the output specifications.

Contacts with others in addition to technical duties, encompass the possibility of working in a team atmosphere, i.e., autonomous working groups, task forces or need to consult with fellow workers or customers.

b) Process/operations interdependence describes the workflow between the various work units. Are the work and activities performed with relative independence by the various work units or does the work flow sequentially between them; do the work and activities flow in a reciprocal manner; etc. (Appendix C).

c) Maintenance complexity determines routineness of maintenance activities, time to allocate technical failures (diagnosis), and the down time (breakdown) associated consequences. It is specifically of interest if rerouting of work is possible in the event of breakdown; if failures are easy to diagnose (locate), if they are maintainable through standard procedures, or if they require special outside contractor's expertise.

The maintenance factor is included in this study because the increasing complexity of today's technology increases downtime costs. Thus, equipment reliability is a decisive production factor [22]. It is also widely accepted that the performance of a firm is directly related to the worker's involvement with the goals of the firm. Such involvement is largely determined by the extent to which the physical and psychological needs of the workers are satisfied. Therefore, it is the interest of workers to realize that the satisfaction of their needs is related to the reliability of the equipment with which they work, i.e., the maintenance plays a role in providing the environment within which the individual carries out his/her tasks [35].

The equipment reliability-satisfaction interface supports the thesis that by improving individual performance (availability of reliable equipment is antecedent to performance), there may be an improvement in job satisfaction [74]. Moreover, an assumption of the existence of individuals seeking for "growth needs" implies the desire for challenge and achievement. It is therefore imperative for workers looking for growth needs to identify themselves with objectives which are desirable by the firm [35], e.g., equipment well-being --availability.

2) Information Intensity is data which alter or reinforce understanding. It changes the mental image and provides insight" [26, p. 309]. Information is used

to interpret situations and to facilitate a decision making process. Information intensity (amount, volume and richness of data -information carrying capacity; media) depends upon the situation. Different technology characteristics provide different situations. The routineness of technology dictates the amount of information required [26] e.g. non-routine technology requires large amount of information communicated through rich media i.e. social, informal, face-to-face discussions that convey multiple cues and facilitate immediate feedback. Communication activity and frequency increase as task variety increases. Complex integrated systems require more information sharing to solve problems and achieve proper completion of interdependent activities. Thus, in complex systems, in addition to technical skills, it is reasonable to assume that workers should acquire social skills sufficient to consult fellow workers and trace the system's problems in a cooperative manner.

Rationale for inclusion of "information intensity" is that, increasingly, shop floor jobs at all levels are being redesigned to incorporate information technology. Yet little is known about the extent of the change taking place in these jobs or their consequences for workers and organizations [85]. "Information intensity" creates a new work environment to which operators respond. "Consequently, it is the interplay between the work environment and the characteristics of application systems that must be better understood if general principles useful for the guidance of system design are to emerge" [85, p. 1210].

Mediator: Job Characteristics

Job characteristics refer to a set of attributes that are widely thought to be important causes of employee attitude and behavior [68]. Hackman et al. [37] hypothesized that job attitudes (satisfaction) are due to five core job characteristics. Spector and Jex [79] found that most of the job-attitudes studies have relied on employee self-reports as measures of both job characteristics and outcomes that raised questions about the interpretation and causal direction of self-report data. Hackman and Oldham [39] attempted to mitigate the effect of self-report data through the collection of data from multiple sources, i.e. to measure the job independently of the individual's idiosyncratic responses.

Extending the Hackman-Oldham theory, research started to integrate with the study of job design variables the organization context variables to have more meaningful explanations of the attitude and behavioral outcomes. Rousseau [69] distinguished between unit technology and job characteristics in a study of their contributions to the prediction of individual responses to work. Measuring technology as a predictor of employee attitude through individual-level descriptions of job characteristics, he used Thompson's [81] classification scheme to categorize the organization's production units. Classification of technologies were made by outside observers according to Thompson's criteria of "long-linked," "mediating" and "intensive" technologies. The study units represented different industries (banks, manufacturing and design-engineering firms, nursing staff, and public utility companies). The research concluded that the technological classification failed to contribute to the prediction of employee attitude beyond its relationship to job characteristics. This finding "suggests that the relationship of technological classification to attitude is mediated by job characteristics" [69, p. 217].

Referring to interactional psychology, Nelson [62] believes that simply measuring perceived job content of an existing employed technology is not sufficient; she recommended to test the change in the individual's perception of job characteristics over the specific technology's life cycle. Job characteristics have potential impact on worker's outcomes "but should do so in a longitudinal, multiple measures design, with a thorough analysis of potential individual and organization moderators included" [62, p. 84]. Paraphrasing Majchrzak and Cotton, changes in perceived job characteristics were inaccurate predictors of workers' outcomes; however, observed job changes were more accurate predictors of outcomes to a computer-automated production system [62].

Recent meta analyses have confirmed the significant relationship between job dimensions and psychological (personal) outcomes. Moreover, the effect of the organizational context on the success of information technology have been argued as well, "however, previous studies of attitudes toward computers have not addressed organizational and job factors as potential correlates" [61, p. 4]. Thus, based on selective examination of the literature, Nelson and White [61] have chosen four organizational context (participative decision-making practices, human resource primacy, communication flow, and supportive motivational conditions) to test their association with a set of job characteristics and positive attitudes in a study undertaken at an initiation stage of technological innovation. Their study concluded that outcomes of new technology are dependent on the individual, the job, and organizational context. They recommended that researchers "should begin to explore the notion of the fit between the person and the job ... not all individuals are predisposed to respond favorably to the changes in job attributes which are suggested by this study" [61, p. 13].

The Moderator: Growth-Need Strength

Many dimensions of individuals' differences may emerge as moderators of effective reaction to different characteristics of the predictor (independent variable) or dimensions of their jobs (e.g., sex, and culture). Attitudes and behavior are functions of the person and the situation. Individuals vary in terms of cognitions, abilities, and motivation and situations vary in terms of rewards, opportunities, etc. which act as moderators influencing one's satisfaction. However, it is hard to generalize on the effects of changes induced by different technology characteristics because such changes can either reduce or enrich job content and may therefore generate quite different reactions [62].

Generally speaking, in attitude studies, gender, education and age as individual differences variables have been widely investigated in terms of their relationships to outcomes. However, Nelson's [62] evaluation of more than thirty studies covering 1978-1989 revealed that these individual differences variables do not represent the whole characteristics through and by which individual moderators may influence the outcomes.

The most profound research on moderating effects has been an investigation of the influence of "higher order" need strength or growth-need strength on the relationship between enriched jobs and individuals' reactions to their jobs. Growth-need strength defined as "the attribute of an individual that determines how positively a person will respond to a complex and challenging job" [37] is the moderating variable in this study. To illustrate this, researchers have pointed out that it is the individual's desire to achieve a sense of psychological growth in work --ego fulfillment and self-actualization. Findings indicate that individuals who have strong growth needs react positively to jobs (enriched) involving high amount of skill variety, task identity, task significance, autonomy, and feedback [26, 37, 39]. However, these findings do not show that person's with low growth needs react unfavorably to enriched jobs; rather, they tend to remain indifferent to their job characteristics, regardless of how challenging or simple, varied or routine, their jobs happen to be [15]. The implication is that there is no stereotype of good or bad jobs. Whereas attempts to enrich jobs are likely to produce favorable reactions in terms of motivation and satisfaction for some individuals, they may never affect the job reactions of others.

Job Satisfaction

Job satisfaction is known to be an attitude of a person showing the extent to which his important needs are satisfied by his job. Locke [53, p. 310] defined job satisfaction as "the pleasurable emotional state resulting from the appraisal of one's job as achieving or facilitating the achievement of one's job values". Definitions used by other researchers focus on particular facets which they regard as most important e.g. Maslow's hierarchy of needs, McGregor's X-Y theory, Herzberg's dual theory, etc. [74] (some of these contributions are discussed in this chapter).

The definitions and concepts used by social scientists for over twenty-five years were drawn together in 1964 by Vroom [86]. Haroun [42, p. 2] paraphrased the findings of that study:

> The terms job satisfaction and job attitudes were often used interchangeably, but both referred to "effective orientations on the part of individuals towards work roles which they are presently occupying". The result of the research Vroom reviewed, was a general picture of a 'satisfying work role' which appeared to be one which provides high pay, promotional opportunities, considerate and participative supervision, an opportunity to interact with one's colleagues, varied duties and a high degree of control over work methods and work pace.

Recent studies have realized the inappropriateness of emphasizing such traditional and tangible motivators (incentives) as pay, fringe benefits, and physical working conditions in the future owing to the significant extent to which they already appear in many jobs. Instead attention and effort must now be devoted to the more intrinsic and non-tangible aspects of the job --the opportunity for self-fulfillment, autonomy, personal growth, etc. This means that work itself must be made more meaningful and challenging - some have even suggested that meaningful work will become the "right" of every worker just as the "right" to fair wages and decent working conditions exists today [54].

Herzberg, Mausner, Peterson, Capwall and Synderman [43] emphasized the distinction between the extrinsic and intrinsic aspects of motivation. Two categories were identified as sources of job satisfaction and job dissatisfaction. Into one category come all those elements surrounding the job such as security, pay, relations with one's superior and colleagues. These factors were called hygiene factors. Into the second category are factors intrinsic to the job itself like the satisfaction experienced by successfully overcoming work problems, meeting challenges or realizing that one is more responsible for achieving his/her task objectives. These factors were called motivators.

Herzberg et al. claimed that their data showed that if any of the hygiene factors was unsatisfactory, people expressed dissatisfaction and that this would continue until these factors were corrected. However, satisfaction with hygiene factors did not in itself motivate, although it was a necessary precondition for the motivation factors to become operative. Herzberg's work clearly complements that of Maslow with his hygiene factors corresponding to Maslow's first two needs and the motivators relating to the last three. The "M-H" theory's main practical outcome has been to reinforce the need for job enrichment.

A recent approach to personal satisfaction is reflected in the concept of Quality of Working Life (QWL), "a term that has gained deserving prominence as an indicator of the overall quality of human experiences in the workplace" [74, p. 229]. QWL, nowadays, is considered as a vital component to achieve high performance goals through the commitment of the workforce without sacrificing quality. A great deal of theoretical and practical work has been done in this field, both in social psychology and in the form of actual changes introduced into organizations. No particular QWL innovation is necessarily the right one. Some researchers believe in self-managing teams (autonomous work groups and decision-partnerships). Others believe in "Quality Circles" (QC). Nevertheless, Bradley and Hill [11] didn't find corroborative evidence for signs of effective employee participation in decision making, organizational redesign, etc., at least in the QC form, but they admitted that both the corporation and the individual were benefitted. They found that better health and safety were the main documented gains. The conclusion drawn was that "in practice, many forms of participation present few organizational difficulties, because they do not significantly erode managerial prerogative" [11, p. 84].

David Pincus [64] viewed the matter from a different angle. He critically analyzed employee involvement programs as alternative dispute resolution strategies. He believes that these programs are valuable, and they will offer an opportunity to enrich the lives of the total human resource of the firm which can improve the efficiency of operations if they are structured properly.

These approaches attempt to meet, at least, one of four objectives: security, equity, autonomy and democracy. The Swedish [24] success in radically changing Volvo's production methods is very instructive. The frustrating traditional assembly line jobs were enriched through the creation of "autonomous work groups," or self-managed work teams responsible for accomplishing defined performance objectives. The Japanese participative management style as exemplified by the popular "quality circles" concepts [11] is another outstanding example of the success of employees' involvement. In this case employees meet regularly to discuss ways of improving the quality of their products or services. Both the Swedish and Japanese experiences scored remarkable results: gains in productivity; better working atmosphere; greater flexibility; improved quality; a drop in absenteeism and a significant drop in in-process time.

There is an abundant literature on the effects of transition from one mode of technology into another on work content and organization (i.e., from conventional to numerically controlled (NC) machine tools). However, most of this highlights the "deskilling" and "degrading" of working life trends as discussed by Braverman [12] and known as the "pessimistic" view. Braverman argued a dual thesis: (1) that whatever the potential for more challenging jobs that may be notionally associated with new technologies, the struggle between workers and managers for workplace and workpace control leads managers to adopt implementation models that progressively deprive workers of their autonomy, and; (2) that competitive pressures and the prevailing profit-motive lead managers to attempt to reduce costs and thus encourage implementation approaches that curtail worker skill requirements and corresponding wage levels. Under these circumstances, workers were expected to experience a decline in the quality of work content and QWL as they change from conventional to NC machines and from NC machines to FMSs. Contradicting Braverman's emphasis on social conflict and his prognosis of progressive deskilling and degradation, are three other well-articulated positions as reviewed by Adler [1]: the "upgrading", "mixed effects" and "contingency" positions.

The "upgrading" position associated with the industrialization theories of Kerr and Myers, and those of the post-industrial society as advocated by Bell [4] offers a prognosis based on the superior productivity of automation when associated with skilled users. Known as the "optimistic" view, researchers expect work requirements to be continually increasing with the passage from conventional to NC to FMS.

Theoretical tradition argues that there may be deskilling effects in the early phase of mechanization, but that automation as a distinct phase holds the promise of job upgrading. Spenner [80] advocated the "mixed effects" view which was illustrated by Blauner's [6] study. The latter sought to determine under what conditions the alienation tendencies are intensified in modern industry and what situations give rise to different forms of alienation. Blauner showed that the extent of alienation is greatly influenced by the particular industry in which a person worked. It is also influenced by his opportunity for personal growth and development--to learn, to advance, to take on responsibility.

Contrary to these "deterministic" theories, many theorists advocate a fourth perspective --the "contingency" approach which essentially states that grading levels are contingent upon organizational and societal factors [32]. They opine that the impact of automation on work requirements reflects many variable contingencies such as management strategies, the state of product and factor market, the local power of contending actors, and the social construction of skill categories (Child [21]). This perspective focuses on the difficulty of making any compelling generalization about automation's impact on work requirements. Thus, technological change does not necessarily lead to deskilling. Accordingly, the dominant concern guiding management decisions is not to eliminate worker skill, but to increase productivity while satisfying a customer demand.

The "pessimistic" issues are employee alienation and displacement. In recent years, "alienation" has gained a profound interest as an empirically measurable concept [2, 46, 76, 87] --alienation from work and from expressive relations. Alienation from work "reflects a feeling of disappointment with career and professional development, as well as disappointment over the inability to fulfill professional norms." Alienation from expressive relations on the other hand, "reflects dissatisfaction in social relations with supervisors and fellow workers" [2, p. 497]. These two types, respectively, are synonymous to what Marx [10] called alienation from the process of production and alienation from the fellow worker.

The two alienation aspects support the argument that satisfaction levels of individuals working in similar (or in the same) production systems (technology) might vary according to social and professional (norms and job characteristics) settings of their jobs. Klopping's [52] "Effects of Office Automation Upon Managers and Workers" found that managers' and workers' (aggregated as one category) job satisfaction varied across office technology levels. When considering only managers as a separate category the same result was evident. But that was not true in the case of workers. Automation invited change such as job simplification and specialization in the organization. It was believed that Taylor's approach to job simplification would lead to efficiency, reduced skilled employees, enhance production control, and increased organizational profits. However, research studies found the unintended consequences of work simplification. Hulin and Blood as quoted by Klopping, expounded on job simplification: "as jobs become increasingly specialized the monotony (perception of the sameness of job from minute-to-minute, perception of the unchanging characteristic of the job) increases" [52, p. 3].

The goal of automation is to make firms more efficient and productive. However, as Klopping paraphrased Matherly and Matherly, worker's attitudes to technological change have to be carefully manipulated. Resistance to change if not timely handled, i.e., manipulate the factors leading to unfavorable attitudes [61], then alienation and organization's ineffectiveness and inefficiency will be the ultimate results.

Chao and Kozlowski [20] in their study regarding employees' perception to robotic adoption in manufacturing firms found that: technology threatens job security, robs employees' selfworth, and deskills jobs. They indicated that employees' responses were frustration and resentment towards robotic technology. Thus, the degree of job enrichment seems to be related to employee behavior, attitudes, and perception. A recent study by Roberts [32] found that well paid jobs will shrink while unskilled, dull and routine tasks will increase. Studies of the industrial revolution supported the pessimistic scenario that the introduction of machinery destroyed many artisan skills and created a huge army of unskilled industrial proletariat. The new technology could be, as Aiken and Haige believe, a source of professional disappointment and social dissatisfaction [2].

Reviewing Blauner [6], Faunce [30], Shepard [76] and Walker [87], there seems to be a curvilinear relationship between the technological typology and the degree of differentiation in the division of labor and satisfaction level where it is predicted that non-mechanized (craft) and automated systems produce greater satisfaction; where mechanized or higher differentiation is followed by higher alienation. A considerable number of studies (Chao and Kozlowski, [20]; Hackman, [40]; Hertzberg, [43]; Rousseau, [68]; Vroom, [83]; etc.) have indicated that routine, non-challenging jobs, may lead to employee dissatisfaction, absenteeism, high turnover rates and ultimately voluntary unemployment. Enlargement and enrichment efforts are aimed at modifying selected attributes of jobs and their environments. The underlying assumption of these programs is that individuals who are satisfied with the attributes of the job will perform better. Consequently, interest has focused on the process of job design -sometimes in combination with sociotechnical considerations or the effects of the technical, social and economic systems on job satisfaction. This combination of sociotechnical and job design assumptions, would probably, stress that: a) autonomous work group job enrichment is preferable to individual job enrichment; and b) changes need to be introduced participatively.

Experiments extend job enrichment concepts to broader systems and refine the knowledge of how to maximize the use of teamwork and optimize the use of skills. Improvements were related to communication, jobs exchange, variable work rate, and product identification. Attempts to improve the quality of working life through job enrichment programs in terms of quality circles and job redesign [11, 40, 66] assume that workers are or can be motivated by higher-order needs. Job design concepts were widely applied in the adoption of job enrichment principles. Researchers and managers alike are increasingly attempting to consider the way jobs are designed as an important factor in determining the motivation, satisfaction, and performance of employees. Carrying out work redesign, however, doesn't ultimately mean enriching the job. Only people with strong growth needs will respond positively to enriched jobs, while others may have negative reactions and experience anxiety [74].

The valuable contribution of Hackman and Oldham [37] in the job enrichment area addressed the redesign of work as a strategy leading to beneficial outcomes such as "high motivation," "high performance," and " satisfaction." They concluded that existing theories of work redesign were inadequate to meet the problems associated with their application thereby highlighting the need for a theoretical model. The resulting model specified the conditions under which individuals will become internally motivated to perform effectively on their jobs. In effect, it extended the relationship between a set of job characteristics and individual responses to the work.

Based on the foregoing literature review this study will present:

1) comprehensive modes of technology in terms of the

interaction of two technology characteristics, "operational complexity" and "information intensity," and 2) clear connections between the technology (predictor), job characteristics (mediator), individual differences (moderator), and satisfaction (outcome). Workers' perceptions of the theoretical framework (predictor-mediator-moderator-outcome) will be correlated. Results are expected to support the hypoyhesis that organizational context, job characteristics, and individual differences affect individual attitudes [61, 62, 69].

CHAPTER III

RESEARCH METHODOLOGY

Introduction

This chapter describes the methodology used to empirically examine the relationships of the predictor, mediator, moderator and outcome model previously described. This methodology examines the relationships between technologies, job characteristics, and job satisfaction as moderated by growth need strength. Included in this chapter are discussions of: the research design, the population sample, the questionnaire structure, the data gathering process, the measurement of constructs and data analysis techniques.

Research Design

The most appropriate research design to be used with a particular research problem depends upon a combination of sampling techniques, the characteristics of the population, survey costs, time constraints and complexity of survey questions. Given the available time to complete the study and limited funds a survey research design in the form of a questionnaire is considered the most feasible method.

The questionnaire is designed to collect data pertinent to the research question on the effects of technology characteristics on job satisfaction. The objective is to generalize any possible patterns of interdependence of technology and job characteristics, growth-need strength and job satisfaction across the population that will be surveyed.

The questionnaire was administered to a sample of individuals drawn from a diverse set of manufacturing organizations. The organizations were selected in such a way (purposive) as to represent different technology characteristics across manufacturing production systems; taking into account the accessibility of their premises.

The questionnaire is based on previous surveys with the addition of some items which measure maintenance complexity. The questionnaire is composed of four sections designed for the collection of quantifiable data for subsequent analysis. A detailed discussion of the three sections structure and development is presented in a following section in this chapter.

The methodology in this study links the individual and the technology data, i.e., links a representative sample of technologies to a representative sample of workers. This methodology ensures the representativeness of the workforce while also providing the data required to understand the effects of technology characteristics in the workplace.

Conducting correlation and regression on the constructs, the analysis methodology intends to find the relationships between technology, job characteristics and job satisfaction. Information obtained from respondents is pooled to reflect the properties of technology characteristics in terms of their effects on job characteristics and job satisfaction. The respondents are equally weighted when aggregating the data as they occupy the same level in the organization's hierarchy [2].

In designing and administering the questionnaire for this study efforts were made to improve response rate by minimizing the questionnaire length, and pre-testing the questions for clarity. Careful attention is given to the selection of words for new items, i.e., questions that measure "maintenance complexity", so as not to distort the sense of the questions. The quest-ionnaire was revised based on the pretest responses prior to its administration to the final sample part-icipants.

To facilitate access and sympathize acceptance of organizations' management a cordial covering letter indicated affiliation with the School of Industrial Engineering and Management at Oklahoma State University was attached to the questionnaire. Moreover, anonymity and confidentiality of survey respondents and organizations was stressed. Finally, an incentive in the form of a summary of the final report was offered to the participant firms (Appendix B).

Population Sample

Technologies: A purposive sampling method to ensure representation of different technologies across manufacturing production systems was used. This method required precategorization of manufacturing technologies according to their representative technology characteristics. The sample was intended to represent high to low operational complexity and high to low information intensity.

Kerlinger [51, p. 129] defines purposive sampling as "characterized by the use of judgment and a deliberate effort to obtain representative samples by including typical areas or groups in the sample." The researcher has visited several firms which have established working relationships with the Department of Industrial Engineering and Management at OSU. Through the assistance of department professors and associates a sample set of firms that were willing to participate in the research was located.

Individuals: The intent was to administer the questionnaire to volunteer participants who are directly involved in the manufacturing process in their organizations. Management implemented the process of obtaining participants, and to the least of the researcher's knowledge participation was voluntary. The study specifically surveyed production workers working in the capacity of operators of the production processes.

Questionnaire Structure And Development

The questionnaire consists of questions from previous surveys [23, 37, 56] as well as several new questions from the literature on maintenance management [22, 35], and information technology [85, 90]. The questionnaire is divided into four sections: 1) operations technology; 2) skill requirements; 3) job characteristics and employees' satisfaction; and 4) personal data.

The first section defines the characteristics of the employed technology in terms of operational complexity and information intensity. These questions are based on the "production technology survey." This survey was developed by the "Innovation and Productivity Research Program" of Rutgers University (Newark, New Jersey) in cooperation with the "Center for Innovation" of the University of Maryland (College Park) [23].

The second section of the questionnaire defines the required level of operating skills and experience as perceived by the technology users. This section was adapted from McCormick's "Positional Analysis Questionnaire" (PAQ) [56].

The third section measures six job characteristics, namely: skill variety, task identity, task significance, autonomy, feedback from the job and feedback from supervisors and co-workers, as perceived by the worker. This section contains statements selected from Hackman and Oldham's [37] "Job Diagnostic Survey." Perceptions concerning characteristics of the production system that she/he thinks are positively affecting the level of her/his satisfaction are also explored.

In addition, the questionnaire elicited some demographic information of respondents: age, sex, education and job title (section four).

Generally speaking, the three sources of this study's questionnaire (JDS, operational technology survey, and PAQ) have been thoroughly tested and are widely used. The results of the testing and use of these surveys indicate reasonable reliability and validity for these instruments [1, 7, 23, 37, 38, 48, 56, 69, etc.]. However, the pretest (pilot test) gave careful attention to the reliabilities of new constructs. Reliability coefficients (Cronbach's alpha) of the two technology characteristics and satisfaction with technology's characteristics were calculated. Internal consistency of operational complexity, information intensity, and satisfaction with the technology's characteristics were .72, .78, and .80, respectively. The result is within an acceptable range, as defined by

Nunnally [64].

A number of questions were modified to allow application of Likert scales; the use of Likert's scales facilitated consistency and ease of response, and improved reliability. The questions were originally designed to survey management and rewriting was required to a format that operators could respond to --Appendix C, questions 4 (b, c, d) and 5 (a-k).

The questionnaire was pretested and reviewed three times. Participants of the pretest/review group included three professors, four associates at Oklahoma State University (graduate students), two supervisors and five operators from manufacturing industry. Other OSU professors provided input regarding the general structure of the questionnaire. In the first pretest run three questionnaires were developed to collect data from three different sources, management, supervisors, and operators. The second run combined the three questionnaires into one, and reformulated the questions to be clearly understood by respondents of different educational levels. The final pretest run was intended to test the response to the amendments to the first and second versions (deletion of redundant questions, combination of others', and provision of explanatory statements for other questions). The third run included operators for the first time. Interestingly, the general understanding of the questions by the different pretest groups is almost the same. Approval of the final version of the questionnaire was issued by the Institutional Review Board of OSU-IRB (Appendix A).

Data Gathering

The questionnaires was administered during September of 1992 to twelve organizations to gather a sample of responses related to at least four different technologies including the combination of both high and low "operational complexity" and "information intensity." The intention was to use judgment and a deliberate effort to obtain an analyzable sample. Personal contact with the management of the organization's representative of the technologies was initiated for gaining their willingness to participate in this study. This contact was used to present the purpose of the study and assure the respondents of confidentiality, select the appropriate technology, identify possible respondents and establish time for the administration of the questionnaire. Of the 12 organizations contacted only six organizations committed themselves to participating and allowed their workforce to complete the questionnaires.

Measurement Of Constructs

To maintain comparability with past research (both in technology and satisfaction) operationalization of constructs were drawn when applicable from previous research [2, 23, 37, 46, 56, 69, 77, 90], thus, enhancing validity. The focus of this study was to examine the relationship between five constructs; technology (predictor), as defined in terms of two interacting constructs, job characteristics' construct (mediator) and satisfaction construct (outcome), while considering the presence of individual differences' construct (moderator). Each of the constructs was measured on the basis of responses to appropriate questions reflecting attributes of the variables.

Technology is defined in terms of the interaction of two technology characteristics, namely: operational complexity and information intensity. These are the independent variables.

To measure technology characteristics, the study surveyed production operators using several technologies and asked them to describe the representative production process in terms of the attributes of the two technology characteristics. The two technology characteristics are represented by the following attributes:

a) information intensity - composed of (1) operating information intensity, and (2) control/follow-up information variety .
b) operational complexity - refers to the (1) production's workflow, (2) level of operational interdependence, (3) frequency of failures, (4)

predictability of failures, (5) length of time needed to remedy failures, (6) consequences of failures, and (7) skill complexity.

Prior to measuring these two constructs ("information intensity" and "operational complexity") the questionnaire measures a construct which identifies the output characteristic --in terms of unit size-- of manufactured products. The output characteristic is a modified version of Woodward's [86] production systems construct. This construct provides an overview of the traditional categorization scheme of represent-ative technologies. With regard to this study this construct is not intended to measure the operational characteristic of production systems per se, however, it is included to provide supplementary information should it be necessary for comparison purposes with previous studies --Appendix C, 2 (a-j).

The five constructs (I, 1 and 2, and II-IV) included in the questionnaire are measured as follows:

I) Technology Characteristics

<u>(1) Operational Complexity</u>

A) <u>Production's Workflow</u> - the flow of work and activities between work units (equipments and individuals).

Section One # 3. a-e

Five workflow activities; independent, semi-independent, sequential, reciprocal, and team, are described below. The characteristics of complexity include dependance of activities across processing units and interpersonal involvement in decision-making and problem-solving. The values 1, 2, 3, 4 and 5 are assigned to the five workflow activities, respectively, as follows:

a. Independent Workflow (value = 1)
   Work and activities are entirely performed independently by one person alone and output (finished product) goes to another work station, to stock, or directly to a customers.

b. Semi-Independent Workflow (value = 2)
   Work and activities are relatively performed independently by the various work units and rarely flow between them.

c. Sequential Workflow (value = 3)
   Work and activities flow between the various work units, but generally in one direction.

d. Reciprocal Workflow (value = 4)
   Work and activities flow between the various work units in a reciprocal "back and forth" manner over a period of time.

e. Team Workflow (value = 5)
   Work and activities come into the production area, and leaders or supervisors from different units diagnose, problem-solve and collaborate as a group at the same time to deal with the work.

B) <u>Operations Interdependence</u>: The degree of flexibility/rigidity in terms of dependency of individual operations, of the manufacturing process, on each other.

Average the following items:

Section One # 5.a

5.b (reverse scoring)

5.e

5.h (reverse scoring)

5.k

5.a. The sequence of operations are rigid and give me no freedom and independence to do my work in the way I think best.

5.b. The equipment/process is multi-purpose, i.e., it can be reset to manufacture different outputs, (reverse scoring).

5.e. If the equipment fails to operate or breaks the work can be rerouted to other equipment.

5.h. How long can the most critical part of your production operations be delayed without bringing the other production processes (operations) to a complete halt? (reverse scoring)

5.k. The operator supervises/operates a completely automated machine which can perform a production operation itself for sustained periods of time, and will shut down automatically in the event of trouble.

C) <u>Maintenance</u> <u>Complexity</u> - the routineness of maintenance activities, time to allocate technical failures (diagnosis), and the down time (breakdown) associated consequences.

Average the following items:

Section One # 5.c

5.d

5.e

5.f

5.g (reverse scoring)

5.c. Equipment "major" breakdown frequency per week.

5.d. Machine general failure types (minor) are predictable.

5.e. Failures are easy to diagnose (locate).

5.f. Failures can be easily corrected by the operator through standard procedures (reverse scoring).

5.g. Failures can be easily corrected by the operator through standard procedures (reverse scoring).

D) Skill Complexity

General Requirements - the knowledge that could be acquired through different sources extended from formal schooling to equivalent experience in allied field [19].

Average the following items:

Section Two # 6.i(a-g)

6.i.a. Arithmetic Reasoning: ability to reason using quantitative concepts and symbols.

6.i.b. Verbal Comprehension: ability to understand the meaning of technical words (terminology) and ideas associated with them.

6.i.c. Mechanical Ability: ability to determine the functional interrelationships of parts within a mechanical system.

6.i.d. Numerical Computation: ability to manipulate quantitative symbols rapidly and accurately, as in various arithmetic operations.

6.i.e. Manual Dexterity: ability to manipulate objects with the hands.

6.i.f. Long-term Memory: ability to learn and store pertinent information and selectively to retrieve or recall, much later in time, that which is relevant to a specific context.

6.i.g. Perceptual Speed: ability to make rapid discrimination of visual detail.

Special Training and Experience Requirements - the knowledge that relates to specific characteristics of the technology, e.g., the degree of computerization [48].

Average the following items:

Section Two # 6.ii(a-e)

6.ii.a. Computer knowledge.

6.ii.b. Multi-disciplinary training (skill mix).

6.ii.c. Use of written manuals to operate the machines and solve problems, i.e., operating instructions.

6.ii.d. Long-period accumulated experience.

6.ii.e. Intuition and judgment.

(2) Information Intensity

Average the following items:

Section One #s 4.i.a-c (reverse scoring)

4.i.d

4.i.e (reverse scoring)

4.i.f

4.ii(a-b)

5.i

5.j

8.b

4.i.a. Tasks are defined precisely and are executed according to specific routines and procedures (reverse scoring).

4.i.b. The machine itself controls the progress of operation. Only malfunctions or the accomplishments of certain steps are indicated, e.g. through control lights (reverse scoring).

4.i.c. The machine measures the progress of the operation. The operator receives the information from control panels and/or visual display units --VDUs-- (reverse scoring).

4.i.d. The operator himself has to control the work process using his experience and/or measurement devices, e.g., micrometer.

4.i.e. Operational problems are solved according to established guides, e.g., operating manuals, (reverse scoring).

4.i.f. Machine failures and production problems require the involvement of many personnel of different expertise.

4.ii.a. How often do you use the computer system or output from the computer system?

4.ii.b. How long do you spend time using the computer system or reading printouts from the system in hours/minutes per day?

5.i. To what extent does the performance of the employed technology require you to work closely with people? ("suppliers/contractors" or people in your own organization?

5.j. To what extent does the employed equipment/ process require you to learn new skills and information related to your job?

8.b. The job requires a lot of cooperative work with other people.

II) Job Characteristics

The job characteristic constructs measure the objective characteristics of the job itself as defined by Hackman and Oldham [37]. These constructs are measured as follows:

a) Skill Variety: The degree to which a job requires a variety of different activities in carrying out the work, which involve the use of a number of different skills and talents of the worker.

Average the following items:

Section Three # 7.c

8.a

8.e (reverse scoring)

7.c. How much variety is there in your job? That is, to what extent does the job require you to do many different things at work, using a variety of your skills and talents?

8.a. The job requires me to use a number of complex or high-level skills.

8.e. The job is quite simple and repetitive (reverse scoring).

b) Task Identity: The degree to which the job requires completion of a whole and identifiable piece of work --i.e., doing a job from beginning to end with a visible outcome.

Average the following items:

Section Three # 7.b

8.c (reverse scoring)

8.j

7.b. To what extent does your job involve doing a "whole" and identifiable piece of work? That is, is the job a complete piece of work that has an obvious beginning and end? Or is it only a small part of the overall piece of work, which is finished by other people or by automatic machines?

8.c. The job is arranged so that I do not have the chance to do an entire piece of work from beginning to end (reverse scoring).

8.j. The job itself provides me the chance to completely finish the pieces of work I begin.

c) Task Significance: The degree to which the job has a substantial impact on the lives or work of other people --whether in the immediate organization or in the external environment.

Average the following items:

Section Three # 7.d

8.g

8.m (reverse scoring)

7.d. In general, how significant or important is your job? That is, are the results of your work likely to significantly affect the lives or well-being of other people?

8.g. This job is one where a lot of other people can be affected by how well the work gets done.

8.m. The job itself is not very significant or important in the broader scheme of things (reverse scoring).

d) Autonomy: The degree to which the job provides substantial freedom, independence, and discretion to the employee in scheduling his work and in determining the procedures to be used in carrying it out.

Average the following items:

Section Three # 7.a

8.h (reverse scoring)

8.l

7.a. How much autonomy is there in your job? That is, to what extent does your job permit you to decide on your own how to go about doing the work?

8.h. The job denies me any chance to use my personal initiative or judgment in carrying out the work (reverse scoring).

8.l. The job gives me considerable opportunity for independence and freedom on how to do the work.

e) Feedback from the Job Itself: The degree to which carrying out the work activities required by the job results in the employee obtaining information about the effectiveness of his or her performance.

Average the following items:

Section Three # 7.f

8.d

8.k (reverse scoring)

7.f. To what extent does doing the job itself provide you with information about your work performance? That is, does the actual work itself provide clues about how well you are doing --aside from any "feedback" co-workers or supervisors give?

8.d. Just doing the work required by the job provides many chances for me to figure out how well I am doing.

8.k. The job itself provides me few clues about whether or not I am performing well (reverse scoring).

f) Feedback from Agents: The degree to which the employee receives information about the effectiveness of his or her performance from supervisor or from co-workers. (This construct is not a job characteristic per se, but included only to provide information supplementary to construct (e) above.)

Average the following items:

Section Three # 7.e

8.f (reverse scoring)

8.i

7.e. To what extent do managers or co-workers let you know how well you are doing on your job?

8.f. The supervisors and co-workers on this job almost never give me any "feedback" about how well I am doing my work (reverse scoring).

8.i. Supervisors often let me know how well they think I am performing my job.

III) Individual Differences

The individual differences construct measures the degree to which each worker has a strong desire vs. weak desire to obtain "growth" satisfactions (challenge and self-actualization) from his/her work [37].

Individual differences are measured by averaging the following items:

Section Three # 9.a

9.b

9.c

9.e (reverse scoring)

9.f

9.g (reverse scoring)

9.a. My opinion of myself goes up when I do this job well.

9.b. I feel bad and unhappy when I discover that I have performed poorly on this job.

9.c. I feel good and happy when I discover that my job contains an amount of challenge.

9.e. I prefer to take a job where the pay is very good than a job where there is considerable opportunity to be creative and innovative (reverse scoring).

9.f. I prefer to take a job where I am often required to make important decisions than a job with many pleasant people to work with.

9.g. I prefer to take a job with very satisfying team-work than a job which allows me to use my skills and abilities to the fullest extent (reverse scoring).

IV) Satisfaction

The satisfaction construct measures the private, affective reactions or feelings a worker gets from working on his/her job and technology is the dependent variable. Satisfaction is measured by:

a) <u>General Satisfaction</u>

General satisfaction is an overall measure of the degree to which the employee is satisfied in his/her work.

Average the following items:

Section Three # 9.d (reverse scoring)

9.h

9.d. I frequently think of quitting this job (reverse scoring).

9.h. Generally speaking, I am very satisfied with this job.

b) <u>Satisfaction With the job itself</u>

The degree to which the worker is satisfied with the characteristics (scope) of the job.

Average the following items:

Section Three # 10.a-g

10.a. The amount of challenge and complex tasks in my job.

10.b. The amount of autonomy (independent thought and action I can exercise) in my job.

10.c. The chance to do a whole identifiable piece of work.

10.d. The variety of skills and talents I use in my job.

10.e. The significance and importance of my job to others.

10.f. The feedback I receive from doing my job itself.

10.g. The feedback I receive from supervisors/co-workers.

c) <u>Skill Match Satisfaction</u>

Is the satisfaction with the match between the worker's skills and the skills required by his/her Job.

Section Three # 10.h

10.h. The match between my skills and the skills required by my job.

Average Section Three # 11.i (a-g) and 11.ii (a-e)

[This measure is included to provide information supplementary to question # 10.h.]

The following statements are designed to obtain your perception concerning the existing characteristics of your job compared with the capabilities you have.

11.i.a. Arithmetic Reasoning: ability to reason using quantitative concepts and symbols.

11.i.b. Verbal Comprehension: ability to understand the meaning of technical words (terminology) and ideas associated with them.

11.i.c. Mechanical Ability: ability to determine the functional interrelationships of parts within a mechanical system.

11.i.d. Numerical Computation: ability to manipulate quantitative symbols rapidly and accurately, as in various arithmetic operations.

11.i.e. Manual Dexterity: ability to manipulate objects with the hands.

11.i.f. Long-term Memory: ability to learn and store pertinent information and selectively to retrieve or recall, much later in time, that which is relevant to a specific context.

11.i.g. Perceptual Speed: ability to make rapid discrimination of visual detail.

11.ii.a. Computer knowledge: data input and retrieval, and interpretation of printout.

11.ii.b. Multi-disciplinary training (skill mix).

11.ii.c. Use of written manuals to operate the machines and solve problems i.e. operating instructions.

11.ii.d. Long-period accumulated experience.

11.ii.e. Intuition and judgment.

d) Satisfaction With the Technology's Characteristics

The characteristics of the designed production system (equipment/process) that may contribute effectively to the level of satisfaction of the operator.

Average the following items:

Section Three # 12.a-h

12.a. The control I practise over the work pace of the equipment/process gives me satisfaction as a result of the feeling of autonomy I enjoy.

12.b. The flexibility of the sequence of operations gives me freedom to do my work in the way I think best.

12.c. The employed technology gives me the chance to learn new skills and information related to my job.

12.d. The frequency of equipment failures has negative effect on my morale as a result of stress I am subject to in order to maintain the required (predetermined) production quota.

12.e. The predictability of failure types positively affect my satisfaction because I feel no hustle to execute production programs within scheduled times.

12.f. The easiness to locate equipment failures alleviates problems that might affect my work.

12.g. The easiness to correct failures by myself positively affect my satisfaction with this job as a result of the variety of skills I practise.

12.h. Most production operations can be delayed for long periods without bringing the entire production line to a complete halt.

Statistical Methods and Procedures

Descriptive and inferential statistics were used. The descriptive statistics were used to describe the collected data with respect to the research constructs. On the other hand, the inferential statistics were used to estimate parameters (infer characteristics of the population) from characteristics of the surveyed sample [51]. Responses are indicated on a 7 point Likert scale. The responses assess the magnitude of the different technology characteristics, job characteristics, individual's growth-need strength (GNS) and attitudes.

1. Descriptive statistics

All variables used in the analysis will be described in terms of means and standard deviations. Means as measures of central tendency and standard deviations as measures of variability are necessary statistics to reduce the individual constructs' scores. Thus, both statistics (mean and standard deviation) epitomize and summarize the whole set of scores. Solving research problems without the "central tendency" or "variability" measures is almost impossible [51].

2. Inferential statistics

Using Baron and Kenny's [3] stimulus-response (S-R) approach, Burns [17] found that usually the researcher would look for differences between different moderating groups, i.e. those with high GNS vs. those with low GNS, or females vs. males, etc. However, with the moderator-mediator-outcomes approach we first inspect for moderator effects, i.e., we analyze correlation results or where respondents' GNS is suspected to be a moderator. As an example, the analysis may reveal a significant inter-action between respondents with a specific level of GNS, a specific level of operational complexity and job satisfaction. According to Baron and Kenny's [3], and Burns's recommendations; careful attention to individual differences is a precondition for the effectiveness of the predictor-mediator-moderator-outcome framework .

Generally speaking, it is important to note that moderator variables are typically introduced when there is an unexpectedly weak or inconsistent relation between a predictor and an outcome variable. Mediation, on the other hand, is best done in the case of a strong relation between the predictor and the outcome variable [3]. In addition, quoting Baron and Kenny [3, p. 1178]:

> there may be a wide variation in the functions served by moderators and mediators. In this case one may begin with a moderator orientation and end up elucidating a mediator process, or begin with a mediator approach and derive moderator-type interventions.

The moderation and mediation test procedures are described below:

<u>Moderation</u> <u>hypothesis</u> <u>test</u> -- within this framework, moderation implies that the relationship between the independent or predictor variable

(technology) and the dependent or criterion variable (satisfaction) changes as a function of the moderator variable (growth-need strength, sex, age, etc.) Thus, the statistical analysis must measure and test the differential effect of the independent on the dependent variable as a function of the moderator. The method used to measure and test the differential effects depends in part on the measurement level of the independent variable and the moderator variable. In this study, both variables are considered to be continuous.

To measure moderator effects in this specific case, it is important to know, initially, how the effect on the independent variable varies as a function of the moderator. This study assumes that the moderation is linear and can be captured by an XZ product term where the independent variable is denoted as X, the moderator as Z, and the dependent variable as Y, and Y is regressed on X, Z, and XZ. The significance of XZ indicates the moderator effects while X and Z are controlled. Other moderation presentations (i.e., quadratic or step function) implies different regression analysis procedures [3].

<u>Mediation hypothesis test</u> -- a series of regression models provide a test of the mediation hypothesis. To test for mediation, the following regression equations will be used: first, regressing the mediator (job characteristics) on the independent variable (technology

characteristics); second, regressing the dependent variable (satisfaction) on the independent variable; and third, regressing the dependent variable on both the independent variable and the mediator. Separate coefficients for each equation are determined and tested for significance [3].

The mediator is assumed, in some way, to transform the relationship between a predictor variable and its criterion variable. Using the separate regression analyses (path analyses) three steps are required to substantiate mediation. These regression paths are identified in Figure 1 as "a," "b," and "c." First, the path "a" between predictor (technology) and mediator (job characteristics) must be substantially significant. If not, the claim of mediation is not supported. Second, the path "b" between predictor and outcome (satisfaction) must be statistically significant. Otherwise, there is no basis for an effect of the predictor on the outcome. Finally, when using both predictor and mediator as independent variables, the predictor-outcome path "b" should be significantly reduced, while the mediator-outcome path "c" should be significant. Thus the amount of reduction in the size of the predictor-outcome path "b" in the third regression relative to the second one is a surrogate measure of the potency of the mediator. If this path becomes nonsignificant while the other conditions hold, mediation has been demonstrated.

Because the independent variable is assumed to cause the mediation, these two variables should be correlated. The presence of such a correlation results in multicollinearity when the effects of the independent variable and mediator on the dependent variable are estimated. This reduces power or strength of relationship in the test of the coefficient in the third operation.

All statistical analyses of data for this study were obtained by using a "statistical analysis package" from SYSTAT, Inc., (1988). The statistical procedures used to test the hypotheses were the Analysis of Variance of the correlation coefficients of the regression models. SYSTAT runs F-tests for the regressed data. A statistical significance level of $p < .05$ was chosen for the purpose of these tests. This significance level was selected to reduce the probability of making type II error, i.e., decreasing the probability of accepting a false hypothesis.

In order to facilitate the data analysis, information from the questionnaire was extracted and displayed on a LOTUS spreadsheet. A detailed coverage of the scoring and analysis processes are presented in chapter IV.

CHAPTER IV

ANALYSIS OF THE DATA

Introduction

The purpose of this study was to investigate the effects of technology characteristics on operators perceptions of job characteristics and satisfaction. Presented in this chapter is an analysis of the data relevant to this study. Analysis of the data relies primarily on correlation, regression and analysis of variance techniques to assess the relationships between the technology characteristics, job characteristics, growth-need strength and job satisfaction. Included in this chapter are the following topics: questionnaire return rates and sample description, reliability of constructs' measures, and the results of hypotheses testing.

Questionnaire Return Rates and Sample Description

Twelve organizations expressed their willingness to review the survey and possibly participate in the study, i.e., make their operators (subjects) accessible to complete the questionnaire. However, following this review only six decided to participate. On a firm basis this was a 50% return rate.

The six firms received 94 blank questionnaires. Sixty-eight (72%) questionnaires were returned. In total, 63 (67%) questionnaires were usable; five questionnaires were discarded due to missing information.

Seventy-six percent of the subjects are male. The average age of respondents is 35.6 years. The mean education level is 13.7 years. The education median is two years beyond high school. Average experience in the job that the respondent thought about while completing the questionnaire was 6.8 years.

Table I presents a summary of the demographic data of the respondents who participated in this study. The demographic data in Table I was not intended to serve as a particular variable or set of variables in the analysis, but rather to provide general background information concerning the respondents.

TABLE I

RESPONDENTS DEMOGRAPHIC DATA

Age		Age Group	Number
		24.0 - 30.0	19
Minimum	24.000	31.0 - 35.0	19
Maximum	54.000	36.0 - 40.0	10
Mean	35.571	41.0 - 45.0	5
Std. Dev.	7.472	46.0 - 50.0	7
		Above 50.0	3
Level of Formal Education Completed		**Education Bracket**	**Number**
		Below 12.0	3
Minimum	7.000	12.0 - 13.5	25
Maximum	20.000	13.6 - 15.0	24
Mean	13.703	15.1 - 17.0	10
Std. Dev.	1.905	Above 17.0	1
Years of Experience in Current Job		**Experience Bracket**	**Number**
Minimum	0.500	Below 3.0	19
Maximum	23.000	3.0 - 7.0	28
Mean	6.810	7.5 - 10.0	10
Std. Dev.	5.590	10.5 - 15.0	13
		Above 15.0	3

Reliability of Constructs' Measures

Self-report questionnaires were used to collect the data. Subjects were assured of anonymity and confidentiality. Table II presents the scales used in the study and reports means, and standard deviations.

The mean scores of the two technology characteristics, operational complexity and information intensity, are 4.265 and 4.110, respectively. The operational complexity characteristic has received a maximum score of 5.381 and a minimum score of 2.571, with a standard deviation of 0.740. The information intensity character istic has received a maximum score of 5.800 and a minimum score of 2.100, with a standard deviation of 0.726. The interaction of the two characteristic is shown in a scatter diagram (Figure 4). Dispersion of the respondents evaluation of the technology they use, with regard to the two characteristics, is quite evident.

TABLE II

MEANS, STANDARD DEVIATIONS FOR SCALES

Scale	Mean	S.D.
TECHNOLOGY CHARACTERISTICS		
1. Operational Complexity	4.265	0.740
2. Information Intensity	4.110	0.726
JOB CHARACTERISTICS		
1. Skill Variety	4.979	1.609
2. Task Identity	4.058	1.720
3. Task Significance	5.974	1.027
4. Autonomy	5.222	1.422
5. Feedback From Job	5.053	1.240
6. Feedback From Agent	3.677	1.712
GROWTH-NEED STRENGTH	4.974	0.795
SATISFACTION		
1. General Satisfaction	5.127	1.621
2. Job Satisfaction	4.735	1.093
3. Skills/Tech Match Satisfaction	4.825	1.880
4. Satisfaction With the Technology Characteristics	4.343	0.845

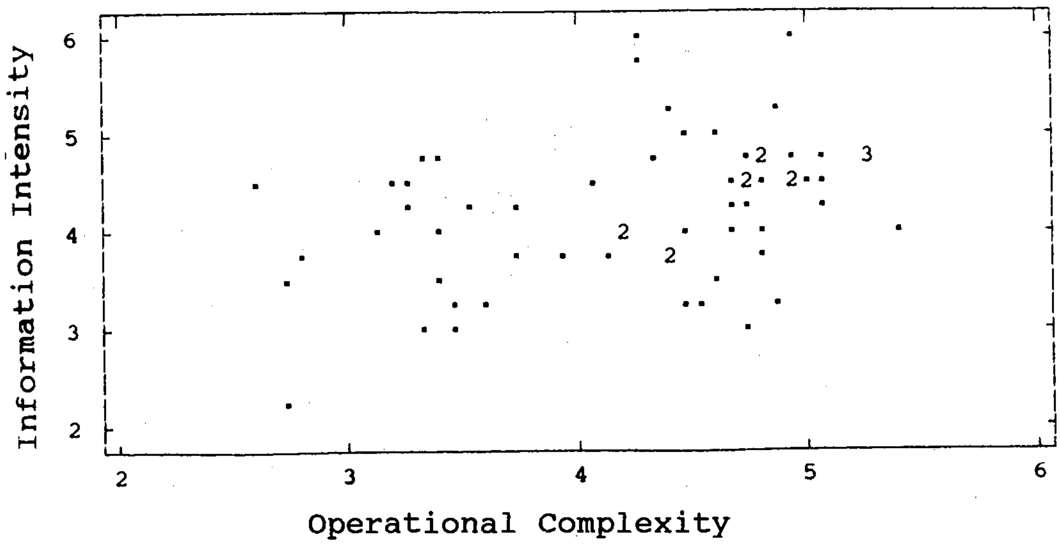


Figure 4. A Scatter Diagram of the Respondents' Perception of the Technology Characteristics

Reliability coefficients (Cronbach's alpha) of the two technology characteristics and satisfaction with technology's characteristics are shown in Table III. Internal consistency of the questions forming the constructs of operational complexity, information intensity, and satisfaction with the technology's characteristics are .88, .70, and .70 respectively. The mean inter-item correlations are within an acceptable level, as defined by Nunnally [64].

Demographic characteristics were examined for their correlations with the outcome (satisfaction) variables (Table IV). Sex, age, level of formal education completed, and experience --in the job that the respondent thought about while completing the questionnaire-- were not significantly correlated with the outcomes; however, experience was significantly correlated with the construct skill/technology match satisfaction --coincidence of the operator capabilities and technology (skills, knowledge, experience, etc.) requirements ($r = .26$, $p < .05$).

TABLE III

RELIABILITIES OF TECHNOLOGY CHARACTERISTICS AND SATISFACTION

Scale	Mean Inter-item Correlation	Cronbach's Alpha
Operational Complexity	0.243	0.876
Information Intensity	0.190	0.700
Satisfaction with Technology Characteristics	0.223	0.696

TABLE IV

CORRELATIONS BETWEEN DEMOGRAPHIC CHARACTERISTICS AND OUTCOMES (SATISFACTION)

	Sex	Age	Education	Experience
General Satisfaction	.07	.16	.11	.05
Job Satisfaction	.23	.14	-.03	.09
Skills/Tech Match Satisfaction	.07	.13	.10	.26*
Satisfaction with Technology	.17	.19	.08	.05

* With the exception of experience ($p < .05$), the demographic variables were not significantly correlated with the outcomes.

Results of Hypotheses Testing

The research hypotheses were examined using Pearson product moment correlations. Technology characteristics were examined (regressed) for correlation with job characteristics (Tables V-VI), and job satisfaction -- (general satisfaction, satisfaction with job, satisfaction with the skills/technology match, and satisfaction with the technology characteristics themselves-- (Table VII-VIII). Job characteristics were examined for correlations with satisfaction (Tables IX-XIV). The mediating effect of job characteristics on the technology-satisfaction path were examined in Figures 5 and 6. The moderating effect of growth-need strength on satisfaction was examined in Figures 7-9.

Hypothesis One: There is no relationship between workers' perceptions of job characteristics and the two technology characteristics of production systems.

TABLE V

REGRESSION OF JOB CHARACTERISTICS ON OPERATIONAL COMPLEXITY

Skill Variety

N: 63 Multiple R: .644 Sq. Multiple R: .414
Std. Error of Estimate: 1.241

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	66.452	1	66.452	43.138	0.000
Residual	93.968	61	1.540		

Task Identity

N: 63 Multiple R: .390 Sq. Multiple R: .152
Std. Error of Estimate: 1.597

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	27.862	1	27.862	10.923	0.002
Residual	155.594	61	2.551		

Task Significance

N: 63 Multiple R: .299 Sq. Multiple R: .089
Std. Error of Estimate: 0.988

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	5.835	1	5.835	5.975	0.017
Residual	59.568	61	0.977		

Autonomy

N: 63 Multiple R: .029 Sq. Multiple R: .001
Std. Error of Estimate: 1.433

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	0.107	1	0.107	0.052	0.820
Residual	125.227	61	2.053		

Feedback From the Job

N: 63 Multiple R: .050 Sq. Multiple R: .003
Std. Error of Estimate: 1.249

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	0.242	1	0.242	0.155	0.695
Residual	95.132	61	1.560		

TABLE V (Continued)

Feedback From Agent

N: 63 Multiple R: .091 Sq. Multiple R: .008

Std. Error of Estimate: 1.719

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	1.506	1	1.506	0.510	0.478
Residual	180.271	61	2.955		

TABLE VI

REGRESSION OF JOB CHARACTERISTICS ON INFORMATION INTENSITY

Skill Variety

N: 63 Multiple R: .283 Sq. Multiple R: .080

Std. Error of Estimate: 1.555

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	12.872	1	12.872	5.321	0.024
Residual	147.549	61	2.419		

Task Identity

N: 63 Multiple R: .062 Sq. Multiple R: .004

Std. Error of Estimate: 1.731

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	0.694	1	0.694	0.232	0.632
Residual	182.762	61	2.996		

Task Significance

N: 63 Multiple R: .191 Sq. Multiple R: .037

Std. Error of Estimate: 1.016

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	2.389	1	2.389	2.313	0.133
Residual	63.013	61	1.033		

TABLE VI (Continued)

Autonomy

N: 63 Multiple R: .154 Sq. Multiple R: .024
Std. Error of Estimate: 1.416

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	2.977	1	2.977	1.484	0.228
Residual	122.357	61	2.006		

Feedback From the Job

N: 63 Multiple R: .164 Sq. Multiple R: .027
Std. Error of Estimate: 1.233

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	2.561	1	2.561	1.683	0.199
Residual	92.812	61	1.522		

Feedback From Agent

N: 63 Multiple R: .130 Sq. Multiple R: .017
Std. Error of Estimate: 1.712

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	3.075	1	3.075	1.050	0.310
Residual	178.702	61	2.930		

The hypothesis that there is no relationship between an individual's perception of job characteristics across technology characteristics was supported by 8 of the analyses conducted above, namely: operational complexity-(autonomy-feedback from the job-feedback from agent); and information intensity-(task identity-task significance-autonomy-feedback from the job-feedback from agent). The results of the regression analyses presented in Tables V-VI indicate that there is no relationship between the perception of job characteristics and technology characteristics with the exception of skill variety when regressed on both operational complexity ($R = .64$, $p < .001$) and information intensity ($R = .28$, $p < .05$), and task identity and task significance when regressed on operational complexity ($R = .39$, $p < .01$, and $R = .30$, $p<.05$, respectively).

Hypothesis Two: There is no relationship between workers' perceptions of job satisfaction and technology characteristics of production systems.

The hypothesis that there is no relationship between operational complexity and satisfaction outcomes was not supported by the regression analyses and correlation coefficients in three out of the four cases (Table VII). General satisfaction, job satisfaction, and skills/technology match satisfaction, were found to be correlated with operational complexity ($R = .36$, $p < .01$, $R = .49$, $p < .001$, and $R = .54$, $p < .001$, respectively). However, the hypothesis that there is no relationship was supported in the case of satisfaction with the technology characteristics outcome.

TABLE VII

REGRESSION OF SATISFACTION ATTRIBUTES ON OPERATIONAL COMPLEXITY

General Satisfaction
N: 63 Multiple R: .362 Sq. Multiple R: .131
Std. Error of Estimate: 1.524

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	21.331	1	21.331	9.186	0.004
Residual	141.654	61	2.322		

Job Satisfaction
N: 63 Multiple R: .488 Sq. Multiple R: .238
Std. Error of Estimate: 0.962

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	17.647	1	17.647	19.079	0.000
Residual	56.422	61	0.925		

Skills/Technology Match Satisfaction
N: 63 Multiple R: .538 Sq. Multiple R: .289
Std. Error of Estimate: 1.598

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	63.405	1	63.405	24.845	0.000
Residual	155.675	61	2.552		

Satisfaction With the Technology Characteristics
N: 63 Multiple R: .072 Sq. Multiple R: .005
Std. Error of Estimate: 0.849

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	0.230	1	0.230	0.319	0.574
Residual	44.019	61	0.722		

TABLE VIII

REGRESSION OF SATISFACTION ATTRIBUTES ON INFORMATION INTENSITY

General Satisfaction
N: 63 Multiple R: .166 Sq. Multiple R: .029
Std. Error of Estimate: 1.612

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	4.508	1	4.508	1.735	0.193
Residual	158.476	61	2.598		

Job Satisfaction
N: 63 Multiple R: .075 Sq. Multiple R: .006
Std. Error of Estimate: 1.099

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	0.421	1	0.421	0.348	0.557
Residual	73.648	61	1.207		

Skills/Technology Match Satisfaction
N: 63 Multiple R: .276 Sq. Multiple R: .076
Std. Error of Estimate: 1.822

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	16.654	1	16.654	5.019	0.029
Residual	202.426	61	3.318		

Satisfaction With the Technology Characteristics
N: 63 Multiple R: .036 Sq. Multiple R: .001
Std. Error of Estimate: 0.851

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	0.056	1	0.056	0.077	0.782
Residual	44.193	61	0.724		

The hypothesis that there is no relationship between information intensity and satisfaction was supported with the exception of the relationship with skills/technology match satisfaction ($R = .28$, $p < .05$).

Hypothesis Three: There is no relationship between workers' perceptions of job characteristics and job satisfaction.

TABLE IX

REGRESSION OF SATISFACTION ATTRIBUTES ON SKILL VARIETY

General Satisfaction
N: 63 Multiple R: .331 Sq. Multiple R: .109
Std. Error of Estimate: 1.543

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	17.841	1	17.841	7.498	0.008
Residual	145.143	61	2.379		

Job Satisfaction
N: 63 Multiple R: .542 Sq. Multiple R: .294
Std. Error of Estimate: 0.926

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	21.751	1	21.751	25.360	0.000
Residual	52.318	61	0.858		

Skills/Technology Match Satisfaction
N: 63 Multiple R: .621 Sq. Multiple R: .386
Std. Error of Estimate: 1.485

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	84.510	1	84.510	38.308	0.000
Residual	134.570	61	2.206		

Satisfaction With the Technology Characteristics
N: 63 Multiple R: .187 Sq. Multiple R: .035
Std. Error of Estimate: 0.837

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	1.554	1	1.554	2.221	0.141
Residual	42.695	61	0.700		

TABLE X

REGRESSION OF SATISFACTION ATTRIBUTES ON TASK IDENTITY

General Satisfaction
N: 63 Multiple R: .368 Sq. Multiple R: .136
Std. Error of Estimate: 1.520

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	22.118	1	22.118	9.578	0.003
Residual	140.866	61	2.309		

Job Satisfaction
N: 63 Multiple R: .510 Sq. Multiple R: .260
Std. Error of Estimate: 0.948

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	19.228	1	19.228	21.388	0.000
Residual	54.841	61	0.899		

Skills/Technology Match Satisfaction
N: 63 Multiple R: .258 Sq. Multiple R: .066
Std. Error of Estimate: 1.831

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	14.533	1	14.533	4.334	0.042
Residual	204.546	61	3.353		

Satisfaction With the Technology Characteristics
N: 63 Multiple R: .092 Sq. Multiple R: .009
Std. Error of Estimate: 0.848

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	0.378	1	0.378	0.525	0.471
Residual	43.871	61	0.719		

TABLE XI

REGRESSION OF SATISFACTION ATTRIBUTES ON TASK SIGNIFICANCE

General Satisfaction

N: 63 Multiple R: .239 Sq. Multiple R: .057
Std. Error of Estimate: 1.587

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	9.335	1	9.335	3.706	0.059
Residual	153.649	61	2.519		

Job Satisfaction

N: 63 Multiple R: .301 Sq. Multiple R: .090
Std. Error of Estimate: 1.051

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	6.703	1	6.703	6.069	0.017
Residual	67.366	61	1.104		

Skills/Technology Match Satisfaction

N: 63 Multiple R: .123 Sq. Multiple R: .015
Std. Error of Estimate: 1.881

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	3.308	1	3.308	0.935	0.337
Residual	215.771	61	3.537		

Satisfaction With the Technology Characteristics

N: 63 Multiple R: .083 Sq. Multiple R: .007
Std. Error of Estimate: 0.849

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	0.303	1	0.303	0.420	0.519
Residual	43.946	61	0.720		

TABLE XII

REGRESSION OF SATISFACTION ATTRIBUTES ON AUTONOMY

General Satisfaction

N: 63 Multiple R: .011 Sq. Multiple R: .000

Std. Error of Estimate: 1.634

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	0.019	1	0.019	0.007	0.933
Residual	162.965	61	2.672		

Job Satisfaction

N: 63 Multiple R: .332 Sq. Multiple R: .110

Std. Error of Estimate: 1.040

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	8.144	1	8.144	7.535	0.008
Residual	65.925	61	1.081		

Skills/Technology Match Satisfaction

N: 63 Multiple R: .033 Sq. Multiple R: .001

Std. Error of Estimate: 1.894

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	0.237	1	0.237	0.066	0.798
Residual	218.843	61	3.588		

Satisfaction With the Technology Characteristics

N: 63 Multiple R: .154 Sq. Multiple R: .024

Std. Error of Estimate: 0.842

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	1.045	1	1.045	1.475	0.229
Residual	43.204	61	0.708		

TABLE XIII

REGRESSION OF SATISFACTION ATTRIBUTES ON FEEDBACK FROM THE JOB

General Satisfaction
N: 63 Multiple R: .052 Sq. Multiple R: .003
Std. Error of Estimate: 1.632

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	0.433	1	0.433	0.162	0.688
Residual	162.552	61	2.665		

Job Satisfaction
N: 63 Multiple R: .318 Sq. Multiple R: .101
Std. Error of Estimate: 1.045

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	7.497	1	7.497	6.869	0.011
Residual	66.572	61	1.091		

Skills/Technology Match Satisfaction
N: 63 Multiple R: .064 Sq. Multiple R: .004
Std. Error of Estimate: 1.891

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	0.896	1	0.896	0.251	0.618
Residual	218.183	61	3.577		

Satisfaction With the Technology Characteristics
N: 63 Multiple R: .224 Sq. Multiple R: .050
Std. Error of Estimate: 0.830

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	2.211	1	2.211	3.209	0.078
Residual	42.038	61	0.689		

TABLE XIV

REGRESSION OF SATISFACTION ATTRIBUTES ON FEEDBACK FROM AGENT

General Satisfaction

N: 63 Multiple R: .354 Sq. Multiple R: .125
Std. Error of Estimate: 1.529

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	20.415	1	20.415	8.735	0.004
Residual	142.569	61	2.337		

Job Satisfaction

N: 63 Multiple R: .569 Sq. Multiple R: .323
Std. Error of Estimate: 0.906

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	23.955	1	23.955	29.159	0.000
Residual	50.113	61	0.822		

Skills/Technology Match Satisfaction

N: 63 Multiple R: .229 Sq. Multiple R: .053
Std. Error of Estimate: 1.845

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	11.532	1	11.532	3.389	0.070
Residual	207.547	61	3.402		

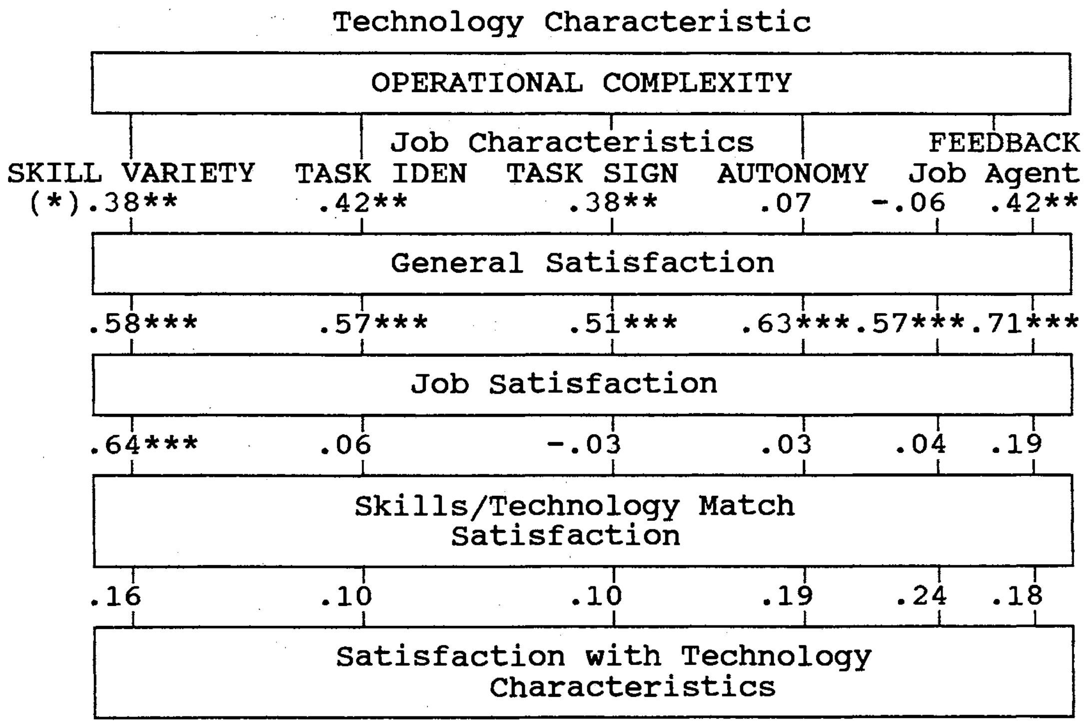
Satisfaction With the Technology Characteristics

N: 63 Multiple R: .141 Sq. Multiple R: .020
Std. Error of Estimate: 0.843

Source of Var	Sum-Of-Sq.	DF	Mean-Sq.	F-Ratio	P
Regression	0.874	1	0.874	1.229	0.272
Residual	43.375	61	0.711		

Job characteristics were found to be associated with the different forms of satisfaction as follows: skill variety, task identity, and feedback from agent were significantly related to general satisfaction ($R = .33$, $p < .01$, $R = .37$, $p < .01$ and $R = .35$, $p < .01$, respectively), and satisfaction with the job itself ($R = .54$, $p < .001$, $R = .51$, $p < .001$ and $R = .57$, $p < .001$, respectively). When "satisfaction with the skills/ technology match" was correlated with: skill variety ($R = .62$, $p < .001$) and task identity ($R = .26$, $p < .05$), significant relationships were evident. On the other hand, the hypothesis of no relationship was supported in the case of satisfaction with the technology itself --characteristics--, i.e., all job characteristics were not significantly related to satisfaction with the technology characteristics. Not surprisingly, all the six job characteristics were significantly related to satisfaction with the job itself: autonomy, ($R = .33$, $p < .01$); feedback from the job, ($R = .32$, $p < .01$); and feedback from agent, ($R = .57$, $p < .001$). Further, task significance, autonomy, and feedback from the job were not significantly related to general satisfaction.

<u>Hypothesis Four:</u> There is no mediating relationship (in terms of job characteristics) between workers' perceptions of technology characteristics and satisfaction.



*** Significant at level p < .001
** Significant at level p < .01

(*) The figures represent the correlation coefficient values "R"

Figure 5. A Diagrammatic Summary of the Data Analysis for Mediation with Regard to Operational Complexity-Satisfaction Interface

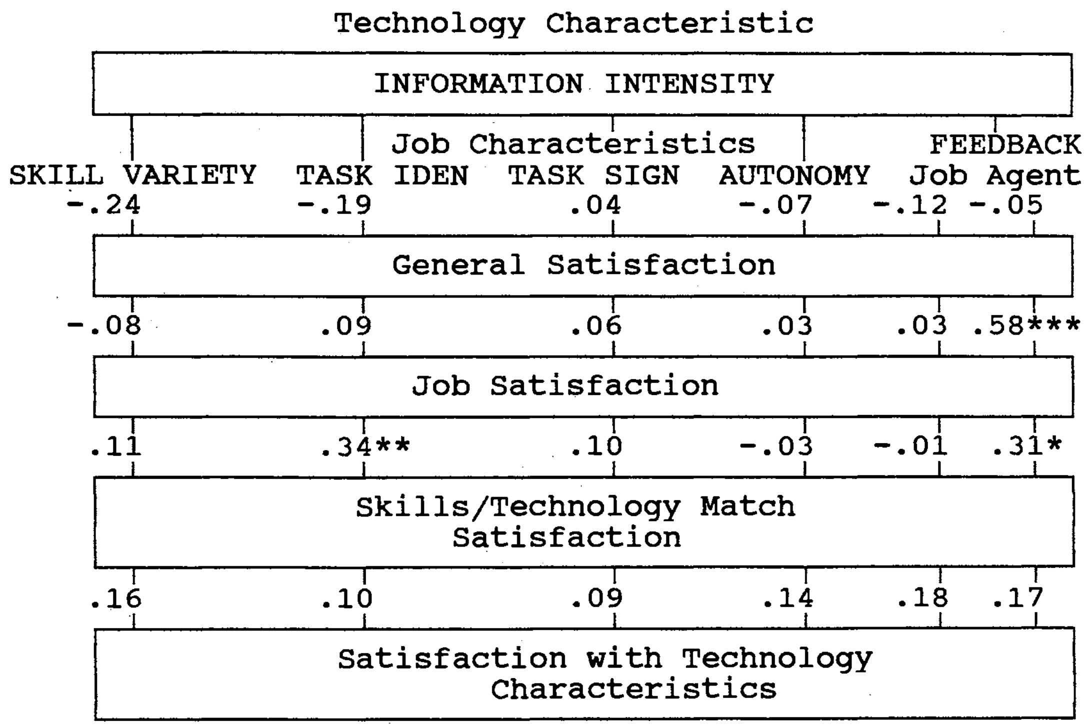
Using step-wise regression analysis, Figures 5-9 summarizes the result of testing the mediation and moderation hypotheses. Figure 5 examines the mediation effect of job characteristics on the predictor (operational complexity)-satisfaction interface.

The effect of operational complexity on general satisfaction was found to be significantly mediated by the job characteristics: skill variety ($R = .38$, $p < .01$); task identity ($R = .42$, $p < .01$); task significance ($R = .38$, $p < .01$); and feedback from agent ($R = .42$, $p < .01$).

The effect of operational complexity on job satisfaction was found to be significantly mediated by all the six job characteristics: skill variety ($R = .58$, $p < .001$); task identity ($R = .57$, $p < .001$); task significance ($R = .51$, $p < .001$); autonomy ($R = .63$, $P < .001$); feedback from the job itself ($R = .57$, $p < .001$); and feedback from agent ($R = .71$, $p < .001$).

Therefore the hypothesis of no mediation effect was not supported in four of the case of "general satisfaction" and the six cases of "job satisfaction". On the other hand, the hypothesis of no mediation was supported in the case of satisfaction with the technology itself --characteristics--, i.e., all job characteristics did not significantly mediate the interaction of operational complexity and satisfaction with the technology characteristics.

The hypothesis of mediation between operational complexity and "skills technology match satisfaction" was supported in all cases with the exception of skill variety which showed a significant correlation ($R = .64$, $p < .001$).



*** Significant at level $p < .001$
** Significant at level $p < .01$
* Significant at level $p < .05$

Figure 6. A Diagrammatic Summary of the Data Analysis for Mediation with Regard to Information Intensity-Satisfaction Interface

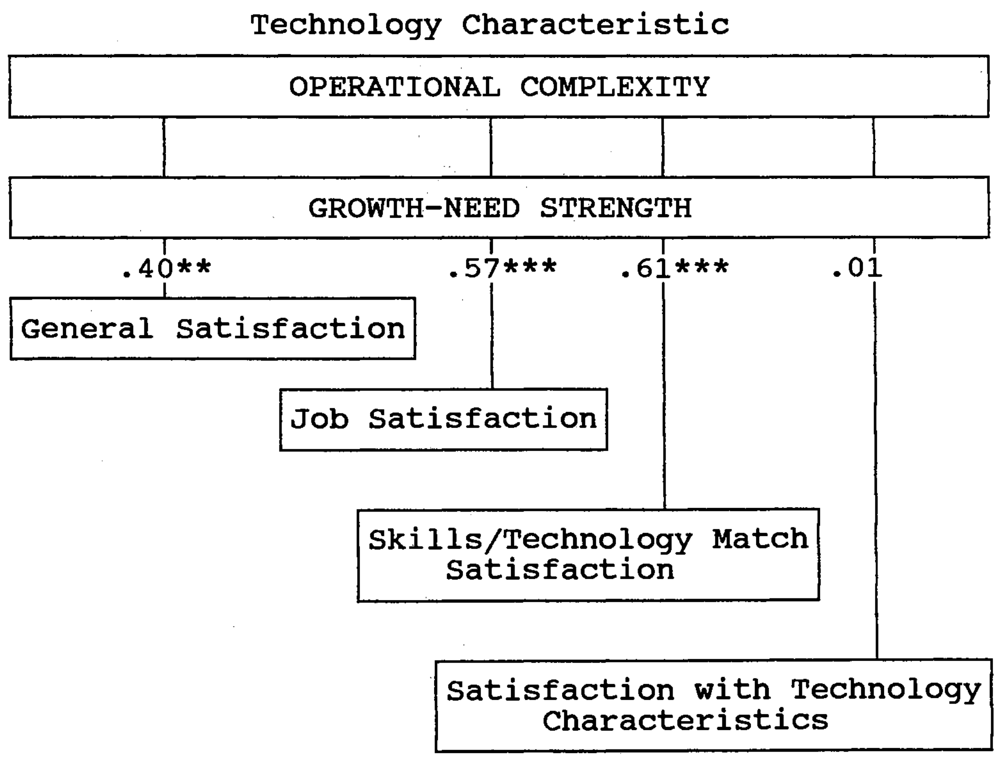
Figure 6 examines the mediation effect of job characteristics on the predictor (information intensity)-satisfaction interface. The effect of information intensity on general satisfaction was <u>not</u> found to be mediated by any of the six job characteristics.

The effect of information intensity on job satisfaction was found to be significantly mediated by <u>only one</u> job characteristic: feedback from agent ($R = .58$, $p < .001$).

The hypothesis of mediation between information intensity and "skills technology match satisfaction" was supported in all cases with the exception of two: task identity ($R = .34$, $p < .01$) and feedback from agent ($R = .31$, $p < .05$). On the other hand, the hypothesis of no mediation was entirely supported in the case of satisfaction with the technology characteristics, i.e., all job characteristics did not significantly mediate the interaction of information intensity and satisfaction with the technology characteristics.

Therefore the hypothesis of no mediation effect was not supported in <u>only</u> three of the tested twenty-four cases of information intensity-job characteristics-satisfaction relationships.

<u>Hypothesis Five:</u> There is no moderating relationship (in terms of growth-need strength) between workers' perceptions of technology/job characteristics and satisfaction.

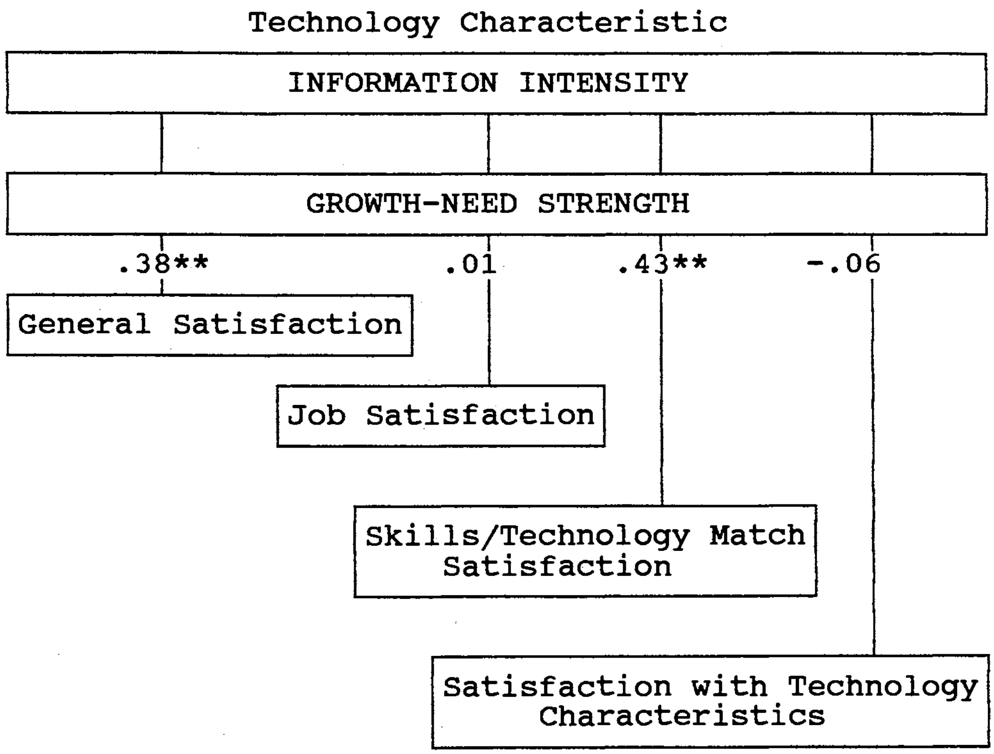


*** Significant at level $p < .001$
** Significant at level $p < .01$

Figure 7. A Diagrammatic Summary of the Data Analysis for Moderation with Regard to Operational Complexity-Satisfaction Interface

Figure 7 examines the moderation effect of growth-need strength on the predictor (operational complexity)-satisfaction interface. The effect of operational complexity on general satisfaction, job satisfaction, and skills technology match satisfaction was found to be significantly moderated by growth-need strength ($R = .40$, $p < .01$; $R = .57$, $p < .001$; and $R = .61$, $p < .001$, respectively).

Therefore, the hypothesis of no moderation between operational complexity and satisfaction was supported in one case only: operational complexity-satisfaction with the technology characteristics.

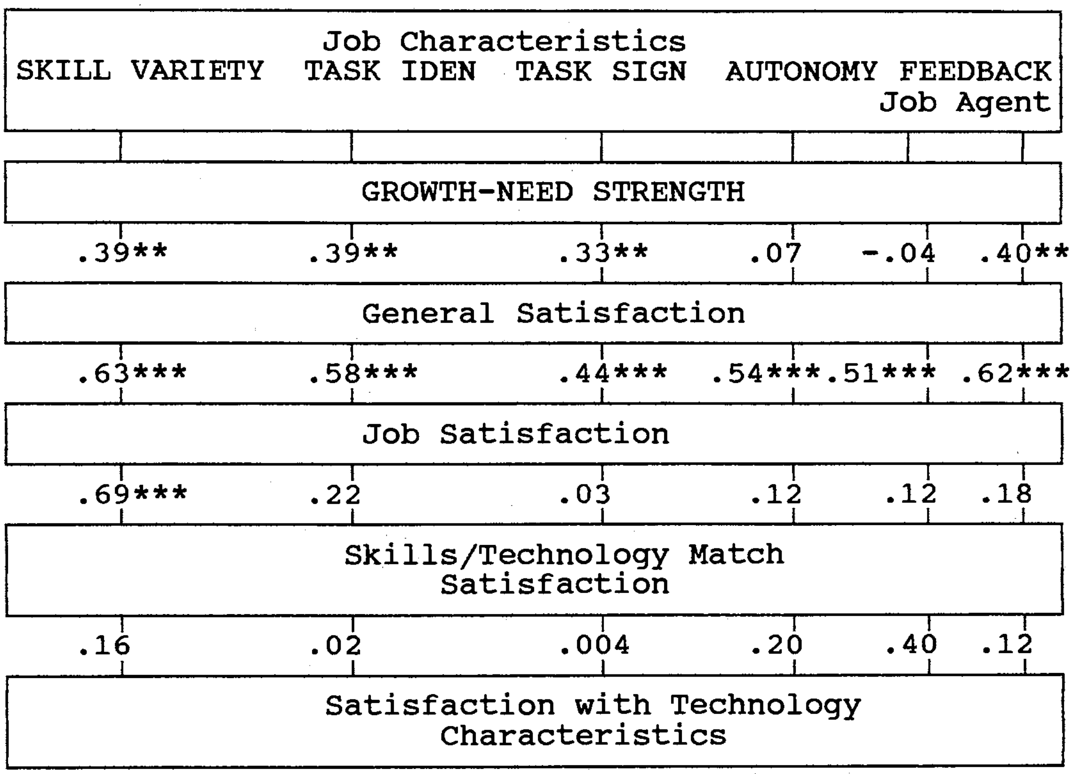


** Significant at level p < .01

Figure 8. A Diagrammatic Summary of the Data Analysis for Moderation with Regard to Information Intensity-Satisfaction Interface

Figure 8 examines the moderation effect of growth-need strength on the predictor (information intensity)-satisfaction interface. The effect of information intensity on general satisfaction and skills technology match satisfaction was found to be significantly moderated by growth-need strength ($R = .38$, $p < .01$; and $R = .43$, $p < .01$ respectively).

Therefore, the hypothesis of no moderation between information intensity and satisfaction was supported in two cases: job satisfaction and satisfaction with the technology characteristics.



*** Significant at level p < .001
** Significant at level p < .01

Figure 9. A Diagrammatic Summary of the Data Analysis for Moderation with Regard to Job Characteristics-Satisfaction Interface

Figure 9 examines the moderation effect of growth-need strength on the interaction of job characteristics and outcomes (satisfaction).

The effects of skill variety, task identity, task significance, and feedback from agent on general satisfaction were found to be significantly moderated by growth-need strength: skill variety ($R = .39$, $p < .01$); task identity ($R = .39$, $p < .01$); task significance ($R = .33$, $p < .01$); and feedback from agent ($R = .40$, $p < .01$).

The effects of the six job characteristics on job satisfaction were found to be significantly moderated by growth-need strength: skill variety ($R = .63$, $p < .001$); task identity ($R = .58$, $p < .001$); task significance ($R = .44$, $p < .001$); autonomy ($R = .54$, $P < .001$); feedback from the job itself ($R = .51$, $p < .001$); and feedback from agent ($R = .62$, $p < .001$).

Therefore the hypothesis of no moderation effect was not supported in four of the case of "general satisfaction" and the six cases of "job satisfaction". On the other hand, the hypothesis of no moderation was supported in the case of satisfaction with the technology characteristics, i.e., "job characteristics"-"satisfaction with technology characteristics" relationships were not significantly moderated by growth-need strength.

The hypothesis of no moderation between "job characteristics" and "skills technology match satisfaction" was supported in all cases with the exception of skill variety which showed a significant correlation ($R = .69$, $p < .001$).

Summary of the Analysis of the Data

Demographic characteristics were examined for their correlations with the satisfaction aggregate (average of the four outcomes --general satisfaction, job satisfaction, skill/technology match satisfaction, and satisfaction with the technology characteristics, Table XV). Sex, age, level of formal education completed, and experience --in the job that the respondent thought about while completing the questionnaire-- were not significantly correlated with the satisfaction aggregate.

TABLE XV

CORRELATIONS BETWEEN DEMOGRAPHIC CHARACTERISTICS AND SATISFACTION AGGREGATE

	Sex	Age	Education	Experience
Satisfaction Aggregate	.19	.16	.12	.19

The summary of the analyses of data for the stated research hypotheses is demonstrated in Table XVI and Figures 10-11. Using Pearson product moment correlations, the research hypotheses (1-3) are summarized in Table XVI.

The hypothesis that there is no relationship between workers' perceptions of job characteristics and the two technology characteristics of production systems was supported in the case of the following relationships:

1. operational complexity with autonomy and feedback.
2. information intensity with task identity, task significance, autonomy, and feedback.

Further, the analysis indicates that significant relationships also exist as follows:

1. Operational complexity with a) skill variety ($R = .64$, $p < .001$), b) task identity $R = .39$, $p < .01$), and c) task significance ($R = .30$, $p < .05$).
2. Information intensity with skill variety only ($R = .28$, $p < .01$).

The hypothesis that there is no relationship between workers' perceptions of satisfaction and operational complexity characteristic of production systems was only supported in the case of satisfaction with the technology characteristics ($R = .07$)

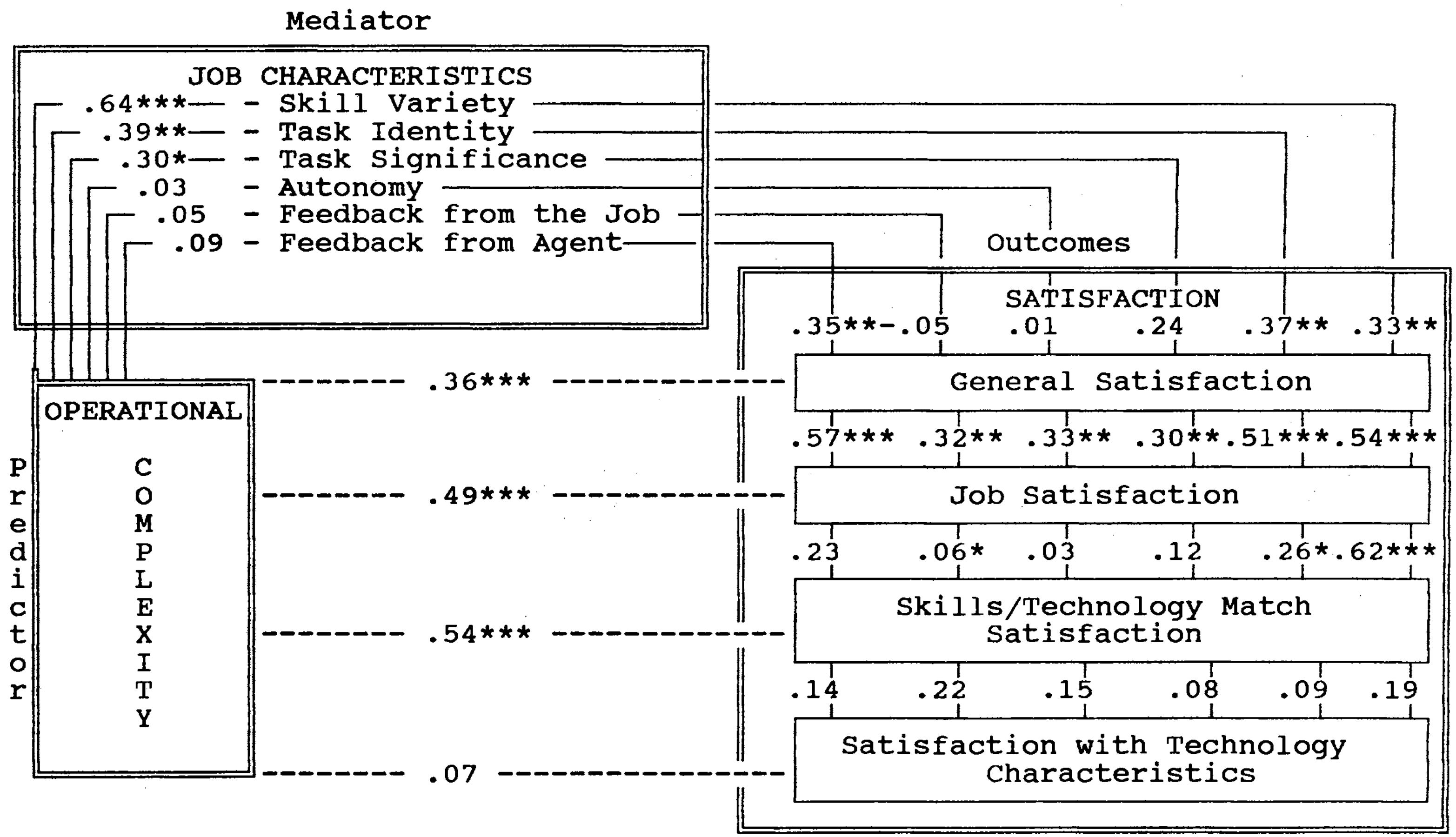
The hypothesis that there is no relationship between the information intensity and satisfaction outcomes was supported with the exception of the relationship with skills/technology match satisfaction ($R = .28$, $p < .05$).

TABLE XVIII

INTERCORRELATIONS AMONG TECHNOLOGY CHARACTERISTICS, JOB CHARACTERISTICS AND OUTCOMES (SATISFACTION)

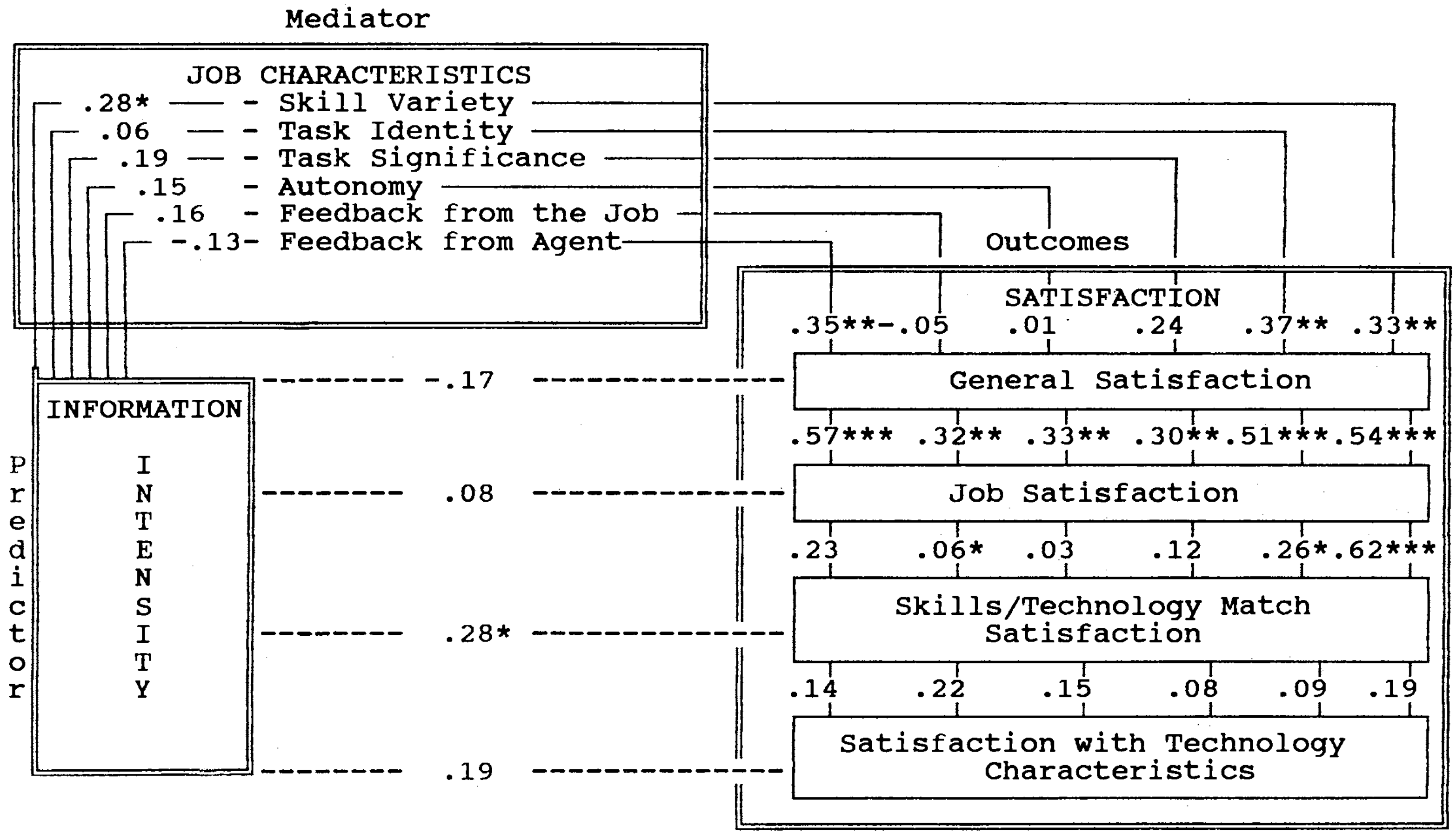
	1	2	3	4	5	6	7	8	9	10	11	12
1 Operational Complexity	__											
2 Information Intensity	.37**	__										
3 Skill Variety	.64***	.28*	__									
4 Task Identity	.39**	.06	.38**	__								
5 Task Significance	.30*	.19	.38**	.27*	__							
6 Autonomy	.03	.15	.07	.35**	.22	__						
7 Feedback From Job	.05	.16	.00	.17	-.04	.46**	__					
8 Feedback From Agent	.09	-.13	.11	.09	.07	.32**	.31**	__				
9 General Satisfaction	.36**	-.17	.33**	.37**	.24	.01	-.05	.35**	__			
10 Job Satisfaction	.49***	.08	.54***	.51***	.30**	.33**	.32**	.57***	.69***	__		
11 Skills/Tech Match Satisfaction	.54***	.28*	.62***	.26*	.12	.03	.06	.23	.40**	.69***	__	
12 Satisfaction with the Technology Characteristics	.07	.04	.19	.09	.08	.15	.22	.14	.27*	.32**	.38**	__

*** Significant at level p < .001
** Significant at level p < .01
* Significant at level p < .05



*** Significant at level $p < .001$
** Significant at level $p < .01$
* Significant at level $p < .05$

Figure 10. A Diagrammatic Summary of the Correlation Analysis for the Stated Research Hypotheses (1-3) with Regard to Operational Complexity



*** Significant at level p < .001
** Significant at level p < .01
* Significant at level p < .05

Figure 11. A Diagrammatic Summary of the Correlation Analysis for the stated Research Hypotheses (1-3) with Regard to Information Intensity

The hypothesis that there is no relationship between workers' perceptions of job characteristics and satisfaction (outcomes) was supported in the case of "satisfaction with the technology characteristics", i.e., all job characteristics were not significantly related to satisfaction with the technology characteristics. However, all the six job characteristics were significantly related to satisfaction with the job itself (skill variety, $R = .54$, $p < .001$; task identity, $R = .51$, $p < .001$; task significance, $R = .30$, $p < .01$; autonomy, $R = .33$, $p < .01$; feedback from the job, $R = .32$, $p < .01$; and feedback from agent, $R = .57$, $p < .001$). Task significance, autonomy, and feedback from the job supported the hypothesis of no relationship in the case of "general satisfaction", i.e., they were not significantly related to general satisfaction (Table XVI, Figures 10-11).

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

A summary of the study, the conclusions of the findings as drawn from the hypotheses, and the recommendations for future research are presented in this chapter.

Summary

The purpose of this study was to investigate the effects of technology characteristics on operators perceptions of job characteristics and satisfaction. The study hypotheses stated:

1- there is no relationship between workers' perceptions of job characteristics and the two technology characteristics of production systems;

2- there is no relationship between workers' perceptions of job satisfaction and technology characteristics of production systems;

3- there is no relationship between workers' perceptions of job characteristics and job satisfaction;

4- There is no mediating relationship (in terms of job characteristics) between workers' perceptions of technology characteristics and satisfaction.

5- There is no moderating relationship (in terms of growth-need strength) between workers' perceptions of technology/job characteristics and satisfaction.

These hypotheses are used to test the relationships established by the model for this study.

Organizations were chosen to participate in this study based on pre-categorization of manufacturing technologies according to their representative technology characteristics. Judgment and a deliberate effort, industrial visits, and assistance of department professors and associates were used to select the participant organizations. The sample was selected to represent high to low operational complexity and high to low information intensity. Perception of the respondents with regard to the two technology characteristic are depicted in Figure 4. Although the extremes (highs and lows) were not significantly represented, dispersion of the responses is quite evident.

The instrument used to measure the study constructs was based mainly on questions drawn from the Innovation and Productivity Research Program of Rutgers University's "Operational Technology Survey" [23], McCormick's "Positional Analysis Questionnaire" (PAQ) [56], and Hackman and Oldham's "Job Diagnostic Survey" [37]. The instrument measured two technology characteristics, five job characteristics, five personal differences, and four satisfaction outcomes.

The research hypotheses were examined using Pearson product moment correlations. Technology characteristics were examined for correlation with job characteristics (Tables V-VI), and job satisfaction --(general satisfaction, satisfaction with job, satisfaction with the skills/technology match, and satisfaction with the technology characteristics themselves-- (Table VII-VIII). Job characteristics were examined for correlations with satisfaction (Tables IX-XIV). The technology-satisfaction path was examined for the mediating effects of job characteristics (Figures 5-6). The moderating effect of growth-need strength on satisfaction was examined (Figures 7-9). Based on the hypotheses testing, the following findings may be drawn:

a.1. Hypothesis one indicated that the job characteristics: skill variety, task identity, and task significance were positively correlated with operational complexity. Information intensity was only correlated with skill variety.

a.2. The surveyed operators reported dissatisfaction with the autonomy attribute. Using the scale's mid-point criterion, the technology surveyed in this study can be categorized as medium to high in terms of operational complexity (mean = 4.265, Figure 4).

b. Hypothesis two indicated that there were positive correlations between operational complexity and these outcomes: general satisfaction, job satisfaction, and skills/technology match satisfaction. Information intensity was correlated positively only with "skills/technology match satisfaction".

c. Hypothesis three indicated that there were relationships of both skill variety and task identity, with "general satisfaction" and the "skill/ technology match satisfaction". Task significance, autonomy, and feedback from the job were related only with job satisfaction.

d. Hypothesis four indicated that the thesis of no mediation effect (with regard to operational complexity-satisfaction) was supported in two out of the six cases of "general satisfaction" and none of the six cases of "job satisfaction". The hypothesis of no mediation was supported in the case of "satisfaction with the technology characteristics." The hypothesis of no mediation between operational complexity and "skills technology match satisfaction" was supported in five out of the six cases tested -- skill variety was the exception.

The hypothesis of no mediation effect was supported in twenty-one of the twenty-four tested cases of information intensity-job characteristics-satisfaction relationships.

e. Hypothesis five indicated that the thesis of no moderation between operational complexity and satisfaction was supported in only one case: operational complexity-satisfaction with the technology characteristics.

The hypothesis of no moderation between information intensity and satisfaction was supported in two cases: job satisfaction and satisfaction with the technology characteristics.

The hypothesis of no moderation effect between job characteristics and satisfaction was supported in two of the six cases of "general satisfaction" and in none of the six cases of "job satisfaction".

With respect to "satisfaction with the technology characteristics" outcome, the no moderation hypothesis was supported in all the six cases tested, i.e., "job characteristics"-"satisfaction with technology characteristics" relationships were not significantly moderated by growth-need strength.

The hypothesis of no moderation between "job characteristics" and "skills technology match satisfaction" was supported in five of the six cases tested, skill variety was the exception.

A summary of these data analyses was presented in Chapter IV, Tables XV-XVI and Figures 5-11.

Conclusions

The main objectives of this study are to identify the following relationships:

1. the perceived job characteristics and the production systems in terms of the technology's "operational complexity" and "information intensity;"
2. workers' perceptions of job satisfaction and the characteristics of the employed technology of that production system.
3. workers' perceptions of job satisfaction, and the constructs that mediate (the characteristics of their jobs) and moderate (individual differences --growth-need strength), respectively.

The specific conclusions derived from the findings of this study are:

I. Operational complexity is significantly and positively related to satisfaction with the job itself, but not to satisfaction with the technology characteristics themselves. Operational complexity is, therefore, an important contextual (organizational) factor that effects an individual's satisfaction through job characteristics.

II. Information intensity, has a negligible effect on an individual's satisfaction.

III. Growth-need strength moderates the relationship between an individual's perceptions of job characteristics and satisfaction. This indicates that the existence of a reasonable level of growth-need strength could be a prerequisite requirement to actuate positive predictor/job characteristics-outcome relationships .

Discussion

The finding that operators reported dissatisfaction with the autonomy attribute (a.i) supports Braverman's [12] deskilling prognosis --the sophistication of technology and methods affects control of tasks --and Blumberg's et al. [7] research finding that workers in flexible manufacturing systems were dissatisfied with their jobs because of the lack of autonomy and skill variety. However, this finding is disputable[1] .

---

[1] It should be noted that this study did not follow the tradition of past research [26, 37, 39] in dividing individuals into high growth-need strength and low growth-need strength categories in order to analyze their reaction to jobs. The rationale for deviating from this approach is that past research has not shown that individual's with low growth needs react unfavorably to enriched jobs; rather, they tend to remain indifferent to their job characteristics, regardless of how challenging or simple, varied or routine, their jobs happen to be [15].

To further explore the autonomy question, the study could be improved if individual's perceptions were examined for consistency with their work group's perceptions as affected by the technology characteristics. However, research on the comparison of individual to work group level characteristics is difficult. The use of indices of group characteristics measured at the individual level is problematic [69]. However, simultaneous measurement of constructs at the individual and group level makes it possible to examine the processes whereby group characteristics shape both individual perception and responses to the work setting [69]. While, the question of work group response was beyond the scope of this study its inclusion in future studies may define an important moderator of technology or suggest a new construct that shapes job characteristic perceptions based on the group influence.

It is interesting to find that "satisfaction with the technology characteristics" had shown little or no significance with all investigated constructs (operational complexity, $R = .07$; information intensity, $R = .19$; and in the case of the six job characteristics, R ranged from .08 to .22). This result defies the thesis that workers' satisfaction may be at least partially shaped by the technical pressures of the task and technology [1]. Meanwhile, the conclusion that operational complexity is significantly and positively related to satisfaction with the job itself, but not to satisfaction with the technology characteristics themselves supports the thesis that the technological classification fails to contribute to the prediction of employee satisfaction beyond its relationship to job characteristics [69]. This suggests that the relationship of technology characteristics to satisfaction are mediated by job characteristic perceptions [37, 69].

However, comparing the controversial results of different studies [1, 7, 8] the mediation effect of job characteristics should be examined over a specific period of time. As advocated by Nelson [62] --simply measuring perceived job content of an existing employed technology is not sufficient; it is recommended to test the change in the individual's perception of job characteristics over the specific technology's life cycle. Job characteristics have potential impact on worker's outcomes "but should do so in a longitudinal, multiple measures design, with a thorough analysis of potential individual and organization moderators included" [62, p. 84].

The outcome "skills/technology match satisfaction" shows consistent significance when correlated with the two technology characteristics (operational complexity, $R = .54$, $p < .001$; information intensity, $R = .28$, $p < .05$); and is strongly correlated with the job characteristic skill variety ($R = .62$, $p < .001$). Moreover, the introduction of the moderator (growth-need strength) strengthens the significance of the relationship. These two findings raise the importance of exploring the notion of the fit between the individual operator and the job [62] and how this fit is affected by the characteristics (requirements) of the employed technology and ultimately how this fit affects the satisfaction outcome.

There is abundant literature on the workers' reaction to technology through their responses to JDS questionnaire items. These studies have explored the effect of the respondents' job characteristics on their "general satisfaction" and "job satisfaction" [1, 7, 8, 37, 69, etc.] However, the concept of "skills/ technology match satisfaction" had not been previously explored. The importance of understanding this relationship stems from the fact that over the last two decades technological changes have altered the nature of manufacturing processes. The altered nature of manufacturing processes has substantial implications for workers [88]. Adoption of advanced manufacturing technologies, in terms of programmable machines and computerized monitoring, provides new conditions under which technology operators are subjected to new skills, knowledge, motivational and behavioral requirements. Advanced technologies often link stages of the production-process concomitant with high degrees of complexity, adaptability and flexibility required during operating cycles. "There is sound evidence of deep-seated changes in occupational structures, at both enterprise and societal levels...we are moving toward a 'white-coat' labor force profile" [88, p. 282].

Such human resource questions present a set of propositions related to technology, skills, training, labor market demographics, workforce diversity, and organizational culture. All these propositions together generate trends with human resource implications, i.e., new occupational profiles in industry. These trends affect the technology-human interaction. The old designs of sociotechnical systems were geared to specialized homogeneous mass markets based on inflexible automation and reduced skills of the craft worker [88]. New occupational shifts and new patterns of skill utilization are the consequences of new technologies. Efficient utilization of computerized machines requires skilled operatives supported by high training.

Innovation in industry has eliminated some jobs and required workers to acquire unfamiliar skills that have created frustration for many workers. New job opportunities are often associated with new technologies. The use of microelectronics has had a significant impact on manufacturing operations, as well as workers. Production technologies and manufacturing methods are undergoing drastic changes. Microelectronics are being incorporated in systems which control key production equipment e.g. robots, CNC machines, CIM, etc. A report by the U.S. Bureau of Labor Statistics (Labor Review Monthly, 1982, p. 37-39) on the "Impact of New Electronic Technology" stated that:

i) the content of jobs and the qualities required of workers are being modified by technological changes. There is less demand for manual dexterity, physical strength for material handling, and for traditional craftsmanship. In contrast, organizations are placing more emphasis on formal knowledge, precision, and perceptual aptitudes. As many manual tasks are mechanized, unskilled workers become monitors of very expensive equipment.

ii) higher educational achievement of workers is becoming essential. The ability to read and write at functional level is mandatory to interpret operating instructions of complex equipment, and to be retrained for the new skills demanded by changing technology.

It would be unwise to conclude from this study that: the technology-autonomy prognosis of Braverman [12] and Blumberge are true; or the information intensity construct has no role in the model; or the satisfaction with the technology characteristics has no relationships with technology and job characteristics. However, further studies should be encouraged.

As with any field research, this study has certain design constraints that limit generalizability of results. The findings could be attributed to the conclusions of past studies [55, 16]:

i. Majchrzak [55] thought that the problem of JDS is the need to use single-item measures for the perceived job characteristics; "yet this problem is not specific to this study ... workers less cognitively complex have been found to have difficulty with the JDS" [55, p. 60].

ii. Majchrzak [55] also thought about the problem of sample size. Small sample size could prevent combing alternative explanations into the same regression equation to test more vigorously their predictive capability [55].

iii. Bryman [16] believed that the result of seeking construct validity might create an invalid relation between the measure and the underlying concept.

iv. Bryman [16] also thought that the attributes of examining test/retest reliability are often not definitive as they are capable of more than one interpretation.

Finally, the study findings strongly raised the question of "fit" between technology requirements and human resource needs and capabilities which requires further in-depth further investigation.

Recommendations for Future Research

Two implications emerge from this study that require further investigation. The first implication is the theme of using technical characteristics to replace the traditional categorization of technologies (basically, Woodward's small-batch, mass-production, and continuous-process classification [89]) and these subsequent modified versions [46, 48, 81.] The second implication is the theme of mediation and moderation as intervening variables in the predictor-outcome relationship. Previous studies have been concerned only with the effects of categorized technologies on skilling and deskilling of the workforce, and workers' alienation. Other studies have examined the effects of technology on job characteristics. Hence, the complexity of the interaction of the technology characteristics, job characteristics and individual differences issue should continue be investigated in future studies.

This study suggests that further empirical studies in the area of technology characteristics-attitudes may be worthy both to academic researchers in the field of organizational theory and design/human resource management, as well as to those applying such theory in organizations. The following suggestions are offered as subareas in which these studies may be conducted:

1. Research should be conducted to correlate the specific components of operational complexity and information intensity with satisfaction (Figure 12).

2. Research should attempt to specify more precisely which technology characteristics more accurately characterize technologies. Despite the existence of technological diversity within industries, it should be possible to formulate classificatory schemes that outline such relationships. It may be important to identify the requirements of the technology characteristics in terms of knowledge, expertise etc. Correlates of these requirements with workforce capabilities and needs could be the ultimate research that provides the answer to the "fit" question.
3. Modification of the study framework as well as the technology and job characteristics constructs may improve the outcomes of this study. A proposed framework is indicated in Figure 12. This is a modified version of the framework used in this study.

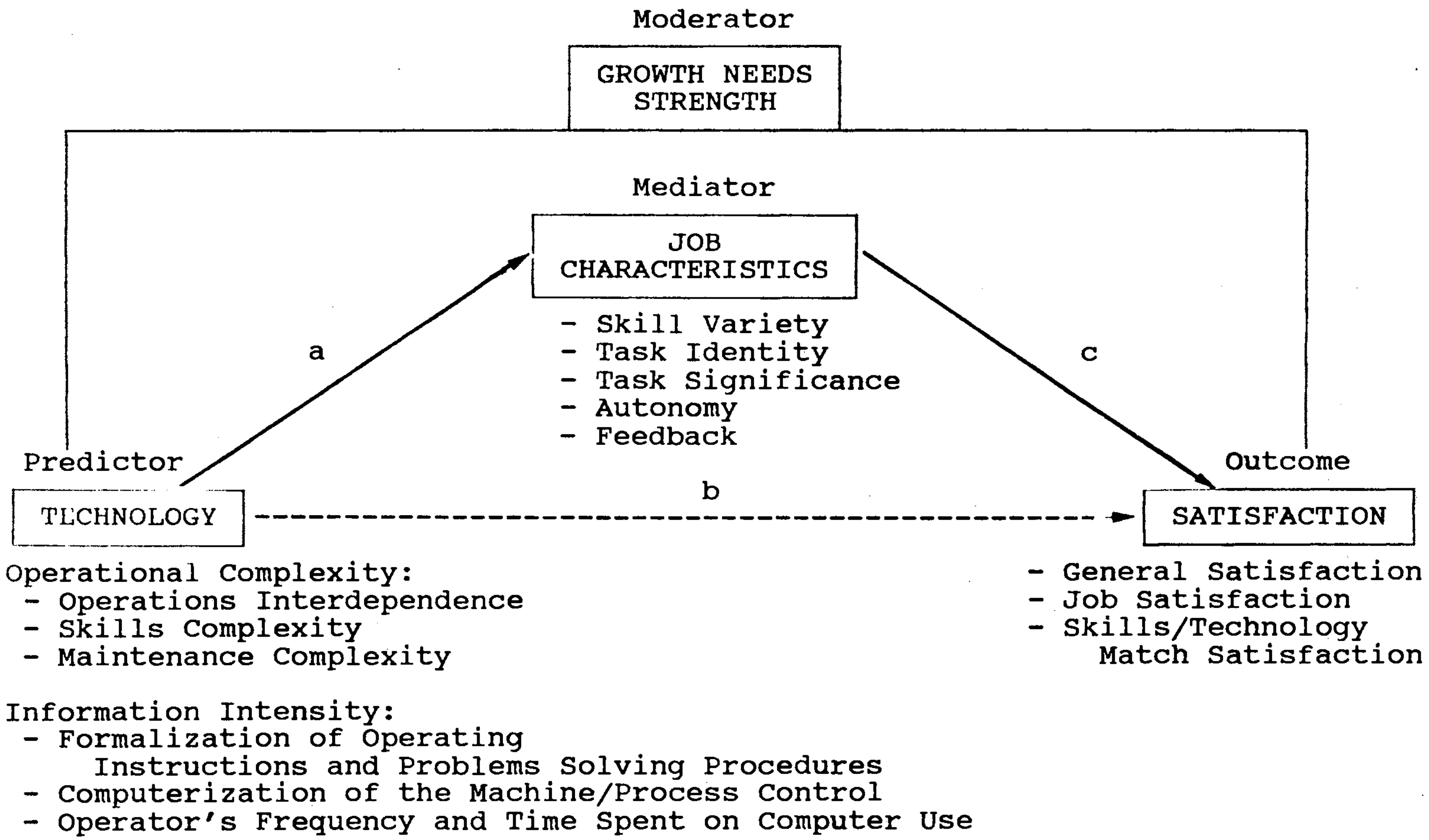


Figure 12. A Modified Model of the Effect of the Interaction of Technology, Job Characteristics, and Growth-Need Strength on Job Satisfaction

4. A replication of this study based on the modified model (see 3 above) could be undertaken in a single organization that houses many units that employ different technologies with different characteristics. This setting may eliminate possible intervening effects such as difference in corporate cultures, geographic locations, etc.
5. Finally, a longitudinal study could be conducted as a single technology is being installed to investigate model relationships over time. This recommendation supports Nelson's thesis [61] that it is important to test the change in the individual's perception of job characteristic and its impact on worker's outcome over the specified technology's life cycle. Comparing each stage's outcomes (correlation of the technology/job characteristics and satisfaction) of the life cycle with the start up situation may render valuable understanding of the underlying process.

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APPENDICES

APPENDIX A

APPROVAL OF THE INSTITUTIONAL REVIEW BOARD (IRB)

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
FOR HUMAN SUBJECTS RESEARCH

Proposal Title: A STUDY OF THE TECHNOLOGY CHARACTERISTICS OF MANUFACTURING PRODUCTION SYSTEMS ON AN INDIVIDUAL'S PERCEPTION OF JOB CHARACTERISTICS AND SATISFACTION

Principal Investigator: DAVID MANDEVILLE / AHMED ELAMIN HAROUN

Date: JULY 27, 1992 IRB # EG-93-001

This application has been reviewed by the IRB and

Processed as: Exempt [XX] Expedite [ ] Full Board Review [ ]

Renewal or Continuation [ ]

Approval Status Recommended by Reviewer(s):

Approved [xx] Deferred for Revision [ ]

Approved with Provision [ ] Disapproved [ ]

Approval status subject to review by full Institutional Review Board at next meeting, 2nd and 4th Thursday of each month.

Comments, Modifications/Conditions for Approval or Reason for Deferral or Disapproval:

Signature: Maria L. Tilley Date: 7-28-92
Chair of Institutional Review Board

APPENDIX B

A LETTER OF AFFILIATION AND SURVEY REQUEST

Oklahoma State University

INDUSTRIAL ENGINEERING AND MANAGEMENT

STILLWATER, OKLAHOMA 74078-0540
ENGINEERING NORTH, ROOM 322
(405) 744-6055
FAX: (405) 744-7673

August 25, 1992

Dear Executive:

Current global competition has created a new technological challenge. Managers in the manufacturing industry are under great stress to support technological advancement while maintaining an appropriately motivated and skilled workforce. Managers and workers, as individuals or as members of formal or informal groups, need information about the best ways to secure the interests of both the organization's competitive advantages and the individuals needs, i.e. creating a match between technological and human requirements.

This department (IE&M), in coordination with professors from other OSU departments and a Ph.D. student Ahmed E. Haroun are interested in addressing these concerns. This study is part of a project directed by the undersigned on the "Productivity Effects of Organizational Technology Attributes and Employee Characteristics Interactions." Manufacturing executives, like you, as well as your managers and workers, are undoubtedly the best source for and can facilitate the collection of this information.

Enclosed is a questionnaire requiring completion by production workers (operators). Please take a few minutes of you and your organization's valuable time to contribute to the future technological advancement and career opportunities in the manufacturing industry. You may be assured of complete confidentiality. At no time will your business be identified in the research report. For a summary of the results, please check the appropriate box in the attached slip and fill in your mailing address. If you need further information, please contact the undersigned at the numbers shown below.

Thank you for your cooperation in this important effort.

Respectfully,

DG Mandeville

Dr. D. E. Mandeville
Committee Chairman, (405)744-6055

Ahmed E. Haroun
Ph.D. Student, (405)744-1717

APPENDIX C

SURVEY QUESTIONNAIRE

QUESTIONNAIRE

PRODUCTION TECHNOLOGY, JOB CHARACTERISTICS AND JOB SATISFACTION SURVEY

This questionnaire has the consent of your employer and is absolutely voluntary. Your responses will not affect your employment in any way.

I would be very grateful for your assistance. All information will be treated in strict confidence. When the study is finished this questionnaire will be destroyed. Completion of the questionnaire should take 20-25 minutes.

Thank you for your cooperation.

Section 1

OPERATIONS TECHNOLOGY

1. Please describe/name the type of product you manufacture.

____
____
____
____

2. Please, place an "x" by the one category that accurately characterizes the production orientation of the production process you use in your work.

a-c: (One-off production; jobbing)

___ a. Single pieces, not assemblies, produced one by one.
___ b. Complex assemblies, produced one by one.
___ c. Fabrication of large equipment in stages.

d.___ Small batches (Equipment is reset every week or more often for outputs measured in items; usually to customer orders).

e-f: (The equipment is reset at intervals of longer than a week for outputs measured in items)

___ e. Large batches.
___ f. Large batches with large batch assembly.

g.___ Mass production: (Batch size, measured in items, is indefinite; a change of batch usually requires a decision in design modification and/or retooling)

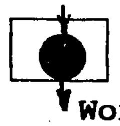
h-j: (Quantities so numerous that products are best measured by weight, volume or capacity)

___ h. Process production; outputs become items at the finishing stage.
___ i. Process production; ingredients of through-put change periodically.
___ j. Process production; ingredients are constant.

3. Please place an "x" in the category that accurately describes the workflow in the product line you work in.

a. Independent Workflow
Work and activities are entirely performed independently by one person alone and output (finished product) goes to another work station, or to stock, or directly to a customer. _____

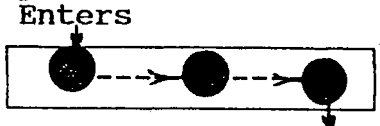
Work Enters



Work Leaves

b. Semi-Independent Workflow
Work and activities are relatively performed independently by the various work units and rarely flow between them. _____

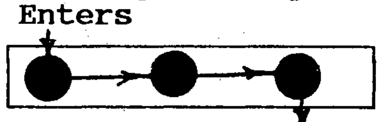
Work Enters



Work Leaves

c. Sequential Workflow
Work and activities flow between the various work units, but generally in one direction. _____

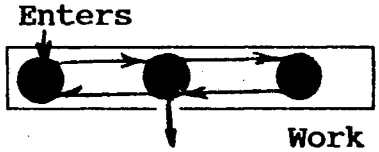
Work Enters



Work Leaves

d. Reciprocal Workflow
Work and activities flow between the various work units in a reciprocal "back and forth" manner over a period of time. _____

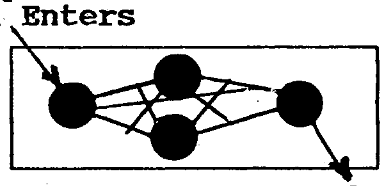
Work Enters



Work Leaves

e. Team Workflow
Work and activities come into the production area, and leaders or supervisors from different units diagnose, problem-solve and collaborate as a group at the same time to deal with the work. _____

Work Enters



Work Leaves

4. INFORMATION INTENSITY

i- Characteristics of operating information.
Please circle the number which mostly corresponds to your opinion for each statement below.

a. Tasks are defined precisely and are executed according to specific routines and procedures.

1-------2------3--------4-------5-------6-------7

Very Inaccurate — Tasks are not Strictly Defined, and are Flexible, executed within certain tolerance. — Very Accurate

b. The machine itself controls the progress of operation. Only malfunctions or the accomplishments of certain steps are indicated, for example (e.g.) through control lights.

1-------2------3--------4-------5-----6--------7

Very Inaccurate — Uncertain — Very Accurate

c. The machine measures the progress of the operation. The operator receives the information from control panels and/or visual display units (VDUs).

1-------2------3--------4-------5-----6--------7

Very Inaccurate — Uncertain — Very Accurate

d. The operator himself has to control the work process using his experience and/or measurement devices, e.g., micrometer.

1-------2------3--------4-------5-----6--------7

Very Inaccurate — Uncertain — Very Accurate

e. Operational problems are solved according to established guides (for example, operating manuals).

1-------2------3--------4-------5-----6--------7

Very Inaccurate — Uncertain — Very Accurate

f. Machine failures and production problems require the involvement of many personnel of different expertise.

1-------2------3--------4-------5-----6--------7

Very Inaccurate — Uncertain — Very Accurate

ii- Please, indicate the degree to which the following state ments characterize the Computer Use in your job by circling the appropriate response.

a. How often do you use the computer system or output from the computer system?

1--------2--------3--------4--------5------6-------7

Not at all — Moderately (quite often) — Most of the time

b. How long do you spend time using the computer system or reading printouts from the system in hours/minutes per day? Hours______ Minutes______

5. Please indicate the degree to which the following statements characterize the operations of the product line in which you work by circling the appropriate response.

a. The sequence of operations are rigid and give me no freedom and independence to do my work in the way I think best.

1--------2--------3--------4--------5------6-------7

Disagree Strongly | I don't Know | Agree Strongly

b. The equipment/process is multi-purpose (i.e., it can be reset to manufacture different outputs).

1--------2--------3---------4---------5------6-------7

Disagree Strongly (Single Purpose) | Possible, but some arrangements need to be done | Agree Strongly (Flexible)

c. Equipment "major" breakdown frequency per week.

1--------2------3----------4--------5-----6-------7

Remarkably Rare (Once or none) | Moderately Occur; (2-3 times) | Frequently Occur (More than 3 times)

d. Machine general failure types (minor) are predictable.

1--------2--------3--------4--------5------6-------7

Remarkably Predictable | Moderately Predictable | Remarkably Unpredictable

e. If the equipment fails to operate or breaks the work can be rerouted to other equipment.

1--------2------3---------4---------5------6-------7

Easily Possible | Possible but Difficult (some arrangements need to be done) | Absolutely Not Possible

f. Failures are easy to diagnose (locate).

1--------2------3--------4-------5-----6-------7

Remarkably Easy to Locate | Moderately Hard to Locate | Remarkably Hard to Locate

g. Failures can be easily corrected by the operator through standard procedures.

1--------2--------3--------4--------5------6-------7

Disagree Strongly | I don't Know | Agree Strongly

h. How long can the most critical part of your production operations be delayed without bringing the other production processes (operations) to a complete halt?

1--------2--------3--------4--------5------6-------7

Immediately or some Hours	Days but Less than a Week	More than a Week

i. To what extent does the performance of the employed technology require you <u>to work closely with people</u>? ("suppliers/contractors" or people in your own organization?

1---------2-------3--------4---------5------6-------7

Very little; dealing with other people is not necessary in doing the job.	Moderately; some dealing with other people is necessary.	Very much; dealing with others is essential to my job.

j. To what extent does the employed equipment/process require you to <u>learn</u> new skills and information related to your job?

1---------2-------3--------4---------5------6-------7

Very little;	Moderately;	Very much;

k. The operator supervises/ operates a completely automated machine which can perform a production operation itself for sustained periods of time, and will shut down automatically in the event of trouble (i.e. he/she can leave at any portion of the task --after set-up-- without stopping the work).

1-------2------3--------4-------5-----6--------7

Very Inaccurate: The operator operates the machine himself/ herself and therefore can not leave the machine without stopping the work.	Uncertain: The operator operates/ supervises a machine which allows him/her to rest or leave the controls for a limited period of time (between successive stages of the work).	Very Accurate

Section 2
SKILL REQUIREMENTS

The following statements are related to the skills required to supervise and operate satisfactorily the equipment and process on which you work.

6. Please write a number in the blank for each statement describing the required general skill levels to perform your job satisfactorily. Indicate your opinion based on the following scale.

1-------2-----3---------4--------5-----6---------7

None is Required	Moderate Level is Required	Remarkably High Level is Required

i. **Required general qualifications:**

a. _____ Arithmetic Reasoning: ability to reason using quantitative concepts and symbols.

b. _____ Verbal Comprehension: ability to understand the meaning of technical words (terminology) and ideas associated with them.

c. _____ Mechanical Ability: ability to determine the functional interrelationships of parts within a mechanical system.

d. _____ Numerical Computation: ability to manipulate quantitative symbols rapidly and accurately, as in various arithmetic operations.

e. _____ Manual Dexterity: ability to manipulate objects with the hands.

f. _____ Long-term Memory: ability to learn and store pertinent information and selectively to retrieve or recall, much later in time, that which is relevant to a specific context.

g. _____ Perceptual Speed: ability to make rapid discrimination of visual detail.

ii. **Required special training and experience:**

a.___ Computer knowledge: data input and retrieval, and interpretation of printouts

b.___ Multi-disciplinary training (skill mix)

c.___ Use of written manuals to operate the machines and solve problems i.e. operating instructions

d.___ Long-period accumulated experience

e.___ Intuition and judgment

Section 3
JOB CHARACTERISTICS AND EMPLOYEES' SATISFACTION

7. Please circle the number which is the most accurate description of your job.

a. How much autonomy is there in your job? That is, to what extent does your job permit you to decide on your own how to go about doing the work?

1---------2-------3--------4---------5------6-------7

Very little; the job gives me almost no personal "say" about how and when the work is done.	Moderate autonomy; many things are standardized and not under my control, but I can make some decisions about the work.	Very much; the job gives me almost complete responsibility for deciding how and when the work is done.

b. To what extent does your job involve doing a "whole" and identifiable piece of work? That is, is the job a complete piece of work that has an obvious beginning and end? Or is it only a small part of the overall piece of work, which is finished by other people or by automatic machines?

1---------2-------3--------4---------5------6-------7

My job is only a tiny part of the of the overall piece of work; the results of my activities cannot be seen in the final product.	My job is a moderate-sized "chunk" of the overall piece of work; my own contribution can be seen in the final outcome.	My job involves doing the whole piece of work, from start to finish; the results of my activities are seen in the final product.

c. How much variety is there in your job? That is, to what extent does the job require you to do many different things at work, using a variety of your skills and talents?

1---------2-------3------4------5------6------7

Very little; the job requires me to do the same routine things over and over again.	Moderate variety.	Very much; the job requires me to do many different things, using a number of different skills and talents.

d. In general, how significant or important is your job? That is, are the results of your work likely to significantly affect the lives or well-being of other people?

1---------2-------3-------4---------5------6-------7

1	4	7
Not very significant; the outcomes of my work are not likely to have important affect on other people.	Moderately significant	Highly significant; the outcomes of my work can affect other people in very important ways.

e. To what extent do managers or co-workers let you know how well you are doing on your job?

1---------2-------3--------4---------5------6-------7

1	4	7
Very little; people almost never let me know how well I am doing.	Moderately; sometimes people may give me "feedback;" other times they may not.	Very much; managers or co-workers provide me with almost constant "feedback" about how well I am doing.

f. To what extent does doing the job itself provide you with information about your work performance? That is, does the actual work itself provide clues about how well you are doing --aside from any "feedback" co-workers or supervisors give?

1---------2-------3--------4---------5------6-------7

1	4	7
Very little; the job itself is set up so I could work forever without finding out how well I am doing.	Moderately; sometimes doing the job provides "feedback" to me; sometimes it does not.	Very much; the job is set up so that I get almost constant "feedback" about how well I am doing.

8. Listed below are a number of statements which could be used to describe a job. Please indicate whether each statement is an accurate or an inaccurate description of your job. Write a number in the blank beside each statement, based on the following scale.

1--------2---------3--------4--------5---------6-------7

Very Inaccurate — Uncertain — Very Accurate

a. ____ The job requires me to use a number of complex or high-level skills.

b. ____ The job requires a lot of cooperative work with other people.

c. ____ The job is arranged so that I do not have the chance to do an entire piece of work from beginning to end.

d. ____ Just doing the work required by the job provides many chances for me to figure out how well I am doing.

e. ____ The job is quite simple and repetitive.

f. ____ The supervisors and co-workers on this job almost never give me any "feedback" about how well I am doing my work.

g. ____ This job is one where a lot of other people can be affected by how well the work gets done.

h. ____ The job denies me any chance to use my personal initiative or judgment in carrying out the work.

i. ____ Supervisors often let me know how well they think I am performing my job.

j. ____ The job itself provides me the chance to completely finish the pieces of work I begin.

k. ____ The job itself provides me few clues about whether or not I am performing well.

l. ____ The job gives me considerable opportunity for independence and freedom on how to do the work.

m. ____ The job itself is not very significant or important in the broader scheme of things.

9. Please write a number in the blank for each statement, describing how you feel about your job (How much do you agree with the statement?), based on this scale:

1--------2---------3--------4--------5-------6---------7

Disagree Strongly | Neutral | Agree Strongly

a. ____ My opinion of myself goes up when I do this job well.

b. ____ I feel bad and unhappy when I discover that I have performed poorly on this job.

c. ____ I feel good and happy when I discover that my job contains an amount of challenge.

d. ____ I frequently think of quitting this job.

e. ____ I prefer to take a job where the pay is very good than a job where there is considerable opportunity to be creative and innovative

f. ____ I prefer to take a job where I am often required to make important decisions than a job with many pleasant people to work with.

g. ____ I prefer to take a job with very satisfying team-work than a job which allows me to use my skills and abilities to the fullest extent.

h. ____ Generally speaking, I am very satisfied with this job

10. Please indicate how satisfied you are with each aspect (statement) of your job listed below. Write the appropriate number in the blank based on the this scale:

1----------2---------3---------4--------5-------6--------7

Extremely Dissatisfied | Neutral | Extremely Satisfied

a. ____ The amount of challenge and complex tasks in my job.
b. ____ The amount of autonomy (independent thought and action I can exercise) in my job.
c. ____ The chance to do a whole identifiable piece of work.
d. ____ The variety of skills and talents I use in my job.
e. ____ The significance and importance of my job to others.
f. ____ The feedback I receive from doing my job itself.
g. ____ The feedback I receive from supervisors/co-workers.
h. ____ The match between my skills and the skills required by my job.

11. The following statements are designed to obtain your perception concerning the existing characteristics of your job compared with the capabilities you have.

Write a number in the blank for each statement, based on the following scale (Example - Arithmetic Reasoning-, Remarkably lower means that the requirement for "arithmetic reasoning" in the job you perform is much lower than the level of knowledge you have as far as that characteristic -arithmetic reasoning)

1-----------2--3---------4---------5--6---------7

Remarkably lower than my ability | Almost the same as my ability | Remarkably higher than my ability

i) Required General Qualifications:

a. _____ Arithmetic Reasoning: ability to reason using quantitative concepts and symbols.

b. _____ Verbal Comprehension: ability to understand the meaning of technical words (terminology) and ideas associated with them.

c. _____ Mechanical Ability: ability to determine the functional interrelationships of parts within a mechanical system.

d. _____ Numerical Computation: ability to manipulate quantitative symbols rapidly and accurately, as in various arithmetic operations.

e. _____ Manual Dexterity: ability to manipulate objects with the hands.

f. _____ Long-term Memory: ability to learn and store pertinent information and selectively to retrieve or recall, much later in time, that which is relevant to a specific context.

g. _____ Perceptual Speed: ability to make rapid discrimination of visual detail.

ii) Required Special Training and Experience:

a. _____ Computer knowledge: data input and retrieval, and interpretation of print out.

b. _____ Multi-disciplinary training (skill mix).

c. _____ Use of written manuals to operate the machines and solve problems i.e. operating instructions.

d. _____ Long-period accumulated experience.

e. _____ Intuition and judgement.

12. How do you think the following characteristics of the production system (equipment/process) could contribute effectively to the level of satisfaction with your present job. Write a number in the blank for each statement, based on the following scale.

1-----------2--------3-----4----------5-------6--------7
Absolutely Not True | I Don't Know | Absolutely True

a. ___ The control I practice over the work pace of the equipment/process gives me satisfaction as a result of the feeling of autonomy I enjoy.

b. ___ The flexibility of the sequence of operations gives me freedom to do my work in the way I think best.

c. ___ The employed technology gives me the chance to <u>learn</u> new skills and information related to my job.

d. ___ The frequency of equipment failures has negative effect on my morale as a result of the stress I am subject to in order to maintain the required (predetermined) production (output) quota.

e. ___ The predictability of failure types positively affect my satisfaction because I feel no hustle to execute production programs within scheduled times.

f. ___ The easiness to locate equipment failures alleviates problems that might affect my work.

g. ___ The easiness to correct failures by myself positively affect my satisfaction with this job as a result of the variety of skills I practice.

h. ___ Most production operations can be delayed for long periods without bringing the other production processes (operations) to a complete halt.

Section 4

Finally, just a few bits of information
about your "Personal Background"

1. Sex: Male (0)____ Female (1)____

2. What is your age? ____years

3. What is your race and/or ethnicity?

   ____ Black (African-American) ____ White
   ____ Native American ____ Asian-American
   ____ Hispanic-American
   ____ Other (specify on this line ______________________

4. Circle the grade that indicate your general education attainment:

K 1 2 3 4 5	6 7 8 9	10 11 12
Elementary School	Middle School	High School or equivalent, e.g., GED (general equivalency diploma.)

5. Indicate if you have attended any of the following (place an "x" beside the school you attended, if applicable):

   ____Technical School Number of years attended ______
   ____Training School Number of years attended ______

6. Have you any higher education other than the attainment of technical or training school? (college or equivalent).
   Yes____ No____

   If yes state years of that education (beyond the 12 years of the general education) and the degree/diploma/certificate earned in the corresponding spaces below:

   No of years Field of Degree/Diploma/Certificate

   ____________ ______________________________

7. How long have you been working on the job you thought about while completing this questionnaire? (just answer to the nearest 1/2 year) ______years

8. What is your job title?____________________________

Thank you for your cooperation.

VITA

Ahmed Elamin Haroun

Candidate for the Degree of

Doctor of Philosophy

Thesis: A STUDY OF THE EFFECTS OF TECHNOLOGY CHARACTERISTICS OF MANUFACTURING PRODUCTION SYSTEMS ON AN INDIVIDUAL'S PERCEPTION OF JOB CHARACTERISTICS AND SATISFACTION

Major Field: Industrial Engineering and Management

Biographical:

Personal Data: Born in Elkaraba, Northern State, Sudan, March 13, 1947, the son of Haroun Ahmed Elamin and Safia Ibrahim Elgadi.

Education: Graduated from Port Sudan Secondary School, Sudan; received a Diploma (Master of Science Degree) in Mechanical Engineering from Moscow Institute of Transport, Moscow, USSR, in July 1974; received a Master of Science Degree in Industrial Engineering and Production Management from Cranfield Institute of Technology (MIT), Cranfield, United Kingdom in September 1981; completed the requirements for the Doctor of Philosophy Degree in Industrial Engineering and Management from Oklahoma State University in May 1993.

Professional Experience: Locomotives and Wagons Maintenance and Operation Engineer, Sudan Railways, July, 1976 to October 78; Management Services Officer, Sudan Railways, October 78 to September 79; Senior Specification Engineer, Sudan Railways, October 81 to October 82; A Lecturer, Sudan University of Science & Technology, Department of Mechanical Engineering -Production Section, October, 1982 to January, 1988; Head of the Production Section, Sudan University of Science & Technology, April, 1984 to January, 1988; Teaching Associate, Oklahoma State University, January, 1990 to December, 1992.

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