A Sociotechnical Approach to Evaluating the Effects of Managerial Time Allotment on Department Performance.

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(ABSTRACT)

Current organizational design changes such as restructuring, production advancements, and information technology improvements have caused many organizations to move to flatter management structures. Changes in the organizational structure along with the demand for improved performance have broadened the scope of responsibilities for first-level managers in manufacturing organizations. First-level managers are required to balance their time to meet greater demands.

The sociotechnical systems principle of joint optimization states that organizations function optimally when design changes are made to meet the needs of both the social and technical subsystems in the context of the organization's environment. This study uses time allotment at the supervisory level to operationalize the sociotechnical systems principle of joint optimization.

Ninety-one first-level managers from both the production and distribution areas of thirteen North American facilities participated in this study. Four survey instruments were used to measure the following dimensions: joint optimization, department performance, time allotment to the social and technical subsystems, and organizational values of appropriate time use.

Five time allotment constructs emerged from the data collected on time use in the social and technical subsystems. These were time spent on Participation and Information Sharing, Customer Needs and Strategic Planning, Skill Development and Compensation, Quality, and Department Operational Needs. The results indicated time allotment constructs along with the organization's values on appropriate time use can be used to predict both joint optimization and performance at the department level. The results also indicated a strong relationship ($\rho = .607$, $p < .05$) between level of joint optimization and department performance.

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Chapter 1 Introduction and Scope of Research

This chapter introduces the research topic. It presents the research problem in the context of background literature. The background literature supports how both the research problem and the research scope are defined.

The objectives of this study are also presented in this chapter along with a conceptual research model. The model is used to portray both the research questions and hypotheses. The problem is further developed throughout this document. Chapter 2 provides an in-depth literature review supporting the development of the research methodology. Chapter 3 describes the methodology and instruments used to address the problem. Chapter 4 describes the results and analyses of data collected in the study. Both Chapters 5 and 6 discuss the information and any insights provided by the study that help to better understand the research problem as it was defined.

1.1 Background

Today's organizations are experiencing many design changes that affect how managers allot their time. In a recent study of the Saturn Corporation, Kochan and Rubenstein identified the balance of time spent between managing people and managing production as one of three critical success factors for high performance and quality at Saturn (ASQC, 1996).

Allotting time to meet the needs of both technology and people is important for first-line managers in today's business environment. However, in recent years, the need to allocate sufficient time to both normal day-to-day activities and performance improvement activities has also been stated as important to the success of high-performing organizations (Kurstedt, 1990, Senge, 1994; Sink, 1995,).

Design changes such as restructuring interventions, technology advancement, and retraining and retooling of the workforce impact how managers allot their time. Restructuring interventions, in particular, are flattening the organization's structure (Kleiner, 1996; Kleiner & Hertweck, 1996). As organizations move to flatter structures, many of the responsibilities belonging to middle management are being integrated into upper management responsibilities or delegated to subordinates. Less middle management has already broadened the scope of responsibility for German and Japanese manufacturing supervisors (first-level managers) (Senker, 1994). In keeping with those trends, British manufacturing companies in recent years have also begun to increase the amount of responsibility and expectations of their first-level managers (Senker, 1994).

Little research exists indicating the relationship of these organizational design changes on the optimal amount of time first-level managers should spend on the needs of production and people, performance improvement, and normal day-to-day activities. There is a need to establish a common framework tooperationalize managerial time allotment in manufacturing organizations.

1.1.1 Managerial Activities

The literature related to managerial tasks and functions, organization performance improvement, and the distribution of time that managers spend on performance improvement activities can be summarized as follows:

- Organizations of the future will have half the levels of management and no more than one third of the managers currently seen in the typical organization today (Drucker, 1988).
- Managers should plan to spend more time on performance improvement activities in the organization of the future (Senge, 1994; Sink, 1995).
- There is further need to define how managers distribute their time and how they allocate managerial tasks and functions (Mintzberg 1975;Bluedorn &Denhardt, 1988).
- There are factors such as temporal norms that affect each individual's perception of time and use of time in organizations. These temporal norms could be linked to organizational culture (Schriber &Gutek, 1987).
- There is a need for improved manufacturing management. Senker (1994) cited the Japanese model of autonomous management at the supervisory level as an ideal. This model allows for more complete responsibility in the supervisor's zone of authority (Senker, 1994).
- There is a need for effective design of more autonomous manufacturing methods such as cell-based production, which requires improved communication and faster response times (Senker, 1994).
- There is a trend to increase organizational flexibility and multiskilling in the workplace, which transfers responsibility and decision making to the "point of action — operators and their immediate supervisors" (Senker, 1994, p. 45).
- There are four areas that affect the performance of the organization at the functional unit or department level of analysis: role structures, physical layout, interaction patterns, and supervisory behaviors (Pasmore, 1988).

Manufacturing organizations will have to achieve more in terms of performance improvement with less management. This summary indicates that due to leaner management structures, the scope of responsibility at the supervisory level is changing and becoming broader. Supervisors are also expected to become more autonomous in their domains of responsibility. Again, because of these changes, it is important to understand how supervisors allocate their time between tasks and functions in their department.

1.1.2 Sociotechnical Systems Theory

The organizational design criteria needed to improve supervision in manufacturing are identical to the characteristics Cherns (1987) describes as basic principles of sociotechnical systems (STS) design. In the past 40 years, STS theory has been employed as a successful method of organizational redesign (Pasmore, Francis, Haldeman, & Shani, 1982). The main objective of STS theory is to develop an optimal organizational design that enables the three STS components of the organizational system to work well together. These components are the social subsystem, technical subsystem, and the environment (Pasmore, 1988). These three components together include the people who work within the organization — social subsystem; the required technology to produce work — technical subsystem; and the customers, government bodies, and suppliers which interact with the organization — environment (Pasmore, 1988).

Organizational design criteria such as autonomous management, complete responsibility in the zone of authority, communication and faster response times, and organizational flexibility that have been identified as improvements in manufacturing supervision (Senker, 1994) can be mapped directly to the following STS principles (Cherns, 1987):

1. The principle of information flow states that information for an action should be directed first to the people whose task it is to act, i.e., operators and their immediate supervisors. Organizations of the future should apply this principle more easily because of the predicted reduction in levels of management. Managerial tasks related to improvement of information flow represent part of the organizational performance improvement effort. Therefore, the amount of time required to address information flow at supervisory level needs to be determined.
2. The principle of power and authority states "those who need equipment, materials, or other resources to carry out their responsibilities should have access to them and authority to command them.... In return, they accept responsibility for them and for their prudent and economical use" (Cherns, 1987, p.157). The need for more autonomous management should further increase the power and authority for supervisors in manufacturing organizations. Therefore, the amount of time required to address the responsibility of power and authority at the supervisory level needs to be determined.
3. The principle of minimal critical specification states only the essential should be specified about any job or role. Tasks are not assigned to specific jobs to increase flexibility and to encourage multiskilling. Therefore, the amount of time needed to address minimal critical specification at the supervisory level needs to be addressed.

Clearly, the organizational design improvements necessary for manufacturing supervision can be defined by sociotechnical principles. Therefore, STS systems theory will be used as a broader framework for this research. Aspects of the three earlier principles will be combined to examine the primary STS principle of joint optimization.

The principle of joint optimization states "that an organization will function optimally only if the social and technological systems of the organization are designed to fit the demands of each other and the environment" (Pasmore, et al., 1982, p. 1182). The principle of joint optimization can be examined from two perspectives in the context of this study. The first is to understand the first-level manager's time distribution between the social and technical subsystems. The second is to examine how time is distributed in departments where first-level managers' perceptions indicate a high level of joint optimization.

1.2 Problem Statement

This research proposes to examine how the proportion of time first-level managers spend between the social and technical subsystems predicts overall departmental performance. This study will examine the relationships between managerial time allotment and (1) department performance, (2) cultural perceptions of time use (i.e. how managers perceive they should use their time in their organization), and (3) perceived level of joint optimization in their department.

1.3 Research Objectives

Neither the scholarly nor practitioner literature provides direct information on what proportion of time is necessary to address the needs of the social and technical subsystems. Information about the balance of time required to achieve joint optimization in manufacturing organizations also does not exist. However, there is research to support that a manager's perception about the usage of time in the organization can predict organizational (or sub-unit) performance(Lim and Seers, 1993). Little is known about the relationship between time spent on the needs of social and technical subsystems, joint optimization, and department performance.

The objectives of this research were to:

(1) Learn what proportion of time managers spend addressing the social or technical subsystems.

(2) Learn which departments perform better and how that performance is related to the managers' time allotment between the social and technical subsystems.

(3) Determine which departments meet both the needs of the social and technical subsystems in the context of their environment by maintaining a high level of perceived joint optimization.

(4) Determine how joint optimization is related to the managers' time allotment between the social and technical subsystems.

1.4 Conceptual Model

As stated earlier, the focus of this research is to study the relationship between time allocation to the social and technical subsystems and perceived department performance. The level of joint optimization was used to measure how well the department subsystems (social, technical, and environment) work together. The total time allotted to the technical and social subsystems includes tasks initiated in either subsystem to meet the needs or requirements of the environment.

The conceptual model for this study used Sink's (1989) portrayal of an organization as a system to describe a manufacturing plant's functions and processes. This model was also used to categorize first-level managers into three types:

- upstream managers involved in functions such as purchasing, raw materials, and supply inventory

- transformation managers involved in a) process or production functions and b) safety and maintenance functions; and
- downstream managers involved in finished goods inventory, warehousing, logistics and customer service functions.

The measure of joint optimization is a combination of each manager's perception of the level of twenty STS characteristics (Promethian, 1994) from the technical subsystem, social subsystem, and environment.

The allocation of managerial time within the department is divided into two categories - tasks in the social subsystem and tasks in the technical subsystem. Tasks in either subsystem may be initiated directly or indirectly by the needs of the environment. Several models can be used to describe the time allotment between these two subsystems. The simplest representation is the pie graph portrayal of time distribution similar to Kurstedt's (1990) ABC model for managerial time allocation.

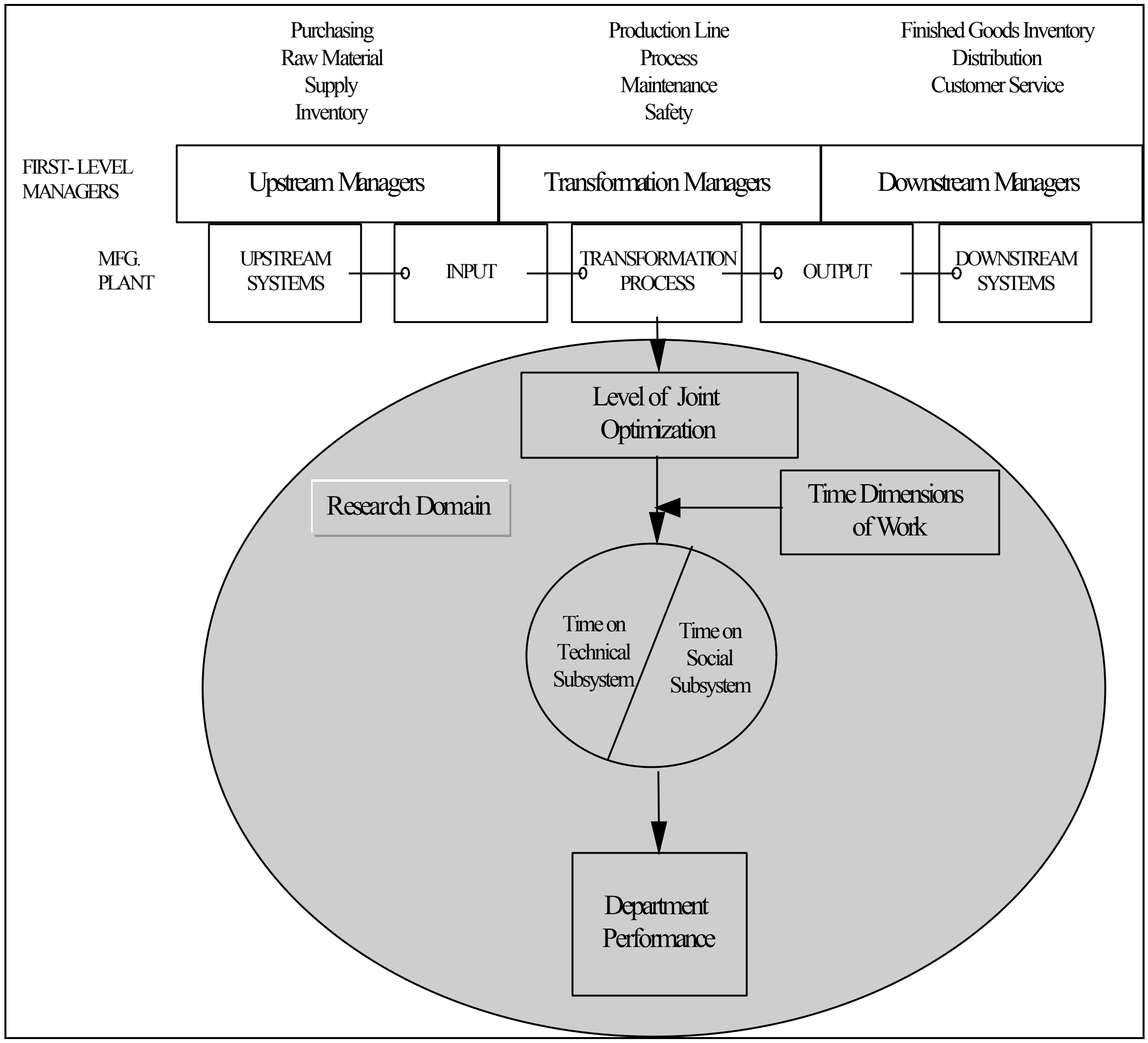

Figure 1.1. Conceptual Research Problem

The conceptual model also depicts the proposed interactions between first-level managers' department performance and proportion of time spent on social and technical subsystems. The conceptual model shows a relationship between first-level managers and the level of joint optimization in their departments. The level of joint optimization is also related to the amount of time allotted to the social and technical subsystems within the department. The manager-s' perceptions about the proper usage of time within the organization (i.e., time dimensions of work) are shown to affect the relationship between joint optimization and the amount of time spent on the social and technical subsystems. Finally, time allotment between the technical and social subsystem is shown to have a relationship with department performance. In this model, department performance is evaluated by both the plant manager as well as the first-level manager.

1.5 Research Questions and Hypotheses

Research questions and hypotheses discussed in this section are based on the proposed relationships between variables selected from the literature and outlined earlier in the conceptual model. The research questions and hypotheses are formed to develop both known and proposed relationships among these variables. The interactions among the following variables: (1) the level of departmental joint optimization, (2) time dimensions of work, (3) time allotment, and (4) department performance are shown in the operational research model (see Figure 1.2).

The following definitions of first-level managers and plant managers were used in the questions and hypotheses and throughout the study:

> First-level managers include all manufacturing supervision at the first level of management above hourly workers and operators. Titles include foreman, supervisor, department manager, team leader, cell leader, etc. These managers include upstream, transformation, and downstream managers.

> Plant Manager is the person in charge of the entire process and plant performance. Typically, this person reports directly to division manager or Vice President of manufacturing.

Research Question 1: How do reports of departmental joint optimization compare between different types of first-level managers?

According to Reinmann, "the larger and more complex the organization, the more likely it is to operate with several different types of technology" (Reinmann, 1980, p. 62). Functional divisions can contribute to differences of technology integration across the organization. For example, the process or production functions of the manufacturing system traditionally tend to be more mechanistic and machine-driven then the rest of the manufacturing system. Therefore, workers likely will interact with a technical subsystem that caters to the specific function of their department. Because of this difference, upstream, transformation, and downstream managers may interact with the technical subsystem that reflects their function in the manufacturing process. Different types of technology may influence how these managers proportion their time between the social and technical subsystems.

Research Hypothesis 1a: Upstream, transformation, and downstream first-level managers across different manufacturing firms report different levels of joint optimization within their departments.

Research Hypothesis 1b: Upstream, transformation, and downstream first-level managers across different manufacturing firms spend different proportions of time on the social and technical subsystems of their departments.

Research Question 2: What balance of time between the social and technical subsystems do first-level managers report for jointly-optimized departments and/or high performing departments?

In Senker's (1994) article, Supervision in Manufacturing Organizations, three manufacturing organizational models were discussed: British, Japanese, and German. According to Senker, both German and Japanese companies recognize the importance of supervision to a manufacturing operations. The tasks performed by manufacturing supervision in both of these countries can be considered tasks in both the social and technical subsystems. Senker cited data on the Allocation of German Industrial Supervisors' Time published by the Institut der deutschen Wirtschaft (1988) which includes a breakdown of supervisors' functions and the percentage of time allotted to each task. For the purposes of this research, the original table has been modified to include a column mapping each function to the social or technical subsystem according to the scale definitions in the STS Benchmark Survey for Organizational Design (Promethian, 1994).

The results of this study indicate that German supervisors spend an average of 54% of their time addressing the technical subsystem and 46% of their time addressing the social subsystem. Supervisors of German manufacturing departments spend almost equal amounts of time addressing the needs of the social and technical subsystems.

Table 1.1 Allocation of German Industrial Supervisor's Time (Senker, 1994)

Function	Percent of Time	STS Subsystem
(1) Organizing the work unit	28	social
(2) Checking, inspecting, quality control	23	technical
(3) Meetings, planning for new activities of the unit	18	social
(4) Training	12	technical
(5) Planning, construction, health and safety, transport	11	technical
(6) Technical study, preparing reports	8	technical

Key lessons from Trist's coal mining studies in 1959 showed that "despite the importance of successful social innovations, managers are more likely to pay attention to technical than social innovation" (Pasmore & Khalsa, 1993, p 556). This practice reduced potential unit performance. Therefore, Research Hypothesis 2a: Departments rating high in joint optimization will have first-level managers who spend equal amounts of time addressing the technical subsystem and the social subsystems. Departments with lower ratings in joint optimization will have managers who spend more time on the technical subsystem.

Research Hypothesis 2b: Departments rating high in joint optimization will rate high in overall performance.

Research Question 3: What relationships do time dimension of work variables have with departmental joint optimization and how managers allot their time to the social and technical subsystems?

Perceptions about time use in organizations may also be affected by the organization's cultural values. Schriber and Gutek (1987) developed an instrument for measuring temporal norms in organizations. Of the sixteen dimensions identified as temporal norms in the original instrument, this study will use six dimensions that Lim and Seers (1993) found to be significantly linked to perceived organizational performance. These dimensions are future orientation, autonomy of time use, allocation of time, awareness of time use, schedules and deadlines, and synchronization and coordination of work with others through time. First-level managers were asked to complete questions from these six scales to measure their perceptions of the appropriate use of time in their organization.

Research Hypothesis 3a: Time dimension variables affect the association between joint optimization and the difference of time spent on technical and social activities.

Research Hypothesis 3b: Time dimension variables predict department performance.

Research Question 4: What proportion of time do first-level managers spend on the social and technical subsystems in departments with perceived high performance ratings?

The role of manufacturing supervision is changing and is more directed to fostering improved operator performance. The intent behind first-level managers spending more time to encourage better performance on the floor is a reflection of a change in priorities (Senker, 1994). According to Senker (1994), some manufacturers believe by prioritizing people before the technical aspects of quality, production, or planning, process quality will follow. In general, companies adopting this viewpoint, recognize this fact as an emerging norm and require that "supervisors spend a higher proportion of their time in supervisory roles" (Senker, 1994, p.55). In more organizations, high-performing supervisors are required to spend a larger proportion of their time on planning and evaluating the tasks required to run their department such as staff appraisals, monthly team briefings, and enforcing company safety policy (Senker, 1994, p.55) in addition to time spent maintaining tools. One of the manufacturers interviewed in Senker's study refers to the shift in the balance between the time spent on supervisory roles (i.e., social subsystem) and tool repair (i.e., technical subsystem) by first-level managers as a direct result of their management's move to upgrade supervision.

As stated earlier, Pasmore (1988) identified four areas which affect the performance of the organization at the functional unit or department level of analysis: role structures, physical layout, interaction patterns and supervisory behaviors. If there is a relationship between time allotment and first-level manager performance, it is proposed that the supervisors' behaviors will have some affect on departmental performance. Therefore,

Research Hypothesis 4: Departments with first-level managers who spend equal proportions of time on the social and technical subsystems are higher performing departments.

1.6 Operational Model

An operational research model shows the proposed interactions among variables used in this study. The dependent and independent variables include type of first-level manager, time allotment, perceptions of the time dimensions of work, the level of perceived joint optimization in managers' departments, and department performance. Sub-variables for independent and dependent variables are further defined in this section. The relationships described in the research questions and hypotheses are labeled in the model.

1.6.1 Research Variables

This section describes the independent and dependent variables to be used in this research (See Figure 1.2).

Independent variables are the presumed cause of the dependent variable which is the presumed effect (Kerlinger, 1986). In this study, seventeen STS scales from the social, technical, and environment systems in the STS Assessment Survey are used as independent variables. Even though the focus of this research is on the time spent on the needs of social and technical subsystems within each department, measures of the STS characteristics of the department's environment are still needed to determine the level of joint optimization in each department.

Each supervisor has a perception of the proper usage of time in his department. The perceptions are formed by the organization's culture and can be measured by Schriber and Gutek's (1987) Time Dimensions of Work scales. Scales from this instrument are considered moderator variables between the relationship in the level of joint optimization in each department and the time spent on the social and technical subsystems.

There were three dependent variables in this study: 1) the technical subsystem time allotment, 2) the social subsystem time allotment, and 3) department performance. The current body of STS knowledge supported that first-level managers did not spend much direct time on issues in the organization's environment. However, research and anecdotal evidence suggested that many organizations were involving managers at all levels with environmental issues, i.e. strategy, customer focus and satisfaction, as well as responsiveness, in their domain of responsibility.

Issues in the environment affect the social and technical subsystems of the department. In this research, the amount of time the first-level manager spends on tasks in the environment, such as time spent interfacing with customers or time spent responding to the technical needs of customers, were categorized as part of either the social or technical subsystem. The department's ability to manage the environment was measured by the STS characteristics relating to joint optimization.

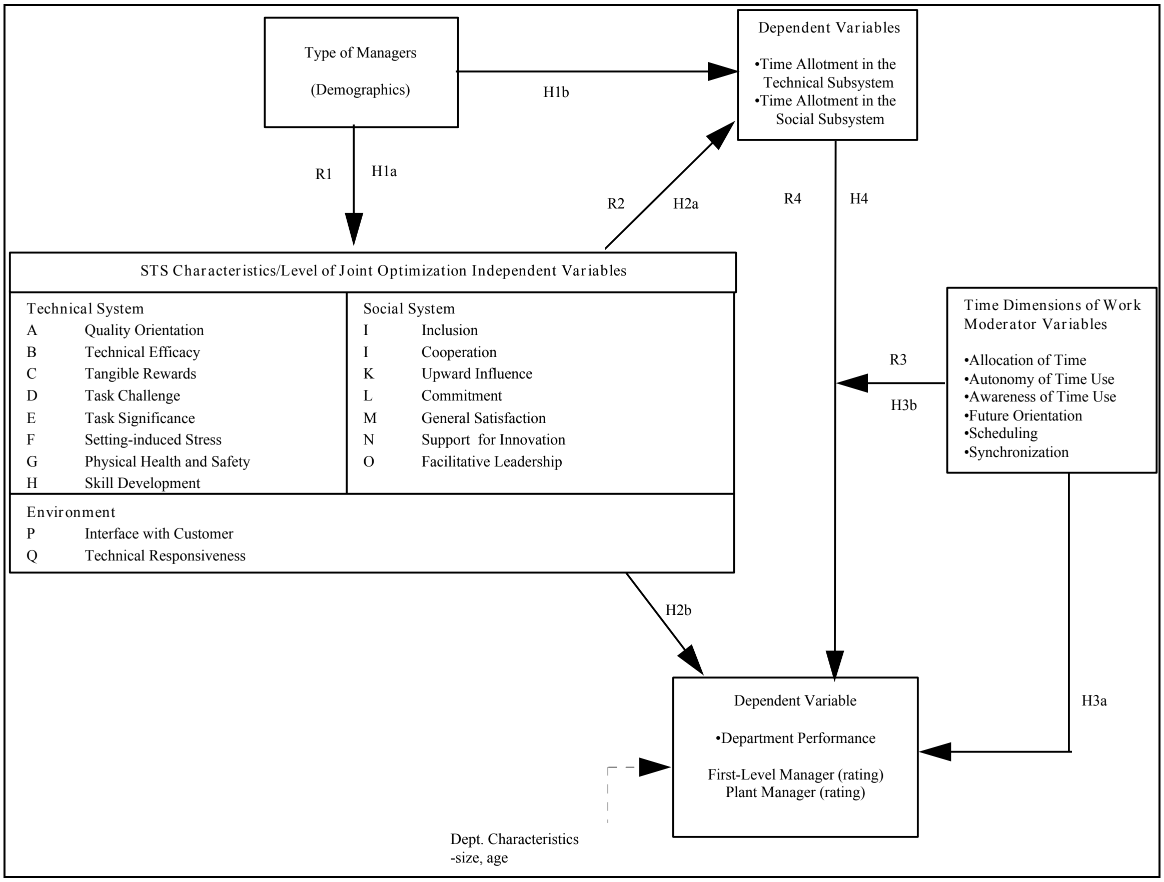

Figure 1.2. Operational Research Model

1.7 Premises andDelimitations

This section further defines the scope of this research by declaring all assumptions made by the researcher, as well as stating all premises and delimitations. Assumptions are statements which are not proven true by past research. Premises are statements which define the basis for reasoning of the scope this research will cover. Delimitations are statements which define what will not be considered by this research.

Assumptions

- The level of joint optimization in a working organizational system is a function of time spent in the social and technical subsystems of that organizational system.
- Joint optimization is achieved by spending equal amounts of time on the social and technical subsystems.

Premises

- The challenges of manufacturing competition and implementation of 'Japanese manufacturing methods' will continue to reduce manufacturing management hierarchies.
- In non-autonomous work groups, managers are directly responsible for how the work group functions, and managerial behavior impacts work group performance.
- Tasks identified in STS theory as necessary to improve both the social and technical subsystems are performed to some degree in all organizations whether or not they have been formally identified as performance improvement tasks.
- Joint optimization is a desired state for manufacturing organizations.
- Time allotment in the social and technical subsystems includes the time spent on the environment. At this level in the organization, needs of the environment initiate tasks in the technical or social subsystem either directly or indirectly.

Delimitations

- Psychological variables, e.g. managerial style, leadership orientation, of the first-level managers will not be considered in this research.

1.8 Desired Outputs and Outcomes

Desired outputs of this research are:

- A comparison of reports of time allotment between the social and technical subsystems by first-level managers across manufacturing firms.

- A comparison of reports of joint optimization by first-level managers across manufacturing firms.
- Information on the balance of time required between the social and technical subsystems to jointly optimize department performance.
- Information on whether jointly optimized departments are high performance departments.
- Identification of any issues regarding the perceptions of time use which relate to how managers balance their time between the two subsystems.
- Identification of any issues regarding the perceptions of time use which relate to the department's predicted performance.
- Information on the balance of time required between the social and technical subsystems for departments with high perceived performance.

Desired outcomes of this research are:

- The findings of the research will contribute to the sociotechnical systems theory body of knowledge.
- From an industrial engineering perspective, these findings will provide more information about the balance needed in managerial time allocation. This information may have further implications for management systems design.

Chapter 2 Literature Review

The purpose of this chapter is to review the body of knowledge pertaining to the research scope outlined in chapter one. This chapter provides supporting information for research questions and hypothesis formed in the earlier chapter.

2.1 Past Studies of Time in Organizations

Many researchers have studied how managers spend their time. Over several decades, different models and instruments have been used to describe managerial time allocation. Existing studies include (1) identifying the amount of time required to complete job tasks in the interest of ranking task importance; (2) demonstrating the effective use of time - for the organization, for the manager, and for the follower group - in the interest of providing a benchmark; (3) examining temporal effects on organizational behavior; and (4) assessing organizational development by examining what proportion of organization time is spent on learning and developing versus performing routine tasks.

In Bluedorn and Denhardt's (1988) review of studies on time and organizations, time was identified as a both a macro-level and micro-level concept. At the macro-level, these authors state that researchers have related time to "organizational culture, strategic planning, and organizational contingency theory"; and, at the micro-level, they have related time to "individual difference, decision making, motivation and group behavior" (Bluedorn & Denhardt, 1988, p. 299). Furthermore, their review went beyond the traditional reviews of time budgets, time and motion studies, and time management to include those studies that discussed the impact of temporal matters on work behavior.

Both time and organizations have been studied from the sociological and organizational perspectives. Researchers who have studied time from a sociological perspective have looked at the relationship between "temporal concepts and social organization" (Bluedorn & Denhardt, 1988, p. 299). Schriber and Gutek's (1987) study on "Some Time Dimensions of Work: Measurement of an Underlying Aspect of Organization Culture" belongs in this category of studies which addresses variables identifying the cultural concept of time within society or within an organization. They developed and tested an instrument to measure norms about time in organizations which allowed temporal comparisons across and within organizations. Bluedorn and Denhardt identified Schriber and Gutek's study as one of a few which incorporated data from comparative research and used the organization as the unit of analysis. According to Bluedorn and Denhardt, this type of comparative research of time and organizations is just beginning and more studies are needed at this level. Bluedorn and Denhardt posed major questions for further research in areas where the literature is lacking. Two questions relevant to this thesis are: "(1) How are temporal phenomena related to organizational strategies and structures? and (2) How are the organization's contextual variables related to the organization's temporal attributes?" (Bluedorn &Denhardt, 1988, p. 314)

In organizational studies, time has been viewed as a resource closely related to organizational productivity, efficiency, and effectiveness. According to Bluedorn and Denhardt (1988), many modern organizations considered time a scarce resource "to be measured and manipulated" as well as "controlled and regulated in pursuit of organizational objectives (p. 303)." This view of time, called time segmentation (Webber, 1972), separates controllable time from uncontrollable time. Controllable time is referred to as self-imposed time, disposable time, and discretionary time. Uncontrollable time, on the other hand, is referred to as job imposed time, required time, fixed time, and response time (Webber, 1972). According to Webber, studies indicated that managers have no more than 20 to 50 per cent controllable time and their objective should be to increase this percentage.

According to Bluedorn and Denhardt (1988), time in planning has also been related to organizational design at the organizational level. Studies in this area examined the variability in the perception time. The perception of temporal variability has been studied in conjunction with the environmental complexity and variability. Both of these components were important to the planning process. Other temporal factors which affect planning were task duration and time span. Both task duration and time span varied across the organization. At operational levels, the longest task may last a day, month, or year, while at more strategic levels, the longest task may last several years or decades.

Along with task duration, individuals also have different temporal orientations which affected the length of their time horizons. Planning at all levels requires people to incorporate views from their individual time horizons. El Sawy's study in 1983 found that it was possible to change an individual's time horizons and therefore increase the length of his or her planning horizon (Bluedorn & Denhardt, 1988). Individual temporal orientations may account for differences in the ability to carry out performance improvement activities. In this research, individual temporal orientations will be measured using Schriber and Gutek's (1987) time dimension scales.

Both objective measurement and subjective observation have been used by practitioners and researchers to study the way an organization spends its time. Information on how time is spent at the macro and micro level has been linked to organizational quality. In many cases, the relationship may be no more than a subjective assessment or statement about what is important or what is valued. Webber studied time and management with a past time, present time, and future time model. He challenged American management to stop filling every moment of present time with activities that had no future value, but instead "to carve time out of the present for less-pressured work on long-range problems and possibilities" (Webber, 1972, p. v). Early on, Webber identified that managers need to spend present time on what many authors now refer to as performance improvement activities. Today's researchers and practitioners still recognize the need for managers to spend more time on these activities (Senge, 1994; Sink, 1995).

2.2 Managerial Tasks and Functions

When managers look at the current business situation and ask where to go next or how to improve or maintain the current level of success, the recommended first step is usually for the manager to do a situation appraisal (Sink and Morris, 1995). In the situation appraisal, managers examine both internal and external issues that affect quality, effectiveness, information flows, etc. At this time, managers should make some assessment of how time is used and should be used at all levels in the organization. Managers should also assess how their time is spent on value added tasks to increase productivity, effectiveness, and quality versus non-value added tasks.

There are a number of studies in the management and psychology body of knowledge that identified managerial tasks and roles. The classical research focused on finding generalizable models of managerial skills, behaviors, and tasks (Whitley, 1989). One of the classic studies conducted by Mintzberg (1975) described managerial behavior in terms of the various roles that managers must play within the organization: (1) interpersonal roles, (2) informational roles, and (3) decisional roles. Mintzberg derived these roles from his study of middle to executive level managers and showed that:

- managerial activities were characterized by "brevity, variety, and discontinuity" (p.50) with very few large single blocks of time to spend on any one activity;
- managers did have regular duties to perform besides handling exceptions; and
- managerial jobs are composed mainly of verbal communication.

These findings were consistent with Webber's (1972) study of the following five types of managers: general executives, functional control managers and staff specialists, service managers, operating supervisors, and sales managers. Webber found that (1) managers needed to consolidate uninterrupted time to think and to break away from the overwhelming "variety, quantity, and urgency of demands" (p. 44) characteristic of their jobs; (2) managers spent about 60-90% of their time on verbal communication; and, (3) managers had to fulfill the requirements of their function during what Webber terms job-imposed time (uncontrollable time).

One of the benefits of this classical approach to the study of managerial tasks and activities is that the researcher can make general recommendations applying to managers at all levels. For example, Webber made recommendations on how to create chunks of uninterrupted time - through prioritization, isolation, attending the urgent and important.

However, one criticism of the classical approach to the study of managerial activities is that "the search for general properties of all managerial work has tended to play down the organizational and industrial specificity of managerial tasks" (Whitley, 1989, p. 213). According to Whitley (1989), managerial tasks have a low degree of standardization. Therefore, comparative research of the managerial assessment of time spent on value-added tasks requires a framework common to all organizations to overcome the effects of a low degree of standardization.

2.3 Sociotechnical Framework

Sociotechnical systems theory has been used for decades as a framework to design and understand organizations, and has been applied in practice as a framework for organizational change. In the definition of sociotechnical systems, every organization is made up of a "social subsystem (the people) using tools, techniques and knowledge (the technical subsystem) to produce a product or service valued by the environmental subsystem (of which customers form a part)" (Shani, Grant, Krishman & Thompson, 1992, p. 92). This framework divides the organization into three interdependent subsystems: social, technical, and environmental. Each must be aligned and work together so the organization can function optimally.

2.3.1. The Sociotechnical Subsystems

The characteristics of each of these subsystems have been operationally defined over the course of many decades of action research. The social subsystem is the human element of the organization capable of innovation and adaptable to change (Pasmore, 1988). At the micro level, the social subsystem embodies characteristics such as individual motivation, group performance, communication, flexibility, involvement, autonomy, commitment and satisfaction (Pasmore, 1988). At a macro level, the social subsystem represents organizational culture and organizational design. The technical subsystem holds the tools, knowledge base, and technology required to acquire inputs, transform inputs into outputs, and provide outputs or services to customers in the organization (Pasmore, 1988; Hendrick, 1991). According to Pasmore's (1988) summary of the effects of technology on organizational behavior, the technical subsystem will have different direct or indirect effects depending on the level of analysis within the organization. At the individual level, the technical subsystem affects work design, productivity, self-perceptions, and psychological contracts. At the functional unit or department level, the technical subsystem affects roles structures, physical layout, interaction patterns, and supervisory behavior. At the organization level, the technical subsystem affects relationships among departments, organizational structure, reward systems, organizational flexibility, and overall competitiveness (p. 58). Therefore, at each level of analysis the technical subsystem has a different type of interaction with the social subsystem.

The technical subsystem is affected by the environmental subsystem at a strategic level (Shani et al., 1992). An organization will choose the technology it requires to service its customers and to compete in its business environment. How the organization competes and what customers the organization targets impacts the technology it chooses, affects the employees the organization hires, and impacts how employees are trained, supervised, and compensated (Pasmore, 1988). Therefore, the environment impacts the organization's social subsystem through staff selection (Pasmore, 1988). Scanning and adapting to the environment is an important function of managers who have an impact on the strategic direction of the company. Lower level managers will be impacted by changes in the environment through changes in the technology in the technical subsystem and by adaptations to those changes in the social subsystem.

2.3.2 The Principles of STS Theory

Several principles guide STS theory. Three are central to the design and continued adaptation to change of STS organizations. These are joint causation, joint optimization, and joint design, all of which involve the organization embracing a holistic systems approach. Other STS principles that affect work design are the principles of minimal critical specification, information flow, and power and authority defined earlier in the introductory chapter.

Decades of STS interventions have applied these principles to varying degrees to achieve organizational improvement through redesign. The principle of joint optimization focuses on meeting the needs of both the social and technical subsystems so the organization at any level of analysis can function optimally. Joint optimization has been misinterpreted by many as "a modification of a technical design for social considerations" (Cherns, 1987, p. 155). However, operationalizing the principle of joint optimization involves focusing on the interrelationship between the social and technical subsystem. A change in the design in either subsystem has a cause and effect relationship with the other. Design changes which do not take into account the interdependent relationship of these subsystems run the risk of sub-optimizing organizational performance.

2.3.3 A Summary of STS Interventions

In Beekun's (1989) meta-analysis of sociotechnical systems, he presented a comprehensive study of variables involved in effective STS interventions. Workgroup autonomy, a variable common to many STS interventions, is based on the principle of minimal critical specification. Beekun reported that providing workgroup autonomy involves adjusting the social subsystem in all or any of the following ways:

- reducing the degree of external supervision,
- increasing the level of multiskilling in the organization by training employees,
- allowing employees to choose their coworkers and work pace, and
- increasing the level of input workers have in decisions affecting them.

In the area of technological change, Beekun's analysis reported very few interventions involved in simultaneous adjustments to both the social and technical subsystems. In the few studies which actually stated the variables used during STS interventions, task interdependence and workflow routines were the two technical variables manipulated when changing the technical subsystem (Beekun, 1989). These two variables were highly related to level of complexity and innovation, which according to Shani et al. (1992) were key organizational design elements in the technical subsystem.

More recently, Shani et al. (1992) reported on STS theory and organizational choice in manufacturing. In their study, they noted that implementation of advanced manufacturing systems in the U.S. lags behind that of Japan, West Germany, Switzerland, and Sweden, mostly due to managerial problems and not technical ones. According to these authors, the problems that U.S.

organizations faced while implementing advanced manufacturing systems came from the "incompatibility of new technologies with organizational structures, decision techniques, management systems, and employee attitudes" (p. 91). Although their discussion of manufacturing technology is focused on the point of implementation, their study has significant implications for the day-to-day success of technology in the organization. Shani et al. identified sociotechnical systems as a unifying framework to guide the organizational transformation process. More importantly to this research, they classify manufacturing technologies into four categories: (1) Stand Alone, (2) Cells, (3) Linked Islands, and (4) Full Integration. These categories were compared to understand how each affected key organizational elements. Key organizational elements were defined as follows:

1) Technical System	▪ level of complexity and innovation
2) Environmental System	▪ complexity and stability
3) Technical/Environmental Interface	▪ strategic goals, risk, and relationship with vendors
4) Social System	▪ Skill requirements, and employment requirements
5) Work Design	▪ Individual or group task design, structure, integration, information flow, control, and rewards

Table 2.2. A Sociotechnical System Based Comparative Examination of Four Levels of Advanced Manufacturing Systems

Key Organizational Elements	Level 1 Stand Alone	Level 2 Cells	Level 3 Linked Islands	Level 4 Full Integration
Technical System				
Level of Complexity	Low	Moderate/High	High	High
Innovation	Process Innovation	Mostly process with limited product innovation	Moderate innovation in both product and process	High innovation in both product and process
Environmental System				
Complexity and Stability	Stable, simple, with low to low moderate uncertainty	Limited turbulence, complex, with moderate to high uncertainty	Turbulent complex, with high uncertainty	Turbulent complex, with high uncertainty
Technical/Environmental Interface				
Strategic goals	To replace an existing machine, group of machines and/or workers	To facilitate some required changes in the firm's product mix; capacity, lead time process	To provide competitive advantage by developing synergy in the production	To become a true competitive force in the marketplace
Risk	Low	Moderate/High	High	High
Relationship with vendors	Bureaucratic control of vendors and suppliers	Semi-bureaucratic control of vendors and suppliers	Vendors and suppliers are linked to the organization	Vendors and suppliers are an integral part of the organization
Social System				
Skill Requirements	High specialization, with routine and repetitive tasks	Limited multiple skill requirements	Multiple skill requirements	Low specialization, with multiple skill requirements
Employment Requirements	Relatively stable	Semi-flexible	Flexible	Flexible
Work Design				
Individual or Group Task Design	Mostly individual task design	Semi-autonomous work group design	Semi-autonomous work group design	Autonomous work groups design
Structure	Rigid/mechanistic	Semi-organic	Organic	Organic/ networked
Integration	Limited local integration	Local integration	Semi-integrated total system	Total system integration
Information flow	Manual exchange of information	Restricted exchange of information	Semi-automatic transfer of information	Automatic transfer of information
Control	Bureaucratic	Semi-bureaucratic	Semi-self-regulated	Self-regulated
Rewards	Individual- based	Individual - or group-based	Group-based	System-based

Adapted from Advanced Manufacturing Systems and Organizational Choice:Sociotechnical System Approach, Shani,A.B. Grant, R.M. Krishnan,Thompson, E.

The comparison in Table 2.1 (Shani et al., 1992) provides information about optimal sociotechnical design for each classification of manufacturing technology. According to these authors, managerial implications for manufacturing organizations are as follows:

i. "incremental joint-optimization of sociotechnical systems appears to be an attractive strategy for mature, complex companies seeking to upgrade their manufacturing technologies. (p 108)"

ii. critical management problems come from the adjustment of the social system and not from the adjustment of the technical system.

From their research, Shani et al. (1992) concluded when organizations make the transformation to a new sociotechnical system, the time frames for adjustment in the social subsystem will be much longer than those in the technical subsystem. Senker's (1994) study on manufacturing supervision supports the hypothesis that in order to maintain a sociotechnical system, once it has been established, equal amounts of time must be spent on both the social and technical subsystems. The tendency, however, is for managers to pay more attention to technical rather than social innovation (Pasmore & Khalsa, 1992) and focus more on the technical subsystem.

2.4 Manufacturing Supervision

The tendency to pay more attention to technical innovation rather than social innovation has strong implications for the quality of work life in organizations. This tendency also influenced how managers divided their time between the technical and social subsystems. In light of the comment that the challenges facing U.S. manufacturing organizations are managerial and not technical (Shani et al., 1992), researchers should be paying more attention to what managers do in manufacturing organizations in conjunction with technical innovation.

Methods of manufacturing supervision differed between U.S. organizations and stronger global leaders in manufacturing (Niepce & Molleman, 1996; Shani et al., 1992). Supervision in the Japanese system is matched to the constraints of the underlying lean production (LP) methodology. Like STS, LP values human beings and labor, however, LP allowed the production process to dictate the work pace and methods which differed from the STS philosophy of allowing workers the autonomy to choose both work pace and methods (Niepce & Molleman, 1996).

Table 2.3. Characteristics of Work Organization in Lean Production and Sociotechnical Systems

Factor	Dimension	Sociotechnical Systems	Lean Production
Minimal critical specification	1. Type ofco-ordination	Standardized skills	Standardized processes
	2. Workplace	Freedom of movement	Fixed location
	3. Interdependence	Reciprocal	Sequential
	4. Leadership style	Facilitator	Hierarchic
	5. Job enrichment	Many control	Few control tasks
	6. Workplace	Autonomy	Process-paced
	7. Work method	Autonomy	Standardized
Boundaries	8. Grouping task	Interrelated	Fragmented
	9. Degree of seclusion	Closed	Open
Multifunctionality	10. Job enlargement		Maximal
	11. Cycle time	Long	Short
Human values	12. Motivation	Internal	External

Source: A case study: Characteristics of Work Organization in Lean Production andSociotechnical Systems, Niepce, W. and Molleman, E.

Both Japanese and German manufacturing organizations focused heavily on supervisor training (Senker, 1994). Senker argued that the "principal need for training supervisors does not arise from the need for them to manage work groups, but from the need for them to play an active part both in facilitating organizational and technological change" (Senker, 1994, p. 46). Again, according to Senker, both of these countries focused more on technical training to reduce production problems. Supervisors in these production organizations had a strong sense of autonomy in their work zone (Senker, 1994). Similar research indicates that operators, on the other hand, may have had much less autonomy in these production environments than what was optimal and required to motivate them (Niepce & Molleman, 1996).

In the typical organizational setting, there may be a trade-off between supervisor autonomy and operator autonomy. The need for autonomy associated with personal growth and achievement may be a cultural need of workers in western countries (Niepce & Molleman, 1996). As Niepce and Molleman discussed, the conflicts over workers needs has strong implications for the use of STS design in production models focused LP methodologies.

STS design encouraged autonomy and wholeness of work often at the expense of work pace (Niepce & Molleman, 1996). STS design encouraged supervisors to spend time on providing job enrichment, allowing participation in work method, and grouping activities. The organizational design of other production methodologies, like LP, may already cause work to be fragmented, require standardization of process, and follow a fixed work pace (Niepce & Molleman, 1996). In such instances, the need for managers to spend time on specific STS activities may be limited by the production process.

2.5 STS Approach to Managerial Time Allotment and Department Performance

Past research and theory indicated that managerial behaviors influenced department performance (Pasmore, 1988). How managers spend their time is one of many important behaviors which has been studied for decades. This study differs from past research by examining managerial time allotment for manufacturing supervisors from a sociotechnical perspective.

This approach addresses many of the problem areas associated with low standardization of managerial work in past studies of managerial time allotment. Every organization can be defined according to the three sociotechnical subsystems whether or not STS was used for the organizational design. This allows researchers to use STS as a framework for all organizations. Manufacturing organizations, in particular, contain key organizational elements important to STS. These organizational elements (Tables 2.1 and 2.2) have already been defined in studies by Shani et al. (1992) and Niepce and Molleman (1996). Both of these studies defined important activities in both the technical and social subsystems within the responsibility of manufacturing supervision. These researchers have also identified organizational elements they have found to be important to department performance. Time spent on these activities may involve managers exhibiting many of the traditional behaviors such as communication, interpersonal, informational, and decisional roles (Mintzberg, 1975). However, this study differs from traditional studies on managerial time because the focus is not on what the manager does, but instead on whether what he/she accomplishes is an activity in the social or technical subsystems.

This approach is also in keeping with current attempts to integrate the usage of STS principles in organizational change research efforts. In particular, a sociotechnical framework has recently been developed for quality transformation in Ford's product development process (Faulkenburg, 1997). These researchers are examining the importance of integrating both human and technological issues when implementing change process programs.

Focusing on the principle of joint optimization is also important for this study. In STS theory, the social and technical subsystems are highly interdependent and their operational dependence is defined under the principle of joint optimization. Previous research has already shown that the environmental subsystem heavily impacts the direction of the organization's technical subsystem at a strategic level (Pasmore, 1989; Shani et al., 1992). Final strategic decisions like the type of market, type of customer, and type of technology the organization will target are generally made at managerial levels above manufacturing supervision. At the department level, manufacturing supervision will interact with the department's environment, e.g. internal customers and suppliers, organization policy. The department's environment will affect its social and technical subsystems. Therefore, tasks and functions which cause the supervisor to interact with the environment will be appropriately categorized as part of either the social or technical subsystem.

Bluedorn and Denhardt (1988) challenged researchers to do more intra-organizational research on time and organizations. This research addresses their challenge in three ways: (1) by studying many manufacturing organizations; (2) by using the STS framework to allow comparison among organizations; and (3) by looking for common effects that the cultural perceptions of time at an organizational level may have on the balance of time at the department level.

Chapter 3 Methodology

The purpose of this chapter is to address how this study was conducted. The study used a correlational research design to organize past observations so they can be used to predict some other aspects of a phenomenon (Thorndike, 1978). This chapter describes the subjects, instruments, and procedures required for this design.

3.1 Subjects

Two groups of managers were asked to complete the survey questionnaires: (1) first-level managers and (2) plant managers at participating manufacturing firms. First-level managers were asked to complete four instruments. The first instrument was the Sociotechnical System Organization Design Benchmark Survey which was completed by first-level managers. It was used to determine the perceived level of STS characteristics in the each department. The second instrument was the Time Dimensions of Work Survey completed by first level managers. This instrument was used to determine managers' perceptions of proper time use in their department due to the culture of the organization. The third instrument was Time Allotment of work completed by first-level managers. This instrument was developed to measure managers' perceptions about the amount of time spent in each of the subsystems. The fourth instrument was a Department Performance Evaluation Survey completed by both first level managers and Plant/Warehouse[1] managers to determine the perceived level of overall department performance. The plant manager's responses to this survey were used as an objective evaluation of department performance.

3.1.1 Sample Size

The number of subjects or required sample size is related to the number of research variables in the study. Thorndike (1978) states two rules of thumb which can be used to determine the approximate sample size in correlational research. The first rule of thumb, and usually the lower limit, says there should be 10 subjects for each variable, and to ensure sufficient sample size for small sets of variables, 50 more subjects should be added to the first total (Thorndike, 1978). The second rule of thumb, and usually the upper limit, says the total number of subjects should be the square of the total number of variables and to ensure sufficient sample size for small sets of variables, 50 more subjects should be added to the total of the squared calculation (Thorndike, 1978).

In this study, there were 12 variables (3 independent, 6 moderator, 3 dependent), and the recommended number of subjects was between 120 and 144. However, response rate must also be considered in survey research when determining the number of required subjects. The average

[1] In organizations with a large organizational structure, managers two levels above the first level manager completed the Department performance evaluation.

response rate for a survey ten pages long (150^+ questions) distributed to a specialized population is 68% (Dilman, 1978). At the expected response, the distribution size required was 175 to 215 surveys. Therefore, at least 10 managers from at least 20 manufacturing and distribution companies should be targeted to participate in the study. In actuality, as many companies as possible were asked to participate in the study to provide enough data to do comparisons across the entire manufacturing and distribution organizational processes.

3.2 Materials

3.2.1 Advantages and Disadvantages of Survey Research

Survey research is a popular method of gathering data about human behavior. Kerlinger (1986) lists the following advantages and disadvantages of survey research:

Advantages

- Survey research is a method to collect a great deal of information from a large population
- Survey research information is accurate within sampling error and can provide an accurate portrayal of values, attitudes, and beliefs.

Disadvantages

- Survey research does not penetrate deeply beneath the surface of the problem or question. It is more suited to extensive rather than intensive research.
- Survey research is demanding of time and money.
- Survey research can not be used to show a causal relationship between variables. Because the research does not manipulate the data collected but instead collects past observation, cause and effect can not be shown by survey research.

With both advantages and disadvantages of this method in mind, survey research was used in this study for the following reasons:

1. Little prior research has been done to establish the amount of time spent on social and technical subsystems in a manufacturing department.
    - This method allowed the researcher to sample a large population in order to collect data about the time allotment variables in manufacturing firms. Other methods considered were observation of managerial behaviors in a plant setting and asking managers to maintain activity journals.
    - Observation would drastically reduce the number of managers the researcher could sample in the allotted time period. A smaller sample size would hinder the statistical significance of the study and would not eliminate the use of survey instruments in the study. Survey instruments would still be required to collect data on the STS

characteristics of the department, perceptions of time dimensions of work, and managerial performance.

- Anecdotal evidence supported the idea that asking managers to keep activity journals on managerial behavior may still only be a collection of the time managers thought they spent on activities. Activity journals are not usually updated at the end of each activity. Most people update their journal at the end of a day or a week with an approximate amount of time spent on each activity. Because of this tendency to approximate the amount of time spent on a given activity, there was little evidence to support the idea that the times logged in the journal would be more accurate than the approximations given in the survey.

2. One of the desired outcomes of this research was to determine whether a relationship exists between managerial time allotment and joint optimization and therefore department performance.

   - This research did not ask why the time allotment relationship existed but asked whether a relationship existed among managerial time allotment, joint optimization, and department performance. The nature of the question did not require deep penetration into the reason for the relationship among the variables and was suited to the extensive type of study characteristic of survey research.

3.2.2 Data Collection Instruments for First-Level Managers

First-level managers participating in this study were asked to complete four survey instruments, containing a total of 185 questions with an estimated completion time of 50 minutes. The questionnaire was divided in four sections:

A - The STS Organization Design Benchmark Survey

B - Time Dimensions of Work

C - Time Allotment Survey

D - Department Performance Survey

3.2.2.1 The STS Organization Design Benchmark Survey

The STS Assessment Survey by Promethian Systems International (1994) is a commercial instrument containing 125 questions to assess the technical system, social system, and environment/integration for organizations or sub-units. Twenty critical organizational states were measured in this survey to form the scale measures for the technical, social, and environmental subsystems (see Table 3.1).

Table 3.1 STS Benchmark Survey Scales

Technical System	Social System	Environment/Integration
A = Quality Orientation	I = Inclusion	P = Interface with Customer
B = Technical Efficacy	J = Cooperation	Q = Technical Responsiveness
C = Tangible Rewards	K = Upward Influence	R = Activity Feedback
D = Task Challenge	L = Commitment	S = Ergonomics
E = Task Significance	M = General Satisfaction	T = Requisite Variety
F = Setting-induced Stress	N = Support for Innovation	
G = Physical Health	O = Facilitative Leadership	
H= Skill Development		

Any questions using the word "I" or "my" were modified to read "we", "my department's", or "ours" in order to measure the manager's perceptions at a departmental level.

Promethian provided the distribution for the (1) technical subsystem, (2) social subsystem, (3) environment/integration subsystem, and (4) overall mean score of the survey. Each subject's mean scores in the three subsystems, technical, social, and environment were computed and standardized against the known distributions, and were considered independent variables for every department. The standardized z-score computed from each subject's overall mean score was used as each department's measure of the dependent variable level of joint optimization.

$$\text{Level of Joint Optimization} \equiv \text{Z- score for the Overall Mean Score} \qquad (3.1)$$

3.3.2.2 Time Dimensions of Work

In their study of 122 manufacturing companies, Lim and Seers (1993) found three scales from Schriber and Gutek's (1987) time dimensions of work to predict organizational performance. A fourth scale was also found to be directly related to performance after post hoc analysis. These four scales are identified with an asterisk in Table 3.2.

Because 80% of the manufacturing organizations used in their sample were mass production operations, Lim and Seers recommended that the dimensions of scheduling and synchronization not be discounted in future research using time dimensions of work. Even though these dimensions were not found to be significant in their research, they believe the nature of the production operations in the companies they studied may have caused these dimensions to be insignificant. Because the nature of production operations used in this study varied, both the "schedules and deadlines" and "synchronization and coordination" scales were also included.

These six scales contained a total of 28 questions. Any questions using the word "you" were modified to read "we" or "people here" in order to obtain the participant's perceptions of his or her department's time dimensions of work .

Table 3.2. Time Dimensions of Work Scales

Future orientation *	Allocation of time *
Autonomy of time use *	Awareness of time use *
Schedules and Deadlines	Synchronization

*Construct directed related to Performance in Lim and Seers (1993) study

3.3.2.3 Time Allotment Survey

The time allotment survey was developed for this study and was used to measure how much time first-level managers spent on the social and technical subsystems in their department. The questions in this survey were based on tasks listed in past STS studies, particularly those focusing on manufacturing applications. The Shani et al (1992) study on Advanced Manufacturing Systems and Organizational Choice: Sociotechnical System Approach pointed out several necessary tasks required in the technical subsystem of a manufacturing organization. Similarly, Niepce and Molleman (1996) focused on many of the necessary tasks in the social subsystem of a manufacturing organization. Tasks from both of these studies and important issues on work design and independence in the social subsystem from Cherns (1987) were used to form the basis of the survey questions.

The time allotment survey contained 20 questions. Eighteen of these questions focused on managerial behavior in terms of time allotment in the technical and social subsystems. One question was focused on the status of the organization's change process. The last question dealt with the percentage of time spent on the social and technical subsystem. Each participant was asked to add any additional information on how time is spent on any other activities.

3.3.2.4 Department Performance Evaluation

Lim and Seers (1992) used a 16-item scale to evaluate organizational performance in their study of the effects of time dimensions of work on perceived performance. The items used to measure the performance dimension were derived from subjective performance measures reported by Lawrence and Lorsch (1967) and Reimann (1982). Traditionally, performance in STS interventions is measured by changes in productivity and quality of work life (QWL). Many of the items used in the Lim and Seers study represented either the productivity or QWL categories.

Both first-level managers and plant managers were asked to rate "how well the department is doing" on each item using a scale from very poorly (1) to very well (5). Lim and Seers (1993) addressed the following areas of performance: Profit margin, total cost, goal achievement, work efficiency, keeping up with technical advances, "getting things done", "running smoothly", coping with unexpected problems, labor productivity, labor costs and rapport with suppliers and customers, interdepartmental working relationships, grievance, absenteeism, tardiness, and turnover.

Two other items were added to measure empowerment aspects of department performance. These were (1) establishing feelings of empowerment in employees and (2) encouraging follow through on new ideas and innovations.

3.3 Procedure

One of the main disadvantages of survey research is response rate. A mail survey will not be returned for many reasons such as: (1) the participant completed the survey but forgot to return it; (2) the survey was received by the wrong person but not passed on to the appropriate person; or (3) the survey was received by the right person who put it aside meaning to respond but never does (Dilman, 1978). According to Dilman, many of the reasons for low response rate had little to do with the quality of the survey instrument, its design or the research question but instead had more to do with the survey implementation. Dilman's Total Design Method (1978) addressed many of the problems causing low response rate by detailing a systematic approach researchers can use to improve participant response. This method was adopted and modified for this research.

Data collection in this study was addressed in four phases:

Phase 1	IRB Review and Approval	3 weeks
Phase 2	Pilot Testing	4 weeks
Phase 3	Soliciting Participants	8 weeks
Phase 4	Data collection and follow up	8 weeks

3.3.1 Phase 1 - IRB Review and Approval

Ultimately, this research is sponsored by the university and must conform with the guidelines for risk and the use of human subjects outlined by this institution. A copy of the IRB proposal package has been attached to this document. (See Appendix A)

3.3.2 Phase 2 - Pilot Testing

The purpose of conducting a pilot study was to pre-test the research method before embarking on the complete study. The purpose of this pilot study was two-fold: (1) to test the approach used to solicit participants and (2) to test the research instrument itself.

Three local manufacturing organizations were asked to participate in the pilot test for this research; only two accepted. Data were collected from thirteen first-level managers ($n_1 = 4$, $n_2 = 9$). Plant manager evaluations were returned by one of the companies ($n_1 = 0$; $n_2 = 1$, $x_2 = 9$).

The collected data were used to perform reliability testing on the Time Allotment Survey (TAS) developed for this research. An item analysis was completed for all TAS survey items. Correlations were calculated for each embedded survey construct and were used to calculate Cronbach's Alpha, which measures the internal consistency of each scale/construct. Alpha scores for the TAS technical and social scales were .911 and .913, respectively, indicating a strong internal consistency among scale items. The reliability analysis from the pilot test was used to make revisions to the TAS survey before the final package was mailed out. All other instruments in the study were used in past research and were developed by other authors. Items in these instruments were subject only to the minor modifications mentioned earlier.

This time was also used to revise the mailing list provided by the Canadian Association of Logistics Management (CALM) and to develop the cover letter sent out to participants. Revising the mailing list involved (1) identifying all the firms which are classified as manufacturing and distribution operations and (2) establishing a contact name or title for plant/warehouse managers asked to participate.

Modifications to Survey Instruments

1. Several minor corrections were made to the layout of the questionnaire booklet. In Section A (STS Benchmark Survey), there were more blanks than questions. In Section C (TAS instrument), pilot data showed the need to repeat the instructions explaining the type of tasks included in their perceptions of time allotment in both the Likert-type response segment and the percentage time allotment segment. Also, in Section C (TAS instrument), the open-ended question asking what percentage of time was spent on other activities was revised to include a percentage breakdown for each activity the participant listed.
2. The following question was removed from the demographic section of the survey:
   - In what department, section or unit of the organization do you work?
3. The following questions were added to the demographic section of the survey:
   - What department, section, or unit of the organization do you work? 1= inventory supply, 2=raw materials, 3=purchasing, 4=production/operations, 5=maintenance, 6=finished goods inventory, 7=logistics/warehouse, 8=customer service, 9=other (please describe)
   - How much time did you take to complete the questionnaire?

3.3.3 Phase 2 - Data Collection and Follow Up

As a result of the pilot study, enhancements were made to the data collection procedure for this research. The research procedure developed was as follows:

1. CALM membership list was used as a contact list for Canadian participants. The Dunn and Bradstreet Manufacturers Handbook along with business phone listings available at www.infospace.com were used to contact American participants.
2. An initial contact call was made to each organization's Plant Manager, Warehouse Manager or Human Resources Manager.
3. Each contact person was sent a Balance of Time Fax Information Package (See Appendix A). Pilot study experiences proved that it was important to allow the plant manager (or contact person) the opportunity to review a sample of the survey items and ask any questions before the company would agree to participate.
4. Once the organization agreed to participate, questionnaires along with a cover letter explaining the study, a participant identification number, and a return envelope for each participant were mailed to each company. Because many of the participants were alarmed by the formality of the informed consent in the pilot study, the original cover letter was reworded to stress that the purpose of the informed consent was to ensure participant's protection (See Appendix A).
5. Each package was distributed to each participant by the contact person.
6. The contact person was asked to ensure that he or she kept a record sheet (provided in the package) of each first-line manager's identification number. This sheet was used as the cross-reference list for each plant or warehouse manager's evaluation. All participants were instructed only to return questionnaires and informed consent sheets (in a sealed envelopes) to the researcher.

Changes to the method of distribution were a direct result of the issue of confidentiality raised by one of the plant managers who participated in the pilot study. These modifications were made to ensure that the researcher had no method of matching a supervisor's identity to the plant manager's evaluation except by identification code.

During a ten week period beginning August 9, 1996, and ending October 18, 1996, seventeen of the seventy organizations contacted agreed to participate in this study (acceptance rate = 24.3%). One hundred and ninety-five Balance of Time surveys were mailed to first-line managers. Ninety-five were returned (response rate = 48.7 %), four of which were not usable. Twenty Department Performance Assessments were mailed to Plant managers and 12 were returned (response rate = 60%). A total of 64 first-level managers were matched to their Plant/Warehouse Managers evaluation.

3.3.4 Post hoc Interviews

Originally, during the pilot-test phase and again during the data-collection phase, approximately six local managers (at each stage) were asked to document how they spent their time on tasks in the social and technical subsystem for a period of two weeks. A brief interview was to be conducted by the researcher to discuss with these managers how and why the time they logged for these tasks differed from the survey responses. Interview questions for this phase were included in the IRB proposal package. However, it was not feasible to conduct post-hoc interviews because many of the plant and warehouse managers believed the survey instrument itself to be a large enough time commitment for the first-line managers.

3.4 Data Analysis Methods

This section describes the analysis methods for the data collected in this study. The section addresses how data were analyzed to evaluate each research question and hypothesis. The section also addresses the role of demographic information collected in the study. Several analysis methods were discussed and reviewed with the Statistical Consulting Center (SCC), whose recommendations are included in Appendix E.

Prior to discussing how data are used in this study to analyze each research question, it is important to assess the psychometric properties of each variable to ensure that the variable used is reliable and valid.

"Reliability allows the survey designers to determine the degree of systematic variance in the questionnaire" (Hayes, 1994, p. 41). Cronbach's coefficient alpha is the internal consistency measure most used to determine reliability. SPSS statistical software was used to calculate the reliability of each scale/construct. Generally, an acceptable value for Cronbach's coefficient alpha for reliable scales is .70. Values of Cronbach's alpha as low as .50 are acceptable for newly developed scales. In assessing the psychometric properties of each scale, some items and/or scales were found to be unreliable. These items and/or variables were removed from the final data. Any adjustments to variables in the proposed research model are shown in the revised operational research model (See Figure 3.1). Scales with reliability measures that were less than .50 were removed and replaced by a single item from that scale. A summary of any changes made to scales due to the reliability analysis is provided below.

- Ten items were removed from the Technical Subsystem Scale (Technical) to achieve a scale reliability above .70 ($\kappa_{final} = .75$).
- Six items were removed from the environmental scale (Enviro) to achieve a scale reliability above .70 ($\kappa_{final} = .76$).
- Two items were removed from the Scheduling & Deadlines scale (Sched) to achieve a reliability above .70 ($\kappa_{final} = .76$).

- Two items were items removed from the Future Orientation scale (Future) to achieve a reliability above .50 (κ_{final} = .65).
- The Autonomy of Time Use Scale (Autonomy) had a low reliability, instead two items were identified to measure the construct (κ_{final} = .57).

The two items selected to represent the Autonomy of Time Use Scale were determined by using SPSS. Factor analysis of the scale showed that two items loaded high on the autonomy of time use construct (factor 1). The factor loading matrix is shown below in Table 3.3. A summary of each of the construct or scale variables including their psychometric properties is presented in Table 3.4.

Table 3.3. Factor Loading Matrix for Autonomy of Time Use Construct

Autonomy of Time Use Items	Factor 1	Factor 2
People here do not have the freedom to use their time the way they choose (Q14)	.878*	-.006
Most people here cannot set their own work schedules (Q7)	.743*	.123
People just expect to "kill time" on the job (Q10)	-.247	.875*
People expect their work to be routine (Q16)	.171	.543*
Around here, people like to talk about the "good old days". (Q24)	.115	.451*

Table 3.4. Definitions and Properties of Research Variables and Constructs

Construct and Variable Name	Operationalization of Variable	Level of Measurement	Data Collection (# of items)	Reliability
Organizational Characteristics				
Company	Companies 1 through 20	Nominal	Contact	—
CompType*	0=Distibution 1=Manufacturing	Nominal	Contact	—
Country	0= American 1= Canadian	Nominal	Contact	—
Org_Size		Ordinal	DPA	—
Floor_Size		Ordinal	DPA	—
No_First_line		Ratio	DPA	—
Technology Level	1 = Level 1 - Individual Task Design 2 = Level 2 - Limited Multiple Skill Requirements 3 = Level 3 - Multiple Skill Requirements 4 = Level 4 - Low specialization with multiple skill requirements	Nominal	DPA	—
Participant Demographics				
Subject	Survey numbers 13 to 215	Nominal	BOT	—
Completion	Completion Time in Minutes	Ordinal	BOT	—
Title	1 = Supervisor 2 = Foreman 3 = Team Leader 4 = Technical Engineer 5 = Other	Nominal	BOT	—
Department	1 = Inventory Supply 2 = Raw Materials 3 = Purchasing 4 = Production 5 = Maintenance 6 = Finished Goods 7 = Logistics/Warehouse 8 = Customer Service 9 = Other	Nominal	BOT	—
Mgr_Type	1 = Upstream 2 = Transformation 3 = Downstream	Nominal	BOT	—
Org_Tenure	Number of years with organization	Ratio	BOT	—
Dept_Tenure	Number of years in department	Ratio	BOT	—
Full_Part_Time	1 = Full Time 2 = Part Time	Integer	BOT	—

Table 3.4 (cont'd)

Construct and Variable Name	Operationalization of Variable	Level of Measurement	Data Collection (# of items)	Reliability
Direct_Reports (DeptSize)	Number of direct reports	Ordinal	BOT	—
Education	1 = Less than 12 years 2 = high school grad 3 = some college 4 = college grad 5 = some graduate school 6 = graduate degree	Nominal	BOT	—
Age	Age in years	Ratio	BOT	—
Sex	1 = Male 2 = Female	Nominal	BOT	—
Degree of Change				
SP_1	Department restructuring 0 = No, 1 = Yes	Nominal	BOT/TAS	—
SP_2	Staff retraining 0 = No, 1 = Yes	Nominal	BOT/TAS	
SP_3	Production advancement 0 = No, 1 = Yes	Nominal	BOT/TAS	
SP_4	Information Technology or Improvement 0 = No, 1 = Yes	Nominal	BOT/TAS	
SP_5	Other 0= No, 1 = Yes	Nominal	BOT/TAS	
Department Performance				
Rater	1 = 2 =	Nominal	BOT/DPA (18)	—
SELFDPA MGRDPA	Rating of the departments ability to meet performance criteria for productivity, quality of work life, and empowerment.	Ordinal range from 18 to 90	BOT/DPA (18)	.88
Perform	Rating of the departments ability to meet performance criteria for productivity, quality of work life, and empowerment.	Ordinal (Mean) 5 point scale Very Poorly (1) to Very Well (5)	BOT/DPA (18)	.88
STS Characteristics				
Subsystem	1 = Technical 2 = Social 3 = Environment	Nominal	BOT/STS	—
Technical	Department's ability to meet technical subsystem criteria such as skill development, tangible rewards, etc.	Ordinal 5 point scale	BOT/STS (38)	.75
ProbTech	Probability of Technical score in technical subsystem distribution.	Ratio	BOT/STS	—

Table 3.4 (cont'd)

Construct and Variable Name	Operationalization of Variable	Level of Measurement	Data Collection (# of items)	Reliability
Social	Department's ability to meet social subsystem criteria such as inclusion, cooperation, etc.	Ordinal 5 point scale	BOT/STS (41)	.89
ProbSoc	Probability of Social score in social subsystem distribution.	Ratio	BOT/STS	—
Enviro	Department's ability to meet Environment and Integration criteria such as interfacing with customer, technical responsiveness, etc.	Ordinal 5 point scale	BOT/STS (21)	.76
ProbEnv	Probability of Environment score in environment/integration subsystem distribution.	Ratio	BOT/STS	—
Overall	Department's ability to meet all the criteria for the three subsystems: social, technical, environment/integration.	Ordinal 5 point scale	BOT/STS (100)	—
JointOpt	Probability of Overall score in overall score distribution.	Ratio	BOT/STS	—
Time Allotment				
SocPct	Percent of time in the social subsystem.	Ratio	BOT/TAS	—
TechPct	Percent of time in the technical subsystem.	Ratio	BOT/TAS	—
Soc_Other	Percent of time spent on social subsystem activities described by subject.	Ratio	BOT/TAS	—
Tech_Other	Percent of time spent on technical subsystem activities described by subject..	Ratio	BOT/TAS	—
TTECH	Time Allotment to activities in technical subsystem.	Ordinal 5 point scale AN (1)- AA (5)	BOT/TAS (9)	.68
TSOC	Time allotment to activities in social subsystem.	Ordinal 5 point scale AN (1)- AA (5)	BOT/TAS (9)	.79
DIFF	Difference in time allotted to the technical subsystem versus social subsystem. 36 - |TTECHSUM-TSOCSUM|	Ordinal Range from 0 to 36	BOT/TAS	—
PctDiff	Difference in percentage of time allotted to the technical and social subsystems.	Ordinal Range from 0 to 100	BOT/TAS	—

Table 3.4 (cont'd)

Construct and Variable Name	Operationalization of Variable	Level of Measurement	Data Collection (# of items)	Reliability
Time Dimensions of Work				
Sched	Scheduling: Departmental ability to schedule, plan, and set deadlines for organizational activities	Ordinal 5 point scale (5) SA - (1) SD	BOT/TDW (7)	.76
Future	Future Orientation: Departmental ability to anticipate goal attainment and focus on the where the department is going.	Ordinal 5 point scale (5) SA - (1) SD	BOT/TDW (2)	.65
Alloc	Allocation of Time Use: Departmental ability to divide total time among all objectives.	Ordinal 5 point scale (5) SA - (1) SD	BOT/TDW (3)	.54
Aware	Awareness of Time Use: Departmental ability to make trade-offs between the quality of work vs. speed of work	Ordinal 5 point scale (5) SA - (1) SD	BOT/TDW (3)	.65
Auton	Amount of departmental freedom to set schedules for completion of tasks.	Ordinal 5 point scale (5) SA - (1) SD	BOT/TDW (5)	.57
Synchro	Synchronization and coordination of work with others	Ordinal 5 point scale (5) SA - (1) SD	BOT/TDW (2)	.63

3.4.1 Demographic Information

Demographic information was used to measure frequencies such as the number of upstream, transformation, or downstream first-level managers who participated in the study. This information was also used to divide the sampled population into cohort groups for statistical analysis. Demographic data contained both organizational characteristics and participant demographics. Data collected in this study are as follows:

- department title, department size (number or employees);
- manager's title, tenure, age, gender, education level;
- organization age, size ;
- facility size, department size (square footage), type of production; and
- degree of change at the department level.

A summary of research questions and data analyses methods is provided in Table 3.5.

3.4.2 Analysis Method for Research Question 1

The focus of this question was to determine the level of joint optimization in different departments participating in this study. Data from the STS survey was used to assess the level of joint optimization.

The mean score data from each scale (social, technical, and environment/integration) and the entire survey were calculated from the STS Survey. These data were compared to Promethian's benchmark database. Once compared to the existing data, all scores were converted to a probability used to measure the level of joint optimization.

Demographic information was used to group the data by type of first-level manager. ANOVA testing was conducted to determine if there were any statistically significant differences between type of first-level manager and level of joint optimization. ANOVA testing was also conducted to determine if there were any significant differences between the proportions of time spent on technical and social subsystems (TechPct, SocPct) for each organization.

3.4.3 Analysis Method for Research Question 2

The focus of this question was to determine the proportion of time a first-level manager spends on the social and technical subsystems when his/her department is jointly optimized. Both frequency and histogram plots of the distribution of the joint optimization scores were used to determine the breakpoint between high and low scores.

The data collected from the Time Allotment Survey were then used to analyze this question. In the time allotment survey, there are two sets of corresponding variables to both social and technical time allotment. The first set of variables includes mean scores of the constructs from the TAS Likert-type scale used in the survey (TTECH, TSOC). The second set of variables includes the proportion (indicated as a percentage) each manager spent on activities in either the social or technical subsystem (SocPct, TechPct).

In the Likert-type section of the TAS instrument, there are nine technical time variables. The sum of these variables was called TTECH. Similarly, there are nine social time variables, and the sum of these variables was called TSOC. A composite variable called DIFF was created to measure the difference of time each manager spent on the technical (TTECH) versus the social (TSOC) subsystem. Bivariate correlation coefficients were calculated on joint optimization versus DIFF.

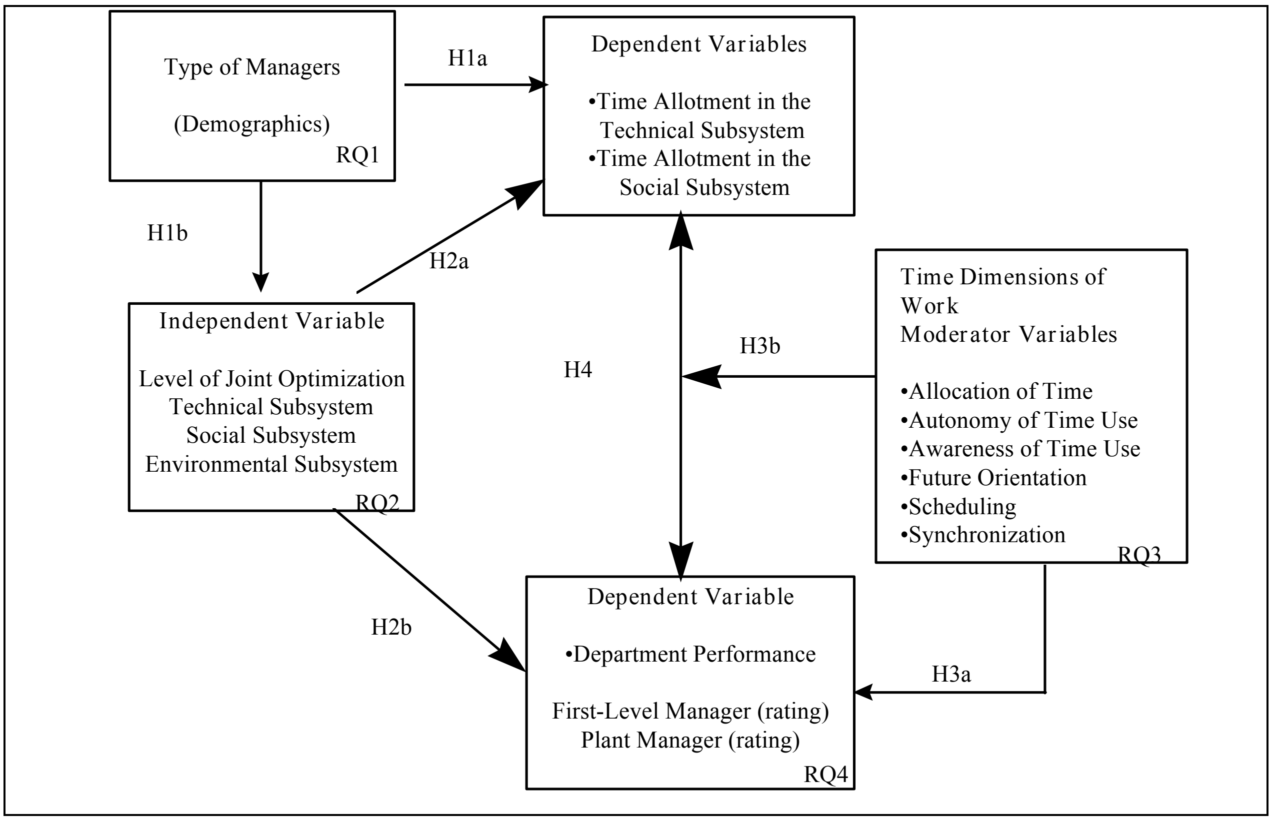

Figure 3.1. Revised Operational Model

Table 3.5. Summary of Research Questions and Data Analyses Methods

Research Question	Data Analysis Method
Research Question 1: How do reports of departmental joint optimization compare between different types of first-level managers?	Z-Score of social, technical, environment subsystems to determine level of joint optimization for each department One-way analysis of variance of joint optimization using 2 levels of manager type as the factor was performed. One-way analysis of variance of the two time allotment percentages (SocPct, TechPct) using manager type as the factor with two levels.
Research Question 2: What balance of time between the social and technical subsystems do first-level managers report for jointly-optimized departments?	Histogram, frequency plots of joint optimization distribution. Bivariate correlation coefficients were calculated on joint optimization versus DIFF. One way analysis of variance of DIFF using the level of joint optimization as a factor with two levels (high or low). One-way analysis of variance of the two time allotment percentages (SocPct, TechPct) using joint optimization as a factor with two levels (high or low).
Research Question 3: What relationship do time dimension of work variables have on departmental joint optimization and how managers allot their time to the social and technical subsystems?	Simple Linear Regression using joint optimization as the response and each of the time allotment variables along with DIFF variable as aregressor. Ordinary Least Squares Regression with the six time dimensions as the regressor and department performance as the response. One-way analysis of variance of each of the time dimension of work variables using joint optimization as a factor with two levels (high or low).
Research Question 4: What proportion of time do first-level managers spend on the social and technical subsystems in departments with perceived high performance ratings?	Histogram, frequency plots of performance score distribution. Multiple Linear Regression to determine whether there are any significant differences between plant manager versus supervisor evaluation of department performance. Analysis of the two time allotment percentages (SocPct, TechPct) using department performance as the response variables.

$$DIFF_i = 36 - |TTECH_i - TSOC_i| \quad (3.2)$$

As shown in equation 3.2, the absolute difference of each manager's time allotment technical mean score (TTECH) from their time allotment social mean score is subtracted from the maximum possible scale difference of 36.

ANOVA testing was done using both sets of variables to determine if there were any statistical differences in the balance of time spent on the technical versus the social subsystem (DIFF) by first-level managers reporting a high-level of departmental joint optimization compared to those managers who did not. Further ANOVA testing was done to determine whether differences exist in the time allotment (TECHPCT, SOCPCT) between jointly optimized departments and other departments.

3.4.4 Analysis Method for Research Question 3

This question focuses on the affects of organizational culture on time use within the organization. Multiple analysis methods were used to evaluate this question. In prior research of this area, a regression analysis was done to determine whether the time dimension scales were predictors of organizational performance. Similar analyses were performed in this study to determine which of these scales were predictors of department performance.

As outlined in the Statistical Consulting Center (SCC) Report (1996), simple linear regression was used to model joint optimization as a function of the time difference variable (DIFF). Then, one at a time, each Time Dimension of Work variable was added to the linear regression model. See Appendix E for details.

$$J.O. = \beta_0 + \beta_1 DIFF + \beta_2 ALLOC \quad (3.3)$$

For each of the Time Dimension variables the model above was used to test if

$$H_0: \beta_2 = 0$$

$$H_1: \beta_2 \neq 0$$

These tests were used to determine which of the time dimension of work variables, if any, contributed to the relationship between joint optimization and the balance of time between the social and technical subsystems.

In addition, ordinary least squares (OLS) regression analysis was used with the six time dimension of work variables as the regressors and department performance as the response variable. R-squared values, t-tests, and p-values were used to determine the ability to predict department performance with the time dimension variables.

Finally, ANOVA tests were also performed to determine if there were any statistical differences in the time dimension of work scores for departments which reported high-levels of joint optimization versus those with low levels. Histograms of joint optimization scores are shown in the Appendix C.

3.4.5 Analysis Method for Research Question 4

This question focuses on department performance and the time allotment required to achieve high department performance ratings. Department performance ratings were collected from two sources: the department first-level manager and the plant manager. Because one plant manager evaluates many line managers, Multiple Linear Regression (MLR) testing was used to determine if there were any significant differences in the two sets of ratings. MLR addressed the problems associated with lack of independence in plant manager evaluations. By using multiple linear regression, plant manager evaluations are block analyzed, which accounts for the dependence structure (SCC Report, 1996). The t-test for significance of the intercept is used to determine whether plant manager ratings differ from self ratings. "If the evaluations between plant managers and line managers is not different, the intercept should not be significantly different from zero" (SCC Report, 1996). The difference between plant manager evaluations and first-level manager evaluations were stored in the variable EVALDIFF.

$$EVALDIFF_i = MGRDPA_i - SELFDPA_i \quad (3.4)$$

As described in the SCC Report (1996), K-1 binary categorical variables (0 or 1) were defined to classify any given plant manager. These variables were called Z_1, Z_2,Z_3…Z_{k-1}, where K equaled the total number of plant managers who participated in the survey. Multiple linear regression was performed with Z_1 to Z_k used as regressors on the response variable EVALDIFF.

The data outline for K= 4 is as follows (SCC, 1996):

Table 3.6 - Regression Variables for EVALDIFF Comparison

Supervisor	PlantMng	EVALDIFF	Z_1	Z_2	Z_3
1	a	x	1	0	0
2	a	x	1	0	0
3	a	x	1	0	0
4	b	x	0	1	0
5	b	x	0	1	0
6	c	x	0	0	1
7	c	x	0	0	1
8	d	x	0	0	0
9	d	x	0	0	0

Histograms, frequencies, and box plots were used to decide the breakpoint between high performing departments and other departments (See Appendix C). ANOVA testing was done to determine whether there are any differences in the time allotment (TECHPCT, SOCPCT) between high performing departments and other departments.

3.5 Summary

This chapter describes how data were collected, stored, operationalized, and analyzed to answer the research questions proposed in Chapter One. The descriptions and code names given to each variable in this chapter are used throughout the remainder of the document. A revised operational model was also provided in this chapter to show the hypothesized relationships between reliable variables.

Chapter 4 Results

The purpose of this chapter is to report the results of this research. Both qualitative and quantitative data collected in this study are presented in figures and tables throughout this chapter. Each section addresses the research questions and the related hypotheses outlined earlier in Chapter One.

Chapters 4, 5, and 6 work together to convert the data collected in this study into information. The data were used for two distinct but related purposes: (1) testing research hypotheses (Chapter 4) and (2) performing post-hoc analyses (Chapter 5). The information provided by the data are categorized into three areas: (1) results supporting or not supporting hypotheses (Chapter 4), (2) results supporting post-hoc analyses (Chapter 5), (3) summary and discussion recommending areas for further research (Chapters 4, 5, and 6).

4.1 Sample Characteristics

Before addressing the specific research hypotheses, it is important to describe the population sample and its characteristics. By understanding the demographic data, the researcher can determine how these results can be generalized.

Ninety-one full-time first-level managers (84 male and 7 female) participated in this study. Typically, these managers were foremen or supervisors, whose job titles included production lab supervisor, quality control engineer, maintenance supervisor, manufacturing supervisor, and warehouse or logistics supervisor. Seventy-one were categorized as transformation managers and twenty were categorized as downstream managers. There were no upstream managers.

The youngest manager was 25 years old and the oldest was 61 years old; the mean age of the participants was 42 years old. Job experience varied from first-level managers with as little as four months to the most tenured supervisors with up to 34 years experience. The average department tenure was 7.3 years and the average organization tenure was 16.3 years. The number of direct reports for each manager ranged from none to 130 operators, where the average number was twenty-three direct reports in each department.

Twenty-seven first-level managers reported no level of change in their departments. Sixteen departments reported Department Restructuring, thirteen reported Staff Retraining, twenty-five reported Production Advancement, twenty-seven reported Information Technology or Improvement, and twelve departments reported other projects including plant expansion, centralization of lab location, and job safety analysis. Many departments reported more than one on-going project (13 departments: 2 projects, 4 departments; 3 projects, and 2 departments:4 projects).

Eleven of the organizations classified their primary function to be production and only one company classified its primary function to be distribution. Nineteen managers were from American facilities, the remaining seventy-two were from Canadian facilities.

Demographic and level of technology use information are listed by company in the appendix in Tables B-1 and B-2 respectively. First-level managers' comments about their departmental or organizational characteristics are listed by subject in Table B-3.

4.2 Research Question 1

The focus of this question was to determine the level of joint optimization in different departments participating in this study. The question asks: How do reports of departmental joint optimization compare between different types of first-level managers? The research hypotheses examined two possible relationships related to the level of joint optimization. The first relationship was with manager type and the second was with time proportion at each subsystem. Both of these comparisons were made because the technical subsystem at the upstream, transformation, and downstream sections of the organizations are usually very different.

First, research hypothesis 1a examines how the level of joint optimization between manager types compare.

Research Hypothesis 1a: Upstream, transformation, and downstream first-level managers across different manufacturing firms report different levels of joint optimization in their departments.

As described in Chapter 3, z-score transformations were used to compare overall mean score of the STS Instrument. The z-score transformation for the overall score was operationalized as joint optimization. Each participant's z-score transformation for each subsystem is included in the appendix. The following sample data demonstrates how a joint optimization score is obtained.

Table 4.1 Sample Z-Score Transformations for STS Subsystems and Joint Optimization

Subject	Z-Score Technical Subsystem	Z-Score Social Subsystem	Z-Score Environment Subsystem	Joint Optimization
37	0.90	0.99	1.00	0.99
78	0.56	0.91	0.94	0.84
74	0.28	0.87	0.65	0.59
126	0.60	0.63	0.00	0.22
96	0.28	0.38	0	0.04

As shown in Table 4.1, first-level managers with high z-scores in all three subsystems will achieve a high joint optimization score (e.g. subject 37) . These first-level managers report maximizing STS characteristics in all three subsystems which is the optimal STS design as measured by the STS Benchmark survey. Joint optimization scores will drop if STS characteristics in any one of the subsystems is not maximized (e.g. subjects 78, 74, 126). Low scores in all three subsystems will result in a very low joint optimization score (e.g. subject 96)

The sample population contained no upstream managers. See Table 4.2. Upstream managers were responsible for purchasing, raw material inventory or supply inventory functions. In many organizations, these functions may have been integrated into a complete inventory management system. In other organizations, purchasing of raw materials and supplies was a centralized function managed at a remote headquarters.

Table 4.2 Count of Managers by Type

Mgr. Type	Description	# of Managers
1	Upstream	0
2	Transformation	71
3	Downstream	20

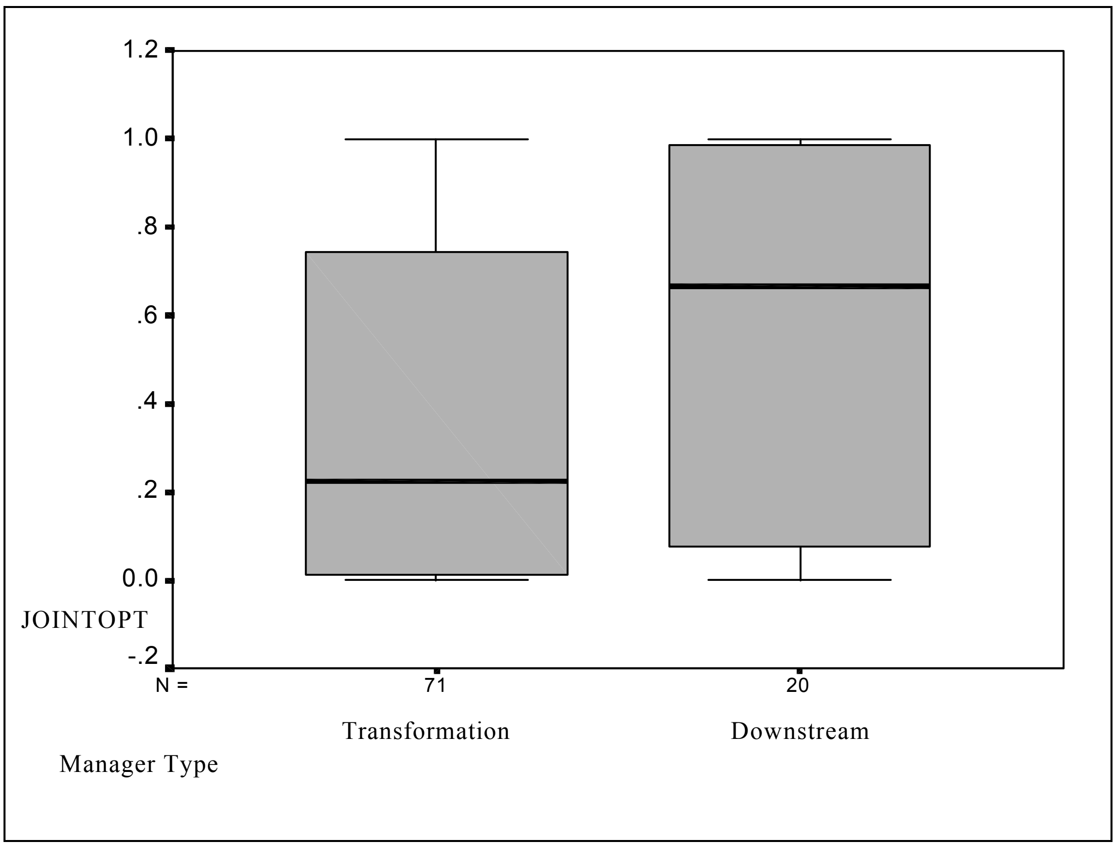

Figure 4.1. Box Plot of Joint Optimization versus Manager Type

A one-way analysis of variance was performed for joint optimization (JOINTOPT) using levels of manager type as the factor. Levene's test was performed on joint optimization scores to ensure the homogeneity of variance assumption was valid for the two groups of first-level managers ($LS_{(1,89)}$=1.497; p = .224). The results of the one-way ANOVA of joint optimization using Manager Type (2 levels) as the factor are shown in Table 4.3.

Table 4.3. One-way ANOVA of Joint Optimization, Factor: Manager Type

Source	SS	df	MS	F	Sig.
Between Mgr_Type	0.631	1	.631	4.418	.038*
Within Mgr_Type	12.701	89	.143		
Total	13.332	90			

* Significant at α = .05

To account for the possible variability in each joint optimization score due to the company to which the participant belonged, a blocking design was also used to perform the ANOVA. Joint Optimization was the dependent variable for two levels of the factor Manager Type. The company to which each first-level manager belonged was used as the blocking variable. Variation in scores due to the company to which each first-level manager belongs is an inherent expectation in this study. Blocking was used to eliminate some of the variation in the ANOVA due to nuisance variables. The ANOVA results are shown in Table 4.4.

Table 4.4. One-way ANOVA of Joint Optimization, Factor: Mgr. Type, Blocking Variable: Company

Source	SS	df	MS	F	Sig.
GROUP	0.469	1	.469	4.480	*.038
COMPANY	3.689	12	.307	2.938	*.002
COMPANY * GROUP	1.018	4	.254	2.432	.055
Error	7.638	73	.105		
Total	28.576	91			

* Significant at α = .05

Similarly, research hypothesis 1b, examines how the proportions of time spent on each subsystem compares across manager type.

Research Hypothesis 1b: Upstream, transformation, and downstream first-level managers across different manufacturing firms spend different proportions of time on the social and technical subsystems of their departments

The variable PCTDIFF was used as the dependent variable.

$$\text{PCTDIFF} = |\text{TechPct} - \text{SocPct}|, \qquad (4.1)$$

where TechPct is the proportion of time allotted to the technical subsystem, and SocPct is proportion of time allotted to the social subsystem. A one-way ANOVA was performed on PCTDIFF usingMgr_Type as the factor. The results are presented in Table 4.5.

Table 4.5 One-way ANOVA of PCTDIFF, Factor: Mgr. Type

	SS	df	MS	F	Sig.
Between Mgr_ Type	19.935	1	19.935	.037	.847
Within Mgr_Type	47412.482	89	532.725		
Total	47432.418	90			

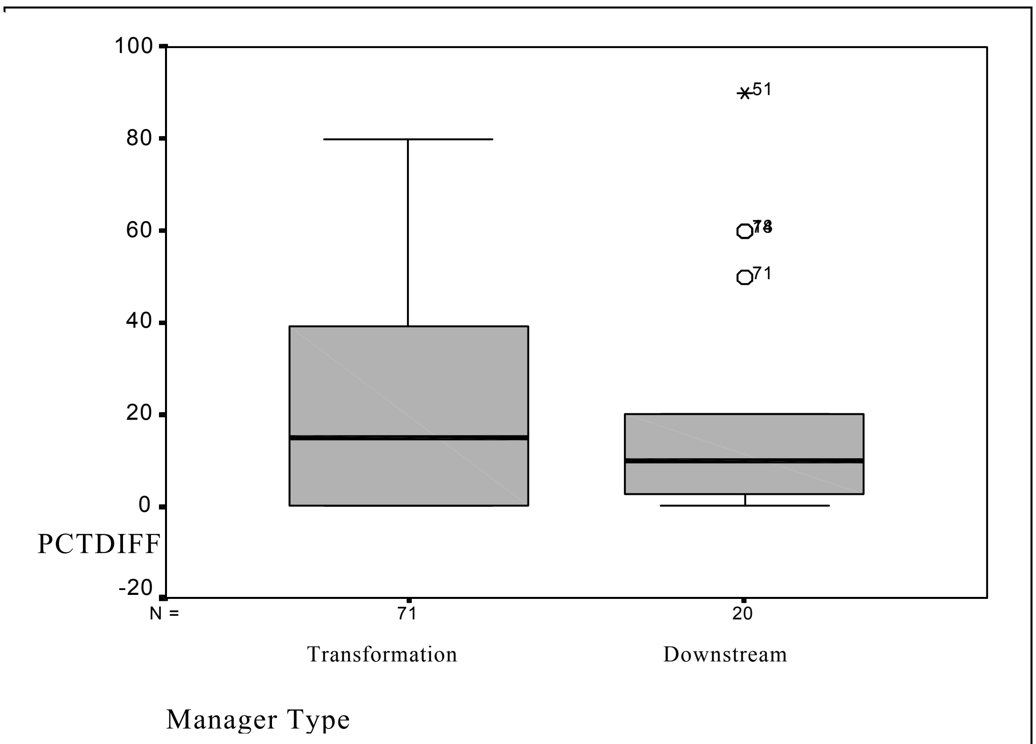

Figure 4.2. Box Plot of PCTDIFF vs. Manager Type (includes outliers and extremes)

4.2.1 Summary of Results for Research Question 1

Research hypotheses 1a and 1b focused on the level of joint optimization and the proportion of time allotted to the social and technical subsystem compared across manager type.

The results of research hypothesis 1a were significant at the α = .05 level. Downstream managers reported higher levels of joint optimization than transformation managers. See Table 4.6. Using company as a blocking variable did not change the significance of the results.

Table 4.6. Summary of Descriptive Statistics for Level of Joint Optimization by Manager Type

	N	Mean	Std. Deviation	Std. Error	95% CI for Mean		Min	Max
Mgr_Type					LB	UB		
2	71	.365	.366	4.35E-02	.278	.452	.000	.999
3	20	.566	.418	9.34E-02	.371	.762	.000	1.000
Total	91	.409	.385	4.03E-02	.329	.489	.000	1.000

The results of research hypothesis 1b showed there were no significant differences between the percentage of time spent on the social and technical subsystems for each level manager type.

4.3 Research Question 2

The focus of this question was to determine differences in time allotment due to level of joint optimization. The question asks: What balance of time between the social and technical subsystems do first-level managers report for jointly-optimized departments?

Research Hypothesis 2a: Departments rating high in joint optimization will have first-level managers who spend equal amounts of time addressing the technical subsystem and the social subsystems. Departments with lower ratings in joint optimization will have managers who spend more time on the technical subsystem.

This research hypothesis tested the relationship between joint optimization and balance of time. The joint optimization score, as mentioned earlier, was determined from the z-score transformation of each participant's overall mean score on the STS Benchmark instrument. As described in Chapter 3, Equation 3.2, the balance of time variable (DIFF) was constructed from the first-level manager's score on the Time Allotment Instrument. Possible DIFF scores ranged from 0 to 36, where 0 represented a manager who spent all of his time in one subsystem and very little on the other and 36 represented managers who spent equal amounts of time on both subsystems. See Table 4.7.

Table 4.7. Sample DIFF Data

Subject	Company	TTECH	TSOC	DIFF
15	6	26	30	32
17	3	29	31	34
18	3	28	30	34
19	3	30	31	35
20	4	24	31	29

Pearson's bivariate correlation coefficient was calculated to determine whether there was a significant relationship between DIFF scores and joint optimization. See Table 4.8.

Table 4.8. Bivariate Correlation Coefficient

	DIFF	JOINTOPT
DIFF	1.000	.224*
JOINTOPT	.224*	1.000

*Correlation is significant, $p < 0.05$ level (2-tailed),df =91.

Two tools were used to determine the break point for low versus high level joint optimization: the frequency distribution of the joint optimization scores (Figure 4.3) and a scatter plot of joint optimization and time difference (Figure 4.4).

The scatter plot shows no linearity in the relationship between joint optimization and DIFF. Therefore, the method used to compare DIFF scores for low and high joint optimization was to compare the top half of joint optimization scores to the bottom half of joint optimizations scores. The ANOVA results are shown in Table 4.9.

Table 4.9. One-way ANOVA of DIFF, Factor: Joint Optimization Level

	SS	df	MS	F	Sig.
Between JO_LVL	15.560	1	15.560	3.012	.086 (n.s.)
Within JO_LVL	459.737	89	5.166		
Total	475.297	90			

n.s. - not significant

Similarly, low and high level joint optimization were used as the factor for one-way ANOVAs of the reported technical time percentage and social time percentage from each department manager. The results are shown in Table 4.10

Table 4.10 Summary of One-way ANOVAs, Factor: Joint Optimization Level

Dependent Variable	F (1,89)	p-value
SOC	.001	.974
SOCPCT	.211	.647
TECH	.002	.964
TECHPCT	1.361	.246

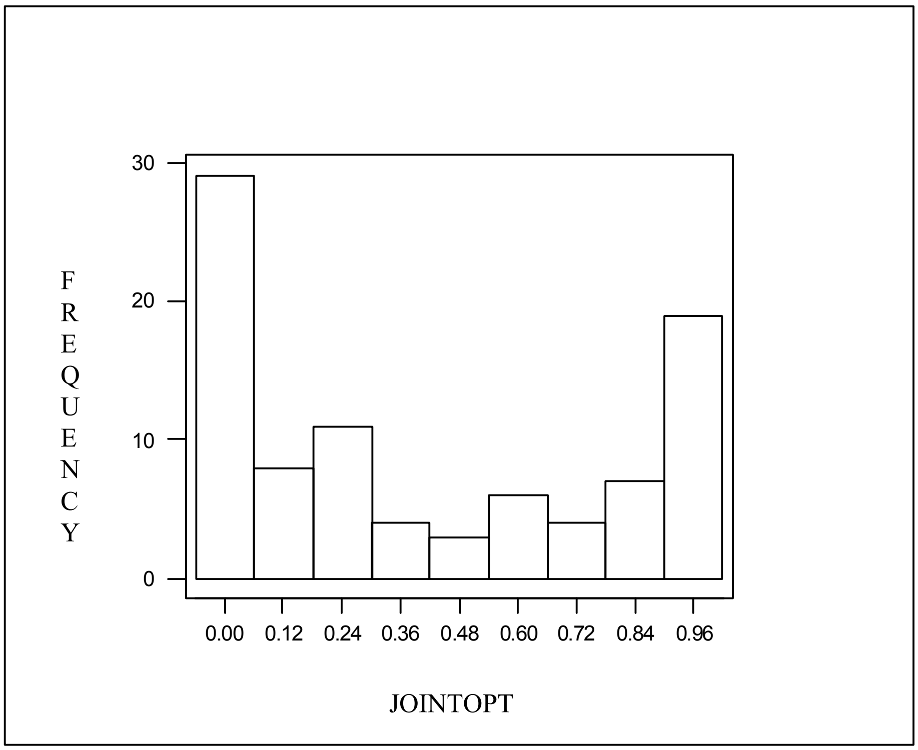

Figure 4.3. Frequency Histogram of Joint Optimization Scores

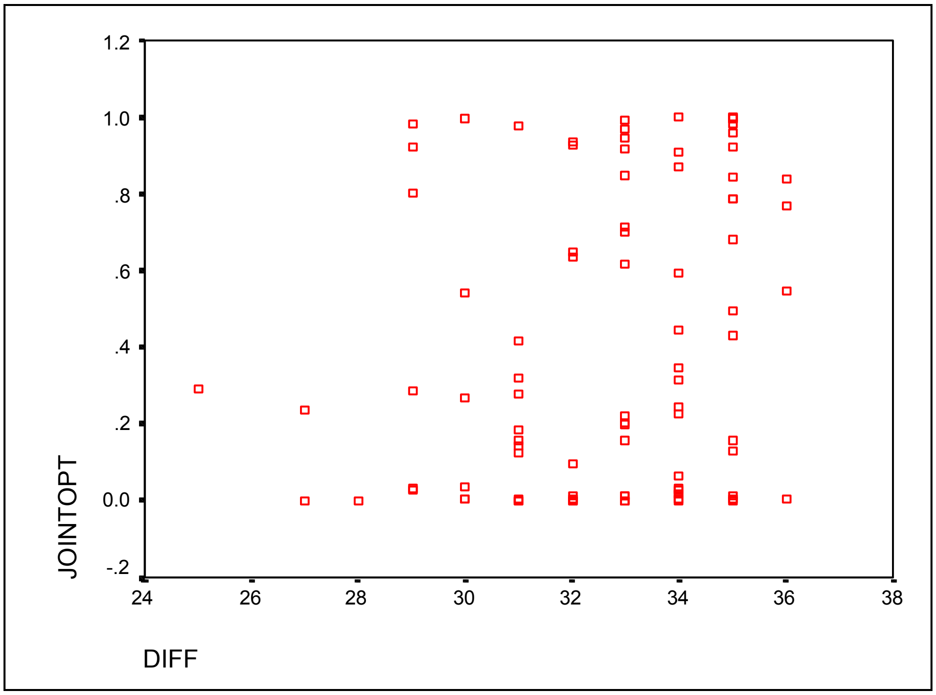

Figure 4.4. Scatter Plot of Joint Optimization vs. DIFF Scores

Research Hypothesis 2b: Departments rating high in joint optimization will rate high in overall performance.

Pearson's Bivariate correlation coefficient was calculated to test the relationship between joint optimization (JOINTOPT) and reported department performance (SELFDPA). The results are shown in Table 4.11. The scatter plot of joint optimization versus perceived department performance (self-reported) is shown in Figure 4.5.

Table 4.11. Bivariate Correlation Coefficient

	PERFORM	JOINTOPT
PERFORM	1.000	**.607
JOINTOPT	**.607	1.000

**Correlation is significant , p < 0.01 (2-tailed), df = 91.

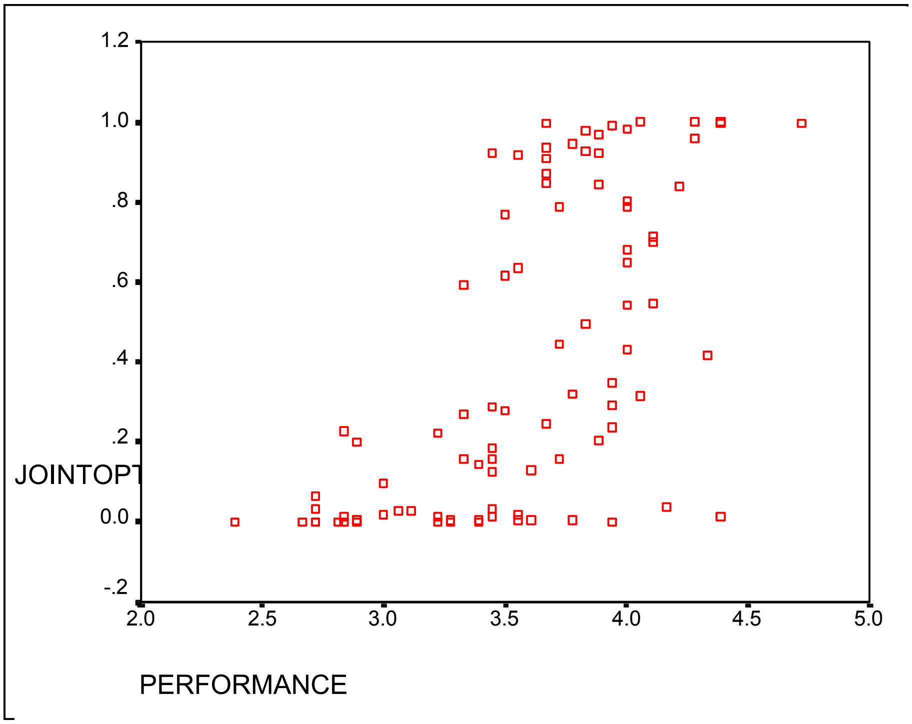

Figure 4.5. Joint Optimization vs. Department Performance

There was a strong positive correlation between joint optimization (JOINTOPT) and department performance (SELFDPA). The data shown in Figure 4.5 indicate that departments with low department performance tended to have lower levels of joint optimization and vice versa. There were a number of departments with low joint optimization scores which reported high performance scores. The implications of these departments' scores are discussed in the following chapter.

4.3.1 Summary of Results for Research Question 2

Research hypothesis 2a focused on the relationship between the amount of time first-level managers spent on both the social and technical subsystem and the reported level of joint optimization. The hypothesis predicted a positive relationship between department performance and time allotment for managers who balanced their time equally between both subsystems. The hypothesis was tested using Pearson's correlation coefficient as well as ANOVA testing. This hypothesis was not supported. Only, the correlation test supported a significant relationship between the balance of time variable (DIFF) and joint optimization. However, the ANOVA test did not support a relationship between level of joint optimization (low or high) and the amount of time spent in either subsystem.

Research hypothesis 2b tested the relationship between joint optimization and department performance. The research hypothesis was supported by a strong positive correlation between department performance and joint optimization where $\rho = .607$ significant at the $\alpha = .05$ level.

4.4 Research Question 3

The question asks: What relationship do time dimension of work variables have on departmental joint optimization and how managers allot their time to the social and technical subsystems? This research question focused on the relationship of an organization's cultural time values with time allotment and joint optimization. Each organizational cultural time construct was predicted to have an effect on the relationship between on time allotment to the social and technical subsystems and joint optimization.

Research Hypothesis 3a: Time dimension variables affect the association between joint optimization and the difference of time spent on technical and social activities.

Pearson's correlation test supported the fact that there was a significant relationship between time allotment measured by DIFF and joint optimization (Table 4.8). As described in Chapter 3, simple linear regression was used to determine which if any time dimensions of work variables affect the relationship between joint optimization and the balance of time. The results are shown in Table 4.12.

$$\text{Joint Optimization} = \beta_0 + \beta_1 \text{ DIFF} + \beta_2 \text{ TDW Variable} \qquad (4.2)$$

Table 4.12. Summary of Regression of Joint Optimization on DIFF and Time Dimension Variables

TDW Variable	Standarized β_1	t	sig	Standardized β_2	t	sig	R^2
	.224	2.173	.032	0			.040
Scheduling	.246	2.509	.011	.406	4.288	.000	.197
Future	.169	1.811	.074	.444	4.752	.000	.244
Allocation	.212	2.054	.043	-.147	-1.430	.156	.072
Awareness	.279	3.006	.003	-.451	-4.857	.000	.251
Autonomy	.217	2.181	.032	-.279	-2.799	.006	.128
Synchronization	.204	2.003	.048	.220	2.168	.033	.099

Research Hypothesis 3b: Time dimension variables predict department performance.

The results of multiple linear regression using department performance as the dependent variable and time dimension variables as the regressors (Table 4.13) showed that awareness of time use, autonomy of time use, and scheduling were significant predictors of department performance.

Table 4.13. Regression of Performance on the Time Dimensions

Model	β	Std. Error	Standardized β	t	sig
Constant	2.967	.795		3.730	.000
Allocation	-.023	-.062	-.034	-.376	.708
Autonomy of Time Use	-.126	.046	-.233	-2.721	*.008
Awareness of Time Use	-.206	.065	-.314	-3.184	*.002
DIFF	.027	.018	.126	1.485	.141
Future	.078	.048	.146	1.632	.107
Scheduling	.272	.094	.309	2.902	*.005
Synchronization	-.119	.073	-.148	-1.616	.110

* indicates significance at $p < .01$, $F(7,83) = 9.234$, $p < .001$, Adjusted $R^2 = .390$

4.4.1 Summary of Results for Research Question 3

Research Hypothesis 3a tested whether time dimension variables affected the association between joint optimization and the difference of time spent in the social and technical subsystem. The hypothesis was supported. The results of the set of regression tests showed that scheduling, future orientation, awareness of time use each had significant affect on the relationship between joint optimization and time allotment between the subsystems at $p < .001$. Autonomy of time use and synchronization also affected the relationship at $p < .01$ and $p <. 05$ respectively. The standardized values of β_1 and β_2 indicate the weighted importance of DIFF (β_1) and each time dimension of work variable (β_2) in their relationship with departmental joint optimization.

Research Hypothesis 3b was tested by using linear regression to determine which time dimensions of work variables predict department performance. The research hypothesis was supported. Awareness of time use, autonomy of time use, and scheduling achieved significant regression weights. However, DIFF, future orientation and synchronization variables contributed to the final adjusted $R^2 = .390$ value of the regression model where $F(7,83) = 9.234$, $p < .001$.

Negative signs in the predictors for Autonomy of Time Use, Awareness of Time Use, and Allocation of Time variables are consistent with the negatively worded items in these scales.

4.5 Research Question 4

The final question focuses on self-rated department performance and plant manager performance evaluation. It asks whether performance is related to the amount of time first-level managers spend working on each subsystem. Research Question 4 states: what proportion of time do first-level managers spend on the social and technical subsystems in departments with perceived high performance ratings?

Research Hypothesis 4: Departments with first-level managers who spend equal proportions of time on the social and technical subsystems are higher performing departments.

There were two sources of the departmental performance measure used in this study: (1) first-level managers self-scored department performance on the DPA instrument, and (2) plant or warehouse manager's evaluated each department on the DPA instrument. Because this research question focused on time allotment as it relates to high performing departments, a comparison was made to ensure that the first-level manager's report of department performance was not significantly different from the score given by the evaluating manager. See Table 4.14.

Table 4.14. Regression Results of EVALDIFF blocked by Plant Manager

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
B	Std. Error	β			
(Constant)	-3.667	2.819		-1.301	.199
Z1	-6.061E-02	4.076	-.002	-.015	.988
Z2	-16.333	6.303	-.330	-2.591	.012
Z3	2.667	5.197	.068	.513	.610
Z4	5.333	3.639	.228	1.466	.149
Z5	-1.083	5.637	-.025	-.192	.848
Z6	13.167	7.458	.219	1.766	.083
Z7	7.667	6.303	.155	1.216	.229
Z8	-11.333	10.163	-.134	-1.115	.270
Z9	-3.833	5.637	-.089	-.680	.499

As described in Chapter 3, multiple linear regression was used to compare the difference between first-level managers and plant managers' departmental performance scores (EVALDIFF). The regression results showed no significant difference of the value of the regression constant β_0 from zero. Therefore, this result supported that there was no significant overall difference between performance scores for the 64 first-level managers whose evaluating managers submitted an assessment of departmental performance. For further explanation of the regression techniques used in this analysis refer to Appendix E.

There were also two measures of time allotment to the social and technical subsystems: DIFF, which was a five-point scale Likert-type score of time allotment, and PCTDIFF, which was a ratio measure of time spent on each subsystem. See Equation 4.1. Possible PCTDIFF Scores are shown in the Table 4.15.

Table 4.15. Summary of Possible PCTDIFF Scores

Proportion on Technical (%)	Proportion on Social (%)	PCTDIFF
50	50	0
55	45	10
60	40	20
65	35	30
70	30	40
75	25	50
80	20	60
85	15	70
90	10	80
95	5	90
100	0	100

Pearson's correlation coefficient was used to determine the relationship between time spent in social and technical subsystems (DIFF, PCTDIFF) measured by the Time Allotment Instrument and department performance (SELFDPA, MGRDPA). There was no correlation between time allotment and performance variables. The results are shown in Table 4.16.

Table 4.16. Correlations between Performance and PCTDIFF, DIFF

	DIFF	PCTDIFF
Performance	.071 n.s.	-.087 n.s.
Manager Performance	.231 n.s.	-.182 n.s.

n.s. - not significant

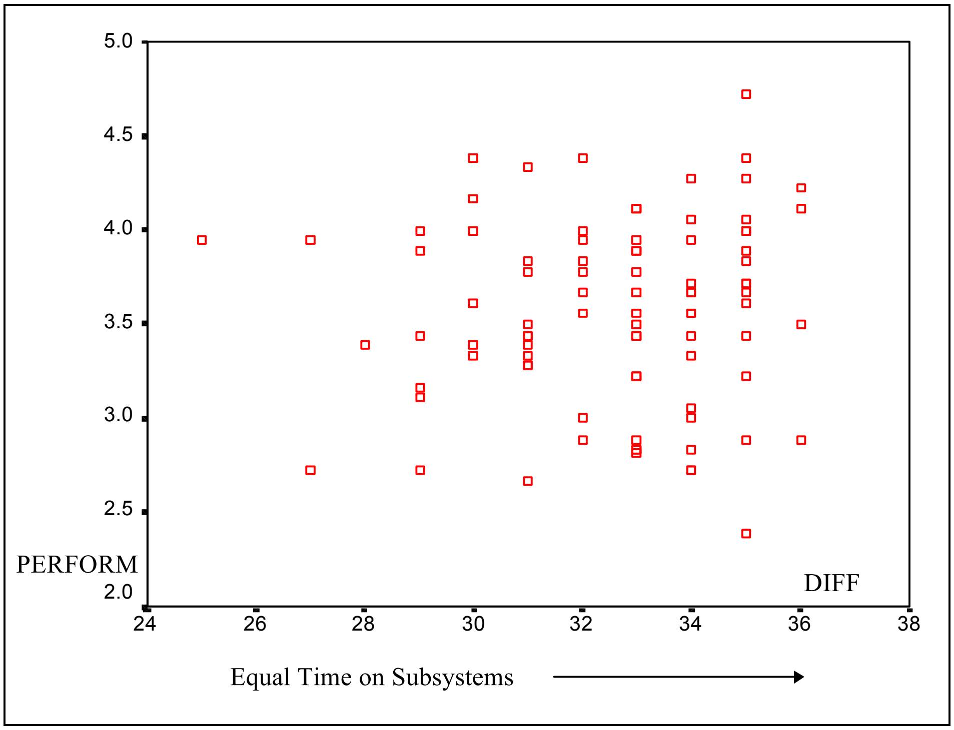

Figure 4.6. Performance vs. DIFF

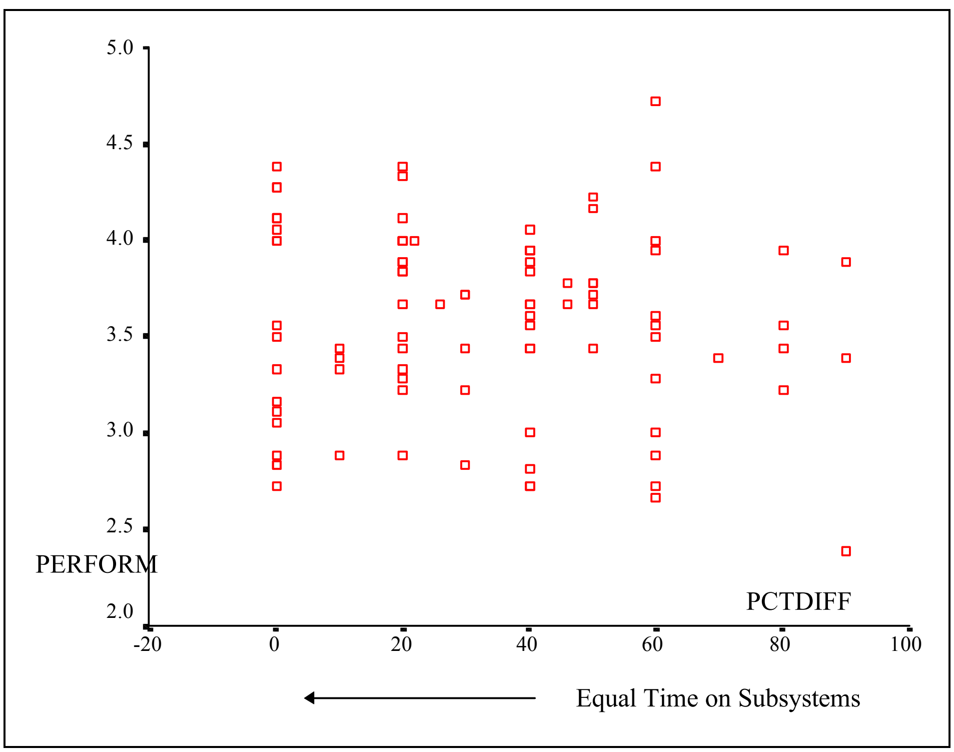

Figure 4.7. Performance vs. PCTDIFF

A scatter plot of Performance versus DIFF (Figure 4.6) showed that the level of department performance varied for every possible DIFF score. Similarly, the scatter plot of Performance versus PCTDIFF (Figure 4.7) showed that the level of department performance also varied for most PCTDIFF scores.

The scatter plot showed modes at the following time allotments between the technical and social subsystems:

- 20-80 or 80-20 split (PCTDIFF = 60)
- 30-70 or 70-30 split (PCTDIFF = 40)
- 40-60 or 60-40 split (PCTDIFF = 20)
- 50-50 split (PCTDIFF = 0)

Each mode was examined to determine whether there was a time split which optimized department performance. The results of this analysis are summarized in the Table 4.17 and shown graphically in Figure 4.8 . Further explanation of the perceived performance and the level of joint optimization at each mode is presented in following sections.

Table 4.17. Level of Joint Optimization and Performance at Time Allotment Modes

		Allotment to Subsystem	Joint Optimization			
Mode	# of Mgrs	T-S, S-T*	Low	Mean	High	Performance
0	18	50	0.165	0.579	0.993	3.5679
10	4	55-45,45-55	0.048	0.156	0.265	3.2639
20	17	60-40,40-60	0.174	0.549	0.925	3.7418
22	1	61-39	0.432	0.432	0.432	4.0000
26	1	37-63	0.872	0.872	0.872	3.6667
30	5	65-35,35-65	-0.098	0.226	0.549	3.3889
40	16	70-30,30-70	-0.021	0.327	0.674	3.5161
46	2	27-37	-0.171	0.425	1.021	3.7222
50	7	75-25,25-75	0.268	0.643	1.018	3.8254
60	12	80-20,20-80	-0.101	0.198	0.497	3.5231
70	1	85-15,15-85	0.003	0.003	0.003	3.3889
80	4	90-10,10-90	-0.020	0.128	0.275	3.5417
90	3	95-5,5-95	-0.236	0.322	0.881	3.2222

T = Technical, S=Social

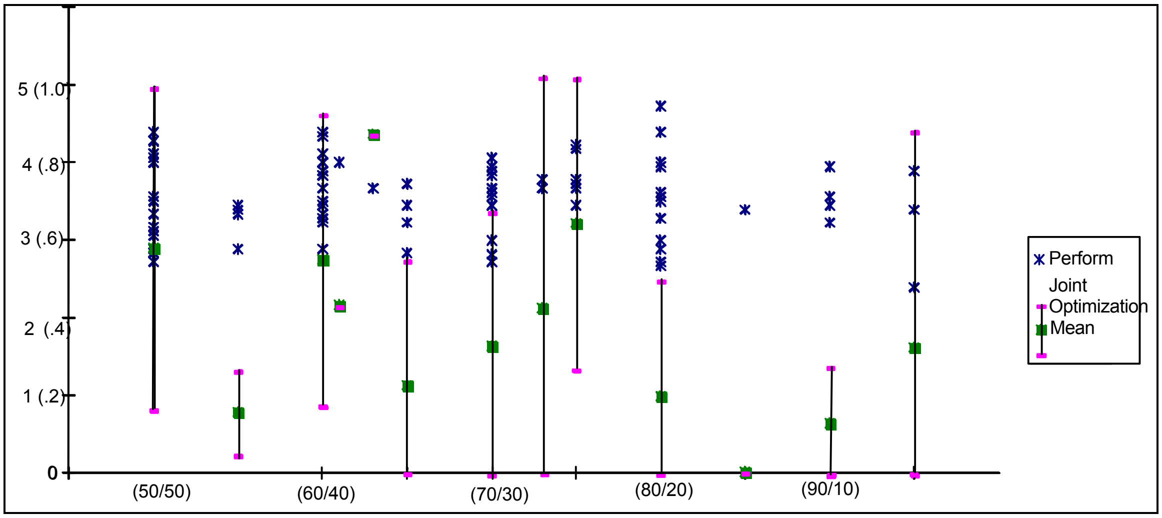

Figure 4.8. Performance vs. PCTDIFF with an overlay of Joint Optimization Scores

80/20 Split

Managers who allotted 80% of their time to TAS technical subsystem tasks[2] and 20% of their time to TAS social subsystem tasks tended to have higher performance scores and higher joint optimization scores. Managers who allotted 80% of their time to TAS social subsystem tasks and 20% of their time to TAS technical subsystem task tended to have lower performance scores and lower joint optimization scores. However, managers who scored high on joint optimization and performance in the 80/20 split also tended to have much lower performance scores from their evaluating manager.

Table 4.18. Summary of Performance at 80/20 or 20/80 Time Allotment

SUBJECT	Overall T/S	Perform	JOINTOPT	MGR DPA	SELF DPA	TAS Technical	Tech Other	TAS Social	Social Other
61	80/20	4.72	1.00	66	85	80	0	20	0
22	20/80	4.39	0.01	55	79	20	0	80	0
25	20/80	4.00	0.54	n/a	72	20	0	80	0
133	20/80	3.94	0.23	n/a	71	20	0	80	0
30	80/20	3.61	0.13	69	65	30	50	20	0
65	20/80	3.56	0.02	68	64	20	0	80	0
116	80/20	3.50	0.28	58	63	80	0	20	0
97	20/80	3.28	0.00	56	59	20	0	80	0
71	20/80	3.00	0.09	n/a	54	20	0	80	0
90	20/80	2.89	0.00	65	52	20	0	80	0
102	20/80	2.72	0.06	n/a	49	10	10	50	30
111	20/80	2.67	0.00	54	48	10	10	80	0

[2] TAS Technical and Social Subsystem Tasks are included in the appendix. These are tasks specific to departmental needs.

One manager (#30) allotted 80% of his overall time to the technical subsystem where a small proportion of that time was dedicated to TAS technical activities and the remainder to other technical activities[3] such as the installation of a new packaging line. This time allotment resulted in a lower performance score and a lower joint optimization score (see Table 4.15).

<u>70/30 Split</u>

Managers who allotted 70% of their time to the overall technical subsystem tended to score higher on joint optimization regardless of the department performance score. However, those managers tended to have significantly lower performance evaluation scores by their plant manager than their self-rated performance score. The data revealed that there appeared to be no combination of 70/30 time allotment split that achieved both higher performance and higher joint optimization See Table 4.19.

Table 4.19. Summary of Performance at 70/30 or 30/70 Time Allotment

Subject	Overall T/S	Perform	JOINTOPT	MGR DPA	SELF DPA	TAS Technical	Tech Other	TAS Social	Soc _Other
87	30/70	4.06	0.31	n/a	73	30	0	40	30
204	30/70	3.94	0.29	63	71	15	15	70	0
37	70/30	3.94	0.99	61	71	20	50	20	10
72	30/70	3.94	0.35	n/a	71	10	20	20	50
45	30/70	3.89	0.21	78	70	10	20	50	20
15	70/30	3.83	0.93	54	69	20	50	20	10
156	70/30	3.67	0.91	n/a	66	40	30	30	0
17	70/30	3.67	0.25	69	66	70	0	30	0
107	70/30	3.61	0.00	n/a	65	10	60	10	20
70	30/70	3.56	0.63	62	64	30	0	30	40
64	70/30	3.44	0.13	39	62	10	60	30	0
127	30/70	3.44	0.19	76	62	15	15	30	40
198	30/70	3.00	0.02	66	54	25	5	25	45
124	30/70	2.81	0.00	n/a	51	15	15	10	60
81	70/30	2.72	0.03	67	49	20	50	20	10
125	30/70	2.72	0.00	n/a	49	5	25	20	50

[3] Technical Other and Social Other were job specific tasks identified in either subsystem. These task were usually unrelated to departmental needs.

60/40 Split

Managers who allotted 40%-60% or 60%-40% to the technical and social subsystems tended to have higher overall performance and joint optimization scores. Spending more time on the technical subsystem than on the social subsystem (i.e. 60/40 split) tended to result in higher performance and joint optimization. Both the performance and joint optimization scores tend to drop when a higher proportion of time is spent on the social subsystem than on the technical subsystem. See Table 4.17. One manager (#108) reported spending 5% of his time on TAS technical activities and 55% on other technical activities such as emergency coordinator, environmental coordinator, and liaison for contractors & issuing work permits. This manager reported significantly higher department performance than his evaluating manager and also had a lower joint optimization score.

Table 4.20. Summary of Performance 60/40 or 40/60 Time Allotment

SUBJECT	Overall T/S	Perform	JOINTOPT	MGR DPA	SELF DPA	TAS Tech	Tech Other	Soc Pct	Soc_Other
60	60/40	4.39	1.00	80	79	25	35	40	0
108	60/40	4.33	0.41	53	78	5	55	20	20
57	40/60	4.11	0.70	71	74	30	10	40	20
66	40/60	4.00	0.80	64	72	40	0	60	0
99	60/40	4.00	0.79	65	72	20	40	20	20
38	40/60	4.00	0.65	56	72	40	0	60	0
78	40/60	3.89	0.84	n/a	70	40	0	50	10
109	40/60	3.89	0.92	n/a	70	20	20	60	0
123	60/40	3.83	0.49	n/a	69	20	40	40	0
28	60/40	3.83	0.98	78	69	30	30	40	0
63	40/60	3.50	0.61	45	63	40	0	60	0
48	40/60	3.44	0.03	60	62	40	0	40	20
83	40/60	3.33	0.16	n/a	60	10	30	30	30
203	40/60	3.28	0.00	54	59	25	15	25	35
34	60/40	3.22	0.00	47	58	60	0	15	25
76	40/60	2.89	0.00	n/a	52	20	20	20	40

50/50 Split

Managers who spent equal time on the TAS technical tasks and TAS social tasks tended to score higher on both joint optimization and department performance. These managers also tended to have consistent performance scores from their evaluating manager if the majority of their time was spent on TAS technical or social subsystem activities. The data showed that managers (e.g. #197) who spent more of their time on the other tasks in the technical subsystem tended to have a much lower score in performance from their evaluating manager than their self score. Overall, however, a 50/50 split appeared to achieve the most consistent scores for department performance between first-level managers and their evaluating managers. This split also yielded the same number of departments with high performance and higher levels of joint optimization as the 60/40 split (50/50: 10 of 15 mgrs.; 60/40: 10 of 16 mgrs.).

Table 4.21. Summary of Performance at 50/50 Time Allotment

SUBJECT	GROUP	Perform	JOINTOPT	MGR DPA	SELF DPA	TAS Technical	Tech Other	TAS Social	Soc Other
59	50/50	4.39	0.99	70	79	45	5	50	0
31	50/50	4.28	0.96	70	77	50	0	50	0
18	50/50	4.28	1.00	69	77	50	0	50	0
131	50/50	4.11	0.72	n/a	74	50	0	50	0
84	50/50	4.11	0.55	n/a	74	25	25	40	10
197	50/50	4.06	1.00	56	73	5	45	20	30
118	50/50	3.56	0.92	76	64	20	30	40	10
205	50/50	3.50	0.77	58	63	35	15	35	15
74	50/50	3.33	0.59	n/a	60	10	40	20	30
58	50/50	3.17	0.98	49	57	35	15	50	0
103	50/50	3.06	0.03	63	55	20	30	40	10
130	50/50	2.89	0.00	63	52	10	40	25	25
200	50/50	2.83	0.23	63	51	30	20	30	20
92	50/50	2.83	0.00	59	51	50	0	50	0
104	50/50	2.72	0.00	66	49	20	30	30	20

4.5.1 Summary of Results for Research Question 4

Research hypothesis 4 tested whether the equal proportions of time spent on the social and technical subsystems resulted in higher performance. The hypothesis was not supported by the results of both correlation tests and scatter plots. The correlation coefficient for DIFF (balance of time spent on both subsystems) and performance was .085, which indicates that there is no relationship between the two variables. The scatter plot of Performance versus DIFF and Performance versus PCTDIFF revealed that there was a lot of variation in performance scores for each possible DIFF or PCTDIFF score.

However, the majority of managers reported that their time was allotted in one of four proportions to the technical and social subsystems - 20/80 or 80/20, 30/70 or 70/30, 40/60 or 60/40, and 50/50. Managers who reported spending 80% percent of their time on the technical subsystem scored higher on performance and joint optimization than managers who reported spending 80% of their time on the social subsystem. Managers who split their time 40/60, 50/50, or 60/40 between the technical and social subsystems tended to score higher on both joint optimization and department performance. Those high performing managers who had a 50/50 time allotment also tended to have performance scores from their evaluating managers that were consistent with their own evaluation of departmental performance.

4.6 General Summary of Results

The results of each of the research questions and hypotheses were presented in this chapter. The results supported research hypotheses 1a, 2b, 3a, and 3b.

- A significant difference in the level of joint optimization does exist between transformation and downstream managers. (Hypothesis 1a)
- A strong relationship does exist between the level of joint optimization and department performance. (Hypothesis 2b)
- The time dimension variables scheduling, future orientation, awareness of time use, autonomy of time use and synchronization each had a significant affect on the relationship between joint optimization and time allotment between the two subsystems. (Hypothesis 3a)
- Time dimension variables and the time allotment variable (DIFF) significantly predicted department performance. (Hypothesis 3b)

The unsupported hypotheses were 1b, 2a, and 4:

- No significant difference existed between the proportion of time transformation and downstream managers spent on the social and technical subsystems. (Hypothesis 1b)
- No significant difference in the amount of time spent on the social and technical subsystems existed between departments with high joint optimization and departments with low joint optimization. (Hypothesis 2a)
- No significant difference in the amount of time spent on the social and technical subsystems existed between high performance and low performance departments. (Hypothesis 4)

The chapter includes all of the results of the research questions and hypotheses using the statistical methods described in Chapter 3. The results of both the supported and unsupported hypotheses led to more questions that could be answered by the data collected in this study. Further post-hoc analyses were performed on the data and are presented in Chapter 5 as part of the discussion.

Chapter 5 Discussion and Post Hoc Analyses

The focus of this study was to use an STS framework to examine the amount of time manufacturing supervisors spent attending to both the social and technical subsystem. The research hypotheses were used to examine the relationship between time allotment in the social and technical subsystems and department performance, joint optimization and also considered what effect time dimension of work variables and type of manager had on the relationship. The purpose of this chapter is to provide information about the relationships and observations made in Chapter 4 in the context of the research questions. Based on the results previously presented, further post-hoc analyses were performed and are presented in this chapter.

The post-hoc analyses presented in this chapter focus on the primary research question of this study: How do first-level managers who achieve high levels of joint optimization perform and allot their time in order to balance the needs of both the social and technical subsystems? The key results from these analyses are summarized in Table 5.1.

Table 5.1. Summary of Results from Post Hoc Analyses

5.1 Department Type and Joint Optimization	
Level of Joint Optimization	• Downstream managers report higher scores than transformation managers
	• Departments involved in information technology improvement or advancement report higher levels than all other departments.
STS Technical Scores	• Downstream managers report higher scores than transformation managers
5.2 Time Allotment and Joint Optimization	
Time Allotment	• Mean score for difference in time spent on subsystems correlated to level of joint optimization
Time Allotment Factors	Five factors emerged from Time Allotment Instrument. Time spent on: • Participation and Information Sharing • Customer Needs and Strategic Planning • Skill Development and Compensation • Managing Quality • Operational Department Needs
Level of Joint Optimization	• Managers who reported higher levels of joint optimization spent more time on Participation and Information Sharing, Customer Needs and Strategic Planning, and Skill Development and Compensation than other managers.
5.3 Joint Optimization and Department Performance	
	• Joint Optimization and Department Performance are strongly correlated. Outliers in the data set had much lower performance scores from their evaluating managers than their self-scores.
5.4 Organizational Value of Time Use, Joint Optimization and Department Performance	
Predictors of Joint Optimization	• Time oriented constructs which were significant predictors of joint optimization: Future Orientation, Awareness of Time Use, Skill Development and Compensation, Autonomy of Time Use
Predictors of Department Performance	• Time oriented constructs which were significant predictors of department performance: Awareness of Time Use, Skill Development and Compensation, Autonomy of Time Use, Scheduling and Deadlines, and Customer Needs and Strategic Planning
5.5 Time Allotment to STS Subsystems and Department Performance	
	• All STS subsystems scores are strongly correlated with performance
	• Rate of performance increased more quickly with higher social STS characteristics than technical STS characteristics

5.1. Manager Type and Joint Optimization

The results in Chapter 4 showed that there was a significant difference between the level of joint optimization and manager type. Downstream managers reported higher levels of joint optimization than transformation managers. The literature indicated that within the same organizational system there are varying levels of technology required to manage and process the product. It is possible that the required technology in the transformation and downstream functions account for the differences in the level of joint optimization.

Further analysis was performed to compare scores in each STS subsystem for downstream and transformation managers. The results of one-way ANOVAs on each subsystem using manager type as a factor are summarized in Table 5.2. Downstream managers had significantly higher technical subsystem scores than upstream managers, $F(1,89)$, $p = .038$. There were no significant differences in the social subsystem and environmental subsystem scores for the two manager types.

There were no significant differences in the environmental subsystems scores in the population sample. Previous studies (Shani et al., 1992) supported that effects from the environmental subsystems such as customer wants, governmental regulation, increased or decreased competition are seen as changes to the technical subsystem (i.e. new machinery, changes in technology) at the department and/or supervisor level. The social subsystem includes individuals' aptitudes, attitudes and beliefs, and lateral and vertical relationships between subordinate and supervisors (Shani et al., 1992). Therefore, the lack of significant differences in the STS scores for this subsystem suggests that there were no significant differences in these characteristics for the sample population.

Table 5.2. Summary Table of One-Way ANOVAs
(Dependent variable by Factor Manager Type)

Dependent Variable	F (1,89)	Sig.
Joint Optimization	4.418	*.038
Environment Subsystem	3.448	.067
Social Subsystem	2.901	.092
Technical Subsystem	6.754	*.011

* Significant at $\alpha = .05$

First-level managers from a number of different companies participated in this study, and the technology varied across organizations. An ANOVA was performed with PROBTECH, the technical subsystem z-score, as the dependent variable, manager type as the factor level, and company as a blocking variable to determine if differences across organizations accounted for any of the variability in the technical subsystems scores.

The results of this ANOVA (Table 5.3) showed that part of the variance between level of STS characteristics in the technical subsystems could be explained by inherent variability in each company's technology F(12,73) = 2.757, p = .004. Overall, however, downstream managers still reported higher technical subsystems scores than downstream managers.

Table 5.3. One-Way ANOVA of PROBTECH, Factor: Mgr. Type, Blocking Variable: Company

Source	SS	df	MS	F	Sig.
COMPANY	2.851	12	.238	2.757	*.004
MGR_TYPE	.476	1	.476	5.523	*.021
COMPANY * MGR_TYPE	.293	4	7.335E-02	.851	.498
Error	6.292	73	8.619E-02		
Total	21.565	91			

Significant at $\alpha = .05$

In the sample population, there was still a significant difference in the level of joint optimization reported by transformation and downstream managers, $F(1,91) = 5.523$ for $p < .05$ once variation from the blocking variable COMPANY was accounted for. Further analysis showed downstream managers ($\overline{X} = .52$) had higher technical subsystem scores than transformation managers ($\overline{X} = .30$).

The technical subsystem is focused on the product and/or service the organization provides and the technology required to manage it. STS characteristics measured in the technical subsystem were quality orientation, technical efficacy, tangible rewards, task challenge, task significance, setting induced stress, physical health and skill developments. The results showed these characteristics were better managed by downstream managers.

These results supported that the level of joint optimization for manufacturing managers is highly related to how the first-level manager interacts with the technical subsystem. In the population sample, the level of technology varied across organizations from completely manual to highly automated for both manager types.

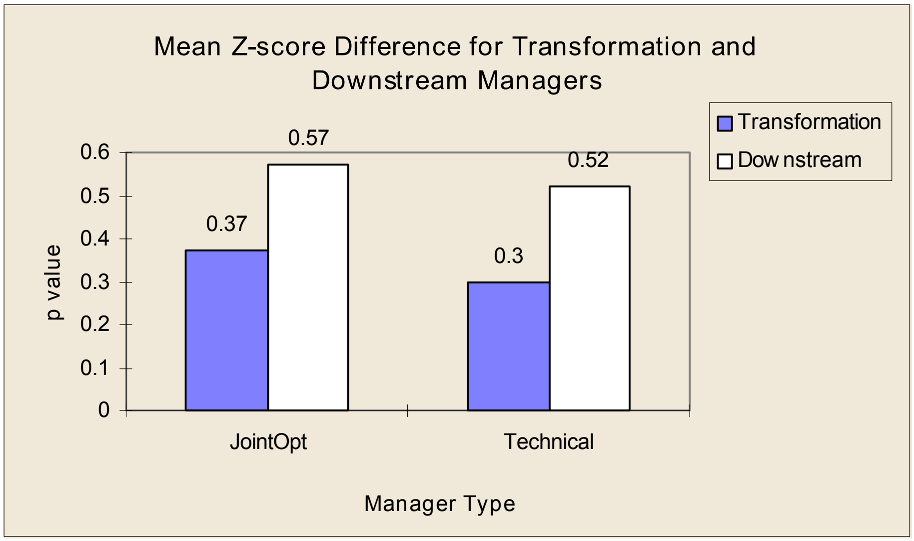

Figure 5.1 Joint Optimization, Technical System Scores by Manager Group

Difference in technical subsystem scores may be explained by functional silos and minimal interaction with the complete work system at the department level. This phenomenon may occur in a plant where there is a first-level manager responsible for production of each of four sub-assemblies and a higher-level manager who is responsible for the production of the complete unit. First-level managers in this environment will generally hold a segmented view of the production process and its purpose.

Although functional silos can exist throughout the organization, first-level downstream managers, even in traditional functional organizations, are more likely to work or manage the entire process in their technical subsystem. For example, warehouse managers work with the entire distribution process from order picking to shipping. The ability to manage the entire process within the technical subsystem may also account for the differences in technical subsystem scores.

Table 5.4. ANOVA of PROBTECH and Special Projects (5 Factors)

Main Effects	SS	df	MS	F	Sig.
SP_1 (Department Restructuring)	.0733	1	.073	.638	.427
SP_2 (Staff Retraining)	.0232	1	.023	.202	.654
SP_3 (Production Advancement)	.0863	1	.086	.751	.389
SP_4 (Information Technology)	.506	1	.506	4.407	*.039
SP_5 (Other/Custom Project)	.179	1	.179	1.556	.216
Model	.827	5	.165	1.440	.218
Residual	9.646	84	.115		
Total	10.473	89	.118		

* Significant at $\alpha = .05$

Another possible explanation for the difference in technical subsystem scores is due to the level of change and the type of change projects in which the department was involved in the months prior to completing the survey. Further analysis into level of change effects on the technical subsystem score showed the following: Of the five types of special projects (see Table 5.4), managers were asked whether they had started in their departments in the last three months. Managers who reported department involvement in a new information technology or information technology improvement projects (SP_4) reported significantly higher technical subsystem scores, $F(1, 84) = 4.407$, $p = .039$, $\overline{X} = .471$ than other departments $\overline{X} = .301$. See Table 5.5. Furthermore, frequency counts showed that 15 of those managers were transformation managers and 11 of those managers where downstream managers. See Table 5.6. This distribution represented only 21% of the transformation managers but 55% of the downstream managers.

Table 5.5. Frequency Counts and Means Scores for Each Special Project Type

Level	SP_1	N	SP_2	N	SP_3	N	SP_4*	N	SP_5	N
0	.363	75	.350	77	.356	65	.301	64	.367	79
1	.283	15	.346	13	.335	25	.471	26	.225	11

Level 0 - No special projects in the last 3 months, Level 1 - Started Special Project in the last three months

Table 5.6 Information Technology or Improvement

	No	Yes	Total
Transformation	56	15	71
Downstream	8	11	19
Total	64	26	90

STS scores indicated no significant difference in the relationship between both types of first-level managers with the social and environmental subsystem. The results also showed there is no relationship between joint optimization and the proportion of time spent on either the social or technical subsystem for each manager type.

Further research should be done to examine the differences in work design, degree of seclusion, and grouping of tasks in transformation versus downstream departments, to determine whether these factors have any relationship to the technical subsystem STS score. These characteristics are dependent on the technological choices made by the department and the organization. Previous studies show these characteristics vary as the level of total integration of technology into the manufacturing process increases (Shani et al, 1992).

5.2. Time Allotment and Joint Optimization

The results in Chapter 4 showed there was a moderate correlation between joint optimization and the difference of time spent in both the social and technical subsystems (ρ = .224). The reason for examining this relationship was to determine whether the sample data showed an optimal relationship between the time spent on each subsystem and department performance.

The time balance variable (DIFF) measured the difference of time spent on each subsystem as reported in the time allotment survey. The DIFF variable measured the absolute difference between social subsystem scale scores (TSOC) and technical subsystem (TTECH) scale scores. Scale reliabilities for the TTECH, TSOC were .68 and .79, respectively. The overall reliability for the Time Allotment Survey (TAS) was .85.

Table 5.7. Factor Pattern Matrix for the Time Allotment Survey Items

Item (Subsystem)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q9 (S)	.820*				
Q15 (S)	.770*		-.126	.359	
Q10 (S)	.536*			-.490	
Q12 (S)	.388*	.182	-.166	-.141	.201
Q5 (T)		.892*	.130	.119	
Q6 (S)		.800*		-.101	-.217
Q4 (T)	.155	.678*		-.204	
Q18 (T)	-.159	.514*	-.434	.213	.331
Q3 (T)			-.739*	-.110	.189
Q1 (T)		-.136	-.708*		-.164
Q13 (T)	.317	.164	-.408*	-.365	-.110
Q14 (S)	.258	.301	-.369*	-.299	
Q11 (T)	-.213	.103	-.158	-.799*	.166
Q2 (T)	-.122				.833*
Q16 (S)	.151		.246	-.329	.638*
Q8 (T)	.224	-.134		-.141	.613*
Q7 (S)	.365	.144	-.153	.137	.511*
Q17 (T)	.381	.106	-.171	-.229	.388*

* Loaded on Factor, S= Social Subsystem, T= Technical Subsystem

The moderate correlation, along with the high scale reliability for the overall TAS instrument, prompted further investigation into the relationship between time allotment measured by the TAS instrument and joint optimization.

First, factor analysis was performed using all the items in the TAS instrument. The items loaded on five factors. The factor pattern matrix are shown in Table 5.7.

Each factor was given a construct name: Factor 1 - Participation and Information Sharing, Factor 2 - Customer Needs and Strategic Planning, Factor 3 - Skill Development and

Compensation, Factor 4 - Managing Quality, Factor 5 - Operational Department Needs. Table B-4 in the appendix contains each item by factor.

As in the previous chapter, ANOVA was used to compare scores for each of the five TAS constructs. Again, the bottom half of the joint optimization scores were compared to the top half of the joint optimization scores. The results are shown in Table 5.8.

Table 5.8. Summary ofOne-Way ANOVA of TAS Construct, Factor: Level of Joint Optimization

TAS Construct	F (1,89)	p-value
Participation and Information Sharing	6.485	*.013
Customer Needs and Strategic Planning	16.190	**.000
Skill Development and Compensation	17.269	**.000
Managing Quality	1.515	.222
Operational Department Needs	1.688	.197

* significant at α =.05
** significant at α =.001

There were significant differences in the time allotment to Participation and Information Sharing, Customer Needs and Strategic Planning, and Skill Development and Compensation for the two levels of joint optimization. As shown in Figure 5.2, departments with higher levels of joint optimization reported spending more time on each of these three significant time allotment constructs.

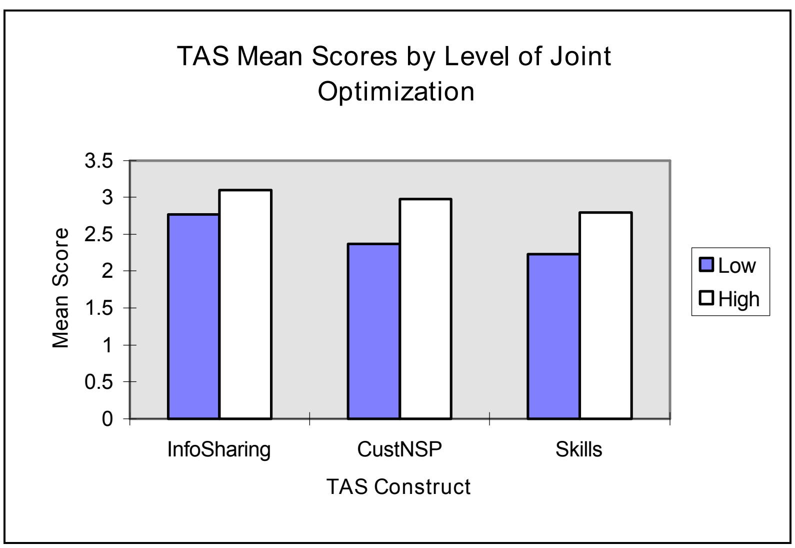

Figure 5.3. TAS Mean Scores by Level of Joint Optimization

The Participation and Information Sharing construct contained four items each from the social subsystem. The Customer Needs and Strategic Planning construct contained four items one from the social subsystem and the remainder from the technical subsystem. The Skill Development and Compensation construct contained four items three from the technical subsystem and one from the social subsystem. The integration of social and technical subsystem items in each of these significant time allotment constructs may account for the moderate correlation observed in the difference of time allotment in each subsystem and the level of joint optimization.

5.3. Joint Optimization and Department Performance

The sample data also showed a strong positive relationship between level of joint optimization and department performance (ρ = .607). As indicated in Figure 5.3, there were several managers (n=7) who reported high department performance and low levels of joint optimization.

The plant manager's evaluation of department performance was compared to self-scores for each of these seven departments. See Table 5.9. Two of the seven first-level managers who reported high performance and low joint optimization had plant managers who evaluated their departments' performance in excess of 20 points lower than their self score. The differences between self-scores and manager evaluations for the other two managers with available data were not significantly different. The gap between perceived performance at the plant manager level and the first-level manager level was greatest for the two managers with the highest self-scores. This gap suggests that these first-level managers were not able to accurately gauge departmental performance expectations and provides some insight into the discrepancy between their performance scores and joint optimization scores.

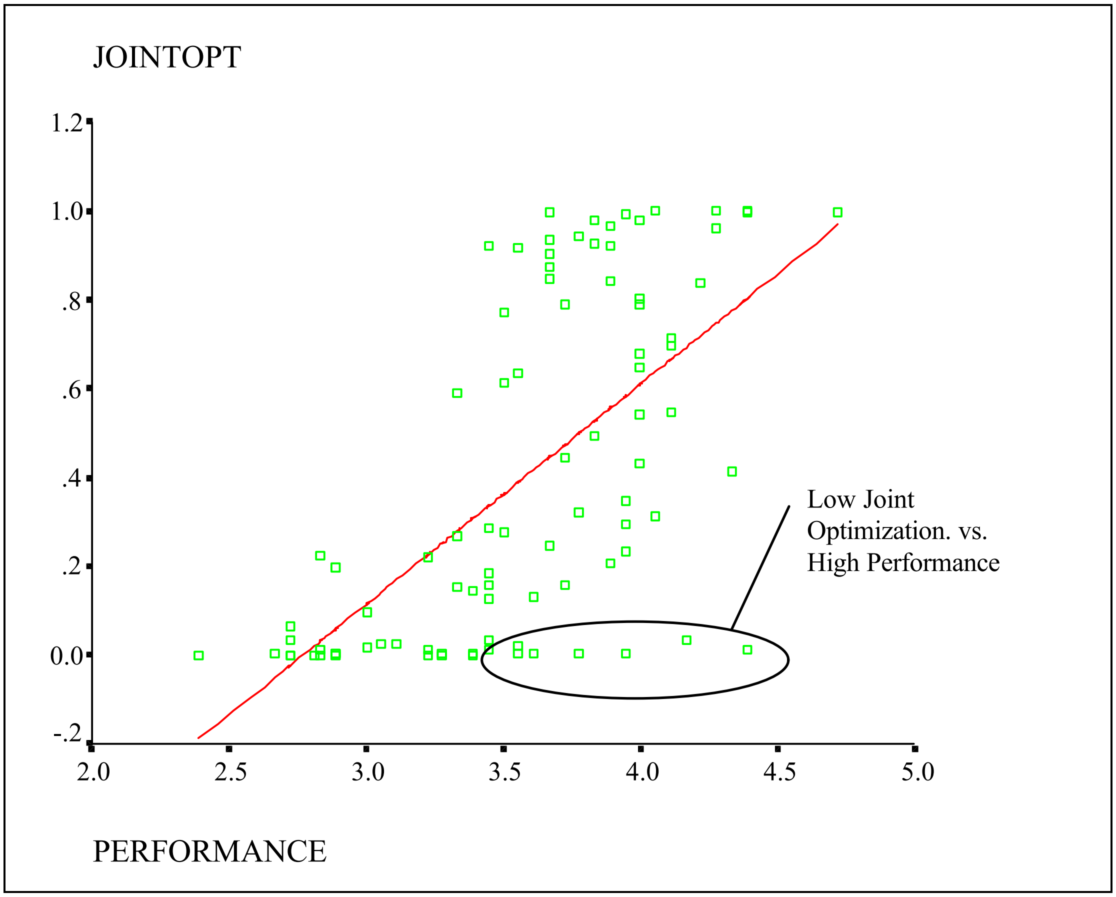

Figure 5.4. Joint Optimization versus Department Performance

Table 5.9. Summary of Performance Scores for Outliers

SUBJECT	SELF Performance	MGR Performance	Delta (self - mgr.)	Mean Self Performance	JOINTOPT
22	79	55	24	4.39	0.01274
96	75	54	21	4.16	0.03566
77	71	n/a	n/a	3.94	0.00163
112	68	64	4	3.79	0.00311
107	65	n/a	n/a	3.61	0.00396
65	64	68	-4	3.56	0.01893
114	64	n/a	n/a	3.56	0.00199

Overall the results from the sample data show that time allotment in the social and technical subsystem is associated with the level joint optimization. Departments with higher levels of joint optimization reported spending more time on three of the five time allotment constructs uncovered in post hoc analysis. As indicated in Table 5.3, these three constructs were a combination of both social and technical activities.

The results also indicated a strong relationship between joint optimization and department performance. Outliers in the data were shown to have significantly higher perceptions of their performances than the plant managers who evaluated them. This suggests that objectives and criteria for performance may not be clearly communicated to or understood by the first-level managers of those departments.

5.4. Organizational Value of Time Use, Joint Optimization and Department Performance

The results summarized in Chapter 4 supported the hypothesis that time dimension of work variables such as scheduling, future orientation, awareness of time use, autonomy of time use and synchronization affected the relationship between the amount of time spent on each subsystem (DIFF) and joint optimization. The results of factor analysis shown in Table 5.7 provided further insight into the moderate correlation between balance of time between the two subsystems (DIFF) and joint optimization. These new constructs were used to replace DIFF in further analysis of the effect of time dimension of work variables on the association of time allotment with joint optimization.

Bivariate correlation showed there was a significant relationship between the time spent on Participation and Information Sharing (INFOSHAR), Customer Needs and Strategic Planning (CUSTSP), Skill Development and Compensation (SKILLS), and the reported level of joint optimization. See Table 5.10. This relationship suggests managers who spend more time on these issues achieve higher levels of joint optimization in their departments. It also interesting to note that each of the characteristics can be mapped to a subsystem. Participation and information sharing is a social subsystem issue. Skill Development and Compensation is predominantly a technical subsystem issue. Customer Needs and Strategic Planning directly caters to the environmental subsystem. The significant correlation of time spent on these three areas to joint optimization reinforces the definition of joint optimization — "that an organization will function optimally only if the social and technological systems of the organization are designed to fit the demands of each other and the environment" (Pasmore, et al., 1982, p. 1182). The significant correlations also suggests that joint optimization can be operationalized through managerial time allotment.

Table 5.10. Bivariate Correlations between Joint Optimization and TAS Constructs

	InfoSharing	CUSTSP	SKILLS	QUALITY	DeptNeeds
JOINTOPT	.266*	.373**	.456**	.116	.153

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

The results of multiple linear regression using joint optimization as the dependent variable and time dimension variables as the regressors showed that future orientation, awareness of time use, balance of time use between social and technical subsystems (DIFF), autonomy of time use, and scheduling were all significant predictors of joint optimization. The model produced an adjusted R^2 value of .389, $F(5,85) = 12.469$, the $p < .001$.

Table 5.11. Regression of Joint Optimization on the Time Dimensions

Model	β	Std. Error	t	sig.
Future Orientation	.123	.038	3.279	.002
Awareness of Time Use	-.121	.051	-2.372	.020
DIFF	.037	.014	2.650	.010
Autonomy of Time Use	-.085	.036	-2.344	.021
Scheduling	.150	.068	2.221	.029

$F(5,85) = 12.469, p < .001$, Adjusted $R^2 = .389$

A similar regression analysis replacing DIFF with the new TAS constructs generated the regression model shown in Table 5.12. The only TAS construct variable which was a significant predictor of Joint Optimization was time spent on skill development and compensation. Time dimension of work variables representing organization values on awareness of Time use and Autonomy of Time use as well as Future Orientation were also significant predictors of Joint Optimization. This model produced an adjusted R^2 value of .401, $F(4,86) = 13.332$, the $p < .001$. See Table 5.12.

Table 5.12. Regression of Joint Optimization on the Time Dimensions and TAS constructs

Model	β	Std. Error	t	sig.
Future Orientation (TDW)	.038	.041	2.044	.044
Awareness of Time Use (TDW)	-.165	.044	-3.729	.000
Skill Development and Compensation (TAS)	.180	.051	3.561	.001
Autonomy of Time Use (TDW)	-.080	.036	-2.240	.028

$F(4,86) = 13.332, p < .001$, Adjusted $R^2 = .401$

Similarly, regression modeling was used to predict department performance with the time dimension variables and the time allotment constructs. As shown in the results in Chapter 4, a different but overlapping set of time allotment and time dimension variables emerged as predictors of performance in the regression model. See Table 5.13.

Table 5.13. Regression of Performance on the Time Dimensions and TAS Constructs

Model (Source)	β	Std. Error	t	sig.
Awareness of Time Use (TDW)	-.202	.062	3.256	.002**
Skill Development and Compensation (TAS)	.119	.059	2.020	.046*
Autonomy of Time Use (TDW)	-.137	.044	3.126	.002**
Scheduling and Deadlines(TDW)	.209	.083	2.526	.013*
Customer Needs and Strategic Planning (TAS)	.110	.054	2.019	.047*

$F(5,85) = 14.433, p < .001$, Adjusted $R^2 = .427$
* significant at α=.05, ** significant at α = .001

The results indicate that time allotted to Skill Development and Compensation along with managers' Awareness and Autonomy of Time Use are strong predictors of both joint optimization and department performance. However, joint optimization is also affected by the Synchronization and Coordination of Work with Others through Time and Future Orientation of the organization. Department performance, on the other hand, is better predicted by the use of Schedules and Deadlines and the time allotted to Customer Needs and Strategic Planning.

Figure 5.4 is a pictorial representation of how the regression predictors for joint optimization and department performance overlap. The results indicated that joint optimization is better predicted by time dimension of work variables along with time allotted to Skill Development and Compensation, whereas department performance is better predicted by a combination of time allotment variables and time dimension of work variables. The regression results support that in the context of manufacturing supervision transformation and downstream departments, Joint Optimization is more of an organizational state variable – predicted by an organization's value of time use and highly dependent on the organizations long term goals, that is Future Orientation. The regression results also support that department performance for these first-level managers is more of an operational variable – predicted by time allotted to (1) Skill

Development and Compensation and (2) Customer Needs and Strategic Planning but also by the Organizational Time Values such as Awareness of Time Use, Autonomy of Time Use, and the Importance of Schedules and Deadlines.

As in Chapter 4, signs for Autonomy of Time Use and Awareness of Time Use are consistent with negatively worded items in these scales.

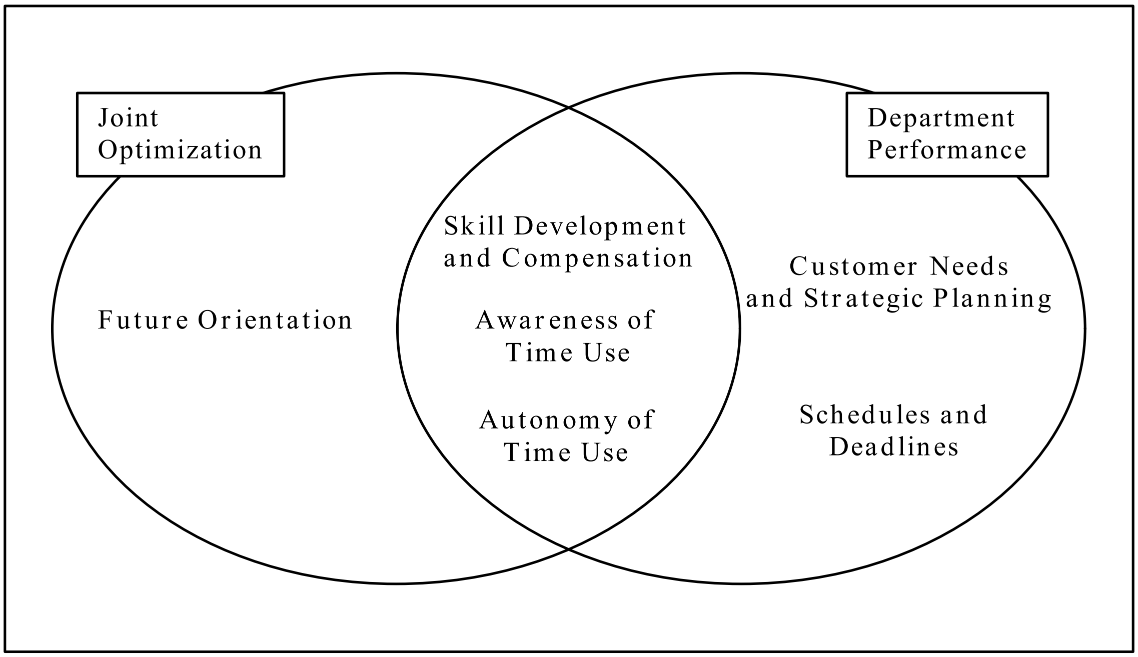

Figure 5.5. Model of Regression Predictors for Joint Optimization and Department Performance

5.5. Time Allotment to STS Subsystems and Department Performance

The results summarized in Chapter 4 showed there were no significant relationships between the proportion of time department managers spent on the social and/or technical subsystems and department performance or joint optimization. However, a review of the scatter plot for performance and percentage of time allotted to either subsystem suggested that there were several optimal time allotments, which improved department performance. Time allotment survey tasks are shown in Table 5.14.

For managers who reported an 80% - 20% balance between time allotted to either subsystems, those who spent 80% of their time of their time on Time Allotment Survey (TAS) technical activities had better performing departments than those who spent 80% of their time on the social subsystem. At the 70%-30% split, there appeared to be no combination which optimized performance. In both of 80/20 and 70/30 time allotments, the evaluating managers' raw scores were significantly lower from those of first-level managers' scores who reported high department performance. Managers who reported a 50/50 or 60/40 time allotment had a greater proportion of their respective groups scoring higher levels of joint optimization and high department performance. The evaluating managers' scores in these group also tended to be consistent with first-level managers' perception of department performance.

Table 5.14. Time Allotment Survey Tasks

TAS Social Task	TAS Technical Tasks
• getting people in your department to cooperate	• achieving, inputting, and implementing quality and/or technology into the process
• encouraging cooperation of employees in your department	• sharing knowledge of the systems and tools required to run the department
• communicating with your departments customers and suppliers	• minimizing the complexity of tasks and work design in your department
• encouraging people to do and learn new processes/methods in your department	• explaining how and why different parts of the work processes are connected
• providing feedback for your direct reports	• helping everyone understand the purpose of their work
• helping people follow through on new ideas and bring them to completion	• providing technical training for machinery, tools, or equipment in your department
• helping people feel involved	

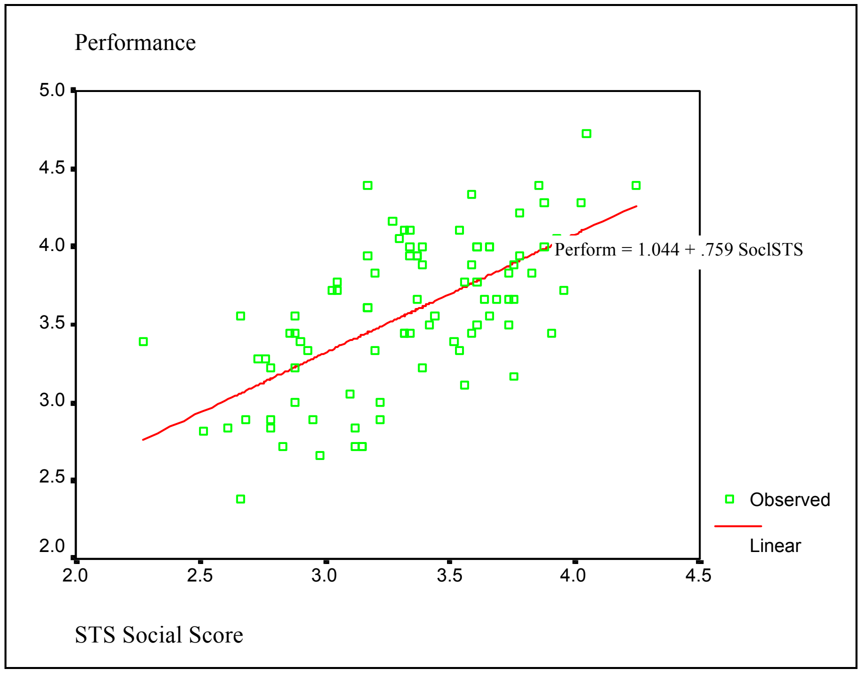

Figure 5.6. Performance vs. STS Social Score

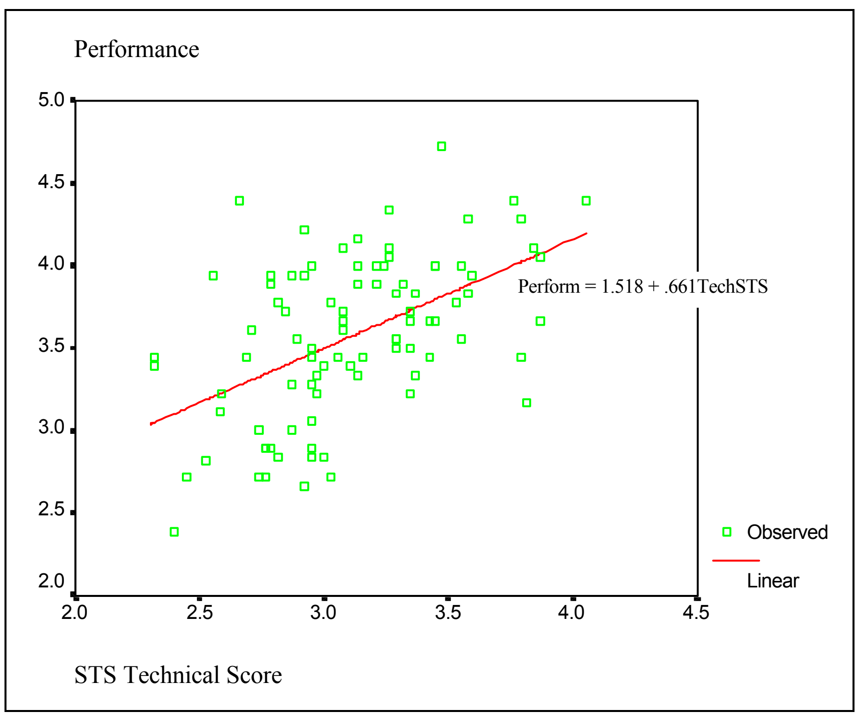

Figure 5.6 Performance vs. STS Technical Score

Further analysis showed that the linear relationship between social system STS scores and performance (Figure 5.5) and the linear relationship between technical system STS scores (Figure 5.6) and performance. The nature of these relationships may provide possible explanations for the time allotment relationship with performance. Linear regression was performed on the both the STS Social Score with Department Performance and the STS Technical Score with Department Performance. The results showed significant linear relationships for each set of data. See Table 5.15.

Table 5.15. STS Subsystem Scores Regressed on Performance

	β_0	SE β_0	T	Sig T	β_1	SE β_1	Beta	T	Sig T
Social Subsystem	1.044	.329	3.169	.0021	.759	.098	.636	7.735	.0000
Technical Subsystem	1.518	.371	4.082	.0001	.661	.119	.511	5.573	.0000

Using the social STS score as a predictor for department performance resulted in an adjusted $R^2 = .398$, $F(1, 88) = 59.8$, $p < .0001$. Similarly, using the technical STS score as a predictor for department performance resulted in an adjusted $R^2 = .252$, $F(1,88) = 31.05$, $p < .0001$. Bivariate correlations summarized in Table 5.16 show similar trends. All three STS scores are significantly correlated to performance, and the strongest relationship was between social (ρ = .636), environmental (ρ = .557), and then technical (ρ = .511) scores, respectively.

The intercept for the STS technical subsystem score with performance is higher than the intercept for the STS social subsystem score with performance. Therefore, at the baseline, organizations with low technical scores tend to have better performance scores than organizations with low social subsystem scores. However, performance increases more rapidly due to increased social subsystem characteristics than increased technical subsystem characteristics. These relationships suggest that if a first-level manager is going to spend more time on the technical subsystem than on the social subsystem, he/she will have to spend much more time on the technical subsystem (i.e. 80/20 or 70/30) to achieve high performance scores. But, data from the evaluating managers showed that these departments were not always recognized as high-performing within the organization.

Table 5.16. Bivariate Correlations of Performance to STS Subsystem Scores

	ENVSTS	SOCLSTS	TECHSTS
PERFORM	.557**	.636**	.511**

**Correlation is significant,p < 0.01

Managers with a 60/40 split where more time was spent on the technical subsystem tended to be higher performing departments. This relationship can be partially explained by the relationship of STS characteristics in each subsystem to performance. Managers who reported spending more time in the technical subsystem balanced the underlying relationship of technical (high β_0, low β_1) and social (low β_0, high β_1) STS characteristics with performance and achieved similar results to those manager who reported spending and 50/50 split on both subsystems.

The relationship with the organization's environment at the department level may also play an important role in the relationship between performance and time allotment. The two sets of information supported this hypothesis. The first was the time allotment factor analysis which showed that time spent on Customer Needs and Strategic Planning was a significant predictor of performance. The second was a significant correlation between environmental STS characteristics and performance. Some of the effects of environmental STS characteristics on performance were also captured in the each department's joint optimization score.

5.6. Summary

This chapter integrated the results of post-hoc analysis with earlier results from hypothesis testing in Chapter 4. Several new significant relationships were revealed in the data from post-hoc analyses. Downstream first-level managers had higher scores in their STS technical subsystem characteristics than transformation first-level managers. STS technical subsystem scores were significantly higher for those managers who reported involvement in a recent (within last three months) information technology advancement or improvement project.

Time allotment scale items were divided into five constructs that included both technical and social subsystem tasks. These were Participation and Information Sharing, Customer Needs and Strategic Planning, Skill Development and Compensation, Managing Quality, and Operational Department Needs.

Significantly more time was spent on Participation and Information Sharing, Customer Needs and Strategic Planning, and Skills Development and Compensation for departments with higher joint optimization scores.

Time allotment and time oriented constructs were predictors of both joint optimization and department performance. The time allotment construct — Skill Development and Compensation and time dimension of work constructs — Awareness of Time Use and Autonomy of Time Use were significant predictors of both performance and joint optimization scores. The time allotment construct Customer Needs and Strategic Planning along with time dimension of work construct Scheduling and Deadlines completed the set of significant predictors of department performance scores. The time dimension of work construct Future Orientation completed the set of significant time oriented predictors of departmental joint optimization.

Post-hoc analyses supported that the relationship between the optimal balance of time to spend on each subsystem, to maximize department performance, may be related to the underlying characteristics of each of the STS subsystems. Each subsystem was strongly correlated with performance.

Chapter 6 Conclusions

The purpose of this chapter is to summarize new knowledge gained from this research from an academic perspective. This summary includes contributions to both the bodies of knowledge in STS theory and time use in organizations. This chapter also serves the purpose of providing a summary of guidance to practitioners who are examining methods to improve department performance and/or improve time use in their organization.

6.1 Contributions the STS Body of Knowledge

This research provides empirical evidence to support the use of time allotment as a means of operationalizing the principle of STS joint optimization in manufacturing departments. The first-level manager's increased focus on time-oriented constructs, such as time allotment to Skill Development and Compensation and Customer Needs and Strategic Planning, in conjunction with the department's value on Awareness of Time Use, Autonomy of Time Use, and Future Orientation, are significant predictors of the level of joint optimization as well as performance in the department. Increased focus on time-oriented constructs, such as Schedules and Deadlines - the importance of staying on schedule, and Future Orientation - the importance of temporally anchored teamwork, had negative relationships with department performance and the level of joint optimization, respectively.

At the department level, the manager's ability to maximize STS characteristics in the technical subsystem was a significant predictor of the level of joint optimization in the department. Managers with higher STS technical subsystem scores also tended to have higher joint optimization scores. Managers involved with an information technology advancement or improvement project had significantly higher technical subsystem scores. In the sample population, 55% percent of the downstream managers were involved with these types of projects versus only 21% of the transformation managers. Overall, in this sample, downstream managers reported a higher level of joint optimization than transformation managers.

The data showed a strong positive association between department performance and the level of joint optimization. This relationship was supported by the fact that three time-oriented constructs were significant predictors of both joint optimization and department performance. These were Skill Development and Compensation, Awareness of Time Use and Autonomy of Time Use. Along with the three shared time-oriented variables, joint optimization was predicted by the department's perceived Future Orientation. Time allotted to Customer Needs and Strategic and the importance of Schedule and Deadlines completed the set of predictors for Department performance. The strong correlation between department performance and the level of joint optimization and the overlapping set of time oriented predictor variables again supported the notion that time allotment can be used to operationalize joint optimization.

6.2 Guidance for Practitioners

The findings from this research have implications for practitioners who are examining ways to improve performance in manufacturing organizations.

The level of joint optimization in a department is a strong predictor of performance. From a practitioner's viewpoint, first-level managers must be encouraged to pay adequate attention to the needs of both the social and technical subsystems in their department, therefore balancing the needs of the people with the needs of the technology.

Departments who had higher levels of joint optimization had managers who spent more time on participation and information sharing, skill development and compensation, and customer needs and strategic planning. Each one of these time allotment areas can be linked to one of the three subsystems:

- Participation and Information Sharing → Social
- Skill Development and Compensation → Technical
- Customer Needs and Strategic Planning → Environment

This relationship again supports the need for first-level managers to spend adequate time on both the needs of people and the product/service including its required technology. However, another part of the principle of joint optimization is also supported by these time allotment constructs. The needs of the social and technical subsystem must be met in the context of the organization's environment. First-level managers with high joint optimization spent more time on task in both the social and technical subsystems related to meeting and understanding customer needs.

Warehousing and distribution managers tended to report higher levels of joint optimization than production and maintenance managers. This sample shows a significant relationship between managers who had hands-on involvement in an information technology project and high technical subsystem scores. Involvement in information technology projects may have heightened the manager's awareness of the requirements of the technical subsystem.

STS theory supports that minimizing external control improves performance. In the sample, time oriented variables such as Autonomy of Time Use, and Awareness of Time Use were significant predictors of both performance and joint optimization. Practitioners can operationalize this result through the support of an organizational culture that fosters time values that allow the manager autonomy of time use but encourage awareness of time use. Both of these characteristics appear to be critical functions of effective management as well as performance.

Future Orientation was a significant predictor of joint optimization and the Importance of Schedules and Deadlines was significant predictor of performance. These time oriented values are also a function of the organization's culture and appear significant to the performance of manufacturing and distribution organizations. Again, practitioners can operationalize these results by supporting an environment that sets clear goals and deadlines and communicates them to the point of action. Also, the future goals and directions of the company should be clearly understood at the department level in order to maximize STS characteristics in the department.

6.3 Summary

Recent publications support the examination of traditional STS theory and encourage the discovery of new ways to operationalize and implement STS principles in today's less traditional non-linear organizations (Baba & Mejabi, 1997). This study examined a non-traditional approach to STS theory by extending the design principle of joint optimization into the organizations daily operations. Less traditional approaches to the must be adapted to apply STS theory to current organizational design. Baba and Mejabi suggest viewing and assessing the subsystems as mutually causal and not separately assessing each of their characteristics as one of the fundamental changes to STS design theory. The use of their concept of STS design should be combined with further research on managerial time allotment.

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Appendix A
Data Collection Instruments

Protocol for IRB Request

Justification of Project

The purpose of this research is to learn about the amount time managers spend on the social and technical subsystems in their department. Through this research, we will use survey instrument to examine how managers spend their time to meet the requirements of both the technical and social subsystems to improve department performance. The findings of the research will contribute to the body of knowledge in sociotechnical systems theory. From an industrial engineering perspective, these findings will provide more information about the balance in managerial time allocation. This information may have further implications to management systems design.

This study is a logical progression for Management Systems Engineering. Today's management of change literature suggests managers must spend more time on performance improvement. As corporations attempt to run leaner operations, reducing the levels of management has become a common component of the organizational change process. This trend in organizational design will continue on through this decade. Furthermore, as organizations move to a flatter structure, we see many of the responsibilities belonging to middle management being integrated into upper management responsibilities or delegated to subordinates. The redistribution of work due to organizational change makes the study of performance improvement activities all the more important. We need to learn more about Who focuses on these activities in the future? and How does the organization ensure these activities are performed and completed in the future?

The body of industrial and organizational design literature identifies the social and technical subsystems as key components to the study of organizational design. This research approaches the question of how organizations will manage performance improvement activities in flatter organizational structures by studying the current distribution of work between the organization's social and technical subsystems. Further, as industrial engineers, we are interested in the study of organizations from a macroergonomic perspective. This perspective endorses the need to design organizations so that interdependent subsystems, such as the social and technical subsystems, work together to improve the organization's overall performance.

By studying how managers allocate their time between two important interdependent subsystems to improve departmental performance, industrial engineers can use these findings to further improve and understand management systems design.

Procedures

The subject pool will contain approximately two hundred manufacturing managers will be asked about the amount of time they spend on specific tasks during their normal work activity. These managers include plant managers and first-level managers (i.e. team leaders, supervisors, foremen, etc.) from the manufacturing industry. Subjects will be recruited in the following three ways (1) manufacturing organizations who are part of the Canadian Association of Logistics Management (CALM) or Luton Associates membership/client lists (2) manufacturing organizations who are the American counterparts of the earlier membership lists, and (3) local manufacturing organizations in the New River Valley region will be asked to participate in the study. Two hundred managers are required for this study.

Once the organization agrees to participate the selection criteria for first level managers is as follows: first level managers must belong to one of each of the following departments or functional units to complete the cross-sectional survey. (1) Upstream Managers - Purchasing, Raw Materials, Supply Inventory; (2) Transformation Managers: Production Line, Process, Maintenance, Safety; or (3) Downstream Managers: Finished Goods Inventory, Distribution, Customer Service. All plant managers from participating organizations will also be selected for the study.

As part of this study's procedures, first-level managers will be required to complete a cross-sectional survey. This survey includes questions about the social and technical subsystems as well as time spent on components of the social and technical subsystems. Several instruments will be used to gather this data (1) STS Benchmark Instrument, (2) Schriber and Gutek time dimension scales, and (3) Time allocation instrument developed for this study.

Plant manager will be required to complete a cross-sectional survey on preferred management style. Each plant manager will also be asked to rank the performance of departments participating in the study. Plant managers will complete the (1) Leader Effectiveness & Adaptability Description Profile and (2) a department and manager ranking instrument developed for this study.

Post hoc interviews will be conducted with managers in local manufacturing industries. These will be unstructured interviews where these managers will be asked to identify whether how they perceived they spent their time matched how they planned their time.

Confidentiality/Anonymity
Each subject will be asked to provide the following information. None of this information will be disclosed without their consent

Biographical Sketch
Delia Grenville is a third semester Masters Student in the ISE department enrolled in the Management Systems option. She will administer this survey to participating department and plant managers as part of her thesis research. Her research also involves an ad hoc interview with a small sample of managers who participated in her study. Delia has had

five years working experience in industry and is familiar with both interviewing techniques and collecting data. Her education includes B.S in Mechanical Engineering received in 1989.

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Participants of Investigative Projects

Title of the Project:	A Sociotechnical Approach to Examining Managerial Time Allotment and Department Performance.
Investigators:	Delia Grenville, Dr. Brian Kleiner

I. The Purpose of this Research

You are invited to participate in a study about the amount of time managers spend on the social and technical subsystems in their department. Managers participating in this study will also be asked to provide information about their department's performance.

II. Procedures

Participants in this research will be asked to complete a series of survey instruments.

Supervisor Survey Questionnaires

These instruments will focus on department performance, task and time allocation, and the cultural value of time in each participating organizations. There is no fixed time limit for completion of any survey instruments, however, the anticipated time to complete all instruments is approximately 50 minutes.

Plant /Warehouse Manager Questionnaires

These instruments will focus on department performance of each of the participating supervisors. These questionnaires should take no more than 5 minutes each to complete.

III. Benefits of this Research

Each manager who participates in the study will be provided summary information about social and technical characteristics of their department as well as information about how their time was divided between the social and technical areas in their department. The assessment of social and technical characteristics of the manager's department are provided by Promethian STS Benchmark Survey. The information about time distribution between the social and technical areas will be summarized from this study. If you would like a copy of these reports, please check the box below.

IV. Extent of Anonymity and Confidentiality

The results of this research will be kept strictly confidential. Only the investigator will have access to the individual survey responses and audio tapes of interviews. The research results will be grouped and summarized by manager type. You will be identified by a subject number only during analysis. The interview tapes will be reviewed and transcribed by the researcher and destroyed after six months time.

V. Compensation

All participants names will be entered in a draw for several Virginia Tech T-shirts

VI. Approval of Research.

This research project has been approved, as required, by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University, by the Department of Industrial Engineering

VII. Participant's Responsibilities

I ____________________________ (print name) voluntarily agree to be a participant in this study. I have the responsibility to complete the questionnaire packet to the best of my ability. If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of the project.

______________________ ______________________ ☐ copy of results requested

Signature Date

Keep this sheet for your reference

VIII. Participant's Permission

I have read and understood the informed consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project.

If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of this project.

Should I have any questions about this research or its conduct, I will contact:

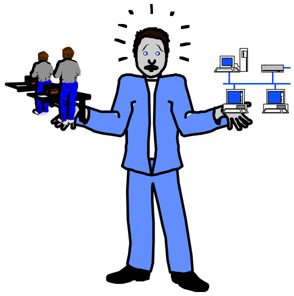
Delia Grenville (540) 552-1704, e-mail:degrenvi@vt.edu
Research Investigator

Dr. Brian Kleiner (540) 231-4926, e-mail:bkleiner@vt.edu
Faculty Advisor

Tom Hurd (540) 231-5281
Office of Sponsored Programs

Keep this sheet for your reference

Balance of Time Study



Research Purpose

First-line supervisors make important decisions every day on how to balance their time to meet the needs of people and technology in their department. This study will help to better understand how the amount of time spent on people versus technology affects how each department performs.

How to Participate

Supervisors who participate in this study can work in any part of the organization. You can select at least three first-line supervisors from each area listed above. There is no maximum number of supervisors who can participate in this study.

- inventory supply and/or raw materials
- production/operations and/or maintenance
- finished goods and/or logistics

Supervisors at your facility

- complete a self-administered survey questionnaire
- approximately 50 minutes

Plant/Distribution manager at your facility

- complete a questionnaire on department performance for each participating department
- approximately 2 minutes each

Questionnaire Package

Should your organization agree to participate, each supervisor participating in the study will receive

- survey instructions
- questionnaire
- informed consent form

Benefits

- Supervisors receive feedback on how they balance the needs of people and technology in their department.
- All participants are entered in a draw for several Virginia Tech T-shirts.
- Confidentiality is guaranteed for all participants.

*Each organization's feedback from this study is representative of the number of first-line supervisors who participate. You can improve the quality of the information you receive by allowing all first-line supervisors (team leaders, etc.) in the facility to participate. *

Contact for More Info

Delia Grenville
Telephone: 540 231-7322
Email: degrenvi@vt.edu

Department of Industrial and Systems Engineering
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061-0118

Sample Questions

SECTION A

Please respond to all the statements by writing 1, 2, 3, 4, or 5 on the line next to each statement. Sometimes the "1" means "Never", but sometimes"1" may mean "Strongly Agree"

1 = Almost never
2 = Sometimes
3 = About half the time
4 = Often
5 = Almost always

1. People in my department do the same few tasks every day.
2. My department can change its ways of doing things when we want to.

....

124. Our pay and other rewards are based on how well our whole team or departments performs.
125. The steps people in this department follow to do their work could be clearly written down.

SECTION B

Please respond to the following statements about what you believe is the proper usage of time in your department using the scale the below.

1 = Strongly Agree
2 = Agree
3 = Neither Agree or Disagree
4 = Disagree
5 = Strongly Disagree

1. Staying on schedule is important here.
2. No one gets upset when we miss a deadline.

....

27. It is important to meet our deadlines
28. People do things when they are ready, not on a schedule.

SECTION C

Before answering the following questions, please consider the amount of time you have spent in the LAST 3 MONTHS on the activities described in the questions below. Your time may have been spent on the phone, sending e-mail, writing memos/reports, in meetings, or in informal face-to-face communication. Please use the following scale when answering the questions below.

1 = almost none
2 = some
3 = about half
4 = much
5 = almost all

On average each week,

1. I spend _____ of my time making sure employees in my department are compensated fairly for their work.
2. I spend _____ of my time arranging for adequate equipment or coordinating its repair in my department.

.....

17. I spend _____ of my time giving people in my department feedback about the work they have done.
18. I spend _____ of my time planning and developing the processes and technical activities needed to run my department.

SECTION D

Please respond to the following statements regarding your department's performance. Compared to how you think your department should be performing, how well is your department performing in the following areas.

1 = very poorly
2 = poorly
3 = average
4 = well
5 = very well

1. Increasing profit margin of department operations.
2. Maintaining budgeted total costs of department operations.

....

17. Establishing feelings of empowerment in employees
18. Encouraging employees to follow through on new ideas and innovations.

Participants Cover Letter

<<DATE>>

First-line Supervisors at Bayer,

Managing your time at work can be a balancing act. From my own experience working with manufacturing and distribution organizations, I've seen first hand the important decisions first-line supervisors make on a daily basis to meet the needs of both people and technology. How you manage your time between the demands of technology and the needs of co-workers can affect the performance of your department. However, no one really knows how much time supervisors should spend on the people side versus the technical side of their jobs.

Supervisors at Bayer are among a small number of people who are being asked to provide information on how they spend their time on people versus technology. In order that the results will reflect the needs of all manufacturing/distribution organizations, it is important that all questionnaires are completed and returned. It is also important that an equal cross-section of manufacturing/distribution supervisors respond to the questionnaire.

The purpose of the informed consent is to ensure that your rights as a participant are protected. Your responses to this survey will be kept strictly confidential. Your name is used only so that I may check it off the mailing list once your completed survey is returned and so that you will be entered in a draw for several Virginia Tech T-shirts open to all participants.

You may also receive a summary of results of this research by selecting "copy of results requested" on the informed consent form, and by printing your name and address on the back of your informed consent form Please do not put this information on the questionnaire itself.

I would be happy to answer any question you might have. Please call. The telephone number is (540) 231-7322.

Thank you, in advance, for your participation in this important study.

Sincerely,

Delia Grenville

Survey Instructions (First Level Manager)

If any part of these instructions are unclear or if you are missing anything from the package described below, please call Delia Grenville at Virginia Tech at (540) 231-7322.

As you complete the survey package, please keep in mind:
Your responses should be based on your experiences on your current position at <<Company Name>>.

- Please answer ALL the questions in both surveys.
- Your name is needed on your survey only to keep track of who returned their surveys. Your responses will be kept strictly confidential.
- Please do not discuss your responses with others until you have finished the questionnaire.
- If any item in the questionnaire is unclear to you please call Delia Grenville for clarification.
- The word department refers to only you and your direct reports, even if another word is used in your company.
- The word supervisor refers to all first-line management above operators even if another word is used in your company such as team leader, cell leader, foreman, department manager, etc.

Step 1
Read and sign the Informed Consent Form. Return the first page with your completed questionnaire and keep the second page for your reference in case you have questions or concerns.

Step 2
Open the Balance of Time Survey. Complete the survey in either pen or pencil.

Step 3
Once you have finished, please put the survey and your signed Informed Consent Form in the return envelope provided. Please return your envelope to me by <<DATE>>.

Once I receive your surveys:
- I will remove the informed consent envelope and put it in a separate file.
- I will record the information from your surveys for analysis at Virginia Tech.
- You will receive summary report on your responses which will provide feedback on how you balance your time between the needs of people and technology in your department.

Survey Instructions (Plant or Warehouse Manager)

If any part of these instructions are unclear or if you are missing anything from the package described below, please call Delia Grenville at Virginia Tech at (540) 231-7322.

As you complete the survey package, please keep in mind:
Your responses should be based on your experiences on your current position at <<Company Name>>.

- Please answer ALL the questions in both surveys.
- Your name is needed on your survey only to keep track of who returned their surveys. Your responses will be kept strictly confidential.
- Please do not discuss your responses with others until you have finished the questionnaire.
- If any item in the questionnaire is unclear to you please call Delia Grenville for clarification.
- The word department refers to each supervisor's direct reports only, even if another word is used in your company.
- The word supervisor refers to all first-line management above operators even if another word is used in your company such as team leader, cell leader, foreman, department manager, etc.

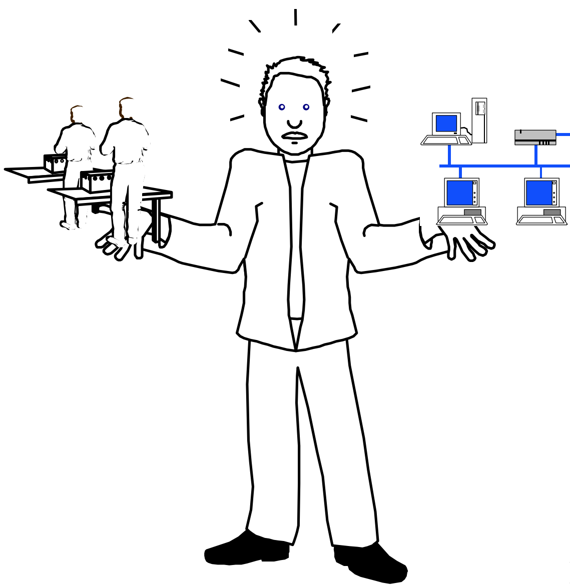
Step 1
Read and sign the Informed Consent Form. Return the first page with your completed questionnaire and keep the second page for your reference in case you have questions or concerns.

Step 2
Open the Department Performance Assessment and note the correct supervisor number on each assessment page. Complete the survey in either pen or pencil.

Step 3
Once you have finished, please put the survey and your signed Informed Consent Form in the return envelope provided. Please return your envelope to me by <<DATE>>.

Once I receive your surveys:
- I will remove the informed consent envelope and put it in a separate file.
- I will record the information from your surveys for analysis at Virginia Tech.
- You will receive summary report on your responses which will provide feedback on how you balance your time between the needs of people and technology in your department.

Balance of Time Survey



First-line supervisors make important decisions every day on how to balance their time to meet the needs of people and technology in their department. This survey will help to better understand how the amount of time spent on people versus technology affects how your department performs. Please answer all of the questions. If you wish to comment on any questions or add additional information to your answers, please feel free to use the margins. Your comments will be read and taken into account.

Thank you for your help.

Department of Industrial and Systems Engineering
Virginia Polytechnic Institute and State University
Blacksburg, VA 24060

Please answer the following questions first: (Do not write your name)

1. What is your formal job title in this organization? ________________
2. What do you consider to be your usual occupation (what kind of work do you do)? ________________
3. In what department, section or unit of the organization do you work? 1 = inventory supply, 2 = raw materials, 3 = purchasing, 4=production/operations, 5=maintenance, 6=finished goods inventory, 7=logistics/warehouse, 8=customer service, 9= other (please describe) ________________
4. How long have your worked for this organization? ________________
5. How long have you worked in the present department, section, or unit of this organization (years/months)? ________________
6. Do you work full-time or part-time (1 = full-time, 2= part-time)? ________________
7. How many people do you supervise personally - people report to you directly (if none , answer 0)? ________________
8. How far did you go in school (1= less than 12 years, 2= high school grad, 3 = some college, 4 = college grad, 5= some graduate school, 6 = graduate degree)? ________________
9. What is your age in years? ________________
10. What is your sex (1 = male, 2 = female)? ________________

Important Reminder: Each of the statements in this survey describes some characteristics of your job, department, or organization. Please answer these questions from your experiences in your current department with <u>your direct reports</u>

Keep in mind that throughout this questionnaire the word department refers only to you and your direct reports, even if another word is used in your company.

Please answer all the questions above before going to the next page......

A

Please respond to all the statements by writing 1, 2, 3, 4, or 5 on the line next to each statement. Sometimes the "1" means "Never", but sometimes "1" may mean "Strongly Agree"

1 = Almost never
2 = Sometimes
3 = About half the time
4 = Often
5 = Almost always

1. People in my department do the same few tasks every day.
2. My department can change its ways of doing things when we want to.
3. People in my department can decide for themselves when to take a short break.
4. People in my department keep up with new technological developments that might affect their work.
5. People in my department meet with others from several levels of the organization.
6. People in my department have seen good ideas put into practice.
7. I regularly let people in my department know how well they are doing.
8. People here look out for the well being of others.
9. The people I work closely with have values and ideas different from mine.
10. People in my department have a hand in picking their new supervisors.
11. If a customer is not satisfied with some of the work we have done, my direct reports hear about it.
12. When people in my department do a good job, they hear about it.
13. In my department, our opinion of ourselves goes up when we do our job well.
14. We care more about the success of the whole operation than about our individual success.
15. We do all the basic quality control tests necessary to check our own work.
16. In my department, we have complete control over the machines and equipment we use to do our jobs.
17. My department can easily switch to making a different product or offering a new service to customers or other departments.
18. Anyone in our department members can represent us at meetings with other departments.
19. We are encouraged to try new ways of doing things, even if they might not work out.
20. I have excellent skills in dealing with people in my department.
21. People in my department go beyond their normal duties to help others.
22. People I work closely with have had life experiences I haven't had.
23. Time-off policies are flexible enough to let people here take care of their personal and family needs.
24. People in my department have a hand in evaluating me.
25. We talk directly to our customers to find out how to serve them better.
26. People in my department perform routine maintenance on the equipment they work with.

Please answer all the questions above before going to the next page......

Please respond to the statements below by writing a 1, 2, 3, 4 or 5 on the line.

1 = Almost never
2 = Sometimes
3 = About half the time
4 = Often
5 = Almost always

27. When we do a bad job, people in my department hear about it.
28. People in my department feel personally responsible for how well this organization does.
29. Statistical methods are used to judge the quality of our work.
30. Jobs in this department require a great deal of thought.
31. The outcome of our work affects other people in important ways.
32. People in my department are allowed to work to their full potential.
33. Information about the financial side of the organization is shared with us.
34. When we try new ways of doing things and fail we are encouraged to try again.
35. I explain clearly what needs to be done.
36. We go beyond our normal duties to help each other.
37. The people I work closely with have a social background different from mine.
38. I listen when people in my department volunteer their opinion on important matters.
39. People outside my department tell me how the quality of our work affects them.
40. Nobody here thinks about quitting his/her job.
41. We do more than our share to help the organization succeed.
42. We are rewarded for doing high quality work.
43. Jobs in this department are simple and repetitive.
44. Jobs here require us to repeat the same physical movements over and over.
45. People in my department have some place here at work where they can go when they need a few minutes of private time to themselves.
46. This organization makes it easy for me to get the skills people in my department need to get ahead.
47. Information about the organization's long range plan is shared with me and my department
48. When people in my department come up with new ideas I reward them in a meaningful way.
49. I let people in my department figure out the best way to do their job.
50. I openly share my knowledge with others.
51. The people I work closely with are men.
52. I ask advice from people in my department on important matters.
53. We treat the people who complete the work we begin in my department as if they are our customers.

Please answer all the questions above before going to the next page......

Please respond to the statements below by writing a 1, 2, 3, 4 or 5 on the line.

1 = Almost never
2 = Sometimes
3 = About half the time
4 = Often
5 = Almost always

---

54. We can keep whatever machines and equipment we use working well without help.
55. People in my department tell me how the quality of work affects them.
56. We feel bad and unhappy when we discover that we have performed poorly on our jobs.
57. People in my department work hard when I am not around.
58. The machines and equipment we use make it easy for me to work with others as part of a team.
59. People in my department are qualified to do jobs other than their own in other departments.
60. Jobs here are monotonous and boring.
61. Work stations in our department are uncomfortable.
62. People in my department can make a phone call in privacy when they feel they need to.
63. When people learn new skills on their job this organization rewards them in some way.
64. People in my department know what information management uses to make decisions.
65. I see my role as encouraging new ways of doing things.
66. I give guidance and help rather than orders.
67. I openly share information with my people in my department.
68. People in my department are consulted when I/others want to change the way they do their job.
69. Time is set aside for us to learn more about what goes on in other parts of the organization.
70. I tell people in my department how the quality of their work affects me.
71. People here are satisfied with the kind of work they do in this job.
72. People in my department are proud of the products and services this organization provides.
73. Dealing with people is an essential part of my job.
74. There are fumes, chemicals, dust or smoke in the air where we work.
75. How fast people in my department work is determined by a machine.
76. Time is set aside for people in my department to learn more about their jobs.
77. Management treats my department like a partner in the business.
78. Technical experts share information openly with my people in my department.
79. There is a clear set of steps people in my department follow in carrying out their work.
80. I encourage people in my department to talk to higher management.
81. People in my department know what our competitors are up to.
82. The tools, equipment or machines we work with are "user-friendly".

Please answer all the questions above before going to the next page......

Please respond to the statements below by writing a 1, 2, 3, 4 or 5 on the line.

1 = Almost never
2 = Sometimes
3 = About half the time
4 = Often
5 = Almost always

---

83. We tell people in other departments how the quality of their work affects us.
84. People in my department enjoy coming to work here.
85. People in my department are proud to tell their friends what organization they work for.
86. Jobs in this department require people to operate mechanical equipment or use hand tools.
87. Safety problems at a work station in this department are taken care of right away.
88. I check to see how fast people in my department are working.
89. The people I work closely with are of different races.
90. We have a chance to share in the profits of the organization.
91. People in my department have no control over the quality of the supplies, parts, or materials we use; we have to use what they give us.
92. Jobs here require us to work at a personal computer or computer terminal.
93. The noise at work stations in this department is so loud people here can't think clearly.
94. The workload in this department is overwhelming.
95. People in my department share a set of common values that we use in making decisions about work.
96. I have influence over the people in my department's pay and other rewards.
97. Jobs in this department consists largely in doing paper work.
98. People in my department have to look busy at their jobs even when they have nothing to do.
99. People in this department need to have many skills to do their job well.
100. Jobs in this department are worthy of a great deal of respect.
101. People in my department could be physically injured doing their job.
102. Machines and equipment are considered to be more important than people in my department.
103. Things about the jobs in this department make people here angry.
104. There is a clear, well-known way to do the type of work we do.
105. I have a chance to learn new skills here.
106. Pay and other rewards are based on the quality of our work, not the quantity.
107. The layout of the building and equipment allows a smooth flow of work through my department.
108. People in this department can do their work by following well-established procedures and practices.

Please answer all the questions above before going to the next page......

Please respond to the statements below by writing a 1, 2, 3, 4 or 5 on the line.

1 = I strongly agree
2 = I agree
3 = neutral
4 = I disagree
5 = I strongly disagree

109. In this department, the fringe benefits we get are just what we need.
110. Jobs in this department take a long time to learn.
111. Jobs in this department are very important in the broader scheme of things.
112. Generally speaking, people here are satisfied with their jobs.
113. The machines and equipment used most are what we need to produce high quality work.
114. The machines and equipment we use can be used to produce many different kinds of things.
115. Our long-term health is in danger because of our working conditions.
116. I think people in my department are fairly paid compared to others in this organization.
117. People in my department know the standards customers use to judge what they buy from us.
118. In this department, we know how to spot and correct problems before they are passed along to others.
119. The machines and equipment we use are exactly what we need to turn out work as fast as possible.
120. People in my department are qualified to do jobs other than their own in this department.
121. Compared to our co-workers, people in my department are paid fairly for the work they do.
122. Within the past three months some of the ways we do our work has been changed, specifically to improve quality. (1 = True, 5 = False)
123. Top management talks a lot about improving quality, but it is really just another fad.
124. Our pay and other rewards are based on how well our whole team or departments performs.
125. The steps people in this department follow to do their work could be clearly written down.

Please answer all the questions above before going to the next page......

B

Please respond to the following statements about what you believe is the proper usage of time in your department using the scale the below.

1 = Strongly Agree
2 = Agree
3 = Neither Agree or Disagree
4 = Disagree
5 = Strongly Disagree

1. Staying on schedule is important here.	1	2	3	4	5
2. No one gets upset when we miss a deadline.	1	2	3	4	5
3. We never seem to have enough time to get everything done.	1	2	3	4	5
4. This organization invests in the future.	1	2	3	4	5
5. People here worry about using their time well.	1	2	3	4	5
6. It is very important to be "on time" for everything.	1	2	3	4	5
7. Most people here cannot set their own work schedules.	1	2	3	4	5
8. Doing things right is better than fast.	1	2	3	4	5
9. People here feel that deadlines don't really matter.	1	2	3	4	5
10. People just expect to "kill time" on the job.	1	2	3	4	5
11. People have to work together to get the job done.	1	2	3	4	5
12. People expect you to know how long it will take you to do something.	1	2	3	4	5
13. It is better to make a bad decision quickly, than a good decision slowly.	1	2	3	4	5
14. People here do not have the freedom to use their time the way they choose.	1	2	3	4	5
15. Tasks usually take longer than planned.	1	2	3	4	5
16. People expect their work to be routine.	1	2	3	4	5
17. We don't pay much attention to schedules.	1	2	3	4	5
18. People do most of their work under deadlines.	1	2	3	4	5
19. Most people don't think about how they use their time.	1	2	3	4	5
20. Schedules usually seem too tight for most big jobs/projects.	1	2	3	4	5
21. To get the job done, it is important for each person to coordinate his/her work with others.	1	2	3	4	5
22. All of our work is lightly scheduled.	1	2	3	4	5
23. Planning for the future is important here.	1	2	3	4	5
24. Around here, people like to talk about the "good old days".	1	2	3	4	5
25. Teamwork is not very important here.	1	2	3	4	5
26. People here plan their time carefully.	1	2	3	4	5
27. It is important to meet our deadlines.	1	2	3	4	5
28. People do things when they are ready, not on a schedule.	1	2	3	4	5

Please answer all the questions above before going to the next page......

C

Before answering the following questions, please consider the amount of time you have spent in the LAST 3 MONTHS on the activities described in the questions below. These activities may have been accomplished by spending time on the phone, sending e-mail, writing memos/reports, in meetings, or in informal face-to-face communication.

Please use the following scale when answering the questions below.

1 = almost none
2 = little
3 = some
4 = much
5 = almost all

On average each week,

1. I spend _____ of my time ensuring that the rewards and compensation for employees in my department match the skill level required to do the job	1	2	3	4	5
2. I spend _____ of my time arranging for adequate equipment or coordinating its repair in my department.	1	2	3	4	5
3. I spend _____ of my time ensuring training and skill development is provided employees in my department.	1	2	3	4	5
4. I spend _____ of my time ensuring flexibility in our processes to meet customers needs.	1	2	3	4	5
5. I spend _____ of my time communicating with our customers about needed changes in our technology.	1	2	3	4	5
6. I spend _____ of my time staying on top of customer needs and wants.	1	2	3	4	5
7. I spend _____ of my time sharing information and explaining goals with employees in my department.	1	2	3	4	5
8. I spend _____ of my time responding to the safety and physical comfort needs of employees in my department.	1	2	3	4	5
9. I spend _____ of my time making people in our department feel comfortable about contributing ideas.	1	2	3	4	5
10. I spend _____ of my time helping others in my department complete their tasks (through instruction, training, working with them side by side).	1	2	3	4	5
11. I spend _____ of my time managing the quality of the work and/or product leaving my department	1	2	3	4	5
12. I spend _____ of my time helping others in my department understand why their job is important to the overall process.	1	2	3	4	5
13. I spend _____ of my time ensuring that employees know how to do (i.e. understand work procedures, technology, and purpose of) more than one job in our department.	1	2	3	4	5
14. I spend _____ of my time communicating the importance of cross-training and flexibility in my department to meet customer needs.	1	2	3	4	5
15. I spend _____ of my time encouraging participation and sharing information with others outside our department.	1	2	3	4	5
16. I spend _____ of my time telling people in my department what needs to be done and why it should be done.	1	2	3	4	5
17. I spend _____ of my time giving people in my department feedback about the work they have done.	1	2	3	4	5
18. I spend _____ of my time planning and developing the processes and technical activities needed to run my department.	1	2	3	4	5

Please answer all the questions above before going to the next page......

19. Has your department started any special projects in the last three months? Yes ☐ No ☐

If yes, what type of projects were these?

- ☐ department restructuring
- ☐ staff retraining
- ☐ production advancement
- ☐ information technology or improvement
- ☐ Other, please describe

    ____

20. Before answering the following questions, please consider the amount of time you have spent in the LAST 3 MONTHS on the activities described in the questions below. These activities may have been accomplished by spending time on the phone, sending e-mail, writing memos/reports, in meetings, or in informal face-to-face communication.

In the last three months, what percentage of your time was spent on the following type of activities. Note percentages must total to 100%.

- getting people in your department to cooperate
- helping people feel involved
- providing feedback for your direct reports
- encouraging cooperation of employees in your department
- encouraging people to do and learn new processes/methods in your department
- helping people follow through on new ideas and bring them to completion
- communicating with your departments customers and suppliers

    ______%

- achieving, inputting, and implementing quality and/or technology into the process
- sharing knowledge of the systems and tools required to run the department
- minimizing the complexity of tasks and work design in your department
- explaining how and why different parts of the work processes are connected
- helping everyone understand the purpose of their work
- providing technical training for machinery, tools, or equipment in your department ______%

What total percentage of your time, if any, was spent on other activities

Please list these activities and each percentage breakdown

____ ______%

____ ______%

____ ______%

____ ______%

100%

Please answer all the questions above before going to the next page......

D

Please respond to the following statements regarding your department's performance. Compared to how you think your department (you and your direct reports) should be performing, how well is your department performing in the following areas.

1 = Very Poorly
2 = Poorly
3 = Average
4 = Well
5 = Very Well

1.	Increasing profit margin of department operations.	1	2	3	4	5
2.	Maintaining budgeted total costs of department operations	1	2	3	4	5
3.	Achieving goals set out for your department	1	2	3	4	5
4.	Getting work done efficiently in your department	1	2	3	4	5
5.	Keeping up the technical advances needed in your department	1	2	3	4	5
6.	Making sure things are running smoothly	1	2	3	4	5
7.	Coping with unexpected problems	1	2	3	4	5
8.	Maximizing labor productivity	1	2	3	4	5
9.	Maintaining reasonable labor costs	1	2	3	4	5
10.	Reducing the number of filed grievances.	1	2	3	4	5
11.	Reducing the level of absenteeism	1	2	3	4	5
12.	Reducing employee tardiness	1	2	3	4	5
13.	Reducing the amount of turnover	1	2	3	4	5
14.	Establishing a good rapport with suppliers and customers of your department	1	2	3	4	5
15.	Establishing effective interdepartmental working relationships	1	2	3	4	5
16.	Working efficiently and "getting things done"	1	2	3	4	5
17.	Establishing feelings of empowerment in employees	1	2	3	4	5
18.	Encouraging employees to follow through on new ideas and innovations.	1	2	3	4	5

Please answer all the questions above before going to the next page......

Please feel free to use this space for any additional comments.

____

____

____

____

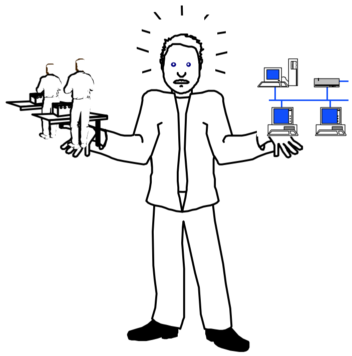
____

Please Return Questionnaire To:

Delia Grenville
Industrial and Systems Engineering Department
Virginia Polytechnic Institute and State University
Whittemore Hall 0118
Blacksburg, Virginia 24060

THANK YOU FOR YOUR PARTICIPATION

HOW LONG DID IT TAKE YOU TO COMPLETE THIS SURVEY? ______ MINUTES



Department Performance Assessment

First-line supervisors make important decisions every day on how to balance their time to meet the needs of people and technology in their department. This survey will help to better understand how the amount of time spent on people versus technology affects department performance. Please answer all of the questions. If you wish to comment on any questions or add additional information to your answers, please feel free to use the margins. Your comments will be read and taken into account.

Plant/Warehouse Managers, please respond to the questionnaire regarding department performance of each first-line supervisor participating in this study.

Thank you for your help.

Department of Industrial and Systems Engineering
Virginia Polytechnic Institute and State University
Blacksburg, VA 24060

Please answer following the questions.

1. How many people work at your facility? ________________

2. How many people work on the manufacturing/warehouse floor? ________________

3. How many first-line supervisors work at your facility? ________________

4. Briefly describe the type of product made at your facility.
____
____
____

5. Briefly describe the type of manufacturing systems or warehouse technology used in your organization (i.e. stand alone, cells, linked islands, full integration , warehouse management system, automating picking/shipping, etc.).
____
____
____
____
____
____

****IMPORTANT INSTRUCTIONS FOR <<PLANT/WHSE MANAGER>> ****

Before distributing these surveys to first-line supervisors at <Company>, please follow these instructions.

- Note on the reference list below beside each survey number the name and/or department of the corresponding supervisor. This list is for your reference only and must not be returned to the researcher. The purpose of this list is so you can have a reference sheet to ensure that you are evaluating the performance of the department which corresponds with the correct supervisor response. This method ensures that the plant /warehouse manager's responses are matched with the correct department but will not allow the researcher to associate this evaluation with any participant by name. This method ensures confidentiality.
- Please keep this sheet for your reference to ensure there are no errors and to help in the distribution of results.

Thank You

List each supervisor and/or department participating in this study below. Only use number for identification on survey.

Survey #	Supervisor's Name and/or Department
196	
197	
198	
199	
200	
201	
202	
203	
204	

**This sheet should be completed by the appropriate Plant or Warehouse Manager*

Please respond to the following statements regarding supervisor __________ (enter survey number only) department's performance. Compared to how you think this department should be performing, how well isthe department performing in the following areas.

1 = very poorly
2 = poorly
3 = average
4 = well
5 = very well

1.	Increasing profit margin of department operations.	1	2	3	4	5
2.	Maintaining budgeted total costs of department operations	1	2	3	4	5
3.	Achieving goals set out forthis department	1	2	3	4	5
4.	Getting work done efficiently inthe department	1	2	3	4	5
5.	Keeping up the technical advances needed inthe department	1	2	3	4	5
6.	Making sure things are running smoothly	1	2	3	4	5
7.	Coping with unexpected problems	1	2	3	4	5
8.	Maximizing labor productivity	1	2	3	4	5
9.	Maintaining reasonable labor costs	1	2	3	4	5
10.	Reducing the number of filed grievances.	1	2	3	4	5
11.	Reducing the level of absenteeism	1	2	3	4	5
12.	Reducing employee tardiness	1	2	3	4	5
13.	Reducing the amount of turnover	1	2	3	4	5
14.	Establishing a good rapport with suppliers and customers of the department	1	2	3	4	5
15.	Establishing effective interdepartmental working relationships	1	2	3	4	5
16.	Working efficiently and "getting things done"	1	2	3	4	5
17.	Establishing feelings of empowerment in employees	1	2	3	4	5
18.	Encouraging employees to follow through on new ideas and innovations.	1	2	3	4	5

Appendix B
Summary Tables

Table B-1
List of Participants

Company	Product	Mfg	Dist	US	Cdn	# Sent	# Rec'd
Bayer Inc.	Chemicals, Pharmaceuticals, Imaging Technology		×		×	4	4
Bayer Rubber	Synthetic Rubber	×			×	70	43
Colgate Palmolive		×			×	3	1
Colgate Palmolive			×			4	3
Hostess		×		×		35	0
Kraft Pennsylvannia	Value added package convenience foods	×		×		13	12
Lever Industrial		×			×	6	0
Lipton Missouri	Liquid Salad Dressing & Marinades, Instant Tea Powder, Seasoned Salt & Spice Blends	×		×		2	2
Lipton Suffolk		×		×		6	0
Matrix Logistics Services			×		×	15	0
McCain Foods		×			×	3	2
Nabisco Brands Ltd.	Canned Vegetables, Canned Baking Powder	×			×	15	13
Philips Electronic			×		×	2	1
Pillsbury Canada	Dough products, frozen pizza, cookie dough	×			×	4	4
Pillsbury Company	Dry Mix Products for the food industry	×		×		6	5
Quaker Oats Company	Monitoring and packaging of foods i.e. snacks, mixes	×			×	3	1
Sunbeam Corporation	Small household appliances		×		×	4	4
Total		12	5	5	12	195	95

Table B - 2
Level Technology by Company

Company	Technology
Bayer Inc	Whs Management System,Paperless
Bayer Rubber	Continuous Chemical Processing utilizing Honeywell control systems
Colgate Palmolive	RF WMS
Colgate Palmolive	
Hostess	
Kraft Pennsylvania	integrated, co-mingled
Lever Industrial	
Lipton Missouri	Planning: MRP & SAP, QAD
Lipton Suffolk	
Matrix Logistics Services	
McCain Foods	
Nabisco Brands Ltd.	Stand Alone Systems, High Use of PLC's, some specialized Q.C. computer software used, not yet fully C.I.M. in plant, some data collection computer systems Inventory Systems - paperless, barcoded identity system using Radio Frequency transmitters and scanners QC systems - real time computerized data entry form shop floor and QC lab - linked to LAN with visibility at severaP.C.'s Process Control - product flow/production control linked at various points using PLC's and 486's unix FIX DMACS Intellution software to regulate/adjust flow /speeds/and product destination. Machine/Line Operations - stand alone using 64 1/0 PLC's to monitor/control specific Line functions - output to shop master 486 for process control functions
Philips Electronic	
Pillsbury Canada	mostly manual labor throughout the plan
Pillsbury Company	Mfg - Automated batching system, where the formulas are loaded into the system in the desired sequence & the product code displayed on an LED at each position indicates what minor ingredients need to be dumped or what packaging is to be used. Operator interface is acknowledgment of the actions performed. Warehouse - RF units installed on the fork trucks feed real time information into our MRP system for warehouse location and amount of product. Pick lists are pulled from the system when the fork driver is ready for his next order.
Quaker Oats Co	Manufacturing systems are partially maintained via PLC Warehousing system is hand picked at this facility. National warehouse is in phase 1 of implementing - Warehouse Management System.
Sunbeam Corporation	No allocation system, No Locator system, No WMS. We use very little technology as far as Tracking and shipping. Extremely paper driven

Table B-3
Comments by First-Level Managers

Subject	Comments
25	My job is performed by MBWA; managing by walking around. There are a lot of small "fires" that have to be dealt with every day. There are long hours with no overtime pay and the possibility of advancement depends on whether someone upstairs likes you; and I don't mean God!
36	Nothing was asked about how supervisors relieve stress, what they do when away from work. This would help to determine the people that are best suited to a front line environment.
45	Many of the questions were quite difficult as they pertained to the people in my department. This obviously rather general & in my department there are some extremely busy/challenging positions and some that are considered, boring and repetitive.
46	I generally feel that my department and I could do much more if proper facilities and equipment were available.
71	This is a union plant with many operating units spread over a large area. There is a little co-operation between maintenance and production which I feel leads to a large part of the inefficiencies I experience.
72	Our department has been re-organized and down-sized significantly over the past 5 years and they are now stretched to their maximum limits and contribution levels. Their work areas have increased and the service levels have dropped off due to a manpower shortage. Our group is amongst one of the hardest working groups in our company I feel, at the lowest end of the pay scale.
76	Morale is very low. People feel if they prolong each job, less new jobs they get. As a supervisor, everyone has to be pushed hard to get it done in a reasonable amount of time. No accountability required on the wage side. Being a supervisor is a stressful thankless job.
77	With increase in paperwork (JSA, audits, etc.) amount of time spent in the field is reduced. Lack of job scopes or customer direct[ion] causes problems in planning and scheduling.
82	Being in a union environment makes it difficult to answer your questions with clarity. We are restricted as you can imagine in the giving of rewards and the degree of personnel movement.
83	This survey focuses on my own department. The difficulties that are in our organization are more site wide and not in the individual work groups.

Table B-3 (CONT'D)
Comments by First-Level Managers

84	I worked as an inspector for the different units for over 10 years, when there was a cut back in the plant, it was time for a change. Maintenance supervision in the weld shop would have been a wiser decision for the company, but it was decided and I agreed to help I the units working as a maintenance supervisor. I enjoy it very much, the I supervise are good workers. But there is an attitude problem in the plant with contract people getting more work therefore the maintenance people get upset.
102	Due to union negotiated pay, we do not have a system to reward good performance, fringe benefits or rewards other than verbal thankyou's.
104	Lab tests are required to ensure quality conformance. Statistical methods on some variables they are calculated on a regular basis, but it is in an aggregate form and does not help to figure out who is in need of improvement and it is not well communicated to all. The biggest limitations to realizing their full potential are 1) their own union contract and 2) the lack of training and skills development provided by our organization for the hourly workers. There is very little, if any, way to reward our hourly employees with anything other than an expression of thanks for the work done. Almost all our department's product is used by internal customers on our site. The maintenance department looks after equipment reliability and repairs. The machines/equipment really have no impact on teamwork, positive or negative. The process is computer controlled. Pay is determined by union contract. There are a few routinized tasks, however, much of the worker is situation dependent and frequently changing. The opportunity is limited for the hourly workers, training is controlled outside our department.
108	A lot of this survey does not apply to my job. If the content was explained as to what was meant one on one the answers may have been different. Very vague on some meaning of "department". Did not receive survey unit Nov 1/996.
112	I feel overall the company is doing well and is improving to do much better for the future of the organization.
114	Part of this questionnaire doesn't really pertain to my function such as supervising employees
120	The question about employee rewards arose frequently. I feel Bayer Rubber corp. pays their employees handsomely enough and has a great many benefits available to their employees. Verbal recognition of a job well done in my opinion is sufficient.

Table B-3 (CONT'D)
Comments by First-Level Managers

124	Many aspects of my job are controlled or limited in regards to cross training my reports. They are governed by strict rules imposed by their labor union. This same union demands a "hands off" role for supervision. The union members are offered advancement based, first on their seniority not on their ability. There is little or no means of rewarding or advancing conscientious employees.
126	Had some difficulty because as well as my 5 direct reports I also give work direction to 25 other employees with respect to only some of their job activities (approx. 20%) & their supervisor (6). My responses here related only to my direct reports who get approximately 10% of my time.
127	Group being supervised is located at 5 different building, 24 hours per day.
130	As a supervisor much of what I control is controlled by a negotiated contract to which I'm compelled to adhere to. However, people in management levels above me insist or allow deviations from the contract without the input of people at my level causing much inconsistency and inefficiency. Also as upper management changes so do our departments operating philosophies.
199	I supervise two departments one is doing very good (Employees are empowered to do the job required). #2 Dept. is beginning to form teams and I could see an improvement.
201	As in most companies, we suffer from "corporate inertia". Supervisors are overwhelmed with responsibilities and details as more individuals are removed from service departments. This does not allow us to stay focused on our specific employee needs or the time to evaluate our processes to make improvements.

Table B-4
Time Allotment Survey
Factor Analysis with Item Description

Item	Subsystem 1= Technical 2= Social
1 = Participation and information sharing	
I spend _____ of my time making people in our department feel comfortable about contributing ideas.(9)	2
I spend _____ of my time encouraging participation and sharing information with others outside our department.(15)	2
I spend _____ of my time helping others in my department complete their tasks (through instruction, training, working with them side by side)(10)	2
I spend _____of my time helping others in my department understand why their job is important to the overall process. (12)	2
2 = Customer Needs and Strategic Planning	
I spend _____ of my time communicating with our customers about needed changes in our technology.(5)	1
I spend _____ of my time staying on top of customer needs and wants(6)	2
I spend _____ of my time ensuring flexibility in our processes to meet customers needs. (4)	1
I spend _____ of my time planning and developing the processes and technical activities needed to run my department.(18)	1
3 = Skill Development and Skill Compensation	
I spend _____of my time ensuring training and skill development is provided employees in my department.(3)	1
I spend _____ of my time ensuring that the rewards and compensation for employees in my department match the skill level required to do the job.(1)	1
I spend _____ of my time ensuring that employees know how to do (i.e. understand work procedures, technology, and purpose of) more than one job in our department. (13)	1
I spend _____ of my time communicating the importance of cross-training and flexibility in my department to meet customer needs(14)	2
4 = Quality	
I spend _____ of my time managing the quality of the work and/or product leaving my department. (11)	1
5 = Operational Department Needs	
I spend _____of my time arranging for adequate equipment or coordinating its repair in my department.(2)	1
I spend _____ of my time telling people in my department what needs to be done and why it should be done.(16)	2
I spend _____ of my time responding to the safety and physical comfort needs of employees in my department(8)	1
I spend _____ of my time sharing information and explaining goals with employees in my department. (7)	2
I spend _____ of my time giving people in my department feedback about the work they have done.(17)	2

Appendix C
Scale Reliability, Frequency Plots, and Histograms

Technical STS Scores

N of Cases = 93.0

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	3.1098	1.4731	4.3978	2.9247	2.9854	.5620

Reliability Coefficients 38 items

Alpha = .7497 Standardized item alpha = .7631

Social STS Scores

N of Cases = 94.0

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	3.3358	1.1277	4.6064	3.4787	4.0849	.5188

Reliability Coefficients 41 items

Alpha = .8637 Standardized item alpha = .8676

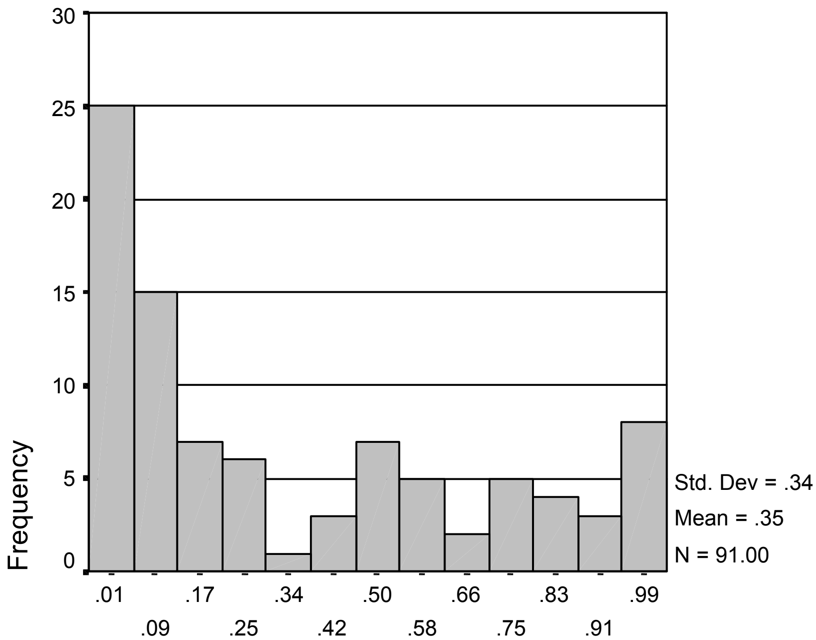
Environmental STS Scores

N of Cases = 94.0

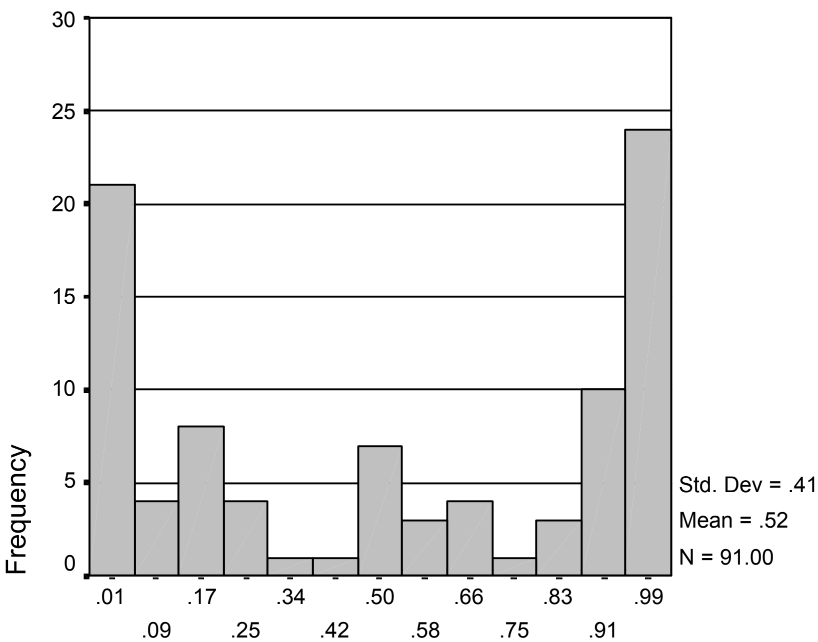
Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	3.0664	2.0106	4.4149	2.4043	2.1958	.4674

Reliability Coefficients 21 items

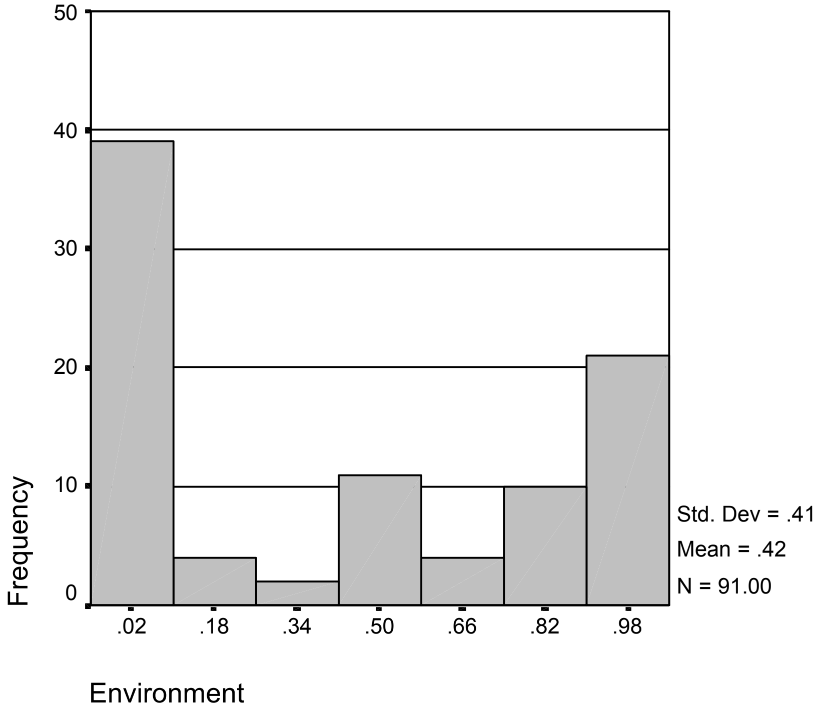
Alpha = .7381 Standardized item alpha = .7354

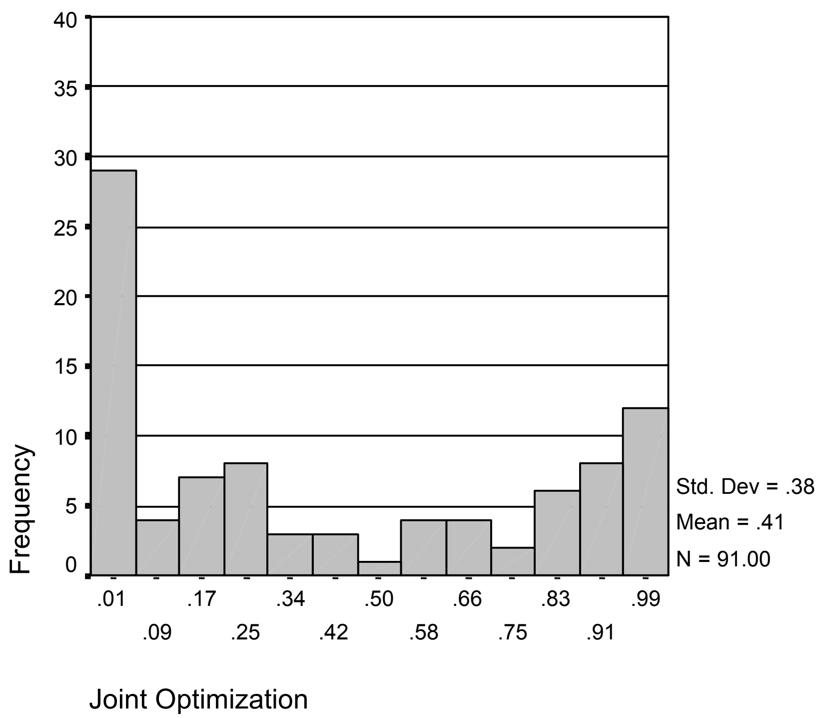


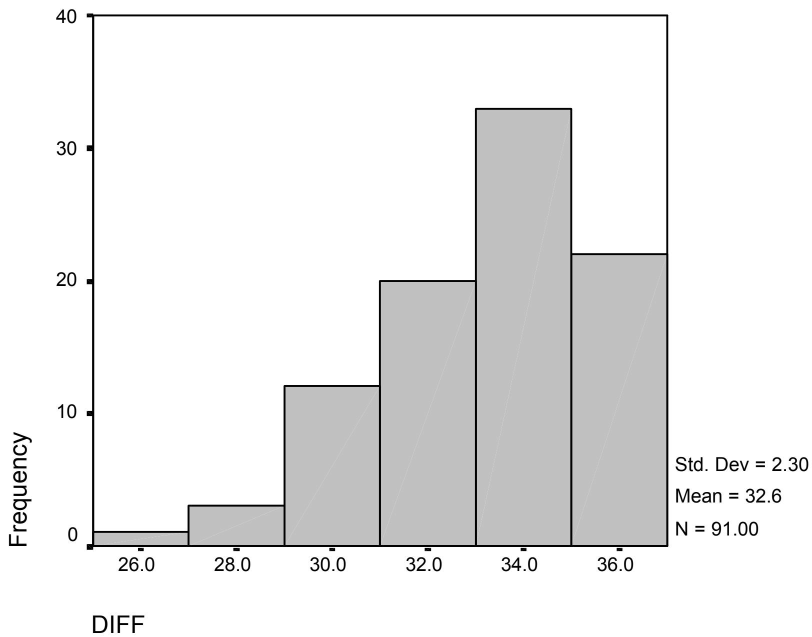
Technical



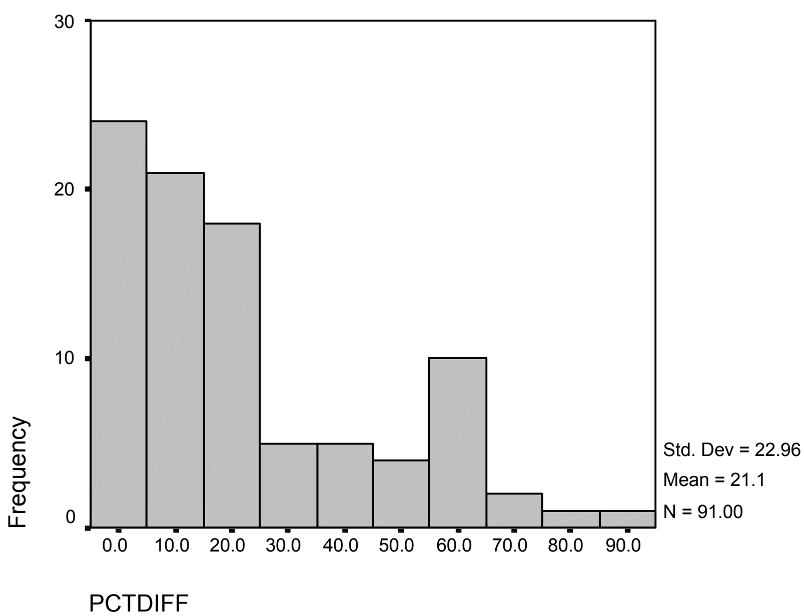
Social


50
40
30
20
10
0
Frequency
.02
.18
.34
.50
.66
.82
.98
Std. Dev = .41
Mean = .42
N = 91.00
Environment


40
35
30
25
20
15
10
5
0
Frequency
.01
.09
.17
.25
.34
.42
.50
.58
.66
.75
.83
.91
.99
Std. Dev = .38
Mean = .41
N = 91.00
Joint Optimization



DIFF Variable: Difference of Time Spent on Technical Subsystem - Social Subsystem (Section C - Likert Scale)



DIFF Variable: Difference of Time Spent on Technical Subsystem - Social Subsystem (Section C - Percentages)

Scheduling and Deadlines

N of Cases = 92.0

Q1: Staying on schedule is important here.
Q6: It is very important to be "on time" for everything.
Q9: People here feel that deadlines don't really matter.
Q17: We don't pay much attention to schedules.
Q18: People do most of their work under deadlines.
Q27: It is important to meet our deadlines.
Q28: People do things when they are ready, not on a schedule.

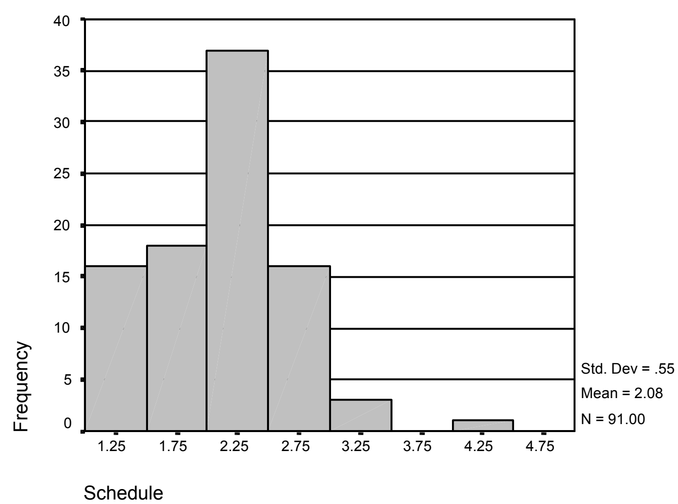
Statistics for Scale	Mean	Variance	Std Dev	N of Variables
	14.5652	14.7979	3.8468	7

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.0807	1.5870	2.6957	1.1087	1.6986	.1756

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q1	12.9783	11.0545	.5974	.4389	.7102
Q17	12.7065	11.1986	.5744	.3649	.7152
Q18	11.8696	11.5652	.3554	.1742	.7628
Q27	12.9130	11.7506	.6055	.4725	.7174
Q28	12.0435	11.1409	.3982	.1833	.7550
Q6	12.4348	11.4792	.4268	.2745	.7446
Q9	12.4457	10.9311	.5138	.3077	.7257

Reliability Coefficients 7 items
Alpha = .7622
Standardized item alpha = .7786



Future Orientation

N of Cases = 92.0

Q4: This organization invests in the future.
Q13: It is better to make a bad decision quickly, than a good decision slowly.

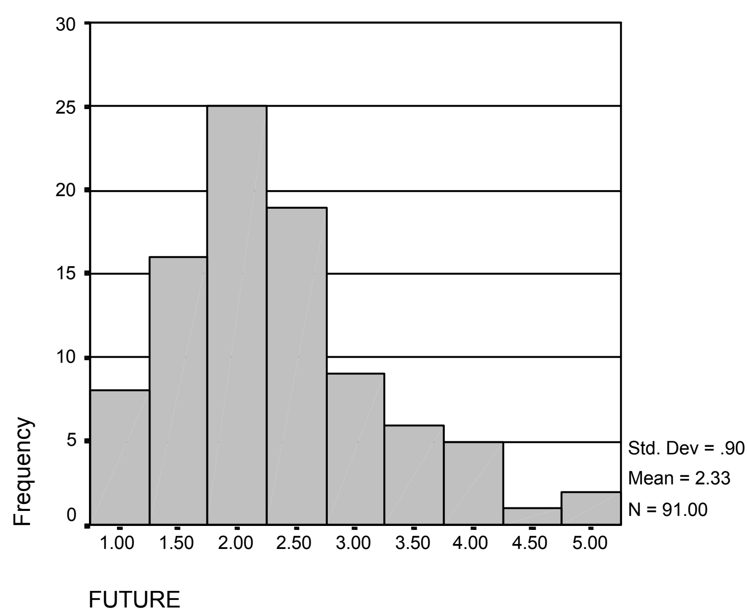
Statistics for	Mean	Variance	Std Dev	N of Variables	
Scale	4.6522	3.2403	1.8001	2	

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.3261	2.2065	2.4457	.2391	1.1084	.0286

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q23	2.4457	1.1728	.4769	.2274	.
Q4	2.2065	1.0228	.4769	.2274	.

Reliability Coefficients 2 items
Alpha =.6448
Standardized item alpha =.6458



Allocation of Time

N of Cases = 92.0

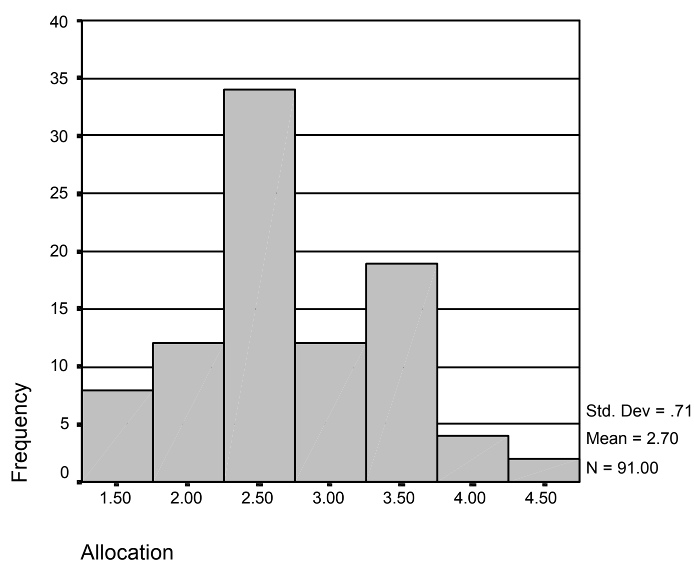
Q3: We never seem to have enough time to get everything done.
Q15: Tasks usually take longer than planned.
Q20: Schedules usually seem too tight for most big jobs/projects.

Statistics for	Mean	Variance	Std Dev	N of Variables		
Scale	8.0978	4.4629	2.1125	3		
Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.6993	2.4565	2.9457	.4891	1.1991	.0598

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q15	5.1522	2.6799	.2905	.0852	.5377
Q20	5.4022	2.2211	.4020	.1686	.3618
Q3	5.6413	2.4084	.3745	.1525	.4103

Reliability Coefficients 3 items
Alpha = .5433
Standardized item alpha = .5417



Awareness of Time Use

N of Cases = 92.0

Q5: People here worry about using their time well.
Q19: Most people don't think about how they use their time.
Q26: People here plan their time carefully.

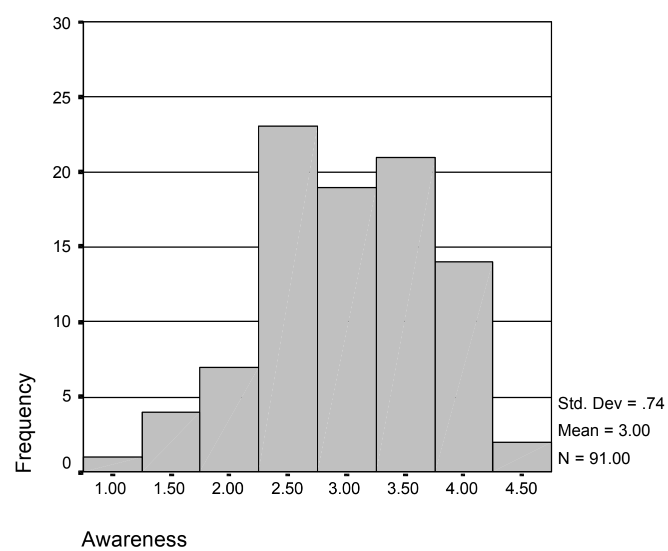
Statistics for	Mean	Variance	Std Dev	N of Variables
Scale	9.0326	4.9989	2.2358	3

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	3.0109	2.9130	3.0978	.1848	1.0634	.0086

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q19	5.9348	2.3913	.5002	.2505	.4995
Q26	6.0109	2.8021	.4453	.2027	.5770
Q5	6.1196	2.6339	.4421	.1981	.5808

Reliability Coefficients 3 items
Alpha = .6513
Standardized item alpha = .6513



Autonomy of Time Use

N of Cases = 92.0

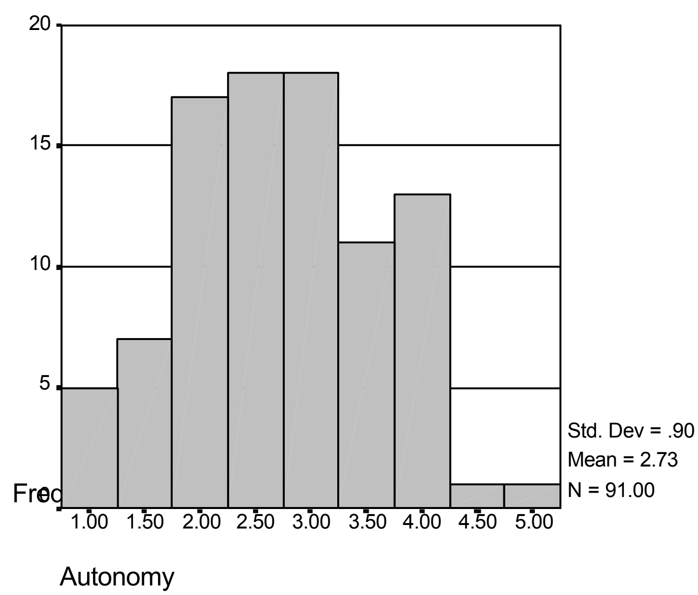
Q7: Most people here cannot set their own work schedules.
Q14: People here do not have the freedom to use their time the way they choose.

Statistics for	Mean	Variance	Std Dev	N of Variables		
Scale	5.4674	3.1967	1.7879	2		
Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.7337	2.4565	3.0109	.5543	1.2257	
					.1537	

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q14	2.4565	1.2618	.4020	.1616	.
Q7	3.0109	1.0219	.4020	.1616	.

Reliability Coefficients 2 items
Alpha = .5712
Standardized item alpha = .5735



Synchronization and Coordination of Tasks

N of Cases = 92.0

Q11: People have to work together to get the job done.
Q21: To get the job done, it is important for each person to coordinate his/her work others.

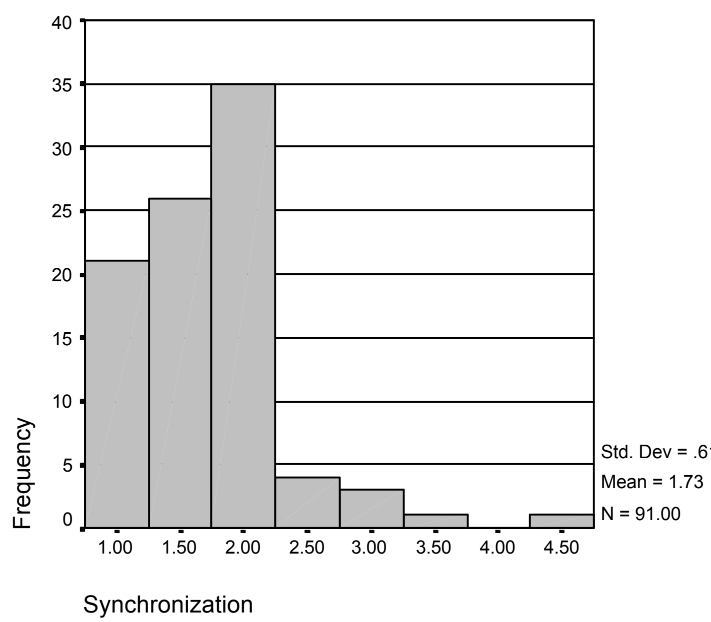
Statistics for	Mean	Variance	Std Dev	N of Variables
Scale	3.4565	1.4596	1.2082	2

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	1.7283	1.5978	1.8587	.2609	1.1633	.0340

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q11	1.8587	.4304	.4598	.2114	.
Q21	1.5978	.5727	.4598	.2114	.

Reliability Coefficients 2 items
Alpha = .6255
Standardized item alpha = .6299



Technical Time Allotment

N of Cases = 93.0

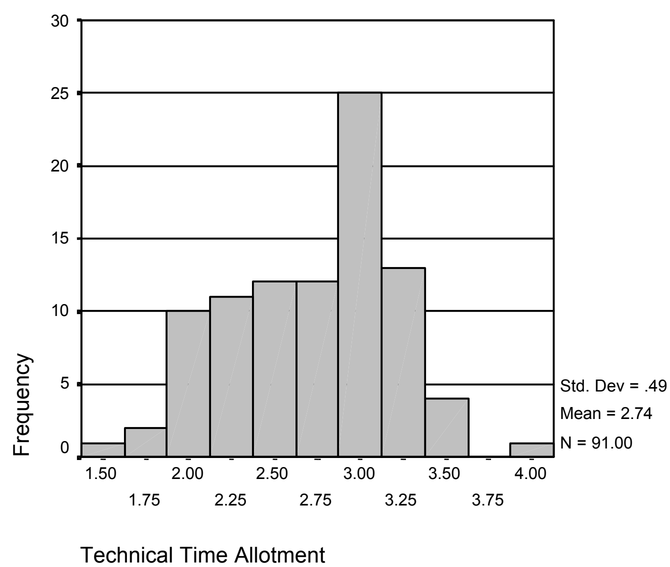
Statistics for	Mean	Variance	N of Std Dev	Variables
Scale	24.6129	19.3050	4.3938	9

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.7348	1.6237	3.3333	1.7097	2.0530	.3326

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q1	22.9892	17.4238	.1651	.1144	.6838
Q2	21.6022	16.8291	.2127	.1710	.6773
Q3	21.8925	15.3796	.4316	.3480	.6316
Q4	21.7097	14.8387	.4494	.3480	.6259
Q5	22.6774	16.6339	.2380	.3436	.6723
Q8	21.2796	16.6819	.3525	.2680	.6506
Q11	21.3871	15.9572	.3463	.1662	.6498
Q13	21.6237	14.4981	.4958	.3567	.6145
Q18	21.7419	14.6066	.4589	.2892	.6231

Reliability Coefficients 9 items
Alpha = .6755
Standardized item alpha = .6709



Social Time Allotment

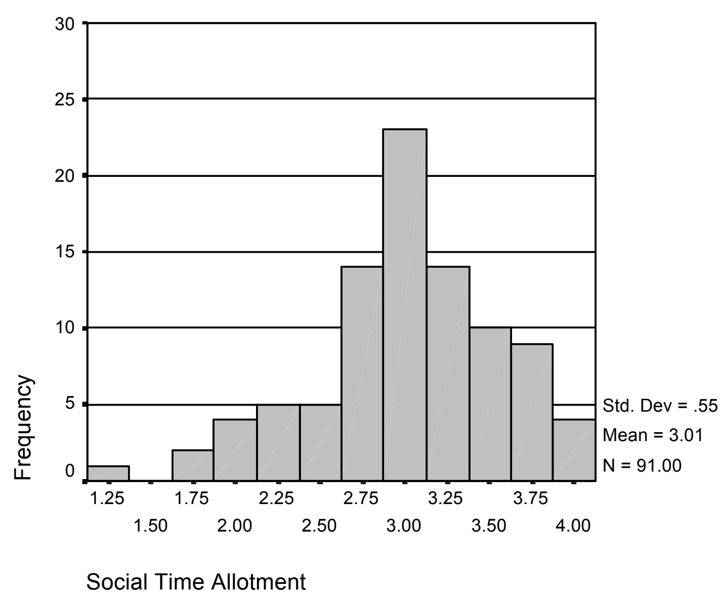
N of Cases = 93.0

Statistics for Scale	Mean 26.9785	Variance 24.1517	Std Dev 4.9144	N of Variables 9		
Item Means	Mean 2.9976	Minimum 2.7097	Maximum 3.3011	Range .5914	Max/Min 1.2183	Variance .0394

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q6	24.0000	21.0652	.1736	.1083	.8252
Q7	23.7419	19.5196	.5653	.3648	.7624
Q9	23.9677	19.2055	.6272	.4768	.7550
Q10	23.9355	19.2784	.5485	.3699	.7634
Q12	24.0860	19.1664	.5818	.3899	.7593
Q14	24.2688	18.2856	.5239	.3030	.7668
Q15	24.2366	19.5086	.4506	.3107	.7768
Q16	23.6774	21.1557	.3536	.2933	.7876
Q17	23.9140	19.0143	.6841	.5324	.7489

Reliability Coefficients 9 items
Alpha = .7925
Standardized item alpha = .8100



Participation and Information Sharing

(See Table B-4 for detailed item description)

N of Cases = 93.0

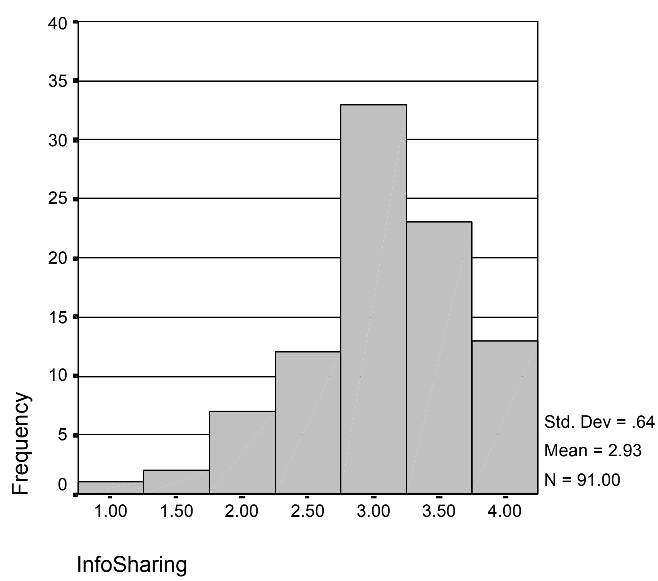
Statistics for Scale	Mean	Variance	Std Dev	N of Variables
	11.6882	6.5430	2.5579	4

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.9220	2.7419	3.0430	.3011	1.1098	.0186

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q9	8.6774	3.8731	.6619	.4426	.5968
Q10	8.6452	4.0358	.5131	.3171	.6770
Q12	8.7957	4.1426	.4956	.2607	.6868
Q15	8.9462	3.9862	.4429	.2460	.7239

Reliability Coefficients 4 items
Alpha = .7319
Standardized item alpha = .7384



Customer Needs and Strategic Planning

(See Table B-4 for detailed item description)

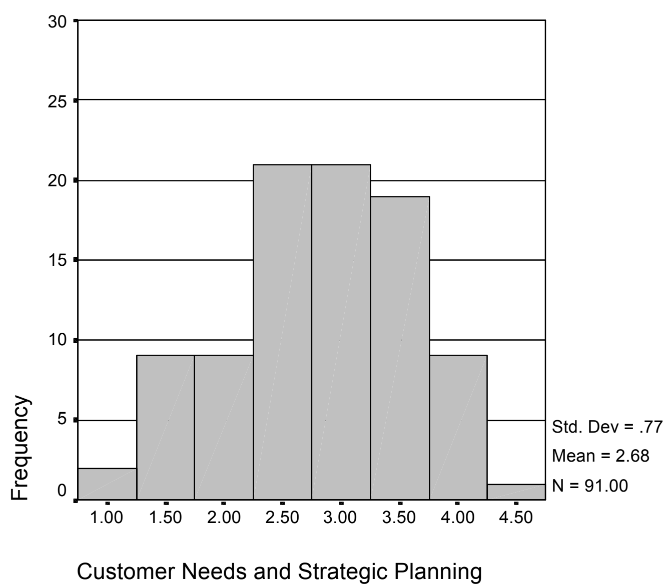
N of Cases = 93.0

Statistics for	Mean	Variance	Std Dev	N of Variables		
Scale	10.6882	9.2821	3.0467	4		
Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.6720	1.9355	2.9785	1.0430	1.5389	.2431

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q4	7.7849	5.6924	.5421	.3036	.6521
Q5	8.7527	5.6664	.6210	.3918	.6122
Q6	7.7097	5.2083	.5402	.3465	.6542
Q18	7.8172	6.2162	.3869	.1718	.7402

Reliability Coefficients 4 items
Alpha = .7273
Standardized item alpha = .7317



Skills Development and Compensation

(See Table B-4 for detailed item description)

N of Cases = 93.0

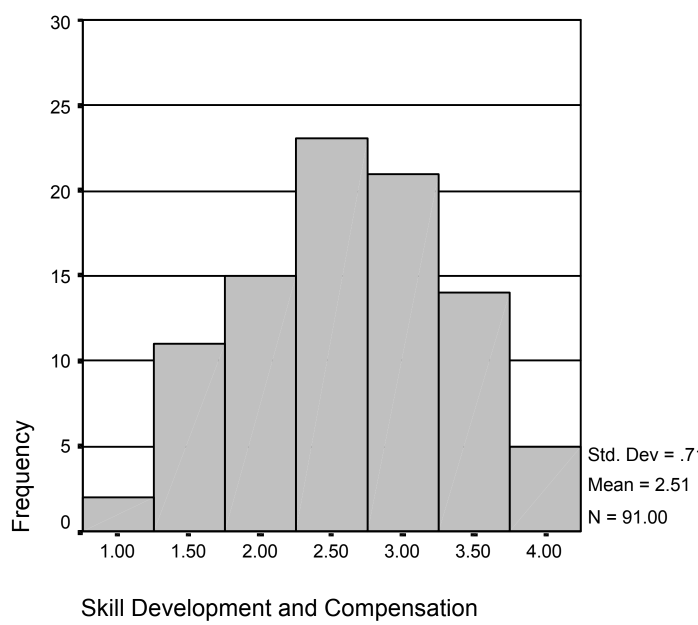
Statistics for	Mean	Variance	Std Dev	N of Variables
Scale	10.0430	7.8025	2.7933	4

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.5108	1.6237	2.9892	1.3656	1.8411	.3665

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q1	8.4194	5.8548	.3010	.0925	.7401
Q3	7.3226	4.8948	.5131	.2692	.6274
Q13	7.0538	4.3340	.5871	.3832	.5756
Q14	7.3333	4.2029	.5708	.3666	.5862

Reliability Coefficients 4 items
Alpha = .7042
Standardized item alpha = .6976



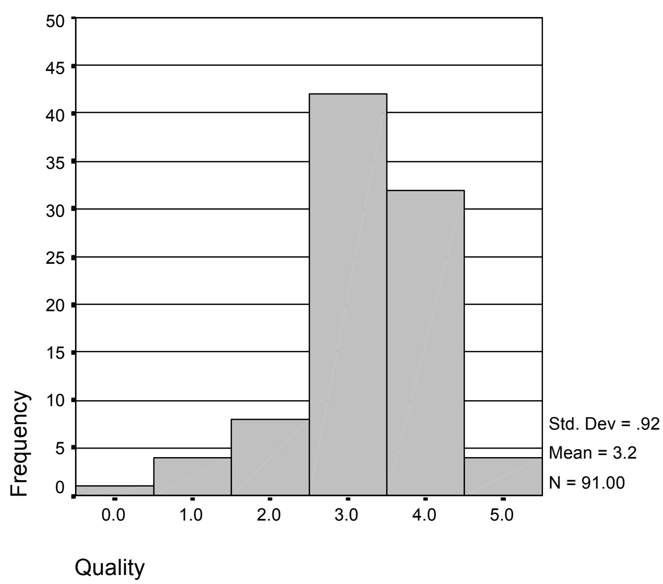
Quality

(See Table B-4 for detailed item description)

No Reliability Analysis - Single Item Scale

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Q11	93	.00	5.00	3.2258	.9104



Department Operational Needs

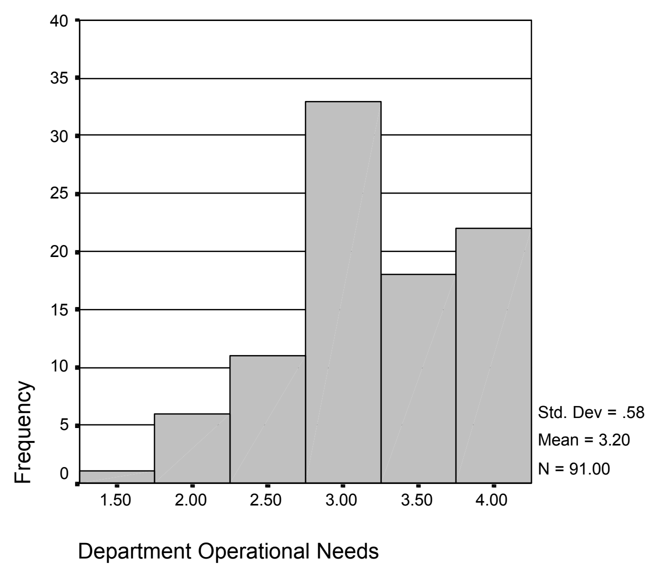
N of Cases = 93.0

Statistics for	Mean	Variance	Std Dev	N of Variables		
Scale	15.9462	8.3775	2.8944	5		
Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	3.1892	3.0108	3.3333	.3226	1.1071	.0207

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q2	12.9355	5.4523	.4776	.2478	.7681
Q7	12.7097	5.6648	.5449	.3253	.7376
Q8	12.6129	5.7833	.5904	.3550	.7245
Q16	12.6452	5.7314	.5818	.3658	.7263
Q17	12.8817	5.6706	.5842	.3885	.7250

Reliability Coefficients 5 items
Alpha = .7770
Standardized item alpha = .7833



Performance (Self-Scored)

N of Cases = 93.0

Statistics for Scale	Mean	Variance	Std Dev	N of Variables		
Scale	64.1895	76.6582	8.7555	18		
Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	3.5661	2.9892	4.1700	1.1808	1.3950	.0864

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q1	61.0282	69.2317	.5012	.4906	.8776
Q10	60.0195	71.9620	.3098	.2985	.8838
Q11	60.5013	69.5083	.4245	.5648	.8806
Q12	60.5894	69.8612	.3979	.6027	.8816
Q13	60.2540	70.8167	.3539	.3877	.8829
Q14	60.6304	67.5699	.5860	.5873	.8745
Q15	60.6089	65.8360	.6643	.6420	.8712
Q16	60.3831	67.8287	.6117	.6126	.8738
Q17	60.9207	66.4517	.6416	.6620	.8722
Q18	60.7809	68.2981	.5077	.5041	.8774
Q2	60.8992	69.6000	.4522	.4929	.8793
Q3	60.6089	70.0045	.5034	.5684	.8777
Q4	60.5659	67.9251	.6329	.5664	.8732
Q5	61.2003	69.5778	.3899	.3426	.8822
Q6	60.4583	68.7240	.6169	.6188	.8742
Q7	60.2540	70.1510	.4633	.5000	.8789
Q8	60.7164	66.9610	.6199	.6184	.8732
Q9	60.8024	68.9295	.5610	.6032	.8757

Reliability Coefficients 18 items

Alpha = .8833 Standardized item alpha = .8847

Performance (Manager Evaluation)

N of Cases = 90.0

Statistics for	Mean	Variance	Std Dev	N of Variables
Scale	61.9889	70.8650	8.4181	18

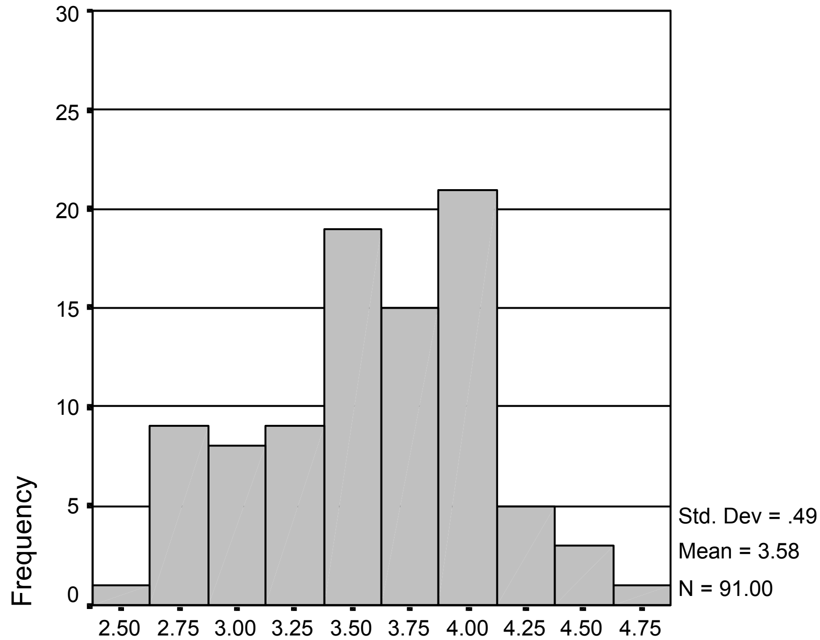
Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	3.4438	3.1556	3.7222	.5667	1.1796	.0247

Item-total Statistics

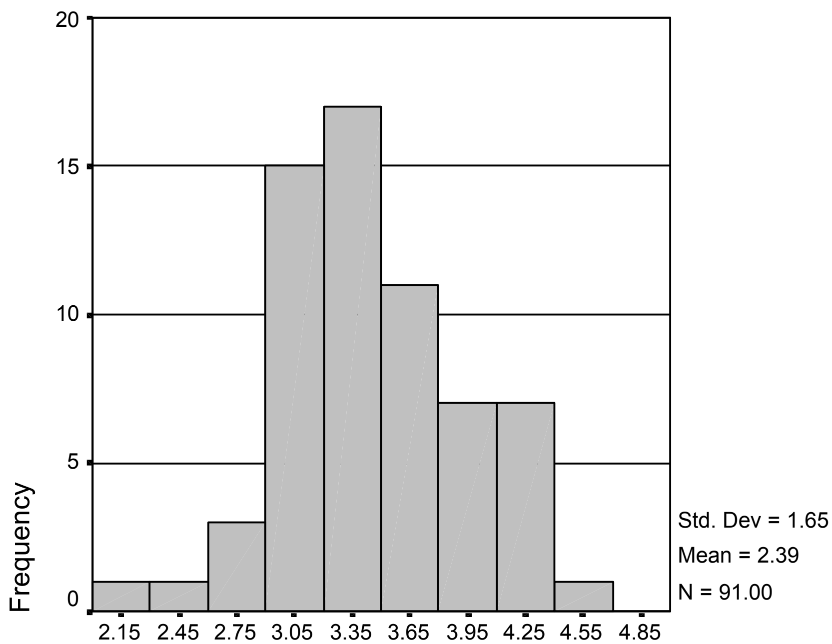
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q1	58.5111	62.7021	.6520	.6482	.8798
Q10	58.5889	67.7280	.2041	.3760	.8939
Q11	58.8333	66.3202	.3188	.8135	.8904
Q12	58.7667	66.4730	.3326	.7889	.8896
Q13	58.7444	65.8778	.3609	.5313	.8890
Q14	58.4778	62.9939	.5722	.6879	.8822
Q15	58.4333	61.1472	.6427	.6869	.8794
Q16	58.2667	61.3888	.7113	.5772	.8774
Q17	58.6333	64.0551	.4460	.6769	.8867
Q18	58.7333	63.1640	.5032	.6543	.8847
Q2	58.5333	62.4315	.5636	.6402	.8824
Q3	58.4778	62.5220	.6528	.5287	.8797
Q4	58.3778	62.7995	.6218	.5992	.8806
Q5	58.6000	62.6472	.5515	.4831	.8829
Q6	58.3222	62.5355	.6138	.6124	.8807
Q7	58.4000	62.1528	.5491	.4859	.8830
Q8	58.5333	63.8472	.5636	.6444	.8827
Q9	58.5778	64.3815	.5976	.5472	.8822

Reliability Coefficients 18 items

Alpha = .8896 Standardized item alpha = .8900



Performance



Manager Performance

Appendix D
Scale Data by Subject

	Z-Score Transformations				Scale Means			
Subject	Technical	Social	Env	Joint Opt	Technical	Social	Env	Overall
15	0.64397	0.98389	0.96915	0.92588	3.36842	3.73171	3.52381	3.54131
17	0.21198	0.57958	0.08301	0.24572	3.07895	3.36585	3	3.14827
18	0.98072	0.99989	0.99987	0.99943	3.78947	4.02439	3.80952	3.87446
19	0.75421	0.96024	0.99996	0.98027	3.44737	3.65854	3.85714	3.65435
20	0.71957	0.00593	0.53735	0.28605	3.42105	2.85366	3.2381	3.17094
21	0.00242	0.89176	0.00009	0.02686	2.57895	3.56098	2.61905	2.91966
22	0.00622	0.20205	0.00209	0.01274	2.65789	3.17073	2.7619	2.86351
25	0.27857	0.96024	0.21373	0.54348	3.13158	3.65854	3.09524	3.29512
26	0.84292	0.93251	0.98477	0.94487	3.52632	3.60976	3.57143	3.56917
28	0.88858	0.99608	0.96915	0.97743	3.57895	3.82927	3.52381	3.64401
30	0.21198	0.20205	0.04639	0.12981	3.07895	3.17073	2.95238	3.06735
31	0.88858	0.99824	0.75342	0.95967	3.57895	3.87805	3.33333	3.59678
32	0.8671	0.52847	0.41995	0.68072	3.55263	3.34146	3.19048	3.36152
34	0.00276	0.00184	0.00079	0.00082	2.58974	2.78049	2.71429	2.69484
35	0.71957	0.94782	0.75342	0.84608	3.42105	3.63415	3.33333	3.46284
36	0.03957	0.99953	0.9421	0.78942	2.84211	3.95122	3.47619	3.42317
37	0.90011	0.99181	0.99959	0.99121	3.59459	3.78049	3.7619	3.71233
38	0.4356	0.93251	0.41995	0.64943	3.23684	3.60976	3.19048	3.34569
45	0.02452	0.62938	0.41995	0.20525	2.78947	3.39024	3.19048	3.1234
46	0.00005	0.99885	0.13801	0.1558	2.31579	3.90244	3.04762	3.08862
48	0.09163	0.52847	0.00001	0.03348	2.94737	3.34146	2.52381	2.93755
49	0.09163	0.28247	0.41995	0.1987	2.94737	3.21951	3.19048	3.11912
50	0.09163	0.00007	0.13801	0.01361	2.94737	2.60976	3.04762	2.86825
57	0.98874	0.47689	0.04639	0.69797	3.84211	3.31707	2.95238	3.37052
58	0.98519	0.98843	0.89917	0.9833	3.81579	3.7561	3.42857	3.66682
59	0.97516	0.99735	0.99305	0.99466	3.76316	3.85366	3.61905	3.74529
60	0.99913	1	1	1	4.05263	4.2439	4.33333	4.20996
61	0.78641	0.99993	0.99996	0.99755	3.47368	4.04878	3.85714	3.7932
63	0.09163	0.93251	0.89917	0.6144	2.94737	3.60976	3.42857	3.32857
64	0.00835	0.47689	0.41995	0.12591	2.68421	3.31707	3.19048	3.06392
65	0.06139	0.00849	0.02404	0.01893	2.89474	2.87805	2.90476	2.89252
66	0.39421	0.93251	0.9421	0.80322	3.21053	3.60976	3.47619	3.43216
67	0.99152	0.98843	0.99707	0.99601	3.86842	3.7561	3.66667	3.76373
68	0.21198	0.06927	0.30932	0.15786	3.07895	3.04878	3.14286	3.09019
70	0.52008	0.72207	0.65156	0.63398	3.28947	3.43902	3.28571	3.33807
71	0.0146	0.28247	0.30932	0.09452	2.73684	3.21951	3.14286	3.03307
72	0.02452	0.52847	0.9421	0.34669	2.78947	3.34146	3.47619	3.20238
74	0.27857	0.86576	0.65156	0.59221	3.13158	3.53659	3.28571	3.31796
75	0.07536	0.99181	0.99707	0.8372	2.92105	3.78049	3.66667	3.45607
76	0.01902	0.00031	0.02404	0.00382	2.76316	2.68293	2.90476	2.78362
77	0.00173	0.20205	0	0.00163	2.55263	3.17073	2.47619	2.73318
78	0.56222	0.91393	0.9421	0.84123	3.31579	3.58537	3.47619	3.45912
81	0.01902	0.1676	0.02404	0.0337	2.76316	3.14634	2.90476	2.93809
82	0.18252	0.00849	0.00027	0.01316	3.05263	2.87805	2.66667	2.86578

	Z-Score Transformations (Cont'd)				Scale Means (Cont'd)			
Subject	Technical	Social	Env	Joint Opt	Technical	Social	Env	Overall
83	0.11038	0.24043	0.21373	0.15502	2.97368	3.19512	3.09524	3.08801
84	0.47772	0.52847	0.65156	0.54706	3.26316	3.34146	3.28571	3.29678
87	0.47772	0.42569	0.08301	0.3131	3.26316	3.29268	3	3.18528
89	0.13172	0.01198	0	0.00264	3	2.90244	2.38095	2.76113
90	0.02452	0.02281	0.00001	0.00237	2.78947	2.95122	2.52381	2.75483
92	0.0313	0.00184	0	0.00011	2.81579	2.78049	2.19048	2.59558
96	0.27857	0.37572	0	0.03566	3.13158	3.26829	2.42857	2.94281
97	0.04952	0.00078	0	0.00022	2.86842	2.73171	2.28571	2.62861
98	0.27857	0.98843	1	0.96689	3.13158	3.7561	3.95238	3.61335
99	0.75421	0.62938	0.89917	0.78767	3.44737	3.39024	3.42857	3.42206
101	0.60366	0.97014	0.89917	0.87234	3.34211	3.68293	3.42857	3.48453
102	0.15576	0.1676	0.00511	0.06361	3.02632	3.14634	2.80952	2.99406
103	0.09163	0.11076	0.00079	0.02689	2.94737	3.09756	2.71429	2.91974
104	0.0146	0.13718	0	0.00035	2.73684	3.12195	2.09524	2.65134
107	0.0111	0.20205	0	0.00396	2.71053	3.17073	2.47619	2.78582
108	0.47772	0.91393	0.01153	0.41451	3.26316	3.58537	2.85714	3.23522
109	0.39421	0.9997	0.89917	0.92351	3.21053	3.97561	3.42857	3.53824
111	0.07536	0.03078	0	0.00111	2.92105	2.97561	2.2381	2.71159
112	0.15576	0.06927	0	0.00311	3.02632	3.04878	2.2381	2.77106
113	0.24405	0.83576	0.00009	0.14345	3.10526	3.5122	2.61905	3.07884
114	0.52008	0.00019	0	0.00199	3.28947	2.65854	2.28571	2.74457
116	0.52008	0.98389	0	0.27663	3.28947	3.73171	2.47619	3.16579
118	0.8671	0.96024	0.83672	0.91746	3.55263	3.65854	3.38095	3.53071
120	0.64397	0.01666	0.41995	0.26962	3.36842	2.92683	3.19048	3.16191
123	0.52008	0.24043	0.75342	0.4949	3.28947	3.19512	3.33333	3.27264
124	0.00122	0.00001	0	0	2.52632	2.5122	2.2381	2.42554
125	0.00041	0.00408	0.00009	0.00024	2.44737	2.82927	2.61905	2.63189
126	0.60366	0.62938	0.00027	0.22039	3.34211	3.39024	2.66667	3.13301
127	0.31531	0.47689	0.01153	0.18621	3.15789	3.31707	2.85714	3.1107
130	0.01902	0.00184	0.00001	0.00074	2.76316	2.78049	2.52381	2.68915
131	0.21198	0.86576	0.96915	0.71527	3.07895	3.53659	3.52381	3.37978
132	0.00018	0.00019	0.00079	0.0001	2.39474	2.65854	2.71429	2.58919
133	0.04952	0.57958	0.41995	0.23444	2.86842	3.36585	3.19048	3.14158
156	0.24405	0.99181	0.99707	0.90597	3.10526	3.78049	3.66667	3.51747
160	0.0313	0.89176	0.41995	0.32045	2.81579	3.56098	3.19048	3.18908
197	0.99152	0.99926	0.99996	0.99953	3.86842	3.92683	3.85714	3.88413
198	0.04952	0.00849	0.02404	0.01683	2.86842	2.87805	2.90476	2.88374
199	0.09163	0.99824	0.02404	0.43188	2.94737	3.87805	2.90476	3.24339

	Z-Score Transformations (Cont'd)				Scale Means (Cont'd)			
Subject	Technical	Social	Env	Joint Opt	Technical	Social	Env	Overall
200	0.13172	0.13718	0.65156	0.22506	3	3.12195	3.28571	3.13589
202	0.60366	0.05363	0.83672	0.4442	3.34211	3.02439	3.38095	3.24915
203	0.09163	0.00121	0.00009	0.00327	2.94737	2.7561	2.61905	2.77417
204	0.07536	0.57958	0.53735	0.2936	2.92105	3.36585	3.2381	3.175
205	0.60366	0.6771	0.9421	0.7698	3.34211	3.41463	3.47619	3.41098
206	0.98072	0.91393	0.53735	0.92305	3.78947	3.58537	3.2381	3.53764
207	0.11038	0.00849	0.00079	0.01135	2.97368	2.87805	2.71429	2.85534
208	0.75421	0.98389	0.9421	0.93351	3.44737	3.73171	3.47619	3.55176
215	0.00005	0	0.00511	0.00001	2.31579	2.26829	2.80952	2.46454

Time Dimension of Work Scale Means						
Subject	Sched	Future	Alloc	Aware	Auton	Synchro
15	3.86	3.50	3.67	2.33	2.00	4.50
17	2.71	4.00	4.00	3.00	4.00	3.50
18	4.29	5.00	4.00	2.00	2.50	5.00
19	4.57	4.50	1.33	1.67	3.00	4.50
20	3.71	3.50	2.67	3.00	3.00	4.00
21	4.57	3.00	4.00	3.00	2.00	5.00
22	4.29	3.00	3.33	2.00	2.50	4.00
25	4.43	4.50	3.33	2.00	4.00	4.50
26	3.86	3.50	3.67	2.33	3.00	4.00
28	4.43	4.50	2.00	3.00	1.50	5.00
30	3.86	3.00	3.00	3.00	3.00	4.00
31	3.71	5.00	2.67	3.33	2.50	4.00
32	3.71	4.00	3.33	2.67	3.00	4.00
34	3.29	3.50	2.67	3.00	3.50	4.00
35	3.43	4.50	2.67	2.67	2.00	4.50
36	4.57	5.00	4.00	3.67	4.50	5.00
37	4.14	4.50	2.33	2.33	4.00	4.00
38	4.29	4.50	3.33	1.67	4.00	4.00
45	5.00	3.00	1.67	2.00	5.00	5.00
46	3.57	2.00	4.67	3.67	4.00	3.50
48	3.71	3.50	3.33	4.00	5.00	4.50
49	4.00	3.50	3.67	4.00	4.50	4.50
50	3.43	2.50	3.67	3.67	4.00	5.00
57	4.00	4.00	2.33	2.33	2.00	4.50
58	3.71	4.50	4.00	2.67	3.50	4.50
59	3.86	4.50	3.33	2.00	2.00	2.50
60	4.71	5.00	2.67	2.67	2.00	4.50
61	4.71	4.00	2.00	2.67	4.00	5.00
63	4.29	4.00	3.00	3.00	3.00	4.50
64	4.57	4.00	2.33	3.00	3.50	4.00
65	3.71	4.00	2.33	3.00	2.50	4.00
66	4.43	4.00	3.67	3.00	4.50	4.00
67	4.57	3.50	2.67	2.67	3.00	4.50
68	3.86	4.00	3.00	3.00	2.50	3.00
70	4.00	4.00	2.67	2.00	4.00	4.00
71	4.14	5.00	4.00	5.00	3.50	4.50
72	4.43	5.00	3.33	2.00	2.00	4.50
74	3.86	4.00	4.67	4.33	5.00	5.00
75	4.43	2.50	3.67	2.00	2.50	5.00
76	1.86	1.00	4.67	4.67	3.50	3.50
77	3.86	4.00	3.33	3.00	4.00	4.00
78	4.71	5.00	4.00	2.33	2.00	4.50

Time Dimension of Work Scale Means (Cont'd)						
Subject	Sched	Future	Alloc	Aware	Auton	Synchro
81	3.14	4.00	2.67	4.00	4.00	4.00
82	3.86	1.50	3.00	4.33	2.50	1.50
83	3.57	2.00	4.00	4.00	4.00	4.00
84	3.57	4.00	3.67	3.33	3.00	5.00
87	3.71	4.00	2.67	3.67	3.00	4.00
89	3.71	3.50	3.67	3.33	4.00	4.00
90	3.57	3.50	3.67	3.67	3.00	4.00
92	3.29	4.50	3.00	3.00	4.00	4.00
96	3.43	3.00	3.00	3.33	2.00	4.00
97	3.86	2.00	3.67	3.33	4.50	4.00
98	4.43	3.50	2.67	2.00	3.00	5.00
99	3.86	4.00	2.67	2.67	4.50	4.00
101	3.86	4.00	3.00	3.00	3.00	4.00
102	3.86	2.50	3.67	2.33	4.00	5.00
103	4.71	1.00	3.00	3.00	5.00	5.00
104	3.29	2.00	4.00	3.67	3.50	4.50
107	4.00	3.50	2.00	3.67	4.00	4.00
108	4.57	4.50	3.33	3.00	4.00	4.50
109	3.43	3.50	4.33	2.33	3.00	4.00
111	3.29	3.50	4.33	3.33	4.00	4.50
112	3.00	4.00	4.00	3.67	3.00	4.00
113	3.43	3.00	3.67	3.00	1.00	3.00
114	3.43	4.50	2.67	3.33	2.50	4.50
116	3.29	4.00	3.00	2.67	3.50	4.00
118	4.00	5.00	3.67	2.00	3.00	4.50
120	4.14	3.50	4.67	2.67	2.50	5.00
123	4.00	3.50	3.67	2.00	3.50	4.00
124	3.71	4.00	3.00	4.00	3.50	4.00
125	3.71	2.50	4.33	3.67	4.50	4.50
126	3.14	4.00	3.33	3.33	3.50	5.00
127	4.00	3.50	2.00	3.00	2.00	3.50
130	3.86	4.00	4.33	2.33	4.50	4.00
131	4.57	4.50	3.33	3.33	2.00	5.00
132	2.57	3.00	3.33	4.33	3.50	3.00
133	4.14	2.00	3.00	2.00	2.00	5.00
156	4.29	2.50	3.33	3.67	2.50	5.00
160	4.71	3.50	2.33	2.33	3.50	4.50
197	4.14	4.00	3.67	3.67	3.50	4.00
198	4.14	4.50	3.33	2.67	3.50	4.50
199	3.43	3.00	4.00	2.67	3.50	4.50

Time Dimension of Work Scale Means (Cont'd)						
Subject	Sched	Future	Alloc	Aware	Auton	Synchro
200	3.29	4.50	2.67	4.00	3.00	5.00
202	3.57	4.00	3.67	3.67	2.50	4.00
203	3.43	2.50	3.67	3.67	3.00	4.50
204	4.29	4.00	4.00	2.33	3.50	4.00
205	4.71	4.50	3.00	2.00	3.50	5.00
206	3.71	3.50	3.67	4.00	2.00	4.50
207	4.00	3.50	3.67	3.67	3.50	4.50
208	4.71	4.50	2.67	3.00	3.00	5.00
215	5.00	3.00	3.67	2.00	5.00	4.00

Time Allotment Scale Means							
Subject	Technical	Social	InfoSharing	CustSP	Skills	Quality	DeptNeeds
15	2.89	3.33	3.25	3.25	2.50	3.00	3.40
17	3.22	3.44	3.50	2.25	3.50	3.00	4.00
18	3.11	3.33	3.75	2.25	3.00	4.00	3.60
19	3.33	3.44	3.75	2.50	3.00	4.00	4.00
20	2.67	3.44	3.25	3.75	2.00	5.00	2.80
21	1.78	2.56	3.00	1.50	2.00	3.00	2.00
22	1.44	1.89	1.75	2.25	1.00	3.00	1.40
25	3.00	3.67	3.00	2.75	3.00	4.00	4.20
26	3.00	2.67	2.25	2.75	2.75	4.00	3.20
28	2.89	3.44	3.75	3.00	2.75	3.00	3.20
30	2.67	2.78	3.00	2.75	2.50	3.00	2.60
31	3.33	3.22	3.25	2.50	3.75	4.00	3.40
32	3.00	3.11	2.75	3.00	2.25	4.00	3.80
34	2.78	3.11	3.00	1.50	3.50	5.00	3.20
35	3.22	2.89	2.75	3.50	2.50	4.00	3.20
36	3.56	3.67	4.00	3.00	3.25	5.00	3.80
37	3.11	3.44	3.25	3.75	2.75	4.00	3.20
38	2.89	3.33	3.25	2.25	3.00	4.00	3.60
45	3.33	3.67	3.75	3.25	3.00	3.00	4.00
46	2.56	2.89	3.00	2.00	2.50	3.00	3.20
48	3.33	3.56	3.75	3.50	3.00	4.00	3.40
49	2.89	3.22	3.50	2.00	3.50	3.00	3.20
50	2.22	2.56	2.00	2.25	2.50	2.00	2.80
57	2.78	3.11	3.25	2.75	3.75	2.00	2.40
58	3.11	3.89	3.75	3.00	3.50	4.00	3.60
59	3.22	3.89	4.00	3.75	3.75	2.00	3.20
60	3.22	3.11	3.25	3.00	4.00	3.00	2.60
61	3.89	3.78	3.00	4.25	3.75	5.00	4.00
63	3.11	3.44	3.25	3.25	3.50	4.00	3.00
64	2.78	3.33	2.75	3.00	2.25	4.00	3.80
65	3.00	2.78	3.00	2.50	2.00	4.00	3.60
66	2.56	3.33	3.50	2.25	2.75	3.00	3.20
67	3.11	3.22	3.25	1.75	3.50	4.00	3.80
68	2.33	2.22	2.50	3.00	1.25	4.00	2.00
70	2.56	3.00	3.00	2.50	2.25	2.00	3.40
71	3.22	3.67	3.00	3.00	3.25	4.00	4.20
72	3.44	3.67	3.50	3.75	3.25	4.00	3.60
74	3.11	3.33	3.25	3.50	3.00	3.00	3.20
75	2.33	2.33	1.75	2.75	1.50	4.00	2.80
76	3.11	3.11	2.75	3.25	2.25	4.00	3.80
77	3.22	3.67	3.75	3.75	2.50	3.00	3.80
78	2.56	2.67	2.50	2.25	2.75	3.00	2.80

Time Allotment Scale Means (Cont'd)							
Subject	Technical	Social	InfoSharing	CustSP	Skills	Quality	DeptNeeds
81	1.89	2.67	3.25	1.00	1.50	3.00	3.00
82	2.00	1.67	1.25	1.00	2.00	1.00	3.00
83	2.33	2.89	2.25	3.00	2.50	3.00	2.60
84	2.78	2.78	2.25	2.75	2.50	3.00	3.40
87	3.11	3.33	3.00	3.50	3.25	3.00	3.20
89	2.44	3.11	2.75	2.00	2.75	3.00	3.40
90	2.78	2.89	2.75	2.25	2.75	4.00	3.20
92	3.22	3.56	3.50	2.50	3.50	4.00	3.80
96	2.22	2.89	3.00	1.25	2.00	4.00	3.40
97	2.33	2.89	3.00	2.25	2.00	3.00	3.00
98	2.78	3.11	2.75	3.25	2.50	3.00	3.20
99	2.67	2.78	3.00	2.25	2.50	2.00	3.20
101	3.11	3.33	3.25	3.25	3.00	3.00	3.40
102	2.56	2.78	2.25	3.75	1.50	3.00	3.00
103	2.44	2.22	2.50	1.50	1.50	4.00	3.20
104	2.11	3.11	3.50	1.75	1.50	1.00	3.80
107	2.00	2.67	2.75	1.75	2.25	3.00	2.40
108	3.11	3.67	3.75	3.75	2.00	4.00	3.80
109	2.78	3.56	3.50	3.25	2.50	3.00	3.40
111	2.33	2.89	3.25	1.50	1.50	3.00	3.80
112	3.11	3.56	3.50	3.25	2.75	3.00	3.80
113	2.22	2.78	2.75	2.50	2.00	3.00	2.60
114	2.33	2.11	1.75	2.00	2.00	3.00	2.80
116	2.44	3.00	3.25	2.25	2.00	4.00	3.00
118	3.33	3.00	2.75	3.50	2.75	3.00	3.60
120	3.44	2.78	2.00	4.00	2.50	3.00	3.80
123	3.11	3.22	3.00	3.50	2.75	3.00	3.40
124	1.67	1.33	1.00	1.25	1.25	1.00	2.40
125	2.11	2.33	2.50	2.25	1.25	3.00	2.60
126	2.00	2.33	2.25	2.00	1.00	3.00	3.00
127	2.00	2.56	2.75	1.25	2.00	3.00	2.80
130	2.56	3.00	3.00	1.25	2.25	4.00	4.00
131	3.56	3.89	3.75	4.00	3.25	4.00	3.80
132	2.44	2.56	2.50	3.00	2.00	3.00	2.40
133	2.22	3.22	3.50	3.25	1.50	0.00	3.20
156	2.44	2.67	2.75	2.50	2.75	3.00	2.20
160	1.89	2.44	2.25	1.25	1.75	2.00	3.20
197	2.00	1.89	1.50	2.75	1.50	1.00	2.20
198	2.56	2.78	2.50	2.75	2.25	3.00	3.00
199	2.00	1.89	1.75	2.25	1.75	2.00	2.00

Time Allotment Scale Means							
Subject	Technical	Social	InfoSharing	CustSP	Skills	Quality	DeptNeeds
200	3.00	3.22	3.00	3.00	2.25	4.00	3.80
202	2.67	2.89	2.75	3.25	3.00	2.00	2.40
203	2.22	2.78	2.75	2.00	2.50	3.00	2.60
204	2.89	4.11	4.00	3.50	2.50	3.00	4.00
205	3.11	3.11	3.00	2.75	2.75	4.00	3.60
206	3.00	2.89	2.75	3.25	2.50	3.00	3.20
207	2.89	3.00	3.00	2.50	3.25	3.00	3.00
208	3.22	3.67	4.00	3.00	3.25	4.00	3.40
215	2.67	1.78	1.75	3.25	1.75	4.00	1.80

Department Performance Assessment Data				
	Raw Scores		Scale Mean	
Subject	Self	Plant Mgr	Self	Plant Mgr
15	69	54	3.83	3.00
17	66	69	3.67	3.83
18	77	69	4.28	3.83
19	72	76	4.00	4.22
20	62	51	3.44	2.83
21	56	58	3.11	3.22
22	79	55	4.39	3.06
25	72	0	4.00	0.00
26	68	0	3.78	0.00
28	69	78	3.83	4.33
30	65	69	3.61	3.83
31	77	70	4.28	3.89
32	72	78	4.00	4.33
34	58	47	3.22	2.61
35	66	57	3.67	3.17
36	67	58	3.72	3.22
37	71	61	3.94	3.39
38	72	56	4.00	3.11
45	70	78	3.89	4.33
46	62	68	3.44	3.78
48	62	60	3.44	3.33
49	52	61	2.89	3.39
50	51	61	2.83	3.39
57	74	71	4.11	3.94
58	57	49	3.17	2.72
59	79	70	4.39	3.89
60	79	80	4.39	4.44
61	85	66	4.72	3.67
63	63	45	3.50	2.50
64	62	39	3.44	2.17
65	64	68	3.56	3.78
66	72	64	4.00	3.56
67	66	57	3.67	3.17
68	67	77	3.72	4.28
70	64	62	3.56	3.44
71	54	0	3.00	0.00
72	71	0	3.94	0.00
74	60	0	3.33	0.00
75	76	0	4.22	0.00
76	52	0	2.89	0.00
77	71	0	3.94	0.00
78	70	0	3.89	0.00

Department Performance Assessment Data (Cont'd)				
	Raw Scores		Scale Mean	
Subject	Self	Plant Mgr	Self	Plant Mgr
81	49	67	2.72	3.72
82	62	55	3.44	3.06
83	60	0	3.33	0.00
84	74	0	4.11	0.00
87	73	0	4.06	0.00
89	61	0	3.39	0.00
90	52	65	2.89	3.61
92	51	59	2.83	3.28
96	75	54	4.17	3.00
97	59	56	3.28	3.11
98	70	0	3.89	0.00
99	72	65	4.00	3.61
101	66	0	3.67	0.00
102	49	0	2.72	0.00
103	55	63	3.06	3.50
104	49	66	2.72	3.67
107	65	0	3.61	0.00
108	78	53	4.33	2.94
109	70	0	3.89	0.00
111	48	54	2.67	3.00
112	68	64	3.78	3.56
113	61	55	3.39	3.06
114	64	0	3.56	0.00
116	63	58	3.50	3.22
118	64	76	3.56	4.22
120	60	0	3.33	0.00
123	69	0	3.83	0.00
124	51	0	2.81	0.00
125	49	0	2.72	0.00
126	58	59	3.22	3.28
127	62	76	3.44	4.22
130	52	63	2.89	3.50
131	74	0	4.11	0.00
132	43	0	2.39	0.00
133	71	0	3.94	0.00
156	66	0	3.67	0.00
160	68	0	3.78	0.00
197	73	56	4.06	3.11
198	54	66	3.00	3.67
199	72	70	4.00	3.89

Department Performance Assessment Data				
	Raw Scores		Scale Mean	
200	51	63	2.83	3.50
202	67	58	3.72	3.22
203	59	54	3.28	3.00
204	71	63	3.94	3.50
205	63	58	3.50	3.22
206	62	55	3.44	3.06
207	58	58	3.22	3.22
208	66	54	3.67	3.00
215	61	64	3.39	3.56

Appendix E
Statistical Consulting Center Report

Sept. 17, 1996

To: Delia Grenville
Industrial Systems Engineering

From: David Lawrence
Angie McMahan
Virginia Tech Statistical Consulting Center

Topic: Balance of Time Survey

Here is a summary of statistical analyses for various hypotheses of interest.

1st hypothesis

H_0: Joint optimization is equal across upstream, transformation, and downstream managers.
H_1: Joint optimization differs across upstream, transformation, and downstream managers.

Analysis:

Perform a One-way Analysis of Variance (ANOVA) with joint optimization as the response variable and manager type as the factor. Multiple comparisons (such as Tukey HSD) can be used if the ANOVA F-test is significant.

Since more than one type of manager per company is surveyed, it seems that you might consider "company" as a blocking variable. This would be important if some variability in the responses could be attributed to which particular company that person works for. Then, the analysis would become a Randomized Complete Block (RCB) design. Joint optimization is still the response variable, manager type is the factor, and, of course, company is the block. Multiple comparisons are still available.

2nd hypothesis

H_0: Joint optimization is not associated with the difference in time spent in technical and social activities.
H_1: Joint optimization is associated with the difference in time spent in technical and social activities.

Analysis:

There are 9 "time technical" variables in Section C, get the sum of these and call it TTECHSUM.

There are 9 "time social" variables in Section C, get the sum of these and call it TSOCSUM.

Create the composite variable for the i^{th} survey as

$$DIFF_i = 36 - \left| \; TTECHSUM_i - TSOCSUM_i \; \right|.$$

Then, perform a correlation test on joint optimization versus DIFF·

$$H_0: \quad \rho = 0$$
$$H_1: \quad \rho > 0$$

The distributions of both variables should be looked at (by histograms, boxplots, descriptive statistics, for example) to decide on the appropriate type of correlation test.

3rd hypothesis

H_0: Time dimension variables do not affect the association between joint optimization and the difference in time spent in technical and social activities.
H_1: Time dimension variables do affect the association between joint optimization and the difference in time spent in technical and social activities.

Analysis:

Two avenues have been discussed here. The first method would be to categorize the time dimension variables (into 3 or 4 levels, for example), with the difference in time spent in technical and social activities also categorized. Using joint optimization as a response variable, perform an interaction test on the two factors created by the above categorization. This would be repeated for each of the six time dimension variables (unless one composite variable is available).

Another way to look at it is to be aware of the relationship between a correlation analysis and the slope produced by a simple linear regression. Therefore, model joint optimization as a function of the time difference variable. Then, add a particular time dimension variable, such as allocation of time (ALLOC), and form the regression model

$$J.O. = \beta_0 + \beta_1 DIFF + \beta_2 ALLOC.$$

Performing the test (given that DIFF is in the model)

$$H_0: \quad \beta_2 = 0$$
$$H_1: \quad \beta_2 \neq 0$$

will give insight into whether this particular time dimension variable adds any important information to the relationship between J.O. and DIFF.

4th hypothesis

H_0: Time dimension variables does not predict department performance.
H_1: Time dimension variables predicts department performance.

Analysis:

Ordinary Least Squares (OLS) regression analysis with the six time dimension variables being the regressor variables, with dept. performance being the response variable. Realize that the six t-tests that are produced are not independent tests.

5th hypothesis

H_0: Department performance is not associated with the difference in time spent in technical and social activities.
H_1: Department performance is associated with the difference in time spent in technical and social activities.

Analysis:

Repeat the analysis of the second hypothesis, inserting department performance in place of joint optimization.

6th hypothesis

H_0: No difference exists in the evaluations from plant managers and line managers.
H_1: Differences exist in the evaluations from plant managers and line managers.

Analysis:

Create the difference in evaluation variable,

$$EVALDIFF_i = PLANTMNG_i - LINEMNG_i \, ,$$

where PLANTMNG is the evaluation from a plant manager and LINEMNG is the evaluation from a line manager. Since a given plant manager evaluates many line managers, the set of

EVALDIFF values are not independent. Thus, two possible ways to account for this are given here.

First method.

Average the EVALDIFF values for each plant manager, which eliminates the lack of independence problem, but at the cost of wasting information on variability that is lost by "smoothing" the data out in the averaging process. By viewing the distribution of the EVALDIFF averages, perform a 2-sided t-test (or analogous procedure)

$$H_0: \quad \mu = 0$$
$$H_1: \quad \mu \neq 0.$$

Similar evaluations between plant managers and line managers will hover near zero because we have already taken their difference.

Second method.

Let K equal the number of plant managers that participate in the survey. Define K-1 binary categorical variables (0 or 1 only) to classify any given plant manager, called $Z_1, Z_2, \ldots, Z_{k-1}$. Then perform a multiple linear regression (MLR) with EVALDIFF as the response variable against this set of K-1 regressor variables. Then, do not look at the regression ANOVA F-test, but rather look at the t-test for the significance of the intercept. If the evaluations between plant managers and line managers is not different, the intercept should not be significantly different from zero. (Plant manager is a *block* analyzed via regression, which accounts for the dependence structure. This is why the regression ANOVA F-test is not applicable here.)

Data outline if K = 4.

LINEMNG	PLANTMNG	EVALDIFF	Z_1	Z_2	Z_3
1	a	x	1	0	0
2	a	x	1	0	0
3	a	x	1	0	0
4	b	x	0	1	0
5	b	x	0	1	0
6	c	x	0	0	1
7	c	x	0	0	1
8	d	x	0	0	0
9	d	x	0	0	0

Survey Note:

Concerning the Likert scale of section C, how do the percentages in parentheses relate? For example, a '1' corresponds to 20% of the time. After 5 questions, at least 100% must be reached, and 13 questions are still to be answered. Is there severe overlap between questions? We were just wondering, it appears a bit ambiguous.

* Call us if you want to meet again

DEJ

Delia Grenville

Professional Experience

Virginia Polytechnic Institute and State University

Research Assistant — January 1997 - present

- Benchmarking Best Practices in NASA Project Management.
- Assist with interviews, write case studies, prepare training materials.

Graduate Assistant — August 1995 - December 1996

- Developed Internet on-line course assessments and on-line summer school course.
- Coordinated department strategic planning sessions and evaluation of core curriculum requirements.

Philip Morris, USA — June 1995 - August 1995

Summer Intern - Manufacturing Systems Integration

- Active member of two performance improvement teams involved in tactical planning and Plan-Do-Check-Act approach to problem resolution. Team roles included facilitator, researcher, challenger.

AMG Logistics — May 1994 - Dec 1994

Logistics Analyst

Project management, operational process improvement — recommendations for design and responsible for implementation.

- Process Documentation: Prepared process documentation for entire distribution operation including customs, warehouse operations, shipping, inventory control, transportation and traffic.
- Cambridge Project: Six month project to manage production inventory and distribution activities of an enamel steel manufacturing plant. Created position and trained operations caseworker to deal with all related logistics and end-of-line production activities. Developed shipping lane strategy with new material handling recommendations to manage distribution and inventory control in manufacturing site.
- Warehouse Congestion Study: Presented an in-depth analysis and model of product flow bottlenecks. Recommended short term and long term changes in production, distribution and allocation strategy.
- Warehouse Management System: Process owner and project manager. Coordinated all team activities for three phase implementation strategy into a 130,000 sq. ft facility including satisfying vendor requirements, mapping business processes to system processes, managing client requirements: hardware, software and training employees

Westburne Supply Ontario October 1992- May 1994
Logistics Analyst
Warehouse automation and facility layout, process improvement through technology

- Implemented and involved in system design and debugging of Radio Frequency Stock Locator System. Coordinated training program for warehouse workers using Continuous Improvement Tools and Techniques. Annual cost savings $375,000.
- Stock located central distribution facility with over 40,000 SKU's. Coordinated all production of stock locator bar coded labels as well as supervised D/E into inventory management system
- Branch location analysis using geographic computer aided analysis. Isolated customer trends and market potential. Used statistical analysis to forecast start-up inventory requirements.
- Responsible for supplier teamwork initiative which reduced process steps by 70% through EDI and automated processing for consignment claims of $40,000 per month.

National Grocers Ltd. January 1990 - October 1992
Retail Systems Analyst
Application migration from mainframe to PC/LAN platform. Automation retail operations.

- Managed projects from conception to completion for the Director of Retail Systems including software development for single and multi-user applications.
- Developed in house Sales Reporting System which reduced reporting time to management for weekly financials from 2.5 days to 1 day using data collection from handheld terminals.
- Provided customer support, developed training methods and documentation for various POS and store systems.

Education

Virginia Polytechnic Institute and State University, Blacksburg, Virginia
Masters of Science in Industrial and Systems Engineering. Management Systems Option. May 1997

Queen's University, Kingston, Ontario
Bachelor of Science with Honours in Mechanical Engineering. May 1989

Professional and Academic Activities

Graduate Student Assembly President
- Represent the needs of graduate students campus-wide, Operating Budget 70K June 1996 - May 1997

Alpha Pi Mu
- Industrial Engineering Honor Society October 1996

Institute of Industrial Engineers
- Student Member of the Virginia Tech Chapter September 1995

Canadian Association of Logistics Management
- Chairperson of the Promotions Committee and Information Logistics Track Chairperson September 1993

Publications

Grenville N.D., Kleiner B.M. (1997) Sociotechnical Approach to Examining Time Allotment in Manufacturing Supervision. Proceedings of Industrial Engineering Research Conference.

Grenville N.D. (1996) Organizational Design and Measurement. Proceedings of The Canadian Association of Logistics Management Conference.

Grenville N.D. (1995) Roanoke Free Clinic Operations Analysis. Proceedings of The Institute of Management Conference.