ABSTRACT

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Title: An Analysis of the Development, Application, and Use of Scientific Management Principles, As Developed by Frederick Taylor, and Information Technology Use on Corporate Efficiency Across Selected Industries

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NORTHERN ILLINOIS UNIVERSITY

ABSTRACT

This research study analyzed whether a relationship exists between information technology and scientific management use and efficiency. Guided by the theories of Frederick Taylor developed during the industrial period, the primary hypothesis posited that the use of scientific management techniques influences the effective application of information technology, which leads toward improved efficiency. Taylor's theories were analyzed to assess present-day applicability, especially in conjunction with emerging information technology. In addition to the quantitative design of the study, a historical perspective was also analyzed. The historical research compared the similarities between industrial and information periods in the United States. Both periods experienced pervasive and dramatic change affecting daily lifestyles.

Primary and secondary data were gathered for the quantitative research. Primary data were obtained using a survey instrument that was developed and submitted to managers in labor intensive industries gathered from the American Management Association, representing finance, health, business, retail trade, and manufacturing. This information was collected to obtain perceptions regarding

efficiency and to answer the research questions. Research questions addressed efficiency as a current concern, levels of efficiency, factors contributing to inefficiency, methods to improve efficiency, purposes and effects of information technology, Taylor's theories, and efficiency ratios.

Secondary information was also gathered to determine efficiency ratios for each respondent. Efficiency ratios were calculated based upon the relationship between operating expense and operating income over a three-year period. The combination of the primary and secondary data provided a foundation for developing conclusions about the relationship between efficiency and scientific management and information technology use.

The results of the analysis of variance (ANOVA) revealed that there was no relationship between information technology use and efficiency, scientific management use and efficiency, and the combined use of information technology and scientific management use and efficiency. In all cases the null hypotheses were accepted. A significant relationship, however, was found for the moderator variable industry. A multiple-comparison test was used to assess this difference, revealing a significant difference between the business services and manufacturing industries.

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AN ANALYSIS OF THE DEVELOPMENT, APPLICATION, AND USE OF SCIENTIFIC MANAGEMENT PRINCIPLES, AS DEVELOPED BY FREDERICK TAYLOR, AND INFORMATION TECHNOLOGY USE ON CORPORATE EFFICIENCY ACROSS SELECTED INDUSTRIES

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DEDICATION

To my wife Carol for her patience, support, and understanding in this endeavor over a long eight years of our life together. Thanks for helping me to achieve this dream.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

Frederick Taylor has been called the father of modern management. His contributions have been instrumental in helping the field of scientific management gain professional stature. Much can be learned from pioneers like Taylor who recognized and dealt with dramatic change. Taylor's theories and ideas need to be explored to learn and to develop insights into and recommendations for present-day applications of his theories. These insights can help business managers become more effective in situations involving the "rapidly expanding range of equipment, applications, services, and basic technologies" (Keen, 1991, p. 98), known as information technology.

Managers today are facing a major change in the way business is conducted as a result of information technology. The magnitude of this change parallels that of industrialization in the early part of the 20th century. The uncertainty existing today, however, is how this transition will be made to meet the growing demands of an information-oriented society. Industrialists learned how to use and manage the new machinery effectively with the help of Frederick Taylor. Improved production through emerging processes such as the assembly line increased volume and reduced costs in creating and meeting product demand.

Information technology is changing the way goods and services are produced and delivered much the same as the industrial plants of the prior age did. Similarities between the two periods need to be explored. One of the obvious differences between the two periods is the computer that replaced the machine, yet the common factor is the effective application of the new technology.

In 1911, Taylor's "principles of scientific management" were disseminated as a remedy for inefficiencies resulting from the rapid transition of industrialization. Eighty-five years later, efficiency (the effective application of time and money toward production) has again become a topic of management attention and concern, especially because of the proliferation of computer technology in the business environment (Stoner, 1978). The origin of the principles that evolved from Taylor's theories may provide insight for managing in today's changing environment. The application of Taylor's scientific management principles combined with the use of information technology may have an effect on workplace efficiency. These principles have provided a substantial foundation for business and industry throughout the current century. Because businesses are again struggling with efficiency, the essence of Taylor's ideas and approach may once again provide the catalyst for change.

Background of the Problem

In the late 1800s, a major change--the Industrial Revolution--occurred that was similar in magnitude to today's information revolution. Responding to these major changes, Theodore Roosevelt announced, "The conservation of our national resources is only preliminary to the larger question of national efficiencies" (Taylor, 1911, p. 5). This priority emphasis on efficiency was later echoed in the remarks of Drucker (1995), establishing a link between the two periods. Although industrialization began in the early 19th century, it flourished in the United States during the latter part of that century. Industrialization changed the world in much the same way as computerization is changing the world today. Because of the rapid, changes occurring during industrialization, organizations lagged in their ability to use and, more importantly, manage the changes efficiently (Stoner, 1978).

Periods of dysfunction usually accompany great change. During this period, cities were rapidly growing, and the production plants were proliferating at a startling pace. Because of these changes, productivity and efficiency in the plant suffered. Before the transition from an agrarian to an industrial economy was complete, the emphasis shifted to controlling the new power and improving the processes created by the machine age and automation. Taylor recognized the need for improvement and embarked on the development of methods of management that changed the world.

No formal means existed for providing order and creating efficient work processes at the time. Taylor responded to the opportunity by devising his "Principles of Scientific Management" to further develop the concepts of productivity and efficiency. Contemporaries, such as Frank and Lillian Gilbreth, Henry Gantt, and others, were inspired by Taylor. In response to the inability of managers to manage the large numbers of new factories efficiently, he analyzed work processes scientifically and made adjustments that would promote greater efficiency, productivity, and profit for both company and employee.

The success of Taylor's work is a matter of record. He helped to create the discipline of scientific management based on the understanding of the dynamics of work processes and methodologies for improving them. In its simplest form, this approach provided the means for improving employee productivity when applied to work processes. The overall efficiency of the organization improved during the industrial period (Stabile, 1987). Modern management began at this time, helping organizations to impose order and to become more efficient.

Appropriate application of Taylor's principles can minimize the cost of human capital and thereby positively affect performance. Improved efficiency ratios therefore become a measure of an organization's level of efficiency (Butler, 1991). Currently, however, with a labor force that is changing from industrial to information workers, efficiency has been associated with the opportunities available or created from the introduction of information technology.

Unfortunately, critics are questioning the value of these technical resources and whether there is an effect on efficiency (Salomon Brothers, 1996). Because computer systems are scientifically engineered to automate routine, mundane tasks, the deployment alone might create the needed efficiency. Although the engineering of technical systems incorporates some of the elements that Taylor espoused, the results indicate that improved efficiency does not occur simply from deployment. Management must actively be involved with the application of information technology in order to achieve its full potential.

Taylor's principles may be viewed as critical success factors for improving efficiency in the organization. Although these principles were very effective at the time they were developed, are they still applicable in today's changing environment (Stoner, 1978)? How can these principles be used in conjunction with the proliferation of information technology designed to accomplish the same goal? Is another set of critical success factors needed to effectively manage business processes today?

Efficiency does not occur naturally in the business world. Human intervention is a requirement regardless of the deployment of information technology. Specific factors that may positively or negatively affect efficient operations and methods used to improve efficiency are necessary ingredients for the development of critical management foci. Taylor's principles, even in their original form, may be applied to work processes involving information technology or modified for particular situations. As Drucker (cited in Tapscott & Caston, 1993) pointed out, although a new type of worker is emerging, productivity will continue to be a management challenge for years to come.

The development of new or revised theories for managing efficiency demands an understanding of the relationship between the use of both scientific management and information technology and the level of efficiency that results. A study of these factors may provide a foundation for understanding reasons or causes for inefficiency. In addition, the degree of similarity between the industrial and information periods may establish a common basis for understanding specific actions and applications today. Ultimately, this may provide a foundation for resolving the efficiency dilemmas in organizations today.

Over the last 30 years, work weeks have increased, not decreased, and efficiency has declined (Bureau of Labor Statistics, 1995). In the banking industry alone, efficiency ratios, which are the measurement of the relationship between operating expense and operating income, have eroded over the last five years (Salomon Brothers, 1996). These results suggest that efficiency should be a concern of management today, at least in the banking industry. Despite these revelations, technology spending continues to increase. In 1993, 45.8% of the total labor force in the United States used computers on the job (Bureau of Labor Statistics, 1995). As an example, banks continue to spend 11% to 20% of operating budgets on information technology (Salomon Brothers, 1996).

Computers were developed to achieve efficiency and thus improve the quality of life by reducing the time spent working. But has this really occurred? Has information technology improved organizational efficiency today?

"Thirty years ago the promise of information technology was that it would stretch our time for relaxation. Instead we find that our time is shrinking" (Stocker, 1996, p. 93). Technology was conceived to do the work of man, thereby creating available time for other pursuits. Unfortunately, the outcome of information technology has not materialized as it was originally envisioned.

The demand today for information technology continues to increase, although little improvement in efficiency, as assessed by corporate financial ratios, seems apparent (Salomon Brothers, 1996). What then is the purpose of information technology? Is the purpose to promote efficiency or to create access to more information, subsequently creating more work? More work can translate into more staff, thus increasing efficiency ratios by inflating both technology and labor spending.

Regardless, businesses are compelled to purchase and implement information technology as a perceived solution to declining profits and/or dwindling productivity. Productivity refers to the level of intensity of output generation (the relationship of input to output). Seldom, however, are behavior and work processes changed as a result of the introduction of technology. The introduction of information technology, without a corresponding change in behavior, may undermine the productivity gains that should result (Feeney, 1976).

When a dynamic change such as information technology occurs in the workplace, a shift in thinking and behaving must ultimately occur. Paradigms are standard ways of thinking and behaving; paradigm shifts challenge these conventions (Tapscott & Castron, 1993). Unfortunately, when change of this magnitude occurs, a corresponding period of dysfunction may develop until the power of a change agent is understood and properly applied. The change agent today is information technology, and the dysfunction occurring is in productivity and efficiency, simply because the corresponding changes in behavior and thinking have not taken place.

Drucker (cited in Tapscott & Caston, 1993) commented that "the single greatest challenge facing managers in the west today is to raise the productivity of knowledge and service workers. Productivity will dominate management thinking for many decades" (p. 6). "Knowledge workers" or "information workers" are terms coined by the United States Department of Labor to describe individuals "whose jobs involve the creation, collection, processing, distribution, and use of information" (Whitten, Bentley, & Barlow, 1994). Because productivity refers to the intensity of output generation, a direct relationship may exist between efficiency (the use of time and money) and the goal (revenue) attained (Feeney, 1976).

Purpose of the Study

The results of the study can be used for future management instruction but can also be applied by practitioners in the field (business managers). Business leaders, managers, and management professors who have an interest in the application of scientific management principles and information technology can benefit from the findings and conclusions of the study. A renewed assessment of Taylor's theories in the world of professional management can be useful for understanding current dilemmas and the challenges confronting management.

Statement of the Problem

What is the relationship between the use of both scientific management and information technology in the workplace and efficiency across selected industries?

Sub-problems include:

1. Is efficiency a current concern of management?
2. What is the level of efficiency in the company?
3. What factors are currently contributing to inefficient operations?
4. What methods are currently used to improve efficiency?
5. Has information technology improved current efficiency?
6. What is the purpose of information technology?
7. Are Taylor's theories currently being used?
8. What is the current level of information technology use in the company?
9. What is the current level of efficiency in the company by efficiency ratio?

Hypotheses

Companies with high information technology use without a scientific management orientation are less efficient than companies with moderate-to-high information technology use and a scientific management orientation.

Null Hypothesis 1 states, The level of information technology use has no effect on efficiency.

Hypothesis 1 states, The level of information technology use has an effect on efficiency.

Null Hypothesis 2 states, Application of scientific management principles has no effect on efficiency.

Hypothesis 2 states, Scientific management application has an effect on efficiency.

Null Hypothesis 3 states, The combination of scientific management and level of information technology use has no effect on efficiency.

Hypothesis 3 states, The combination of scientific management and the level of information technology use has an effect on efficiency.

Rationale for the Study

Causal explanations for efficiency have not been established conclusively from the purchase and deployment of information technology alone (as measured by technology spending) (Bureau of Labor Statistics, 1995). In addition, research has not established that a relationship exists between the use of scientific management principles and technology deployment when compared with efficiency. Because the use of information technology requires changes in behavior, the application of Taylor's principles of scientific management to work processes may have an effect on efficiency through scientific analysis and alteration of work processes, capitalizing on the benefits of technology.

Businesses today tend to focus on information technology as a solution to problems. However, when technology is introduced, the need to analyze and change the work process is often overlooked. Taylor did just that. The theories he developed focused specifically on the work process, changing the behaviors of both manager and employee to achieve efficient operation and maximum performance. Because information technology is powerful, companies may have focused so much attention on the technology that the basics of efficiency management may have been forgotten or overlooked in the process.

The challenge today is to understand and determine how to deal with emerging information technology effectively. Without a clear understanding of the purpose of information technology, technology spending and workloads will increase simultaneously. As a result, reduced work time, less staff, and other anticipated benefits will not occur and efficiency ratios may continue to erode.

Although Taylor's theories have revolutionized management, many contemporary theorists believe that Taylorism is obsolete (Van Tassel, 1993). However, one of the hypotheses of this study states that the application of Taylor's principles in work processes using information technology has a relationship to efficiency. If efficiency is a concern, the discipline emanating from Taylorism may warrant renewed consideration.

Theoretical Base

To analyze the impact of scientific management principles for application and comparison, one must understand the basis for scientific management. The principles outlined below, as developed by Taylor (1911b), form the foundation for analyzing the use and applicability of Taylor's theories today. According to Taylor, scientific management consists of four basic themes:

> 1. Tasks are scientifically analyzed and developed for every aspect of a worker's job. This is a replacement for rule-of-thumb management.
>
> 2. Workers are scientifically selected, trained, and educated on the work that will be done. In the past, this was developed by the worker himself.
>
> 3. Managers work closely with employees to ensure that tasks are completed according to the principles of science previously developed.
>
> 4. Management and workers divide work, almost equal ly between them, based upon the individual better suited for the task. (pp. 36-37)

Taylor's own words (cited in Gilbreth, 1914) best summarize scientific management principles:

> The art of management has been defined as knowing exactly what you want men to do and then seeing that they do it in the best and cheapest way; the principal object of management should be to secure the maximum prosperity for the employer coupled with the maximum prosperity for each employee. Scientific management has as its foundation the conviction that the true interests of the two are the same; that prosperity for the employer cannot exist through a long term of years unless it is accompanied by prosperity for the employee, and vice versa; and that it is possible to give the worker what he wants most--high wages--and the employer what he wants--a low labor cost--for the manufacturers. (p. 1)

From this basic tenet of scientific management, comparisons and applications to present management practice are explored.

Operational Definitions

Scientific management: A management school of thought developed by Taylor in the late 19th century that emphasized the development of a true science of management, the scientific selection of workers, and assignment of tasks for both the development of workers and their relationship to management (Stoner, 1978).

Process reengineering: The name given to the management process developed by Hammer and Champy (1993) in their book, Reengineering the Corporation. Reengineering is "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed" (p. 32).

Industrial Revolution: The period characterized by the growth of factories and manufacturing enterprises beginning in the early 19th century and flourishing between 1870 and 1920. During this period, the percentage of individuals employed in manufacturing and industry increased from 17% to 26%, and the percentage of individuals employed in agricultural-related jobs declined from 50% to 27% of the workforce. During the latter decades of the 19th century, factory foremen positions increased by more than 400% (Tozer, Violas, & Senese, 1993).

Information revolution: The period of time presently occurring (1957 to present), characterized by the number of workers employed in information-related jobs exceeding the number of those employed in industrial jobs (McNurlin & Sprague, 1989). Although the rudiments of this period emerged immediately following World War II, the information period truly began with the development of the microcomputer in the late 1970s. Information workers constitute the majority of individuals who are in the workforce during this era (Whitten et al., 1994).

Paradigm shifts: Changes in standard conventions or ways of thinking and acting, particularly relating to business and economy (Tapscott & Caston, 1993).

Management theory: Thoughts, principles, and approaches for coordinating the activities of a variety of workers to achieve a defined objective (Stoner, 1978).

Efficiency: "The ability to get things done correctly, to achieve outputs or results that measure up to the inputs (labor, materials and time) used to achieve them. The ability to reduce the cost of the resources to attain a given goal" (Stoner, 1978, p. 13). Resources refer predominantly to salaries and other expenses including information technology. The objective of efficiency is the optimal application of time and money toward the production of the output. Efficiency, therefore, is a measure of how effectively the resources are used to produce income for the organization.

Information technology: Information technology is a term used to describe "a rapidly expanding range of equipment, applications, services, and basic technologies" (Keen, 1991, p. 98).

Work processes: A work process is "a collection of activities that take one or more kinds of input and create an output that is of value to a customer" (Hammer & Champy, 1993, p. 35). The process, therefore, is the totality of the actions dedicated to achieving a particular objective. The process itself consists of individual tasks, structures, and people.

Productivity: Productivity refers to the intensity of output generation. Since outputs refer to the products produced, the rate produced shows the level of productivity occurring (Feeney, 1976). Productivity is the ratio of output produced to the amount of input (Boyes & Melvin, 1991).

Efficiency ratio: An efficiency ratio is a measure that compares the cost of production with income derived from such production. As in the "efficiency" definition, two elements are involved--inputs and outputs. The inputs are the resources used, and the outputs are the income generated from this application. Components of the efficiency ratio include operating expense (labor, materials, supplies, computer expense, and other miscellaneous expenses) and operating income. The efficiency ratio is calculated by formula and results in a percentage (operating expense/operating income). The net result shows the efficiency with which the organization is generating operating income (the cost to produce one dollar of revenue). For example, if the efficiency ratio is 60%, the company spends $.60 to produce $1.00 of revenue. The lower the percentage, the more efficient the organization is, by definition.

Organization of the Research

Chapters 2 through 6 identify, in depth, the historical setting of the industrial period, Taylor and the origin and development of the "principles of scientific management," the evolution of management theory and productivity management, and a review of the information period today. These chapters constitute the literature review for the study. Individual chapters are provided to expand upon each of the topics that, for the most part, outline the variables in the study (i.e., application of scientific management, application of information technology, efficiency/productivity, and historical foundations).

Chapter 7 provides the methodology for the research conducted. Chapters 8 and 9 present the findings from the research and summary and conclusions, respectively.

CHAPTER 2

REVIEW OF RELATED LITERATURE

A primary purpose of the literature review is to understand what has been done and to use this to introduce the study (Tuckman, 1988). The review of literature for this study is organized into four separate and distinct chapters. Each chapter focuses on a particular variable defined in the study or on information necessary for answering research questions leading toward the outcome of the study. In addition, the research study involves a historical comparison between the industrial and information periods to expand upon what is presently known about the dependent variable efficiency and how it relates to each period.

Literature Sources

The sources used for the review of literature consisted of topics involving scientific management application and development, industrial and information periods, efficiency and productivity in business today, information technology, Frederick Taylor, and contemporary management theory. Literature sources have been gathered from dissertations and dissertation abstracts, Carl uncover (for journal articles), business periodical index (for scholarly journals), and the Illinet library card catalog of publications.

Outline of the Literature Review

The following provides a review of chapters, the topic emphasized, sources, and purpose for each chapter under the literature review.

Chapter 3: Historical Setting and Foundation

This chapter reviews and establishes the historical foundation of the industrial period in the United States. The research is integral to the study because this is the period during which Taylor developed and successfully used his principles of scientific management. The chapter review consists of the categories and subtopics stated below.

Overview and Importance of the Industrial Period

This overview establishes the relationship of the chapter to the research. In addition, the impact of the industrial paradigm shift on the period is explored.

Background of the Industrial Period

This section is a historical perspective on the origins of the industrial period in the world and its emergence in the United States. The Industrial Revolution had a pervasive impact on the world, both then and now. The changes which occurred as a result of this are reviewed and analyzed.

The Rationale for Efficiency

Efficiency became a major concern of the period, resulting from the rapid and significant changes brought about by the new technology. This section establishes the need for efficiency and productivity in the new factory paradigm and the basis for exploring some of the problems experienced during this period.

Factors Affecting Efficiency

During this changing period, specific factors emerged that contributed to inefficient operations. These factors are identified and analyzed. The need for efficiency and productivity during this period is also researched to establish the origins and urgency for resolution.

Taylor as Facilitator of Change

Taylor was a key figure during the industrial period. A review of his relationship and importance to the new paradigm and the role he played during this period is explored. The sources from which this foundation is developed are taken predominantly from historical textbooks on western civilization and dissertations.

Chapter 4: Taylor and the Principles of Scientific Management

Taylor was a major figure affecting this country's success during the industrial paradigm shift. Prior to the onset of the industrial period, the United States was a nation of craftsmen and farmers, ill-equipped to deal with the demands of mass production and the burgeoning changes affecting the century. Frederick Taylor was effective during this period in helping industry make the transition into a new age of prosperity.

Because Taylor was successful during the last paradigm shift, his importance to the present change is timely. The chapter's review consists of the categories and subtopics stated below.

Overview

The initial overview reviews how Frederick Taylor relates to this research and the importance he had on the industrial period. This section establishes the foundation for the development of the theories he contributed and the factors influencing their development.

Background

This section is a historical review of Taylor's early training and development. The review provides a foundation for understanding the individual and the precipitating factors which may have led to the development of his theories. His early academic background as well as the beginning of his professional career is studied, again establishing the foundation for the development of his theories.

The Principles of Scientific Management

The actual principles contained in Taylor's theories are analyzed. This provides the framework for understanding the principles of scientific management.

Critique of Taylor's Theories

Taylor's theories met with considerable success but were also subjected to significant criticism. The specific critiques and their origins are presented and analyzed.

Taylor's Impact on the Management Profession

Scientific management defined the field of professional management. The pioneer efforts of Frederick Taylor and the effect they have on the perpetuation of this new professional field of management are outlined.

Taylor's Impact on the Information Period

Taylor's impact on the current information period is presented. This section provides a foundation for this relationship and the effect these theories may or may not have for managing today.

The sources utilized in the literature review include biographies of Taylor as well as profiles of his personality and motivations for developing his theories. Primary readings include Taylor's own manuscript on the development of the principles of scientific management, letters, experiments, and critiques of his theories. In addition, journal articles of specific experiments and commentary on the principles of scientific management are reviewed. Finally, dissertation abstracts involving the application of his principles in various scenarios are reviewed.

Chapter 5: Productivity and Efficiency Management

Because the purpose of the research is to evaluate and understand efficiency and productivity during the present era, this chapter reviews the state of the art of productivity management theory today. Management theory has evolved since Taylor's time from fads and theories, such as Management by Objectives (MBO), participative management, and matrix management, to reengineering. To develop recommendations for managing efficiency in the future, it is necessary to understand current thought. The chapter consists of the categories and subtopics as stated below.

Overview

The initial section establishes the purpose and relationship of management theory and productivity management to the research. This provides a foundation from which Taylor, the industrial period, and the information period are linked. Additionally, the current state of the art of productivity in the United States and the concerns thereof are reviewed.

Background/Historical Foundation of Management Theory

A historical review and perspective is provided regarding the development of management theory in the period since the industrial period in the United States. This section outlines the phases of development as well as important contributors to management theory.

Productivity Management Elements and Theories Management

Productivity is a major objective of the process of management. Productivity also is directly related to the efficiency of the organization. The components of productivity management and theory as well as the present views on the topic are reviewed. This establishes a foundation for analyzing methods for improving efficiency and productivity in the workplace.

Relationship to Efficiency

Productivity theory and its mechanics are reviewed in conjunction with the effect on and relationship to efficiency. Because efficiency is a key variable in the study, productivity analysis provides a foundation for this relationship.

The sources of literature considered are dissertations, management publications, and journal articles involving the analysis and use of various theories.

Chapter 6: Information Technology and the Information Revolution

One of the foundations of this research is to understand the impact of information technology on efficiency in the workplace. Because information technology is the catalyst precipitating the information paradigm shift, it is necessary to understand the state of the art of the industry. Information technology has caused tremendous change in the way we live today. Because the demand for information is constantly growing, rapid technological enhancements and upgrades necessarily result, making it difficult to remain current.

Because the changes occurring from computerization are pervasive, an understanding of the magnitude of such change is imperative. The categories and subtopics for this review are stated below.

Overview of the Current Period

The information revolution, similar to the Industrial Revolution, represents pervasive change. This section reviews the relationship of the new paradigm--information--to the research and establishes the basis for rapid growth and use of information technology in the world today.

History of the Information Era

The origins and the factors affecting the emergence of the information period are reviewed. A number of significant advancements and technological developments occurred during this period, rivaling those of the inventions of the industrial period. These advancements as well as their significance are outlined and reviewed.

Paradigm Shift Implications

The information period, similar to the industrial period, is marked by a shift in paradigms. This section explores the implications of the paradigm shift occurring today and what effect this is having on efficiency in today's society.

Application of Information Technology

Information technology continues to develop at a rapid pace. The application of information technology and its understanding and critical nature is reviewed to establish the need to effectively apply the new technology. Application is emphasized as an important consideration in this process and therefore is analyzed.

Use of Information Technology

This section provides an overview of the current state of use of information technology by industry today. Actual budgets are reviewed, and concerns and specific trends in expenditures of various industries are outlined.

Efficiency and Information Technology

The relationship between efficiency/productivity and the use of information technology is reviewed. This is a key relationship in the research but is also important to establish or raise issues for measurement of efficiency. Based upon the significant usage of information technology, are present efficiency measures appropriate for analyzing the results obtained?

The sources utilized emphasize the latest in technology and its application in this current period. Journal articles as well are reviewed for analysis involving the magnitude of technological change.

CHAPTER 3

HISTORICAL SETTING AND FOUNDATION

The Industrial Period

A review of the Industrial Revolution establishes a foundation for understanding the magnitude of change affecting the United States at the time and how this might relate to the changes taking place today. The last great change to take place in this country (and the world) was industrialization. This transition, having only occurred within the last 100 years, saw tremendous advances and changes that challenged all previous modes of life. Within the span of 30 to 50 years, major advances were made in lighting, telephone communication, automobiles, airplanes, railroads, and numerous others. All of these advances continue to affect lives even today, yet at their onset, they created major upheaval as well as major opportunity for the improvement of daily living.

Although the technology of the Industrial Revolution was less sophisticated than advances occurring today, the impact on both daily living and corporate production may be similar. Change is change regardless of the time and the events precipitating the transition. How people react and embrace change merits analysis. Knowing and understanding how the changes in the industrial period were ultimately assimilated may provide insight into efforts to understand and assimilate current changes.

The primary objective today, as it was then, is to control and take full advantage of the advances occurring. As Baker (cited in Nelson, 1980) commented about Taylor during the industrial period, "It was no small matter when a man arises who can show us new ways of commanding our environment" (p. 199). Taylor saw this opportunity and developed and implemented theories for taking command of the new environment. The success achieved by Taylor may be instrumental in understanding and gaining insights for achieving the same level of control today.

Barker (1992) refers to a new paradigm as a time when a society's ability to resolve problems is at its lowest. Because of such a new paradigm, as in the industrial period, the culture has neither grasped nor commanded the changes that are occurring such that the ability to resolve problems at a more advanced or accelerated level is enhanced. Consequently, a review of the industrial period is important in understanding today's paradigm shift.

Background of the Industrial Period

Although the Industrial Revolution can be dated to the late 17th century, it was not until the late 18th century (1770) that productivity changed dramatically, marking the first stage of the Industrial Revolution (Schaeffer, Resnick, & Netterville, 1970). The magnitude of change brought about by industrialism mirrored that of a "revolution," altering the economic equilibrium between agriculture and industry. The Industrial Revolution can be characterized as the "substitution of machinery for hand labor in many manufacturing processes" (Ferguson & Bruun, 1969, p. 637). This "revolution," although devoid of gunfire or physical upheaval, embodied the essence of its meaning. A revolution generally represents dramatic and pervasive change of a fundamental nature, impacting large groups of people. This change affects how people live, work, think, and even govern. The Industrial Revolution was such a time. Fueled by the emergence of the machine, countries rich in natural resources such as iron ore and coal dominated the industrial world. England initially outproduced the rest of the world combined. However, by 1914, the United States surpassed England, gaining stature as the industrial leader of the world (Schaeffer et al., 1970).

This transition was one of the most significant changes affecting the world at the time, establishing new standards and forever changing previous conceptions of the production of goods. Before this period, the world was predominantly agrarian. As industrialization expanded in the United States in the late 19th century, the percentage of the labor force employed in agricultural pursuits declined significantly from 50% in 1870 to 27% in 1920 (Tozer et al., 1993). During this same period, the manufacturing labor force increased from 17% to 26%. Skilled craftsmen and artisans were becoming obsolete as the demand for unskilled factory labor was at a premium.

From the onset of industrialization through 1900, the population in the United States tripled (Schaeffer et al., 1970). This startling growth in population occurred as a result of the outcomes of industrialization. Travel became less difficult and more commonplace, permitting easier access to medical attention and other emerging advances in technology. The emergence of the railroad system facilitated the transportation needed to provide people with the technological benefits of the age. By 1890 one third of the population in the United States lived in cities (New Grolier Multimedia Encyclopedia, 1993).

Jane Addams, founder of Hull House, characterized the era in her own words: "Perhaps no presentation of history is so difficult as that which treats of the growth of a new consciousness" (cited in Smith, 1984, p. xvi). The new consciousness was a way to describe the changes in thinking and behaving caused by the new technology and machinery. During this time, the United States was adjusting to this new consciousness or paradigm.

Economically, the production of goods was rapidly increasing due to the opportunities caused by the significant gains in productivity that occurred. Machinery became the change agent of the time, facilitating rapid enhancements in productivity. The magnitude of the opportunities available as a result of this machinery is evident in its sixfold displacement of hand labor on record (Smith, 1984).

The new technology of the time included machines and labor-saving inventions. Inventions were proliferating at a pace of about one every 15 months in the United States during the period from 1870 to 1920 (Tozer et al., 1993). Presumably, the objective of this onslaught of inventions was to save time in man-hours. As Henry George, a contemporary of the time, commented in 1879, "It had been natural to expect that at the beginning of this marvelous era that labor-saving inventions would lighten the toil and improve the conditions of the laborer" (cited in Smith, 1984, p. 200). Although to some degree this occurred, with the emergence of the factory system and resulting management structure, the reverse actually took place, as will be explained later in the chapter.

By 1870, the United States was emerging as a major industrial nation because of the application of mass production techniques. Factories became the natural setting for implementing these new techniques (Tozer et al., 1993). Because the demand for unskilled labor to assemble parts in a mass environment was at a maximum, workers and their families flocked to the cities. By 1930, one fifth of the world's population resided in cities, representing "one of the greatest social transformations in human history" (Schaeffer et al., 1970, p. 259).

During this period, inventions and other innovations continued to create remarkable opportunities for the common man. Electricity, the electric light bulb, Bell's telephone, electric railways, and alternating current all contributed to major life changes. Within the span of a few short decades, the ways people traveled, lived, and worked were on the verge of being totally altered by such inventions. As the century ended, the country was poised for production, with the automobile and the airplane yet to come in the early days of the new century.

Henry Adams, the first professor of American history at Harvard University, regarded the age as one of the creation and utilization of energy. He further believed that this new energy was out of control (Smith, 1984). Harnessing this energy became more than a challenge as evidenced by such factors as the proliferation of the factory system and the population growth of cities. In many ways, the speed with which change was occurring gave little time for reflection and planning but ample opportunity for fortune.

As industrialization spread from England, the United States and Germany emerged as the industrial leaders by the first decade of the 20th century (Schaeffer et al., 1970). The United States led in the development of mass production techniques while Germany led in the advancement of science.

During this period, the factory became the new arena for the production of goods. Using the inventions, machinery, and new technology of the time, "the efficient exploitation of human and natural resources on a worldwide scale made possible an increase in productivity that is without precedent in all history" (Schaeffer et al., 1970, p. 259). This truly was the dawn of mass production and, conversely, the demise of the craftsman. Prior to 1870, the predominant mode of manufacturing was the craftsman. From 1870 to 1890 factories became the primary mode of production, increasing in number from 50% to 80% by 1890, all but eliminating craftsmen from the labor force (Tozer et al., 1993).

With the substantial growth in the number of families and city populations, the size of the labor force increased tremendously. Of even greater importance during this period was the substantial increase in the number of factory foremen or management. Within the span of 10 years (1890 to 1900), the number of foremen increased 400% from 90,000 to 360,000 foremen (Tozer et al., 1993).

Increasing numbers of foremen were needed to manage the huge numbers of workers coming together in the factory. As this occurred, the need for organizational change became apparent. The structure of shop management at the time was not conducive to the new demands of the era.

"Contemporary shop management was like some ingenious mid-19th century machine, an ad-hoc reaction to the needs of the moment rather than as a result of careful design and systematic application of science to utilitarian needs" (Nelson, 1980, p. 12). This statement captures the spirit of the time and the emerging problems of factory management. The lack of planning was characteristic of the intense desire to capitalize on the moment, often accompanying rapid change. Only later was this weakness recognized and addressed by Taylor.

Opportunities created by utilizing new technology were offset by growing problems with labor (Nelson, 1980). Although fortunes were being amassed by many entrepreneurs, an undercurrent of opportunity lost was festering on the shop floor. The new labor force required more effective management strategies.

Efficiency: The Watchword of the Time

After 1870, the flurry of inventions created many opportunities too new yet to understand or to recognize potential for future applications. Entrepreneurs proliferated at the time, fostering overnight changes. By the year 1900, the number of millionaires far exceeded the levels at 1850 (from 300 to 300,000), demonstrating the climate of opportunity available to enterprising entrepreneurs (Angel, 1995).

During the first decade of the 20th century, the growth of factories, as well as the influx of immigrants, brought people to the city. The country, at the time, was not ready to deal with such a massive influx of people. With increases in city populations doubling and tripling in the span of 10 to 20 years (1900 to 1920), the country was confronted with a new problem, consumption. With 73% of the labor force employed in nonagrarian industry (factories), workers themselves became a large consumer group (Angel, 1995). Demand for goods and services was not only created by the latest inventions of the time but continued to increase at a startling pace.

The changes that occurred were staggering. Numerous inventions, advances in medicine, and developments in transportation resulted in dramatic changes in consumer behavior. What emerged was a sizeable middle-class population that demanded much by way of goods and services. By 1920, agriculture was replaced with business and industry as the dominant force (Tozer et al., 1993).

In order to capitalize on growing demand, machine owners began to focus on methods to provide goods to the large middle class. The production of such goods needed to be at optimal levels to stimulate sales to the growing middle class. Henry Ford had such a vision. Providing the common man an affordable automobile required the ability to produce the car at a lower cost. Using an assembly-line concept, Ford increased the amount of output and, therefore, lowered his costs. This emphasis and recognition of the need for reducing costs, decreasing time, and increasing overall output became known as efficiency.

The speed with which factories occurred and grew caused efficiency to lag. Only after factories were established was it obvious that this new power was not well utilized and that greater opportunities were available through more attention to direction and control. In order to survive, companies had to concentrate on getting the most output from the resources employed. Efficiency became the "watchword" of the era and affected many organizations in their pursuit of production.

"The new machines changed conditions in the handicraft trade so radically and multiplied the output so enormously that the accelerating consequences resulting from the industrial revolution still dominate our modern civilization" (Ferguson & Bruun, 1969, p. 637). Because of this rapid growth in production, the nature of management and work had to change. The world was quite illprepared to effectively manage or control the volume of production brought about by the new technology. In order to produce at the rate demanded by the populace, schedules had to be met. Time became increasingly more important, requiring workers to begin and end work based on the clock. Foremen became very authoritarian, inspecting production and monitoring worker starting and ending times (Schaeffer et al., 1970).

During this transition in the growth of factories and cities, industrialists (machine owners) began to concentrate their energies on methods for increasing the efficiency of the worker (Tozer et al., 1993). Efficiency became such a concern of the time that President Theodore Roosevelt emphasized the nation's efficiency as a priority over the conservation of natural resources, the latter of which became his legacy (Taylor, 1911b).

In the early days of the new century, an aggressive merger movement occurred that created industrial firms of considerable wealth and size (Stabile, 1987). The Sherman Anti-Trust Act, passed in 1890, attempted to prohibit the creation of monopolistic giants that could unfairly restrain trade (Clark, 1992). Although this act ultimately was repealed, a recognition of the potential power of industrial giants began to emerge as a concern. Frank Doster, Kansas leader of the Populist party, at a Labor Day speech in 1894, declared:

> Although steam, electricity, and compressed air are utilized to do the work of man, they have been made the monopoly of the few. In the face of the power offered by monopolies of these tremendous engines of industry and commerce the republican and democratic parties stand paralyzed--hypnotized. As it were, unable to control it or give direction and shape for common good. . . . The failure to adapt the legislation of the country to the strange conditions which this new life has forced upon us is the cause in greater part of our industrial ills. (cited in Clark, 1992, p. 46)

The changes occurring, although substantial, created a sense of dysfunction or a questioning of the motives and direction of the country. Without appropriate legislative action, corporations could forge ahead virtually unchecked.

As corporations continued to merge and combine, unwieldy industrial giants were created seemingly overnight. This growth mandated an even more intense focus on efficiency. Without more efficient methods for producing output, opportunities in this "gilded age" would be lost.

Efficiency became more than a means of optimizing production; it became a means of survival. Efficiency connotes how well resources (time and money) are applied toward the production of a defined output. Although one of the new technologies, electric lighting, was of considerable importance to the factory, the structure of the management system remained an issue (Nelson, 1980). The new technology, particularly the machines, created almost unlimited opportunities; however, the workers facilitated the output. Because mass production techniques generally were the foundation upon which factories were built, both workers and foremen became critical elements for the effective and efficient production of goods for sale.

With a dysfunctioning management structure in the factory, labor problems continued to worsen. Workers, disgruntled with conditions, engaged in the restriction of production, often in blatant sabotage, dependent upon the severity of the conditions (Nelson, 1980). At the heart of the problem were poor working conditions, physical abuse, and a series of other management issues surrounding shop foremen. Since foremen had total control, they proceeded to wield considerable power and to enforce their own brand of punishment or reward.

Unfortunately, as efficiency grew in popularity, a phenomenon known as "soldiering" occurred. "Soldiering" was a term used to describe a situation when workers began to deliberately hold back production, doing less than could be accomplished (Wrege & Greenwood, 1991). This occurred when machine owners cut piece-rate amounts when daily earnings became too high. By holding back on production capability, piece-rates would remain constant (Nelson, 1980).

The efficiency "craze" defined the time. Machine owners began to concentrate on improving efficiency as a means of capitalizing and keeping up with the demand of the rising middle class. Taylor concentrated his energies on the workplace and the work process. He was the first to analyze efficiency from a scientific viewpoint and to standardize this approach for application in many areas. The principles of scientific management that he developed were applied in a wide range of endeavors.

The dramatic events that took place during this period, with the development of machines and inventions, created not only changes in the way goods were produced but also behavioral changes. These changes were not only pervasive but required monitoring for proper application of resources. The new technology and the opportunities created therefrom were not immediately understood nor fully controlled. For this reason, Frederick Taylor saw an opportunity to develop a method for providing efficient control and direction of output.

Factors Affecting Efficiency

In many ways, the difficulties stemming from the period were centered around the organization and structure of factory management. Labor in great masses came together so rapidly that standard methods for managing and producing output were not immediate concerns. Foremen ruled the factory. Management, therefore, became one of the predominant factors affecting efficiency. Management techniques were not standardized, nor did they take into account any specific foundation in science.

As previously indicated, power in the factory was originally decentralized to shop foremen. Standard structures for factory management were nonexistent. Foremen were responsible for their own methods, which created a wide variety of styles for managing production in the factory at the time. Without organized programs of management techniques, foremen were free to experiment with whatever method they felt achieved their ends. At the time, the only gauge of success was the amount of money generated for the machine owner. Uniformity in the factory did not actually occur until late in the 19th century (Nelson, 1980).

Because of the ad-hoc nature of management and execution of duties, efficiency suffered. Although production remained high due to the capability of the machines, so too did the costs of production.

Taylor observed some of these difficulties in his early experiments. He not only focused on the scientific development and management of the work activities but also the flow of work, the physical layout of the factory, and the specialization of duties for shop foremen. Analyzing the entire work process and making appropriate changes resulted in efforts at organization that translated into improved production on a consistent basis.

Taylor embraced and recommended standardization wherever possible. He recognized that by standardizing work processes and business practices, a manufacturer could capitalize on the "best" method for producing the output at the least cost. At the time, this was becoming imperative because of the growing demand for products created by the period. As consumption increased, especially in the cities where large volumes of people lived and worked, more products were in demand. Organizations that survived were those best able to keep up with the demand while optimizing the cost of producing the product without going out of business.

During this time standardization began to grow in popularity in the business office as well as the factory. Basic office products such as stationery, forms, and other supplies were standardized to avoid time-consuming, costly individuality that previously had been the norm (Mackay, 1985).

During this period, record keeping also became a necessity in order to effectively run the burgeoning businesses that evolved from the development of the new machines. Office efficiency became increasingly important, with the proliferation of paper in the form of transaction documentation, invoices, and other necessary documents for growing businesses. According to Robert H. Montgomery, author of A Complete Guide to Modern Systems and Practice in 1911 (Mackay, 1985), archival paper documents were not particularly necessary for analyzing business decisions early in the new century. However, as the century progressed, archiving records and documents became a necessity. Establishing "precedents" could only be accomplished by quick and accurate access to historical documents.

Efficiency and factors affecting efficiency took many forms at the time. Within the shop, the management structure and the analyses of work processes typically affected the efficiency of the operation. In the office, the most pressing need of the time became the ability to file and rapidly retrieve the growing number of paper documents.

Safety also began to emerge as another issue of the time. With the massive growth in new industries and expanding factories, safety emerged as a concern for both workers and the enterprise. Foremen and managers began to analyze the merits of scientific management to promote safety in the shop (Stabile, 1987). By scientifically analyzing and developing efficient work processes, management believed that a direct relationship existed between efficiency and factory safety for the worker. In short, safety could be encouraged by ingesting it into the work process through the scientific analysis of such processes.

Within the business, office furniture, too, was not without scrutiny. The classic rolltop desk saw its demise during this period of time, virtually disappearing from most progressive shops by World War I (Mackay, 1985).

This type of office furniture was cumbersome and did not lend itself well to production. Rolltop desks, furthermore, permitted workers to hide work, making it difficult to manage work flow and plant capacity.

In an effort to promote efficiency in production, the office began to evolve in a manner similar to the layout of the shop floor. Paper had to be filed and organized in such a way as to promote easy retrieval. Office furniture and tools had to be designed to optimize employee time and promote productivity and efficiency. Time became increasingly important, especially in its relationship to money.

From the proliferation of technological developments (inventions) and new machines, machine owners built factories to facilitate the production of their unique products. As the employee base grew, so did the number of foremen. Standardization in the way people were managed began to evolve. As new companies grew in size, the office also began to be a focus of attention. New methods were needed to promote productivity for moving and managing paper as well as the best use of time and money. File card systems and improved ledger systems evolved to organize data efficiently during this period (Mackay, 1985).

Efficiency did not occur naturally in the process but grew out of necessity. Many factors that would be considered deterrents to efficient production, however, did not become evident until the need presented itself. With the startling pace at which inventions occurred, industrialists flocked to capitalize on the new technology with little thought to the efficiency of its utilization. Such was the time. Enough opportunity existed that the talents of a Frederick Taylor were not immediately required. Yet to continue as "going concerns," new competitive industries recognized that improved ways were needed to produce products at lower costs to stimulate greater demand as well as remain competitive with other industrialists.

Taylor as Facilitator of Change

Taylor emerged from the industrial period in the United States as the father of modern management. Because of the massive changes occurring during this period, he saw opportunity in the need to control the power of the new technology. Taylor did not focus on inventing new technologies but on applying the technology more effectively. To that degree, he capitalized on the dysfunction created by the change in paradigms, the new technologies, and the dramatic increases in production.

Frederick Taylor created a science of management, needed because of industrialization. Since the country had no prior model for the changes that were occurring, individualization prevailed. With few controls, the production in the plant ultimately suffered. When change of the magnitude of the Industrial Revolution occurs, people tend to deal with the changes in ways familiar to them, even if those ways are incorrect for the new situation. "Rule-of-thumb" was the prevailing style of management. Unfortunately, "rule-of-thumb" management was not effective in the factory because more than one worker was involved and responsible for production. Taylor understood this and sought to eliminate "rule-of-thumb" management by focusing on standardizing work for the "one best way" of doing things and then controlling the standardization to ensure that it was properly applied all the time (Kakar, 1970).

In short, Taylor developed the methodology for facilitating order and control from the changes occurring during the industrial period. His guidance helped to create and foster the growth of industrial giants and to help others to succeed over time. His relationship to this most important age was that of a facilitator in the creation of methodologies that imposed order amid dysfunction and helped the country to move through the new paradigm being experienced in the age of automation.

Summary

The industrial period produced significant and pervasive change for the United States and the world. Beginning in this country in 1870, the Industrial Revolution produced numerous inventions and technological enhancements which not only changed the way business was conducted but had a significant effect on daily life. The advances that took place were precipitated by the development of machines. Machines and the automation that occurred prompted the development of the factory system and, subsequently, mass production.

The world changed dramatically as a result of the events occurring during this period. This change in paradigms saw the transition of the American economy from an agricultural to an industrial society. So significant and pervasive were these changes that the efficiency of the nation became a considerable concern. The field of professional management emerged during this period as a result of the need to improve efficiency. Pioneers such as Taylor developed theories that assisted the nation in the transition between these periods to new levels of prosperity. So important were these changes that they are still experienced in business today.

CHAPTER 4

FREDERICK TAYLOR AND THE PRINCIPLES OF SCIENTIFIC MANAGEMENT

Managing today is a challenge because change continues to challenge the ability to effectively and efficiently use resources to their fullest potential, particularly information technology resources. Without a blueprint for success, strategies are often difficult to develop unless a frame of reference exists. The industrial revolution, which occurred in the late 18th and early 19th centuries, provides a reference point. The challenges created and confronted during this period provide a perspective from which to learn.

During this period, Taylor, the father of scientific management, was instrumental in analyzing these changes and implementing methods for applying the new technology. His influence was pervasive and helped shape industrial strength and, therefore, the future of the United States. Taylor's principles of scientific management, developed during the industrial period, provided the structure for enhanced production and efficiency at a time when the power of the new technology was not well applied. Because one of the hypotheses of this research suggests a relationship between the use of these principles and efficiency in the organization, an in-depth look at Taylor's origins, successes, critiques, and development is fundamental to the background of the study.

Biographical Sketch

Frederick Winslow Taylor was born in 1856 in Philadelphia, Pennsylvania. The second of three children of Franklin and Emily Taylor, Frederick grew up in an upper-class household of Quaker descent.

The household environment of Taylor's youth was defined by predominantly Quaker characteristics, consisting of seclusiveness, simplicity, moral fervor, and cleanliness (Kakar, 1970). Both Franklin and Emily Taylor were well educated and sought the same for their children. Originally, the Taylors planned for Frederick to become an attorney like his father and his older brother to become a physician.

His mother was described as possessing an "independent and strong-willed character." She subscribed to the child-rearing philosophies and beliefs of the time that said that "an infant's nature is depraved, willful, and intensely selfish. This must be suppressed by strict obedience training" (Kakar, 1970, p. 16). All indications were that she adhered to this model of child growth and development meticulously. According to Frank Copley (cited in Kakar, 1970), Taylor's official biographer, Emily Taylor developed a method of child training that consisted of work, drill, discipline, and intra-family competition.

Emily Taylor's attention was intensely focused on the development of her two sons. The fervent desire for her boys to be brought up "pure in mind and body" ultimately "robbed her of the joys of motherhood" (Kakar, 1970, p. 17).

The children of the Taylor household were assigned regular duties throughout the home. These duties were expected to be carried out without fail, lest the attention of Emily Taylor be attracted. Her expectation was complete adherence to duty and schedule. Failure to comply, however infrequent, would capture immediate attention and subsequently her displeasure.

Frederick, on many occasions, incurred the disdain of his mother. This initially occurred as a result of his poor spelling ability (until age 14) but also as a result of other shortcomings (Kakar, 1970). From the rigors of this household, it can be surmised that Taylor's compulsive nature originated from the disciplinary style of Emily Taylor.

Franklin Taylor, Frederick's father, had quite the opposite personality of Emily. He was a soft-spoken, cultivated gentleman who enjoyed poetry and history. His nature was reserved, a posture he believed epitomized that of a gentleman, which, he hoped, would transfer to his sons.

In 1872, at the age of 16, Taylor entered Exeter Academy, a preparatory school for Harvard University. Taylor's parents expected Frederick to enter Harvard's law school upon completion of his Exeter training. In his first year, Taylor did not excel as a student but did as an athlete (Nelson, 1980). As a successful pitcher on the baseball team, he was an early proponent of overhand pitching (Wrege & Greenwood, 1991). This, he believed, enabled him to attain greater speed in contrast to the custom of underhand pitching at the time. Additionally, he was a member of the crew and an accomplished tennis player.

In his second year at Exeter, Taylor greatly improved his academic standing. At this time, his interests also changed to mathematics (Nelson, 1980). During his second year, he was exposed to the essence of time study for the first time. Taylor related a story in which Professor George Wentworth created a puzzling challenge for him and his fellow students. The mathematics professor typically assigned lessons that, in Taylor's words, precisely required two hours for completion. This created quite a conundrum for Taylor. How the professor could ensure such precision in completion time for the lessons was beyond his reasoning ability. Taylor later learned that the professor accomplished this by timing each lesson prior to assigning it as a means of guaranteeing such precision. The professor literally completed each assignment himself, taking five readings, and compared this with that of an average student's time. The ratio of his time to that of the students produced the time required to complete the assignment and thus the attained precision (Wrege & Greenwood, 1991). This initial exposure may have foreshadowed his interest in the concept of time study, which later became his legacy.

His fellow students characterized Frederick as a "bit of a crank" (Kakar, 1970, p. 18), meticulous in adhering to all rules for sports or games played. He continued to display an intense sense of self-control and compulsiveness in play. In one example, he was said to have become quite fascinated by the game of croquet in which he painstakingly attempted to work out all angles of play (Nelson, 1980).

With the rigorous discipline of Exeter and his improving academic standing, he passed his entrance exam to Harvard in 1874. At that time, he began to complain of problems with his eyesight and frequent headaches. Depending upon the literature reviewed, his eyesight problems have been the topic of some discussion. Some authors believe the eyesight problems were psychosomatic, emanating from an "identity crisis" (Kakar, 1970, p. 27). This was hypothesized due to a conflict with his planned law career. Others indicated that his problems were strictly physiological. The intense study at Exeter strained weak eyes ultimately requiring correction (glasses). Regardless, Taylor left Exeter in 1874, returning home to convalesce. During this period, it became obvious that Harvard Law was not his calling, and, after much consternation, he shocked his family by accepting an apprenticeship with Enterprise Hydraulic Works in 1874 as an apprentice patternmaker and machinist (Kakar, 1970).

Taylor's parents recanted their original intentions and quickly encouraged an academic pursuit of engineering. This, unfortunately, was not his immediate direction. Taylor believed an apprenticeship was his best course of action and would afford him the type of education he could not obtain in school.

Driven by the puritan work ethic and the influence of his uncle, Caleb Taylor, a bank president, Taylor embarked on a rapid course of learning during the apprenticeship. He literally worked for no pay his first year, $1.50 per week the second year, $2.50 per week the third year, and finally $3.00 per week the fourth year (Nelson, 1980). This arrangement, Taylor stated, was acceptable, given his family financial status and the fact that he sought to exchange wages for speed of learning. Apprenticeships were fast becoming obsolete because of the amount of time demanded by apprenticeships. Taylor took advantage of this diminishing opportunity to obtain what he perceived to be a necessary education (Kakar, 1970).

In 1878, Taylor completed his apprenticeship and joined Midvale Steel Works as an unskilled laborer, an important move for Taylor. For the next 12 years, Taylor progressesd as a mechanical engineer through various positions and experiments conducted at Midvale Steel Works. During these years with Midvale, Taylor perfected the time-study and the differential piece-rate system.

Taylor continued his academic education while employed at Midvale. In late 1879 or 1880, he entered Stevens Institute of Technology in Hoboken, New Jersey, and arranged a home-study program that permitted him to work, study at home and take final examinations with the regular students (Nelson, 1980). Although this was an unusual approach to pursuing a degree at the time, he nevertheless graduated in June 1883 with a mechanical engineering degree, having never attended a single class on record.

Midvale provided an inspiring environment for Taylor's professional growth. He began as a common laborer and left, in 1890, as chief plant engineer (Schacter, 1989). Taylor benefitted significantly from the scientific expertise of key individuals such as Charles Brinley and Russel Davenport, superintendent and general manager respectively, while at Midvale. However, William Sellers is the individual who permitted Taylor the freedom and latitude to conduct experiments. William Sellers was the president of Midvale Steel and the country's most noted engineer at that time (Kakar, 1970).

In 1878, Taylor was promoted to subforeman of the machine shop; it was the first management position he held (Iron Age, 1897). During his tenure as subforeman, Taylor learned firsthand the dynamics of production, output, and direct interaction with factory workers. The decentralized nature of factory management of the time permitted foremen much freedom to "drive" production. Taylor, like other foremen, sought to do the same, as well as to make an impression on factory management with increased output. Shortly thereafter, a battle ensued between Taylor and his workers for a period of two to three years as a result of this demand for increased production. During this period, dismissals occurred, threats were made on his life, and equipment sabotage occurred (Nelson, 1980).

Although Taylor reacted as any shop foreman would have at the time, he affixed great importance to the event. This importance was twofold. According to Taylor, as a result of this ongoing struggle, "he devised a 'scientific' piecework system that reconciled the manager's desire for increased production and the worker's desire for a higher wage" (Nelson, 1980, p. 33). Secondly, as a relatively new supervisor, Taylor saw firsthand the dysfunctional state of factory management in its decentralized form (Nelson, 1980). These two important events ultimately led to the development of scientific management principles. To others, these events were typical occurrences of a normal factory system. For Taylor, they were challenges and manifestations of a dysfunctional system that presented an opportunity for change.

As a result of this conflict, Taylor developed a system to reconcile the interests of both management and worker. This revelation was somewhat prophetic in that it kindled Taylor's drive for understanding the dynamics involved in productivity enhancement. Two elements evolved which later would become key elements in his principles of scientific management: (a) a desire to meet or work toward common goals that met the needs of both management and worker and (b) the scientific development of a piecework system. This may have been an early foreshadowing of the "mental revolution" which Taylor later believed must occur (Sashkin, 1981).

Following this milestone conflict, Taylor's career at Midvale began to progress at a rapid pace. His appointment as a machine shop foreman marked a turning point in his career objectives. Having achieved a level of concurrence in output and stability, Taylor was able to step back and analyze the issue more objectively. He concluded that "the main trouble . . . is that you have been quarrelling because there have been no proper standards for a day's work. . . . the great thing is we do not know what is a proper day's work" (Kakar, 1970, p. 216). Upon arriving at this realization, Taylor understood the need to develop standards for each task or activity. He then embarked upon a campaign to identify production standards through experiments to learn the time required to perform various tasks (Kakar, 1970). The experiments Taylor devised consisted of detailed time-motion studies for the tasks performed and the time required for completion. The development of these standards would ultimately be instrumental in the elimination of "soldiering" on the shop floor (Kakar, 1970). In addition to analyzing the work process, Taylor applied the scientific method to the tools used by employees. While at Midvale, Taylor performed detailed experiments on metal-cutting tools. Using this approach, improvements were made to these tools that facilitated increased production (Nelson, 1980). The results of these experiments revealed that "round-nosed" cutting tools could be run at much higher speeds and for longer durations than traditional diamond pointed tools, thereby increasing their productive capacity (Wrege & Greenwood, 1991).

During this period, Taylor found himself in a highly motivated and enthusiastic state, most likely as a direct result of the success he was attaining. He remarked, "My head was full of wonderful and great projects to simplify the processes, to design new machines to revolutionize the methods of the whole establishment" (Nelson, 1980, p. 20). These significant events marked the dawn of scientific management and propelled Taylor on a path of continued experimentation and analysis.

Early Development of Taylor's Theories

Taylor emerged from the industrial period as a leader in the development and analyses of methods for managing and performing tasks. Stimulated by the inefficiencies inherent in the production process, Taylor embarked on a path to "scientifically" evaluate and analyze work processes, studying the one best way to perform tasks. This concept, though greatly simplified, identified the depth of his thought and his contributions to industry. Although his theories, in some respects, were regarded as eccentric, he nevertheless attracted a wide following. Individuals such as Dean E. F. Gray of the Harvard Business School described Taylor and the development of scientific management as "promising to be the most important advance in industry since the introduction of the factory system and power machinery" (Kakar, 1970, p. 1).

Taylor and his followers were often labeled as "efficiency experts," caught up in the efficiency craze of pre-World War I America. This designation, unfortunately, minimizes the significance and importance of his contribution and its subsequent effect on the world. Indeed, his legacy incorporates a pervasive influence on most industries domestically and abroad, even spreading to industrialized nations such as Russia, Poland, England, Germany, Italy, and France (Kakar, 1970). These countries, as emerging industrial powers, migrated to scientific management out of the need to "organize management" and to capitalize on the financial benefits available through the effective application of the new technology (Knouse, Carson, & Carson, 1993).

Taylor's theories were used widely. The underlying concepts of his theories defined management as a science, paving the way for an emerging profession. Henceforth, management gained stature as a recognized profession, later becoming an academic offering in the university.

Early in his career, Taylor observed and pursued more effective methods for performing tasks in the process of producing outputs. As an observer, he noted that a significant change had occurred in the world and that outdated methods of completing tasks could no longer be used effectively. The new automation paradigm, in conjunction with the factory system, changed production processes significantly. This paradigm, unfortunately, was not immediately recognized. In many instances, companies grew overnight, providing ample opportunity for a variety of disparate work processes to emerge in pursuit of production. Because of this rapid industrial growth and the decentralized management structure, foremen and workers performed work in the ways they knew best, using the old "rule-of-thumb" paradigm.

Understanding that a change was taking place was as important as the outcome. Taylor recognized this change and understood that a vision was required to define completely different methods of management and work flow. This understanding was a critical first step for a new vision to emerge.

Taylor knew that, prior to the industrial revolution, the predominant mode of production was the involvement of skilled craftsmen and artisans. These individuals produced an entire product from start to finish. In an industrialized world, this process became ineffective due to the cost and time required to produce the output. Furthermore, lengthy apprenticeships were required to attain the requisite skill level. The transition from skilled to unskilled factory work, demanding increased speed in production, created a conflict between the two. Already factories were striving to produce more at less cost. Taylor's observation and subsequent implementation of scientific management eliminated unnecessary steps and maximized the use of time. A new science of management emerged that was unique, at first, to the factory. The concept of scientifically analyzing and defining the "one best way" of completing tasks became the underlying philosophy behind Taylor's principles of scientific management. This concept became so fundamental and widespread that "many of his ideas are now looked upon as so self-evident as to be a part of normal industrial practice" (Kakar, 1970, p. 2).

In his single-minded endeavor to improve productivity, Taylor has often been criticized for using methods that were considered dehumanizing and lacking in concern for the workers of the time. In particular, time-motion studies were challenged and later banned by the United States government as detrimental to the work climate (Nelson, 1980). Although this controversy continues today, few regard Taylor as a humanist. Ironically, Taylor was very concerned about the relationship between management and worker. In fact, he emphasized methods for improving this relationship in his theories, believing that the goals of both management and worker were the same:

> What is called for is a complete mental revolution on the part of workers and on the part of managers, such that both take their eyes off the division of profit and together turn toward increasing the size of the profit, until it becomes so large that it is unnecessary to quarrel over how it shall be divided. (Sashkin, 1981, p. 206)

Taylor did not revolutionize management as much as create a science of management. One of the objectives of his theories (scientific management) was to raise management to the level of a true science (Knouse et al., 1993). Through the development of the principles of scientific management, he accomplished this goal by instituting management as a profession.

Because of Taylor's efforts, management became a profession. Following his death, both critics and followers continued to advance management theory. Such notable theorists as Frank and Lillian Gilbreth, Henry Gantt, Henry Fayol, Elton Mayo, Douglas McGregor, and Abraham Maslow contributed their own theories to the management profession, building on the momentum created by Taylor.

So pervasive to management and production were Taylor's theories that they continue in use today, even outside the factory. Business offices as well as the armed services, among other disciplines, have benefitted from the application of his theories. His methods and thought processes have stimulated different ideas or views of management and production. Unfortunately, much of the criticism today emanates from Taylor's own written descriptions of experiments that were conducted, often precipitating negative reactions to his theories. In one such experiment he described the required mental qualifications for efficiently handling pig-iron as "he shall be so stupid . . . that he nearly resemble in his mental make-up the ox than any other type" (Sashkin, 1981, p. 208). Obviously, this description is subject to criticism. However, the foundation principle behind this description is the critical analysis of the type of individual best able to perform, most efficiently, the routine task of pig-iron work. His analysis was not of the work but rather of the type of worker who had the greatest potential for success (Sashkin, 1981). Implied in this unsavory description is a condition for scientifically selecting the right worker for the right task. The U.S. Army, for example, learned that the type of individuals best suited to be fighter pilots have been short, stocky, individuals. Their compact physical stature minimized the period of unconsciousness in flights where gravitational forces were considerable. This typically occurred during combat engagements requiring intensive evasive action and maneuvering. A compact physical stature permitted quicker blood flow to the brain, minimizing "black-out" time (personal communication, Brigadier General Michael Sheridan, USMC, Retired, July 1991).

Car manufacturers, such as Toyota, Nissan, and General Motors, have also implemented scientific selection of workers for their enterprises. Toyota initiated the use of tests to determine the qualifications of individuals for virtually all positions in the organization. Fourteen hours of testing is conducted such that "we're going to know more about these people than perhaps any company has ever known about people" (Butler, 1991, p. 23). These examples illustrate the process of scientifically analyzing the "right" person for the job as well as analyzing the task. This testimonial further defines Taylor's importance and contribution to the management profession as it continues in various forms today.

The Principles of Scientific Management

Scientific management principles began to emerge from Taylor's experimentation and first-hand plant observations while at Midvale Steel Works. After his initial revelations of the need for standards or knowledge of what constituted a proper day's work, the rudiments of scientific management began to evolve.

The factory system, as established, emerged as a result of machine processes (Nelson, 1980). The factory created the setting for mass production, technological change, and other benefits emanating from the industrial era. Yet at the same time, the factory system and its decentralized management structure created the labor and production problems that quickly followed. Although this new production arena was critical to the industrial paradigm, success was achieved through the efforts of Taylor.

Taylor provided a foundation for his theories in two written publications, Shop Management (1903) and The Principles of Scientific Management (1911). These two primary sources defined the new theory of management and provided the guidelines for its proliferation in industry. Taylor believed, and sought to prove, that management was a true science (Knouse et al., 1993). This concept originated from a disdain for the prior "rule-of-thumb" method of management.

According to Taylor (1911b), the goal of management "should be to secure the maximum prosperity for the employer compared with the maximum in prosperity for each employee" (p. 9). This tenet of scientific management was radical for the time. The notions that management and workers had the same interests and that mutual prosperity was the goal were difficult to grasp at the time. In many ways this more closely resembled contemporary theories of empowerment today. In addition, Taylor referenced the achievment of the highest level of prosperity by attaining the highest level of efficiency. This suggests a hierarchy of development reminiscent of Maslow's hierarchy of needs and self-actualization.

Taylor's insensitive characterization of workers as "naturally lazy" has served to distort the message or meaning of his theories. Although Taylor frequently described workers in this context, he was beginning to center his attention on actual causes of this behavior.

The problem was not the natural laziness of men (if this exists) but, on the contrary, the inadequacy of the systems established which perpetuated aberrant behavior. Although not well articulated, Taylor was attempting to highlight the human issues of management and workers, not merely the scientific analysis of work processes and tasks. By devising methods to permit workers to control what they could earn, Taylor sought to improve the integrity of the worker. Controlling their output enabled workers to seek naturally to achieve to the fullest and enjoy their accomplishment given the right system (Taylor, 1911b).

As such, the foundation for Taylor's theories emphasized two key areas: (a) the relationship between management and worker and (b) the application of the scientific method to the work process. Taylor rightfully argued for a complete "mental revolution" on the part of both management and worker (Sashkin, 1981). This concept challenged management, in particular, to think differently than they had before in order to capitalize on the benefits available. Taylor understood that in order for improved productivity to occur, active participation on the part of management was a requirement in the process.

This active management participation provided the foundation for his "Principles of Scientific Management." These principles identified four new duties of management, as explained in Taylor's (1911b) own words:

> 1. Develop a science for each element of a man's work, which replaces the old "rule-of-thumb" method.
>
> 2. Scientifically select and train, teach, and develop the workman, whereas in the past he chose his own work and trained himself as best he could.
>
> 3. Heartily cooperate with the men so as to insure all of the work being done in accordance with the principles of science which has been developed.
>
> 4. An almost equal division of the work and the responsibility between the management and the workmen. (pp. 36-37)

In each of the four principles, Taylor espoused direct management intervention and an investment in the worker. Both of these concepts were completely radical and objectionable at the time, derived from first-hand observations, particularly at Midvale Steel Works.

Taylor's personality, given his family background and training, fits positively with the demands of the time: "the right man for the right task" (Knouse et al., 1993, p. 1642). His primary objective was "to convince . . . readers that every single act of every worker can be reduced to a science" (Taylor, 1911b, p. 64). Taylor painstakingly experimented by observing, timing, and analyzing many types of jobs, from pig-iron handling to shovelling. The results revealed comparative information about what laborers earned and what it cost to produce the output. Time and money were again highlighted as necessary ingredients for achieving success. By increasing the output and subsequently the wages of each worker through scientific analysis of the process, savings were achieved by reducing the per-unit cost.

Another aspect of the program was the relationship between boss and subordinate. Taylor indicated that bosses should be viewed as friends, helping workers to learn by teaching, guiding, and generally helping them to be successful (Taylor, 1911b). In other words, the two shared a common purpose toward meeting all of their needs. If bosses help workers to achieve success, workers will earn more. Because the output has increased, the company's costs will decrease, thereby causing profits to increase. Both foremen and machine owners benefit. This is the essence of scientific management. Unfortunately, this concept was revolutionary in Taylor's time.

Taylor's careful description of the positive relationship between boss and worker was better articulated in his writings than on the shop floor. The manifestation of his theories actually produced dehumanizing, mind-numbing work and became the source of criticism of Taylor's theories. He was characterized as "a man whom one would never describe as a 'humanist' after even a casual inspection of his words and deeds" (Sashkin, 1981, p. 206).

Taylor's methods left little unanalyzed in the process. The four basic tenets of scientific management were applied to a complete assessment of the job, including physical movements, tools, equipment, furniture, the process, and the functions of management (Taylor, 1911b). In other words, little if anything was left to chance, eliminating the "rule-of-thumb" management mode referred to so often by Taylor.

Of Taylor's four components of scientific management, only the first--the development of a science for each element of a man's work--emphasized an engineering orientation. Taylor believed success would not be imminent unless the other three components occurred (Taylor, 1911b). This important distinction presupposes that scientific management is not based upon the total de-humanization of the worker. Included in these other tenets is a decidedly human element, demanding direct intervention by management in the process. According to Taylor, only through the combination of all four elements of scientific management will the greatest benefits be derived.

Although Taylor's primary belief was the production of a given product at the lowest cost, he recognized that this could not be an ad hoc accomplishment. One of his greatest contributions to management was the need to separate planning from the execution of tasks (Taylor, 1903). From this basic concept, the development of distinct planning departments evolved in organizations. Taylor believed that the old "initiative and incentive" system was ineffective because it afforded each worker the option of exercising judgement in the performance of tasks (Taylor, 1911b). By permitting this to occur, tremendous disparity in performance occurred, most often to the detriment of the organization. In other words, without systematic or defined planning, people would be free to choose how they would perform the task. This ultimately would result in disparate levels of productivity and a loss in overall efficiency.

Taylor understood the synergistic effect of workers functioning commonly in the most efficient manner possible. This is precisely what he accomplished at Midvale. Taylor described this phenomenon in his writing by comparing the surgeon and the workman. The surgeon, according to Taylor, has been trained to perform tasks in the best way possible as determined from experience, testing, and practice using instruments that have been developed and enhanced over time (Taylor, 1911b). Taylor used this analogy to emphasize that the improvement and development of the work process emanates from the collective experience of the workers. From this foundation, the tasks performed and the tools used need to be modified and improved upon, in close communication to management, to enhance the end result. In concept, Taylor believed management should participate closely with workers in developing improvements to the work process. In practice, however, this was not always well applied.

The development of the principles of scientific management occurred as a result of a lack of information. Factories and their management had few guidelines for the work and/or machine processes they were using. Because of his desire to become a good shop foreman, Taylor challenged his workers to increase production. What he experienced was opposition and dysfunction emanating from a lack of knowledge of the productive capacity of the worker and the tools used (Kakar, 1970). Once he realized this, Taylor initiated a campaign to experiment and discover the boundaries for what constituted a proper day's work. Scientific management surfaced from this initial realization.

Some of the literature highlighted Taylor's intense family background as the impetus that compelled him to ultimately develop the principles of scientific management. This premise may provide deeper insights into the social and psychological motivations instrumental in Taylor's development and life choices. However, the demands of the time were accurately foreseen by Taylor as a need for a "complete mental revolution" (Sashkin, 1981, p. 206), characterizing the change in paradigms taking place.

Critique of Taylor's Theories

Opposing views of Taylor existed in the literature. Sashkin (1981) described Taylor as "a man whom one would never describe as a 'humanist' after even a casual inspection of his words and deeds" (p. 206). This representation of Taylor exemplifies contemporary opinion. Although he is regarded as a true management pioneer, his reputation and fame began to wane during his lifetime (Schacter, 1989). Taylor typically was very critical of politicians, big business, and other humanitarian gestures, especially to workers (Nelson, 1980). He openly and frequently expressed his opinions and biases, leading to opposition and disfavor. Taylor continued to hold to the concept that the primary motivation for workers was money and little else (Nelson, 1980). However, Taylor's theories also emphasized a holistic approach to production, centering around human interaction. Within the four basic principles of scientific management, "he did not completely neglect the behavioral side [but] felt that high wages would generally suffice" (Schacter, 1989, p. 11). Taylor is frequently criticized for his views on motivation, authoritarianism, social factors, and the concept of "men as machines" to the detriment of his theories of scientific management (Locke, 1982).

Conversely, he was considered a true management pioneer and an important figure in the history of management theory. There may have been a natural proclivity to criticize Taylor (or anyone else) who would develop a new process that not only was very successful but spread rapidly worldwide. Prior to Taylor, management as a science or a profession did not exist. As an obvious and visible change agent, Taylor was subjected to intense scrutiny and criticism. Change produces disruption and anxiety manifested in animosity toward the object of change. Although his methods and behaviors may be criticized, the effect they had cannot. Radical change is seldom immediately embraced and, over time, can be subject to further critical analysis given the benefit of hindsight. Today the trend toward "political correctness" has rendered blasphemous many statements from revered individuals, although they were accepted at the time. Taylor's critics today may fall into this category. The criticisms, however, play a role by clarifying their applicability for revealing insights in the understanding of today's management dilemmas. The scope of this research is not to delve deeply into the critiques of his theories but to determine whether they apply today.

Although criticisms exist, a number of writers have defended his theories and reputation. Authors such as Drucker have indicated that Taylor's theories were never clearly understood (Locke, 1982). Taylor's lack of tact, by his own admission, was exploited by his critics as insensitivity to workers, disguising his true zeal for improving productivity (Taylor, 1911b). Locke, Butler, and Schlacter are a few authors who suggested not only current applicability but another look at dispelling the negativity surrounding Taylor's work. Knouse et al. (1993), in their comparison of the theories of Taylor with W. Edward Deming, indicated also that Taylor may have been misunderstood. Clearly, many of his theories were more complex than was the original contention. Knouse et al. postulated that, had Taylor lived longer, he may have revamped his theories of worker participation and motivation. Butler (1991) stated that Taylor probably created some of the misunderstanding of his own theories in his manner of participation. The infamous description of "Schmidt" and the pig-iron experiments is easy to criticize as ethnically biased (Knouse et al., 1993). Yet in reality, this concept challenged managers to carefully select workers based upon their capabilities or opportunities for success (Locke, 1992).

Given the current propensity for political correctness, Taylor's descriptions of his experiments can be construed to be insensitive and dehumanizing. With descriptions like that of "Schmidt" in his writing, Taylor did little to foster his cause, both then and now (Taylor, 1911b).

According to Locke's (1982) evaluation, Taylor's criticisms were categorized as follows:

1. That his concepts of worker motivation were oversimplified, focusing on money as the primary motiva-

tor.

2. A lack of attention to or awareness of social factors in the work environment.

3. An authoritarian approach to management. An absolute belief in authority.

4. Overspecialization of tasks and work processes.

5. Insensitivity of his theories to workers, treating them as automatons or machines.

6. Exploitation of worker productivity.

7. Antiunionism.

8. Dishonesty in reflection on experiments and results.

Based upon these criticisms, Taylor's approach to management was clearly seen as offensive by some critics. Although Locke (1982) systematically challenges the validity of each of these, the toll was clearly taken on him late in his life.

Taylor and unions did not agree. The Watertown Arsenal strike, which occurred late in his life (1911) was an example of such disagreement. The strike represented more of an attack on Taylor and his principles of scientific management than it did on other grievances (Nelson, 1980). The U.S. House of Representatives later investigated the strike. Taylor followed this investigation intently, participating and providing influence wherever possible. Unfortunately, the result was a criticism of time study, eventually leading to other hearings involving the U.S Commission on Industrial Relations. In 1915, a vote by the commission eliminated the use of stopwatches and bonus pay systems in government offices (Nelson, 1980).

The impact of these decisions on Taylor left him exhausted, chagrined, and depressed. In this state, he contracted pneumonia and died in March 1915. This most turbulent time, culminating with Taylor's untimely death, occurred when relations with labor unions were at their worst. Although this created considerable concern for his followers, time eventually settled the furor and helped to solidify his reputation and contributions to management.

Taylor's Impact on the Management Profession

Taylor's contributions to management are enormous, still in use in many forms today. The basic principles he espoused set in motion the field of management and the development of numerous subsequent theories. Prior to Taylor, formalized management did not exist. Through his efforts, a structure emerged. The ideas he developed formed the basis for managerial structure as it continues today. According to Locke (1982), the following ideas and techniques either continue in use or were instrumental in developing others:

1. Scientific decision making;

2. Management-labor cooperations;
3. Time and motion study;
4. Standardization;
5. Task;
6. Goal setting;
7. Management training;
8. Planning departments;
9. Scientific selection of workers;
10. Shorter hours; rest periods; and
11. Bonus. (Locke, 1982, p. 22)

The effect of these ideas was to provide a foundation for management techniques still used 85 years later. Taylor reacted to his environment (Nelson, 1980). He responded to a growing factory system and the dysfunction occurring in the new automation paradigm. Kakar (1970) suggested a psychological commentary that indicated Taylor's inner conflicts caused this creative drive; nevertheless, management theory began with Taylor.

Following Taylor's death, the conflicts subsided and new or renewed interest in scientific management grew. Changes were taking place, and a new cadre of professional managers was emerging to replace the machine owners and other financiers at the upper echelon in companies (Nelson, 1980). These managers generally were steeped in production and favorably disposed to scientific management. The war, too, propelled the proliferation of scientific management together with the personnel movement as complementary to one another.

Although Taylor contributed significantly by engineering tools, one of his greatest contributions may be the understanding of the relationship between manager and subordinate. Taylor clearly outlined the need for managers and workers to work together toward common goals. Although these were key aspects of his principles, in practice, this did not always work, particularly within large organizations. Today, however, needs have not changed. Concepts such as reengineering are reminiscent of a scientific viewpoint of the work process by management. Although reengineering is organized around a process rather than a task, the theories nevertheless are similar.

Taylor's relevance today depends upon the applicability of scientific management principles in an information and technologically oriented society. Although differences exist between the industrial and information periods, Taylor's four basic principles of scientific management continue to be relevant today. Contemporary theorists such as Hammer and Champy, co-authors of Reengineering the Corporation (1993), have emphasized process over individual tasks as critical for successful management today (Gibson, 1997). Although contemporary theories such as these may have evolved beyond scientific management, their foundation flowed from Taylor's theories.

Process versus specialization and division of labor is not a proven solution for efficiency in management. Taylor's importance is derived from the fundamental principles that precipitated the development and evolution of future management theories. Furthermore, the concept of time and its relationship to cost (efficiency) continue in importance as areas of focus. Efficiency ratios, which measure the relationship between operating income and operating expense, are key measures today of a firm's ability to efficiently utilize its resources. With the largest single component of operating expense being salary dollars (human resources), the effective utilization of these resources remains an important consideration in the profitability picture of any company.

Inherent in Taylor's theories was a need for change, a revolution in thinking. Change was required in the way work processes were managed and how tasks were performed to achieve the greatest level of success. This need for improved methods of performing tasks or functions will always be in demand. Even today, although the introduction of the computer can streamline work processes, this will only occur if behaviors are changed to attain the benefits of the technology. Information technology does not eliminate work processes; it changes them by minimizing the manual effort. This only works if the technology is properly applied. To ensure that proper application occurs, the work process must be analyzed and scientifically changed to capitalize on the benefits of technology. This fundamentally is the contribution made by Taylor and provides the foundation for assessment in any area.

The principles of scientific management provide a means for controlling the environment and resolving problems. Control is accomplished in advance by "scientifically" analyzing the work tasks, selecting workers, engaging in cooperation, and creating division of labor (Taylor, 1911b). The rudiments of these basic principles can be found in many industries, work processes, and actual systems today. Computer systems were designed, whether by intent or not, utilizing some of these principles.

Much can be learned from Taylor's theories. Few theories have the luxury of producing factual evidence of their merit as does scientific management. Upton Sinclair once wrote that Taylor "gave about 61% increase in wages, and got 362% increase in work" (cited in Sashkin, 1981, p. 208). Results of this nature are difficult to argue with.

The application of his theories created opportunities for industries to grow and flourish and was instrumental in developing the industrial strength of America at the time. In short, Taylor's importance emanated from his ability to grasp and understand the changes taking place and thus permit companies to control and seek advantage through change. He was a facilitator or transitioner of behavior.

Managers recognize that opportunities will be created if an organization can standardize the performance of the best employees, often referred to as the concept of "best practices." Systems are designed (engineered) today that capitalize on this method of improving performance. A good example of this are the cash registers used in fast-food restaurants. These devices have been engineered to minimize physical motions, key strokes, and mental analysis. The purpose for this development, presumably, is to minimize error and accelerate handling time when traffic is heavy. This method is a direct application of Taylor's first principle: to scientifically improve the cashier's job through increased efficiency.

Because of the present changing paradigm, the need to control the advances in information technology that are occurring is once again important. Taylor facilitated change during the industrial period by providing methods to control the machines and factories. Another facilitator is needed today. Understanding Taylor's background and how he developed his theories may provide a decided advantage when confronting this issue today.

Some of the underlying concepts behind his theories were quite radical, ahead of their time, and actually very humanistic. The essence of scientific management is not the description of the process but rather the "mental revolution" that must occur (Butler, 1991). Taylor understood that this mental revolution must occur in order for success and prosperity to be achieved. Today's challenge is to accomplish this same "mental revolution."

Taylor's Impact on the Information Period

During the industrial period, machine processes facilitated the emergence of the factory system that in turn, influenced the development and application of Taylor's principles of scientific management. In the information period, a similar chain of cause and effect may be occurring. Today, rather than machines or "machine processes" emerging as agents of change, computers or "computing processes" are the primary factors of change. Computer processes, unlike machine processes, produce information rather than products. In this regard, because the outcome of machine processes is "a product," the output of computer processes becomes "information." The arena where this production takes place is the data center, unlike the factory system of the past. What may not be present today in the information period is someone who, like Taylor, recognizes the dysfunction occurring in the work process and develops methods for improvement.

Although the outputs differ between the industrial and information periods (products versus information), the cause-and-effect chain of events may be similar. Table 1 provides a matrix of the potential similarities between the two periods.

Taylor sought to improve the process of production by emphasizing a different way of thinking and managing. By doing this, he literally improved the profitability of the companies he worked with. Although the machine age permitted the proliferation of a wide volume of products, cost ultimately became a concern. The relationship between time and money ultimately became the primary focus for creating value within the company. In a similar way, organizations today incur costs to produce information in varying forms. As in the industrial period, the relationship between the cost of producing the information and the time required is also an issue. The Internet is a good example of the capability of producing information today much as machines produced products in the industrial age. Yet although this tremendous ability to produce information exists, guidance is required to understand how to take advantage of it to achieve or create real value.

Table 1

Similarities Between the Industrial and Information Periods

Category	Industrial Period	Information Period
Source	Natural resources	Raw data
Change agent	Machines	Computers
Arena	Factory	Data center/ network
Process	Management structure/work processes/labor/ furniture/tools	Management structure/work/ processes/labor/ furniture/tools
Output	Products	Information

Taylor applied his innovative mind not only to work processes but also to the management of work processes and the engineering or improvement of work tools. Work processes today rely upon computers; however, they may not capitalize on the application of the technology to achieve benefits effectively. In short, the introduction of the computer into work processes in some cases is an addition to the existing process rather than an opportunity to change the process. Management requires guidance for using the new technology and for evaluating "scientifically" the value of the technology to the organization.

Taylor's focus on increasing the output of each worker through the scientific analysis of the work process actually lowered the per-unit cost of the output. This same relationship may exist today, manifested in the form of an efficiency ratio. The efficiency ratio defines the cost of producing the output. A major component of this formula is operating expense, which includes the following accounts: (a) salaries, (b) fixed assets, (c) technology, and (d) premises. The largest amount of operating expense is, by far, salaries or the cost of human resources. In short, these same cost elements remain the same today as they once were; only the work processes have changed.

Taylor clearly developed and articulated ways to address these issues during the industrial period. Given the need for efficiency today, both the elements and, arguably, the method remain the same. A continued emphasis on efficiency requires that costs be reduced by increasing the output per individual.

Listed below is a an assessment of Taylor's principles and how they apply today.

Scientific Analysis of Work

The fields of industrial engineering and operations research are used today to analyze and improve upon work processes (Stoner, 1978). Fast food chains continue to minimize the time required to process orders. Although not enough of this is done today, the concept remains strong and is needed. An element of this--time study--has become less favorable, although understanding the concept of time in work processes is a recognized need in the production processes (Belcher, 1987).

Scientific Selection and Training of Workers

The fields of human resource management and industrial psychology are used today as standards to procure the right individuals (Locke, 1982). Companies such as Toyota and Nissan, as reflected by Butler (1991), indicate the levels of evaluation used to select the "right" individuals for the job. For Toyota, all levels of employment receive no less than 14 hours of testing to ascertain "job fitness." This particular aspect of scientific management has proliferated over the years.

Cooperation Between Management and Workers

Today, the very latest in management theory frequently calls for managers to "coach" workers and encourage their success. The reengineering movement today speaks directly to this (Hammer & Champy, 1993). Senge (1994), in his book The Fifth Discipline, also outlined the need for lifelong learning and a sharing role with management and employee.

Division of Labor

Although the concept of division of labor is often criticized as obsolete, it continues to endure today. Managers are trained to plan, to organize, and to control, and staff are instructed to perform the tasks in the work processes. This division continues to exist in the workplace today (Stoner, 1978).

The basic principles of scientific management, however they were intended, have withstood the test of time. The previous illustration indicated that a place still exists for the application of these principles. The question remains whether they are truly applied in the ways Taylor intended.

Efficiency appears to be an issue once again today. A wide volume of management theories are currently in existence. Production, management, technology, and efficiency all remain popular topics or issues. Although these challenges persist, an understanding of the innovation and impact of Taylor's work during the industrial period can help illuminate what must be done today. The problem remains very perplexing. With the constant and frequent advances in technology, jobs and personal lives should become much simpler. Instead, work hours have not declined, and overall efficiency has become questionable at best.

Logically and in practice, Taylor's principles are hardly obsolete. Unfortunately, how they are interpreted and applied may be distorted. The application of Taylor's principles met with great success during the last great change in paradigms. A reassessment of these principles and their development may provide enlightenment or, at least, an understanding that greater interaction must occur in order to meet the needs of today.

Since Taylor, a number of management pioneers have advanced the science of management. To understand the applicability of scientific management today and/or to develop a new set of principles requires an evaluation of the development and state of productivity and production management. Present theories continue to evolve, particularly because of the ever-changing technological environment. The next chapter explores the state of the art of productivity and production management today and those theories instrumental in addressing these most important issues.

Summary

Taylor had tremendous influence and effect on the fields of professional management and management theory. His theories and the principles he developed provided the foundation and impetus for continued evolution of new theories throughout the 20th century.

This chapter provided an overview of Taylor's origins as well as his early experiments and studies. In addition, the actual principles he developed were explored in detail, including criticisms and shortcomings of his theories. Scientific management provided a considerable foundation for many organizations and countries in order to improve efficiency and productivity. The importance of these concepts has captivated the attention of numerous management theorists throughout this century.

The next chapter outlines the history and foundation for the evolution of management theory. This includes a timeline on which Taylor's theory as well as contemporary theories are placed. In addition, the evolution of productivity and the elements which are a part of it are also explored.

CHAPTER 5

THE EVOLUTION OF MANAGEMENT THEORY AND PRODUCTIVITY

As outlined in depth in the previous chapter, professional management began with the pioneering theories developed and implemented by Frederick Taylor. Over the past 90 years numerous other theories and schools of thought have evolved, promoting professional management in both industrial and business settings.

Management implies control and direction. The field of professional management evolved because of a need to provide control and direction for the industrial processes and outputs occurring therefrom. This need was precipitated by the demands placed upon controlling and directing the elements of cost, output, and time. These same elements are also important considerations for calculating, analyzing, and monitoring both efficiency and productivity.

This chapter is a critical ingredient of the complete study. To formulate conclusions about effective management practices in the information period, management theories and the concept of productivity must be reviewed and understood. Productivity, which is the relationship between output and the required inputs, is closely related to the dependent variable of the study, efficiency (Belcher, 1987).

Both efficiency and productivity describe work processes. Because efficiency is measured by the relationship of operating expense to operating income, there are a number of similarities to productivity. One such similarity is human resources. The amount of output produced has a direct relationship to the people who produce it. In this regard, productivity refers directly to the intensity of output produced by human resources using the raw material, equipment, and technical resources available to them (Belcher, 1987). The effective application of these resources in concert indicates the level of productivity. Therefore, the efficiency ratio actually is a measure of inputs and outputs, or productivity, by definition.

Drucker (cited in Tapscott & Caston, 1993) declared that productivity "will dominate management thinking for many decades" (p. 6). Because productivity already has dominated management thinking and precipitated numerous theories, a review of the literature relative to these theories of productivity and management is vital to the results of the research. The question implied in this research, however, is how to manage today, especially with the abundance of technical resources available. The measures currently used to assess productivity and efficiency, unfortunately, have not revealed the desired result, thereby producing concerns. This is especially true with advancing information technology that, presumably, was designed to improve productivity and/or efficiency.

One of the more powerful examples producing this concern is the poor performance in national labor productivity over the last 30 years (since 1965). Productivity is defined in this context as the output per hour of all persons for the business sector (Bureau of Labor Statistics, 1995).

The annual percent change in productivity by decade over the past 100 years is shown in Table 2. This is measured on the basis of the ratio between gross domestic product (GDP) and number of hours worked or paid (GDP/hours) (Bureau of Labor Statistics, 1995).

This concern is clearly illustrated in Table 2. Although productivity is increasing annually, the rate of change has significantly declined since the 1960s. What is most disturbing to economists is the average annual change over the last 20 years. This period of time is defined by the proliferation and rapid advancement of microcomputer technology. Yet during this most technically prolific time, productivity rates have drastically slowed. Only recently has this begun to rise (first quarter 1997 productivity growth annualized indicated a

2.9% change) (Bureau of Labor Statistics, 1995).

Table 2

Average Annual Change in Labor Productivity
(Percent Change) in the United States
(GDP/Hours)

Period (years)	Average Annual Percent Change			
	Business	Nonfarm	Mfg.	Average
1890-1899	2.35	2.68	1.60	2.21
1900-1909	1.92	2.16	1.43	1.83
1910-1919	1.99	2.34	1.40	1.91
1920-1929	2.42	2.35	5.71	3.50
1930-1939	1.67	1.71	2.43	1.94
1940-1949	2.70	2.17	1.44	2.11
1950-1959	3.54	2.82	1.92	2.76
1960-1969	3.40	2.92	2.80	3.04
1970-1979	1.99	1.79	2.91	2.23
1980-1989	1.26	1.05	2.73	1.68
1990-1996	1.03	0.91	2.70	1.55

Results of this nature have both puzzled and concerned economists and businessmen, raising questions about future trends. Although many theories have been advanced there is no one cause that can be cited. Some possible explanations include: "increased government regulation, the changing industry mix of our economy, declining expenditures for research and development, changes in composition of the workforce, and complacency of American managers" (Belcher, 1987, p. 7).

What is important to this research, however, is that the decline in productivity growth occurred simultaneously with the greatest period of technical advancement yet seen. This begs further analysis because the changes taking place are not unique to the United States. The world, too, has transitioned to the information age. Unfortunately, when compared with other industrial nations, the productivity of the United States does not fare well. Of the top six industrial nations between 1960 and 1986, Japan led with an annual average growth rate of 5.5%, compared with the United States at 1.1% (Belcher, 1987).

Because productivity growth is such an important indicator of a country's overall well-being, when productivity growth dropped substantially after 1965, economists became very concerned. Among other factors (labor quality, education level, quality of education, and demographic change), technological innovation has been closely monitored as affecting overall productivity. According to economists, technology alters productivity (Boyes & Melvin, 1991). The reason for this is technical innovations; when innovations occur, productivity increases. There is a correlation between technical expenditures on research and development and the discovery of new knowledge; as one moves, so too does the other.

At the time of this decline in productivity growth, expenditures on research and development had declined considerably. As research and development spending eroded, the number of patents awarded also began to decrease (Boyes & Melvin, 1991). Economists indicated that this drop was attributed to decreased spending on research and development and subsequently a decrease in technological innovation. During this same period, productivity (as measured by the Department of Labor) declined, corroborating the economic view that technological advancement plays an important role. Technology, in this context, is used broadly to refer to technical innovation. However, even though research and development expenditures may have decreased during this period, information technology was evolving at a rapid pace. The 1980s and 1990s, in particular, were defined by the microcomputer and networking technologies. Unfortunately, the advances in these technologies and their subsequent proliferation have not led to substantially improved output per hour. Although the 1990s have not been distinguished by dramatic productivity improvement, the trend may be shifting (Bureau of Labor Statistics, 1995).

Productivity, therefore, is related both to labor quality and technological innovation (Boyes & Melvin, 1991). Because of this, management is once again elevated in importance. Analysis of the elements of both productivity and management theory requires renewed attention because of the addition of a new dimension of resources requiring management--technical resources. Understanding the history and foundation of management thought provides a basis for determining the requirements and the demands for managing in today's information age.

Background/Historical Foundation of Management Theory

Throughout history various forms of management have been used to accomplish labor-intensive and time-sensitive tasks. A basic fundamental of management involves directing the work of others. However, for this research, the review of management history is limited to the industrial and information periods (1900 to present). During this period, a number of management theories and schools of thought emerged, emanating from Taylor's significant foundation. The historical review provides a brief overview and timeline for each of these theories as well as their origins and underlying concepts.

According to various management texts, management and organization theory are categorized into four basic schools of thought:

1. Classical School: Scientific management and classical organization theory;
2. Behavioral School: Human relations;
3. Quantitative School: Operations research; and

4. Integration School (Stoner, 1978).

A recap of the history of these management theories is provided in Table 3. No specific school of thought has been defined specifically for the contemporary period. However, a number of theories have emerged that merit consideration in addition to the four basic schools of thought.

Classical School

The classical school emerged during the late 19th and early 20th centuries. Although the need to manage people and/or work processes has been around for some time, this was not formalized until the late 19th century when management began to evolve as a true science. The classical school of management, which prevailed for a number of years, was precipitated by the demands of an industrialized nation (Van Tassel, 1993). During this period, factories were built to house the new machines and to facilitate production. The demands created by mass production required new methods for maximizing production and improving efficiency. This created the need for new behaviors to ensure accomplishment of this goal.

Forerunners of scientific management who emerged during this period were Robert Owen and Charles Babbage. Robert Owen was a manager of a number of cotton mills in Scotland. He sought to improve productivity by focusing

Table 3

History of Management Theory by School of Thought, Theorist, and Area of Focus

School/Theorist	Year	Area of Emphasis
Classical School		
Owen	Early 1800s	Worker as vital machine; reform; increase production.
Babbage	Early 1800s	Division of labor; improve factory efficiency; assembly-line concept/development.
Taylor	1890-1915	Scientific management; task, scientific selection/training of workers; differentiated pay rate.
Gantt	1900-1919	Pay for production; focus on motivation; public rating of employees.
Gilbreth, F.	1900-1924	Time-motion; fatigue reduction of workers.
Gilbreth, L.	1900-1972	Help workers reach full potential as human beings through scientific management; promote welfare of the worker.
Fayol	1900-1925	Classical organization theory; definition of management; formal training of managers.
Transitional School		
Follett	1920-1930	Abandoned formal authority; managers assigned based upon most knowledgeable.
Barnard	1920-1961	Informal groups important in the workplace; individual needs must be kept in balance.
Behavioral School		
Munsterburg	Early 1900s	Industrial psychology; psychological influence to achieve efficiency; psychological testing and guidance.

(continued on following page)

Table 3 (continued)

School/Theorist	Year	Area of Emphasis
Mayo	1920-1940s	Human relations movement; first industry research experiments; social satisfaction of the individual.
Argyris	1950s-present	Work environment; minimize competition; encourage decision making.
MacGregor	1950s-present	Theory X and Theory Y.
Maslow	1950s-present	Hierarchy of needs; self-actualization.
Likert	1950s-present	Participative management.
Quantitative School		
No names	1950-present	Operations management; specific tools (i.e., PERT, CPM, network modeling, queuing theory).
No names	1950-present	Management information systems; integration of the computer.
Integration School		
No names	1950s-present	Systems theory approach; comprehensive view of the whole.
No names	1960s-present	Contingency theory approach; school of thought applied to specific situation.
Contemporary Theories		
Deming	1980s-present	Quality management; customers need focus; 14 principles for quality improvement.
Drucker	1950s-present	MBO.
Ouchi	1980s-present	Theory Z.
Peters	1980s-present	Excellence in management.
Hammer/Champy	1993-present	Reengineering; enabling power of information technology.

on the worker and the conditions in which he worked. Although not a humanist, his work emphasized reform that he believed would ultimately improve production (Stoner, 1978). As early precursors to future theories which involved working conditions, Owen's theories advocated output improvement through the satisfaction of basic needs (working and living conditions).

Babbage, on the other hand, approached productivity improvement scientifically. Distinguished as the father of the computer, Babbage sought productivity improvement through division of labor. Trained as a mathematician, his precise nature led to precision in production using concepts such as the assembly line (Stoner, 1978). Although neither Owen nor Babbage lived to see scientific management put in action, they nevertheless contributed to its development.

Scientific management emerged with the work conducted by Taylor. Taylor's emphasis was on the task, focusing on improved productivity through pay for production. His theories centered around four basic principles, consisting of: (a) the development of a science for every task of a worker's job, (b) the scientific selection and education of workers, (c) the careful monitoring of tasks to ensure they are carried out based upon the principles of scientific management, and (d) cooperation between management and workers (Taylor, 1911b). Taylor, as a pioneer of modern management, later became known as the father of scientific management. The origin of future theories may be traced to the foundation work developed by Taylor.

Other contributors to the field of scientific management included Henry Gantt and Frank and Lillian Gilbreth. Gantt worked with Frederick Taylor at Midvale, Simonds, and Bethlehem Steel. He is most known for the chart that he developed for production scheduling known as the "Gantt chart." As a proponent of paying for performance, his theories differed slightly from Taylor's differential piece-rate system (Stoner, 1978). Gantt was more of a humanist than Taylor. His focus was on systems to motivate the worker, recognizing that the key ingredient for improved performance was morale. Although his theories included a tendency towards humanism, Gantt nevertheless was viewed as a classical management theorist.

The Gilbreths contributed an enhanced understanding of the nature of time and motion. Frank Gilbreth regarded motion and fatigue as directly related. If unnecessary motions were eliminated, fatigue on the job would be reduced (Stoner, 1978). The Gilbreths, like Gantt, were contemporaries of Taylor, developing and enhancing their theories in the early decades of the 20th century. Lillian carried on the work of Frank following his untimely death in 1924. Although she worked closely with her husband on time and motion studies, she later began to focus her studies on the welfare of the worker.

Another contributor to the classical management stage was Henri Fayol. Fayol was part of the classical organization theory movement. His contributions focused on the development of guidelines for effective management practices in the workplace. Fayol also was a contemporary of the other classical theorists but directed his efforts towards communication. He believed that managers could be taught to manage and that managerial ability was not innate. In particular, Fayol is known for the components of management he identified that formed a basic definition of management (Van Tassel, 1993):

1. Planning--developing plans of action.
2. Organizing--organizing resources to accomplish the work.
3. Commanding--conducting meetings and conferences to maintain a focus, knowing and working with staff and providing leadership.
4. Coordinating--facilitating and linking activities towards achieving common goals.
5. Controlling--executing the plan.

Because Fayol believed that management talent would be in continual demand, he considered the need to teach prospective managers important for any growing business.

To facilitate this, he outlined 14 basic principles of management that he believed were important for management development (Stoner, 1978):

1. Division of labor,
2. Authority,
3. Discipline,
4. Unity of command,
5. Unity of direction,
6. Subordination of individual interest to the common good,
7. Remuneration,
8. Centralization,
9. The hierarchy,
10. Order,
11. Equity,
12. Stability of staff,
13. Initiative, and
14. Esprit de Corps (Stoner, 1978, p. 42).

Fayol helped to shape and contribute to the development of management as a profession through the identification of these principles.

Transitional School

Transitional theorists emerged from a foundation in the classical management school to direct management theory towards the behavioral school of thought. Two prominent individuals who emerged were Mary Parker Follett and Chester Barnard. Although both management theorists clearly had roots in classical theory, particularly scientific management, they each defined new aspects of management theory which characterized them as transitional theorists.

Follett believed that although managers and subordinates had a relationship founded on a common purpose, this was not entirely effective. She theorized that the effectiveness of the manager should be derived from his or her superior knowledge, not simply based on the formal authority of management (Stoner, 1978). The manager would be accepted more readily by the staff out of respect for their knowledge and competence. This concept, although closely related to Taylor's concept of division of labor (based upon the jobs people were best equipped to handle), provided the underpinnings of a relationship founded on ability, taking into consideration the worker's perception of the manager.

Barnard (cited in Stoner, 1978), on the other hand, focused on the dynamics of organizations. He recognized that workers were members of informal organizations that were important in satisfying basic needs. For a formal organization to be successful, the company needed to maintain a balance with and a recognition of the informal organization. Barnard later delineated between "efficient" and "effective" with respect to success in the organization.

> When a specific desired end is attained, we shall say the action is effective. When the unsought consequences of the action are more important than the attainment of the desired end and are dissatisfactory, effective action, we shall say, is "inefficient." When the unsought consequences are unimportant or trivial, the action is efficient, . . . what we mean by "effectiveness" of cooperation is the accomplishment of the recognized objectives of cooperative action. The degree of accomplishment indicates the degree of effectiveness. (Van Tassel, 1993, p. 105)

Obviously, Barnard was leaning toward an emphasis on human relations as well as emphasizing the importance of both formal and informal organizations. The cooperation that resulted from these organizations was the foundation from which positive results occurred.

Behavioral School

The behavioral school evolved from the limitations of classical theory, particularly scientific management. Although the goal remained the same (production and efficiency), a recognition emerged that other refinements were necessary because of the challenges of working with people.

Scientific management produced phenomenal results; however, as time progressed, these results became less predictable. The behavioral theorists, as a result, attempted to introduce both sociological and psychological concepts into the theories, emphasizing both individual and group dynamics (Stoner, 1978). This produced an emphasis on human relations in management.

The behavioral school of thought produced a number of theorists who were instrumental in the evolution of management theory. The earliest of these were Hugo Munsterburg and Elton Mayo.

Munsterburg was formally educated in psychology, having both Ph.D. and M.D. degrees. His emphasis was on industrial efficiency through psychology. The basic theories he developed emphasized increasing productivity in three ways:

> 1. Find the best possible man whose mental qualities identify him as best qualified for the job.
> 2. Create the best possible work that is ideal psychologically for increasing production.
> 3. Create the best possible effect by psychologically influencing and motivating employees (Stoner, 1978, p. 46).

The first two reflect a strong Taylor influence. These principles were written in 1913, shortly after Taylor's Principles of Scientific Management was published. Munsterburg was one of the first to discuss psychological testing and guidance for selecting and placing employees for specific jobs. In addition to Taylor, Munsterburg was also influenced by Freud, incorporating these theories into the beginnings of a new field of industrial psychology.

Mayo, with his foundation in psychology and sociology, developed the human relations movement. The rationale for his theory was that effective management would occur from an understanding of the reasons why people behaved in certain ways. Human relations management would result from this understanding thereby increasing morale and subsequently promoting efficiency.

The origin of Mayo's theories occurred with the results obtained in the now-famous Hawthorne studies (Stoner, 1978). From 1927 to 1932 he, along with several colleagues, conducted a study of human behaviors at the Hawthorne plant of Western Electric. By manipulating a number of variables in a factory experimental production group, Mayo and his associates sought to determine which factors might be influential in improving productivity. What they found was that both control and experimental groups demonstrated increased productivity regardless of the variables manipulated. The conclusion was drawn that the special attention given affected the behavior and not the conditions manipulated. As a follow-up to the study, Mayo and his associates interviewed the employees who participated in the study. The results of these interviews revealed that the informal relationships maintained on the job were very important for improving productivity (Stoner, 1978). This conclusion was similar to Barnard's theories, which also espoused the importance and influential nature of informal groups and their effect on productivity.

Aside from these results, another important contribution made by Mayo was the use of scientific research in an industrial setting (Van Tassel, 1993). Western Electric's Hawthorne plant was the first formal study conducted during that time.

The human relations movement of the behavioral school helped to shape and provide an understanding of the social environment that exists in the workplace. In addition, this movement helped to improve upon classical theories by emphasizing the human dimension as an important consideration for improving productivity. Unfortunately, productivity results were not as had been expected, remaining relatively unpredictable.

The behavioral school of thought continued to flourish with the contribution of theorists such as Douglas MacGregor, Chris Argyris, Rensis Likert, Abraham Maslow, and Frederick Herzberg. These individuals, unlike Mayo, were more formally trained in the social and psychological sciences and focused more on behavioral aspects rather than human relations. Generally, the behaviorialists believed that more of a "self-actualizing" approach stimulated motivation rather than a "social approach" for improving productivity in workers (Stoner, 1978). This concept, well-defined later in Maslow's writings, emphasized employee needs at various levels within a hierarchy. By satisfying the lower level or basic needs, higher level needs become evident, leading toward self-actualization and motivation. Once managers understood this approach, methods could be used to motivate employees depending upon their position within the hierarchy of needs.

Douglas MacGregor defined management in terms of two distinct orientations, Theory X and Theory Y. Under Theory X, the organization perpetuates a negative opinion, characterizing workers as lazy, reluctant to assume responsibility, requiring direction, and mentally lacking. Theory X is an authoritarian orientation that permits little interaction and feedback. Theory Y, on the other hand, is the ideal approach (Van Tassel, 1993). Workers are viewed as vital, taking responsibility, bright, energetic, and interested in the organization.

Argyris focused his efforts on the work environment. He believed that by minimizing competition and encouraging employees, particularly in decision making, negative factors would disappear. His rationale was that increased responsibility and involvement in decision making breeds contentment (Van Tassel, 1993).

Likert believed, as did Argyris, that employee participation in decision making was imperative. This notion was based upon the theory that involvement precludes resistance. By allowing employees to participate in decision making, those same employees helped to shape the result which they, in turn, would implement. Likert described this approach as "participative management." He further identified four types of organizations:

1. Exploitative authoritative,
2. Benevolent authoritative,
3. Consultative, and
4. Participative (Van Tassel, 1993).

The ideal, of course, for Likert was the participative organization.

Maslow defined a hierarchy of needs and the concept of self-actualization. By establishing basic and higher level needs of people, he provided managers with a means for motivating employees through need satisfaction. Maslow's hierarchy of needs can be used as a tool for understanding and correcting employee motivational problems (Van Tassel, 1993).

Herzberg, through interviews, defined jobs in terms of satisfiers or dissatisfiers. Satisfiers are motivators, whereas dissatisfiers centered around maintenance factors (Van Tassel, 1993). He identified satisfiers as achievement, recognition, responsibility, advancement, work itself, and growth, and identified dissatisfiers as company policy, administration, supervision, worker conditions, salary, status, interpersonal relationships, job security, and personal life.

MacGregor, Argyris, Likert, Maslow, and Herzberg clearly presented an intense focus on the individual. Although the behavioral approach has contributed significantly to the understanding of the individual, not everyone performs in expected ways. Questions have also been raised on the adequacy of these theories for truly understanding human motivation (Stoner, 1978).

Quantitative School

The next phase of management development evolved from methods employed by the military services during World War II. Two primary methods emerged during this time: operations research and management science.

Operations Research

The operations research approach originated from a need to resolve complex problems quickly (Stoner, 1978). This method employed some of the techniques of Taylor and Gantt but also developed other tools such as program evaluation and review technique (PERT) and critical path methodology (CPM) (Van Tassel, 1993). The underlying concept behind operations research was the convergence of sophisticated tools and people for a specific purpose. Operations research is particularly effective for large-scale projects or complex situations requiring timely resolution and direction.

Management Science

Another approach--management science--brought about new management techniques such as capital budgeting, cash flow management, production scheduling, and optimal inventory to assist managers in planning and controlling activities (Stoner, 1978). Although management science as well as operations research have proven to be successful in certain circumstances, neither emphasized the human or behavioral aspects of management.

Integration Approach

Given the success of each school in specific circumstances, a need arose to understand how and when to apply various theories. As a result, the integration school evolved, emphasizing two approaches for integrating theories, the systems and contingency approaches. Both systems and contingency models attempted to integrate the various management schools of thought. The rationale for the development of these theories was the inability to apply any one theory to all management situations. Each of the theories identified may address a specific management situation but not all. The two integration models attempted to provide a comprehensive framework for diagnosing and resolving management problems (Stoner, 1978).

Systems Approach

The systems approach viewed the organization from the whole as opposed to the part. This approach provided enhanced benefits in that decisions were made based upon the effect the decision had on all aspects of the organization rather than on a specific department, as in a traditional hierarchy. According to systems theory, "the activity of any part of an organization affects the activity of every other part" (Stoner, 1978, p. 53).

Contingency Approach

The contingency approach also attempted to integrate the various schools. This approach, in contrast to the systems approach, recognized that the different schools of thought may be applied and work very successfully in different circumstances. According to contingency management theory,

> the task of managers is to try to identify which technique will, in a particular situation, under particular circumstances, and at a particular time, best contribute to the attainment of management goals. (Stoner, 1978, p. 54)

Both theories recognized the value and the timelessness of the theories developed. These approaches merely attempted to apply these theories more effectively in current situations, given the changes and complexity facing managers in the present and future.

Contemporary Thought

Contemporary theories continue to evolve in the present environment. Many of the latest theories have evolved in direct response to the concerns and challenges facing managers today with the same goal of productivity and efficiency. Although the transition to an information society began in the late 1950s, the slowdown in productivity growth did not begin until the late 1960s. Following this period, a number of management theories began to emerge in response to various situations. Among the more popular and influential theories are total quality management (TQM), MBO, Theory Z, excellence in management, and reengineering. Each of these theories has a focus on production, efficiency, and productivity.

TQM

TQM emerged from the work of W. Edwards Deming (Knouse et al., 1993). Deming, a mathematician by education, developed his theories in Japan following World War II. During his education, he was employed at the Hawthorne plant of Western Electric. However, there is no indication of any involvement with the famous Mayo studies. These studies, nevertheless, apparently had a tremendous influence on the theories Deming later developed. Deming's work was not recognized in the United States until a 1980 documentary presented his theories to the country under the caption, "If Japan can do it, why can't we?" Deming's basic theories revolved around the concept of quality and the deliverance of quality outputs focusing on customer needs. Deming's theories were summarized in 14 principles that he developed and advanced as a means for improving quality in the organization:

1. Create constancy of purpose,
2. Adopt the new philosophy,
3. Create mass inspection,
4. End the practice of competitive bidding on price alone,
5. Improve constantly and forever quality,
6. Institute training,
7. Institute leadership,
8. Drive out fear,
9. Break down barriers,
10. Eliminate slogans and quotas,
11. Eliminate numerical quotas,
12. Remove barriers that rob people of pride of workmanship,
13. Encourage education and self-improvement, and
14. Take action. (Knouse et al., 1993, p. 1626-1629)

<u>MBO</u>

In 1954, Drucker's <u>The Practice of Management</u> defined the term "management by objectives." MBO was developed as a planning mechanism that permitted managers to define clear objectives that related directly to corporate goals and to the individual functions of the manager within the organization (Stoner, 1978). These objectives, furthermore, had to be established by the managers who influenced and achieved them. Ownership became an important tenet of this theory to ensure success. The purpose of MBO was to "achieve an efficient operation of the total organization through the efficient operation and integration of its parts" (Stoner, 1978, p. 152). Drucker has researched and written widely on management topics throughout the last 40 years.

Theory Z

Theory Z was advanced by David Ouchi (1981) to incorporate Japanese management principles into the management style and business environment of American industry. Theory Z emerged at approximately the same time that Deming's theories were growing in popularity. This management theory outlined the Japanese approach to management, emphasizing people management rather than technical implementation alone. The basic tenets of Theory Z included "a style that focuses on a strong company philosophy, a distinct corporate culture, long-range staff development, and consensus decision-making" (Ouchi, 1981, cover). Ouchi's theory emphasized productivity improvement through employee involvement. The basic foundations of Theory Z are: trust, loyalty to a firm, and commitment to a job over one's productive years.

Excellence in Management

Excellence in management began from the research and writings of Tom Peters with the publication of In Search of Excellence in 1982. The goal for Peters's research was to identify management characteristics of highly successful companies and to draw conclusions for application in other companies. The results of Peters's (1982) and Waterman's (cited in Van Tassel, 1993) studies were summarized into eight principles of management that define excellent companies:

1. A bias for action,
2. Close to the customer,
3. Autonomy and entrepreneurship,
4. Productivity through people,
5. Hands-on, value driven,
6. Stick to the knitting,
7. Simple form, lean staff, and
8. Simultaneous loose-tight properties (Van Tassel, 1993, p. 129).

Peters has continued to write prolifically on this topic since the initial publication emphasizing the concept of excellence.

Reengineering

One of the latest management theories to evolve within the past few years is reengineering. With the publication of Reengineering the Corporation: A Manifesto for Business Revolution, Hammer and Champy (1993) have somewhat incorporated a number of contemporary theories and integrated information technology to produce successful results in the current age. Reengineering is defined as

> the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, service, and speed . . . calls for the simultaneous changes in human and technology systems with a focus on the customer every step of the way. (Hammer & Champy, 1993, p. 32)

The essence of reengineering theory is achieving "breakthroughs, not by enhancing existing processes, but by discarding them and replacing them with entirely new ones" (Hammer & Champy, 1993, p. 33). The ability to discard and replace existing processes is accomplished with the "enabling power" of information technology.

Management History Summary

The purpose for the historical review of management theory is to outline its evolution during the 20th century. In addition, another purpose is to draw attention to efficiency and productivity as the common goals of all theories. Each school of thought presented a different means for motivating and controlling behavior leading toward the attainment of the common goals.

The common theme and challenge of every theorist is to find the best way to motivate employees to produce more, to become more efficient, and to enhance profitability. Each of the theorists identified with specific schools of thought believed that he/she had the answer or the method that ultimately would be put into practice in any situation. In reality, great strides and advances have been made, yet the productivity or efficiency results originally sought are still lacking.

Because this research is about efficiency and its relationship to scientific management and information technology, an understanding of the evolution of management theory is important for future recommendations. Because efficiency and productivity are again at issue, as evidenced from the U.S. Department of Labor statistics outlined in Table 2, broad understanding of the genesis of management theory (which is focused on productivity and efficiency) is important for understanding what must be done today.

Scientific management was the first management theory of the modern world (Van Tassel, 1993). The foundation of scientific management stimulated the growth and development of future theories. Even the operations research movement of World War II, which was successfully employed, derived its origin from scientific management. Gantt charts are currently in use, as are the basic principles of scientific management.

Although many new management trends continue to evolve, the basic goals to improve efficiency and productivity remain the same. The next section explores a more detailed explanation of productivity and the current theories for managing people effectively today.

Contemporary Management/ Productivity Theory

Productivity, as previously indicated, is an important consideration and/or goal of past, present, and future management theory. A number of definitions of productivity exist, which include "the relationship between the output generated by a production or service system and the input provided to create this output . . . the efficient use of resources (labor, capital, land, materials, energy, and information) in the production of various goods" (Prokopenko, 1987, p. 3); "the relationship between the output of an organization and its required inputs" (Belcher, 1987, p. 3); and "it is what you get for what you put in: Output/input. It's a ratio. It is the optimal use of all resources - labor, capital, materials, energy, and technology . . . . including physical and human capital" (Grayson & O'Dell, 1988, p. 31).

Although many definitions have been developed, the few cited emphasize the relationship of input to output. Productivity can be considered a measure of the overall level of satisfaction of the following:

1. Objectives: The degree to which they are

achieved.

2. Efficiency: How effectively resources are used to generate useful output.

3. Effectiveness: What is achieved compared to what is possible.

4. Comparability: How productivity performance is recorded over time (Prokopenko, 1987, p. 6).

Productivity is an important economic indicator. The effect of productivity is universally felt, impacting national welfare from which all benefit (Prokopenko, 1987).

As an economic measure, productivity is measured periodically and used to indicate positive or negative trends of a nation's output. The measure of output per hour is used to assess growth-rate changes in productivity (Grayson & O'Dell, 1988). This measure is determined by the ratio of gross domestic product (GDP) to hours worked or paid. GDP, the measure of the output of the country, is determined from "the market value of all final goods and services produced in a year with domestic resources" (Boyes & Melvin, 1991, p. 143). This ratio establishes the level of productivity. Only the manufacturing industry has posted increasing growth rates from the early 1960s through the late 1980s (2.7% to 3.5%), in contrast to the nonfarm, nonmanufacturing business sector (2.2% to -.7%) (Grayson & O'Dell, 1988). The latter sector is comprised predominantly of service-oriented businesses.

Table 4 provides a comparison of productivity growth rates of the manufacturing and services sectors. Percentages are based upon the ratio of GDP to hours worked.

Table 4

Sector Comparison of Average Annual Productivity Growth (1979 to 1985)

Sector	Average Annual Growth Rate
Manufacturing	3.1
Services:	
Real estate	-1.4
Public relations	1.8
Communications	3.9
Trade	1.3
Finance, insurance	-1.3

Source: Grayson and O'Dell, 1988.

The services sector growth-rate average is rather poorly reflected when compared to manufacturing. Although the United States presently leads the world in overall productivity, annual growth rates are declining compared with other industrial nations. Table 5 shows a comparison of annual average growth rates for a number of industrial nations.

The average annual growth rates shown in Table 5 were calculated from the ratio of GDP to employees as opposed to GDP to hours because the number of hours worked or paid is not readily available. The results reflected, however, are not encouraging for the United States. At these levels, the United States will be overtaken by many of these nations in overall productivity within the next 5 to 10 years.

Table 5

Ranking of Industrial Nations by Annual Average Growth Rate in Productivity from 1973 to 1986 (GDP/Employees)

Country	Average Annual Growth Rate (percentage)
Japan	2.8
Norway	2.4
Germany	2.2
Belgium	2.0
United Kingdom	1.5
Canada	1.2
Netherlands	0.7
United States	0.5

Source: Grayson and O'Dell, 1988.

Obviously, these ratios have created concern from a number of economists. The dismal performance of the services sector is a particular concern, especially because 80% of the information technology expenditures have occurred in this sector (Grayson & O'Dell, 1987). However, because this group consists of information workers who are generally highly educated, the possibilities for achieving goals of at least a 2.5% growth rate per year are realistic. Another concern is the amount of information technology expenditures attributed to this sector. Presumably, the level of information technology expenditures should have positively affected productivity growth through innovation, yet this does not appear to be happening.

Aside from the broader measures of national productivity, standard measures of productivity in the workplace consist of the ratio of outputs to inputs in the following formula (Belcher, 1987):

$$\frac{\text{Output}}{\text{Labor + Materials + Capital + Energy}} = \text{Total Productivity}$$

Formulas exist for each of the four categories of input (i.e., labor, materials, capital, and energy). An example for labor would be units produced to man-hours. Weighting can be useful to assess overall organization productivity to a specific output (Belcher, 1987).

For the services sector, productivity is measured similarly; however, other measures such as quality, timeliness, and efficiency may become necessary. Through a similarly used weighting process, the measures can be assigned a given priority or level of importance and then aggregated for evaluation.

The services sector is defined by knowledge workers. Knowledge workers today are what Drucker (1995) described as the area of attention for productivity improvement in the near future. Knowledge or information workers are defined as those individuals "whose jobs involve the creation, collection, processing, distribution, and use of information" (Whitten, Bentley, & Barlow, 1994, p. 40). Because the poor performance of this group has resulted in a decrease in national productivity growth, the services sector must be the area of emphasis. In addition, with the dependence on information technology for this group, a true challenge exists to improve these numbers. The question remaining is, how?

Today, one of the most talked-about fads or buzzwords is reengineering. Hammer and Champy (1993) co-authored Reengineering the Corporation, an approach to management that emphasized attention to the business process, incorporating information technology. Much of the literature in management today has emphasized reengineering, reinventing, or rethinking the corporation. This need to change emanates from the new paradigm.

Drucker (1995) continually referenced the knowledge worker. He indicated very clearly that the productivity of this group is, and has been, extremely poor and that this category of worker will be the management challenge of the new era.

Because of the importance of productivity, substantial investments in information technology have occurred. Although reengineering and other management trends have also been employed that emphasize the use of information technology, "if the logic behind all this technology improvement and job elimination were sound, United States productivity would have skyrocketed. But productivity growth in the United States has lagged behind that of the world's other major economies" (Reichheld, 1996, p. 117).

Reichheld (1996) suggested new measures for productivity, focusing on the relationship between cost and revenue rather than unit costs. This relationship is very similar to the efficiency ratio which measures the cost of producing a dollar of revenue. The premise and challenge underlying this approach is to measure the value derived from the customer.

Relationship of the Chapter to Efficiency

Efficiency is the dependent variable of this study. An "efficiency ratio" has been used as a means of assessing the level of efficiency in the organization. Very similar in definition to productivity, the efficiency ratio measures the relationship of input to output. The efficiency ratio defines output as the operating income of the company. The input consists of operating expenses, including labor, materials, capital, and energy. The only difference between this ratio and the productivity formula is that they are reversed. Both ratios, therefore, measure overall productivity or efficiency. From an economic viewpoint, a more focused definition is used to measure productivity based upon labor hours worked (Grayson & O'Dell, 1988). This latter measure is probably the most accurate measure of productivity.

Efficiency, therefore, is really an element in pursuit of achieving overall productivity. According to Grayson and O'Dell (1988), efficiency should never be the single concentration or goal for knowledge workers. Although efficiency is an appropriate emphasis for production workers, this should not solely be so for knowledge workers. The knowledge worker's output is not necessarily a product; although efficiency is important, it is not the only element. Grayson and O'Dell suggested an "effectiveness" orientation as opposed to efficiency. Effectiveness is defined as "having maximum value to the larger organization in the pursuit of its mission and objectives" (Belcher, 1987, p. 157). Effectiveness, according to this definition, includes the elements of quality, timeliness, efficiency, and innovation. The combination of the four elements produces the effectiveness of the organization.

An effectiveness orientation suggests alternate means of evaluating the performance for the dominant labor force today--knowledge workers. The absence of effectiveness elements may explain why the nonfarm, nonmanufacturing sector has produced such poor productivity growth rates. Manufacturing and business sectors quite possibly may not be able to be measured the same.

Nevertheless, efficiency and productivity are very closely related. As a management focus or emphasis, productivity and efficiency are as much concerns today as they were during Taylor's time. The challenge of management has been to uncover the means by which efficiency can be attained and improved upon. Because the goal of achieving efficiency in the organization involves working closely with people, the human equation cannot be ignored.

The recent introduction of information technology has altered the equation. As an element of the productivity measurement formula, the relationship of information technology to the output can and should be measured. Because production is "the relationship of how well an organization utilizes and converts its resources (manpower, material, equipment, capital, and energy) through some type of production process into company outputs (tangible items or services)" (Belcher, 1987, p. 63), information technology should be evaluated similarly.

Although information technology is typically used to enhance the effectiveness of the organization, its introduction should be carefully planned so as to automate only effective work processes. The goal, therefore, should be first to improve the effectiveness of the work process prior to automating it.

In conclusion, productivity and efficiency are related. Productivity, as an economic indicator, is an effective measure of the nation's output. These measures were not actually used until the late 19th century when the industrial world precipitated the need to track and monitor productivity. For management today, this has not changed; only the type of work has.

Summary

This chapter outlined the evolution of management theory and practice from the start of the 20th century to the present. Throughout this period of time, the field of professional management has grown considerably in both number of managers and professional recognition. The driving force behind the evolution of management theory has been the achievement and maintenance of efficiency and productivity. For the past nine decades, theorists have been researching and experimenting to determine the best methods for motivating people to achieve this goal. The measure of productivity growth has become a major economic indicator determining the overall welfare and capacity of a nation.

During this same period, the United States has also shifted a second time, from an industrial society to an information society, as measured by the percentage of the labor force employed in information-oriented endeavors. The earlier shift occurred when the number of industrial workers exceeded those employed in agriculture. Today's workers are different from the industrial workers of the past and have been characterized as "knowledge workers." An intense focus on this group is necessary to understand, measure, and improve productivity and efficiency in the next century in conjunction with emerging information technology.

The importance of efficiency and productivity cannot be underestimated based upon this long history. The next chapter reviews the changes taking place today in the new information age and how the computer or information technology is affecting the efficiency or productivity of the nation.

CHAPTER 6

INFORMATION TECHNOLOGY AND THE INFORMATION REVOLUTION

The previous chapters have focused predominantly on the evolution of scientific management and the state of the art of management theory (efficiency and productivity). However, a review of the relationship of these topics to efficiency is not complete without consideration of information technology and the changes precipitated by the computer.

The significant event during the industrial period was the proliferation of machines and the factory system. Today, the significant event is the computer. In this regard, parallels may exist between the two periods in respect to the importance of events and their impact on the relative time periods. The purpose for this chapter is to establish a foundation for exploring and understanding the evolution of information technology and its impact on efficiency, the key variable of the study.

When the new machines began to proliferate during the industrial period, the assumption, as Henry George explained in 1879 (cited in Smith, 1984), was that "labor-saving inventions would lighten the toil and improve the conditions of the laborer" (p. 200). This new "energy," however, was neither well controlled nor understood, ultimately impairing the efficiency of the nation. Today, information technology has created a similar scenario. Computers have emerged as the new "machine" of the present era, creating enormous opportunities that rival those occurring at the turn of the century. Yet despite the availability of this new technology, efficiency is once again a topic of concern.

As in the industrial period, the assumption made today is that computers will not only reduce working hours but also make our lives much easier, increasing our leisure time (Stocker, 1996). For this reason, many organizations remain perplexed, not finding the dramatic improvement in production, profitability, or productivity from the significant investment in information technology. In addition, the advances that are being made in information technology are moving at such a pace that continued investment becomes mandatory in order to remain up to date and competitive.

Currently, the high cost of technology is continually scrutinized in an effort to reconcile the cost with the presumed opportunities that should result. But where are these opportunities? Information technology is the change agent of the present age as the machine was the change agent of the industrial era. Unfortunately, understanding and gaining control of the new technology is as much a challenge today as it was at the turn of the century. Advancements in information technology are neither well applied nor used effectively in the workplace to achieve the significant opportunities available. Given the rapid rate with which technological advancement occurs, the benefits seldom keep pace. The perceived benefits are manifested in the relationship between the costs incurred and the output produced (defined as efficiency) in companies today. Because information technology requires a considerable and continual cash outlay, the challenge is to achieve results that are commensurate with these high costs. This may be in the form of increased output or enhanced information which can provide new opportunities or avenues for success. Questions remain, however, whether information technology expenditures will result in improved efficiency and productivity at the levels needed to be competitive in the world marketplace.

Unfortunately, an increasing number of publications and articles are emerging at the same time as the absence of tangible benefits from information technology is becoming apparent, raising questions about what must be done to use the technology more advantageously. What seems to be lacking is the effective application of the technology deployed and the resulting change in behavior that invariably must occur to capitalize on the opportunities that should result.

Because of the magnitude of change taking place today, a review of the origins and background of information technology and the information period is imperative. Additionally, the current level of information technology use and its effect on efficiency are necessary components to be reviewed and synthesized into an adequate foundation for the research.

History of the Information Era

Information and the need for information has always been important. The need to access, organize, retrieve, and use this information more effectively has resulted in a number of innovations leading to the development of the computer. The origin of the computer actually dates from 1830 when Babbage, the father of the computer, conceived of the "difference engine." The access and availability of information as well as its strategic importance did not emerge as a major driver until the second half of the 20th century. In 1946 the first general-purpose computer was developed by John Mauchly and J. Presper Eckert and named ENIAC (electronic numerical integrator and calculator). ENIAC was created at the request of the U.S. military to develop a machine that could rapidly calculate missile trajectories (Capron, 1990).

The development of ENIAC foreshadowed the emergence of the computer age and was the forerunner of the first commercially sold computer, UNIVAC I. This event occurred in June 1951, introducing the first generation of computers (Capron, 1990). For the next three decades, data processing using large mainframe computers defined the era. The primary role or purpose of these computers was to automate functions and minimize the manual effort required for routine tasks. Originally, this emphasis was directed at clerical functions (Tapscott & Caston, 1993). As offices proliferated, the need for clerical work continued to increase. During this period, computers were used to capture, store, and process the growing volume of data, particularly financial, unique to the particular business. As a result, the next few decades were marked by major advances in mainframe technology (large centralized computers) to accommodate the increasing volume of required data to manage the business.

The direction of computer advancement from the 1950s through the 1970s was similar to the advancement of machine technology in the industrial period. The data center became the arena for production and processing of information in contrast to the factory as the arena for production of output in the industrial period. Computers were used to tabulate, store, track, and report on various details of the business. Since the majority of the data was financial, data processing departments emerged as subsets of the finance or accounting department. With heavy clerical requirements for reporting, tracking, and storing data, computers served to minimize the costs of human resources by automating these functions.

During this period, space programs and rocket technology also emerged. The launching of Sputnik in 1957 was a major event that awakened the world to a new reality (Coleman, 1995). Computerization developed rapidly after this event as the demands for rocket travel necessitated unmanned functioning of tasks beyond the scope and capability of ordinary people. Also during this year, another important event occurred. In 1957, the United States transferred from the industrial era to the information era when the number of workers in the country whose jobs involved information surpassed the number of industrial workers (McNurlin & Sprague, 1989). By the 1970s, the majority of the workforce constituted information workers (over 50%). This number increased to approximately 70% of the work force by 1990 (Coleman, 1995).

Although mainframe computing continued to evolve and proliferate from 1957 through the 1970s, another event occurred in 1975 that would have considerable future impact. During this year, the first microcomputer--the MITS Altair microcomputer kit--was developed (Capron, 1990). Although this was an immediate success, the microcomputing age did not actually begin until 1977 with the founding of Apple Computer. IBM's Personal Computer (PC) followed shortly thereafter in 1981.

The importance of the microcomputer, with its startling growth over the past 20 years, is defined by the power it has placed in the hands of end users, removing that power from the sole province of the data center. The latest major development occurred only within the last several years. The United States Department of Defense once again, as with ENIAC, developed a remote network in 1969 to facilitate electronic communications through microcomputers. Originally entitled "ArpaNet," this collection of networks was the ancestor of the Internet today (Levine & Baroudi, 1993). Increased use of the Internet has accelerated over the last few years. The World Wide Web actually debuted in 1989. Since then, use of the Internet has increased substantially to approximately 40 million users today, which is expected to grow to over 150 million by the year 2000 (Meeker & DePuy, 1996).

Another recent development in an increasingly rapid development range is Java. Java is a programming language designed by Sun Microsystems that first became available in January 1996 (Rosen, 1997). Java is significant because it has the ability to run on any computer, designed to be platform-independent and object-oriented. This creates enormous potential for increasingly more flexible use with networks of the future.

This historical picture outlines the genesis of the information era and the paradigm shift that has been occurring during recent years.

Paradigm Shift Implications

As outlined in the historical background, the United States moved from an industrial to an information society in 1957. Although more people were employed in information-oriented jobs than industrial jobs, the paradigm shift probably did not occur at this point. Paradigms are standard ways of thinking and behaving (Tapscott & Caston, 1993). According to Barker (1992), the new paradigm most likely began to surface around this time. However, thinking and behavior did not change until much later with the proliferation of the microcomputer. Because of this shift, dysfunction has resulted that, according to Barker, is manifested by the inability to effectively resolve problems (operationalized as inefficiency). The same phenomenon occurred at the turn of the century.

As an example of changes that affect thinking and behaving, the financial industry (i.e., banks) has been discussing the possibilities of home banking for the past decade. Home banking permits customers to access their accounts and perform banking transactions from home using their microcomputer and modem. Although a small percentage of customers use home banking today, growth will likely occur when microcomputer technology is incorporated with the television set. When an integration of this dimension occurs, customer patterns (behaviors) will change, decreasing the amount of walk-in traffic to the bank. The event will not only change the bank office layout but will likely minimize the number of branches banks deploy.

A major change in behaviors and the way consumers use services will be created. When the electric light and telephone were first introduced, people began to think and act differently. Wang (1994) provided an example of the impact of this change by describing an early management conference of chief executive officers scheduled in 1882 by the German Post Office. The conference was convened to discuss "how not to be afraid of the telephone" (p. xvi). Unfortunately, no one attended the conference. CEOs were outraged at the thought of using the telephone to conduct business, believing that only staff should use this technology. Although not readily accepted by this group, the telephone precipitated major change in thinking and behaving at all levels.

A similar phenomenon is beginning to occur today. CEOs are generally reluctant to use microcomputer technology and networking features (i.e., the Internet) even though most development today is focused on internet and intranet technologies. Like the telephone, this technology is changing and will continue to change behaviors.

People are changing their behaviors because of the availability of new technology. As an example, children are no longer limited in their ability to do research. Because of the Internet, the boundaries for conducting research span well beyond the physical library to the world. Since paradigms define the rules for behaviors, paradigm shifts change the rules (Barker, 1992). The telegraph, for example, virtually eliminated the pony express business overnight. When behaviors change at this level, entire industries can appear or disappear in a very short period of time. Information technology now creates such possibilities as did machine technology at the beginning of the 20th century.

Today information technology, particularly microcomputers and networking, are driving change. Many colleges today offer distance education through video conferencing. Students are able to take advantage of courses offered at distant locations not physically accessible to all of the students.

The greatest effect this new paradigm has had is the attention placed on the importance of information. Toffler (1990) defined information as power. Organizations today are beginning to understand the importance of the competitive advantage available by the quantity and accessibility of information rather than the physical assets they own. Toffler further emphasized that information technology is an enabler, creating opportunities for power not previously available to some individuals. Although he depicted a sobering look of the world to come, the reality is that this is what is occurring. Unfortunately, society has yet to accept the paradigm shift that has occurred primarily because of the speed with which technology has caused breakthrough change. By providing volumes of information much faster, those in possession of such information and knowledge possess true power.

The current transition period requires not only understanding but adoption of the new technology in order to mitigate the dysfunction which naturally results in the process of change. However, during this lag period, great power opportunities exist for exploitation much as they once did in the early days of the industrial period. At that time natural resources, including human resources, were totally exploited to create vast industrial giants. A similar phenomenon is occurring today. The only difference is that the shift in power discussed by Toffler (1990) emanates from the access to and availability of information and knowledge rather than the natural resources of the past. A good example of this shift in power is the knowledge now available to customers and clients. With television, personal computers, and other vehicles for disseminating information, customers are armed with so much knowledge that they can literally dictate the type and quantity of services desired. Companies today aggressively seek to meet customer needs through information to attract and maintain their patronage for the future.

Because information is now immediately available as a result of information technology, immense opportunities are created even for small companies who can wield power comparable to that of larger competitors. The same holds true for countries. Power can shift dramatically to tiny countries on the strength of information and knowledge to which they have access. Japan, a relatively small country, has exceeded the average annual productivity growth rate of the United States over the past several years. As a further example, the majority of the top 10 financial institutions in the world are Japanese.

Application of Information Technology

Information technology has been called, in the words of Hammer and Champy (1993), an "enabler" because it gives power, capacity, or ability to the end user. Although information technology has the potential to enhance, this does not remove the need for human intervention. As a result, the attainment of the functionality and the productive opportunity available from information technology rests with the ability to effectively apply the technology within the organization.

According to a Wharton research study on efficiency and information technology in financial institutions, "managing well" was concluded as an important ingredient for achieving efficiency (ARGO Data Resources Corporation, 1996). More specifically, the research tested a total of seven separate hypotheses:

- Workplace practices improve process performance;
- Information technology is directly related to information technology costs;
- Installed information technology costs lead to increased information technology return on investment (ROI);
- Installed information technology functionality leads to increased information technology ROI;
- Information technology leads to better process performance;
- Workplace practices lead to information technology functionality;
- Workplace practices lead to information technology ROI (p. 3).

Of the seven hypotheses, only one proved significant and was not rejected: "Workplace practices lead to information technology functionality" (ARGO Data Resource Corporation, 1996, p. 3). These findings suggested that workplace practices are the driving factor for improving information technology functionality and, therefore, efficiency. The outcome of the research translates into the way information technology is managed and applied, indicating a decided human element. The research further identified a number of workplace practices that were considered instrumental for improving information technology functionality:

- Employees involved in decisions;
- Compensation based on contribution;
- Careful selection processes;
- Commitment to employee development;
- Core full-time work force, supplemented by part-time workers; and
- Broad, flexible job designs/teamwork (p. 4).

Interestingly, of the six workplace practices, the first four relate directly to Taylor's four key principles of scientific management; the sixth could also be related. According to this study, information technology alone does not guarantee functionality; through effective application and management as defined, information technology can produce desired results.

Although the results of the Wharton study (ARGO Data Resources Corporation, 1996) may be surprising to some, they are consistent with the fact that human resources are and will continue to be involved. Information technology does not manage itself but must be properly applied in order to achieve the benefits.

The ability to manage information technology implies application. Technical resources, like human resources, must be managed in order to achieve the functionality they offer (ARGO Data Resources Corporation, 1996). A renewed emphasis on management skills is needed to obtain the most from the resources deployed.

Management nevertheless changes somewhat in this new arena. Managers must learn how to manage information technology, not simply how to use it. Again, as Drucker (cited in Tapscott & Caston, 1993) pointed out, "Productivity will dominate management thinking for many decades" (p. 6). Increasing productivity or functionality involves coordination, organization, and control, which are key components of the management process. Although some technologies exist that can immediately be put into operation and increase productivity, this is not the norm. In most cases, new systems can do little else but exist until the potential value they can create is properly applied.

Use of Information Technology

Information technology use today is substantial in most industries. With a plethora of upgrades and new developments, information technology expenditures are continuing to increase. The primary catalyst for the growth of information technology was the development and advancement of the microcomputer. According to a 1994 survey, the United States led the world with a ratio of .319 microcomputers per person (Meeker & Depuy, 1996). Within two years, this grew to 36% of the households in the United States having personal computers, according to an International Data Corporation global news media survey conducted in 1996 (International Data Corporation, 1997). This number is well on its way toward reaching half of the United States population within a relatively short period of time.

Microcomputers today are well becoming standard fixtures in American households similar to how televisions (97%) and corded telephones (96%) have become in the past (Meeker & Depuy, 1996). With both televisions and telephones at ratios of almost one to one, can microcomputers be far behind, especially with the growth of the Internet? This growth and utilization is further demonstrated by nationwide computer use reaching 45.8% in the workplace in 1993 (Bureau of Labor Statistics, 1995). The United States is definitely a nation of computer users, leading the world by a good margin in average number of computers per person. With expenditures in excess of $360 billion a year this is an industry that, although not the largest, is rapidly growing in the United States (Wang, 1994).

Today there are approximately 180 million microcomputer users in the world, a number that is expected to grow to approximately 225 million by the year 2000 (Meeker & Depuy, 1996). These numbers further emphasize the increasing demand for microcomputer technology and the substantial amount of corporate spending on information technology. Of some of the current top users of information technology, the average annual information technology budget is approximately $185,404,000 (1996), up 6.93% from 1995 (McGee, 1996). Although information technology expenditures continue to rise, the focus of various industries on information technology is directed as indicated in Table 6.

Table 6

Comparison of Information Technology Average Budgets by Industry and Relationship to Staff

Industry	Information Technology Budget (in millions)		Total FTE/ IT FTE	IT $ to Total FTE
	1995	1996		
Finance	256,461	239,553	16.33	9,760
Health	79,403	113,718	146.69	2,245
Business	325,036	322,116	21.00	9,461
Retail	98,323	132,496	151.08	1,215
Manufacturing	106,824	142,846	52.38	4,363
TOTAL	173,391	185,404	44.17	4,267

Table 6 shows that, generally, spending for information technology increased between 1995 and 1996. Only finance and business services show budget reductions. Information technology costs per full-time equivalent (FTE) were calculated to assess and to compare the level of expenditures per FTE. The financial industry and business services, consistent with the direction indicated in the literature, reflected the highest numbers indicating investments being made for the future. The small ratio of total FTE to information technology FTE for a number of industries may indicate closer attention to the end user for focused technical support and the decentralized nature of computing within these industries.

An examination of specific information technology trends within the five industries (i.e., financial services, health services, business services, retail trade, and manufacturing) helps to support the financial information contained in Table 6 and to identify the type and level of information technology commitment and use planned for the future.

The Banking Industry

Gupta (1996), in an Information Week article on industry trends, identified a number of uses within the banking industry. Financial institutions are directing their energies at home banking and internet banking. In addition, data mining, a priority for linking client information for relationship building and cross-selling opportunities, is accomplished using a data warehouse (central database of information). Internet banking is viewed cautiously as important. In 1995, only 1% of banking transactions was accomplished electronically through home banking. Although home banking is expected to grow to about 6% of banking transactions by 1998, bank executives remain uncertain about home banking. Another demand for bank information system departments is system conversions due to mergers and acquisitions. As new institutions are brought together banks are standardizing on common software and platforms to ensure compatibility.

Other areas of concern and focus for the financial services industry are year 2000 issues, continued networking of remote branches, and technical training. Year 2000 alone is expected to require millions of dollars for compliance and preparation for the new millennium. Training, on the other hand, is imperative if the bank is to take advantage of the functionality offered. This is a considerable challenge because of the cost to remain current with changing technologies.

Finally, networking remains an ongoing trend. As more branches are either acquired or built, the full functionality of the main bank must be delivered to the remote site. Various networking technologies being utilized include Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM), public and private frame relay, and intranet technologies (Gupta, 1996).

Health Care Services

The health care industry is focused on two primary areas of information technology for their future: internet/internetworking and paper elimination. The Internet is being applied to provide health care services to remote geographic regions. A concept called "telemedicine" is being planned to connect a wide range of physicians, pharmacies, and others using high-speed digital technology. According to an HIMSS survey (DePompa, 1996), 55% of the respondents used the Internet for clinical research, and 33% used the Internet for electronic mail.

Paper, as in other industries, is also a concern. Work is underway to use the Internet and intranets to reduce paper and maintain paper records electronically. In addition, the administration of these records and various forms would also be expected to create opportunities for streamlining access and administration (DePompa, 1996).

Insurance

Insurance, as in the financial world, is concerned with data mining of information (using data warehouses), increasing the use of internets and intranets, imaging, and computer-integrated telephone. Companies like CIGNA, Prudential, and Metropolitan Life are investing in electronic access to customer representatives, automating claims adjustments through knowledge-based systems, and installing sophisticated call centers integrated with computer and telephone technology ("Sharing data", 1996).

Business Services

Many of the business services companies are concentrating on the implementation of systems, applications, and products (SAP).

> SAP is a suite of applications covering business processes that include sales, materials management, and distribution. It's designed for companies that want prepackaged, highly integrated client-server applications and operates under the premise that some businesses need a single suite of products to control and track business operations throughout the enterprise. (Gilloly, 1996, p. 102)

Professional Services

Trends in this industry are directed at providing services through the Internet, remote access and support for remote users, and expanded networking services (internet, intranet, and applications such as Lotus Notes). In short, the goal of this industry is to be able to provide support to anyone, anytime, anywhere (Foley, 1996).

In general, industry trends indicate an obvious movement toward using and applying internet and intranet technology. Global or cross-industry trends seem to be directed at internet/intranet use, data mining/data warehousing, expanded networking, and the year 2000. Each of these technologies has the capability of simplifying and expanding services currently provided at the convenience of customers, with the exception of year 2000, which tends to be reactive in nature. Furthermore, having the ability to capture, store, and link data about clients permits staff to build and deepen relationships through expanded and centralized information. The prophecies of Toffler (1990) are entirely consistent with these latest trends reflecting the strategic nature of information and the recognition that information is true power.

Efficiency and Information Technology

Regardless of the true purpose of information technology, a common perception is that it is designed to make us more productive and/or more efficient (Stocker, 1996). As a result, an analysis of efficiency and information technology in the workplace is most important to the research. Financial institutions, in particular, rely heavily on the efficiency ratio, which "has become a key performance indicator in the banking industry" (Kimball, 1997, p. 31). Efficiency, as defined, measures the costs incurred to produce the output (translated into revenue). Because the majority of the costs of production result from human resources (typically 40-50% of operating expense), the goal of becoming efficient is attained by reducing this cost or by increasing production at the same cost. Because of the high cost of human resources, companies have long sought methods of becoming more efficient and productive to manage these costs effectively. In some cases, the answer to this challenge has been to implement information technology as a means of increasing production without necessarily increasing salary costs. Information technology use and spending have resulted from a desire to improve the efficiency ratio in the organization. But has this occurred? The literature in banking is, at best, dubious. Although banks spend large sums of money on information technology, the gains are not being reflected in their efficiency ratios (Salomon Brothers, 1996).

Similar to the Wharton study (ARGO Data Resources Corporation, 1996), the literature has offered other means for improving productivity and efficiency beyond information technology alone. Heine (1997) suggested that more intensified training must occur for managers to understand the daily workflows and operations in order to improve them. In addition, Heine indicated that managers typically favor upgrading or adjusting computer systems rather than confronting the more difficult task of changing human work habits.

At the turn of the century, efficiency became an issue with the arrival of machine technology. Although this technology redefined production, little was done to address the human management issues before the arrival of Taylor. Information technology is currently redefining how information is stored and delivered, yet human involvement remains an integral part. As more avenues of information are created and linked, new functions result. These functions require human interaction and discernment previously not in existence. The Wharton study (ARGO Data Resources Corporation, 1996) indicated that information technology alone does not create efficiency or functionality for the company. Rather, how the technology is managed is what increases the functionality of information technology, therefore creating the advantage.

Little has been written on the combination of cost reduction, particularly salaries, through the application of information technology. Although the banking industry has been highlighted in its struggle with information technology spending and meager efficiency results, Bureau of Labor Statistics (1995) records indicated that the same poor productivity results are occurring in other industries as well (Salomon Brothers, 1996).

In contrast, literature (ARGO Data Resources Corporation, 1996; Heine, 1997; Wang, 1994) is beginning to emerge on the application or management of information technology rather than simple deployment. Hammer and Champy (1993) emphasized this in their reengineering theories. Process reengineering requires managerial analysis of the work process. The theories emphasize the application of information technology but require human intervention.

Efficiency, with its relationship to the use of information technology, remains questionable. Although a causal relationship has not been established between efficiency/productivity and information technology use and/or spending, analysts are very concerned about the nation's declining productivity growth. This concern emanates from the considerable expenditures on information technology specifically incurred to raise productivity (Wang, 1994). According to Nobel laureate Robert M. Solow (cited in Wang, 1994), "You see computers everywhere except in the productivity statistics" (p. 107). As indicated by the Bureau of Labor Statistics (1995), productivity growth decreased from 2.4% in the 1950s to 1.3% in the 1980s, a time period when information technology growth and use were proliferating (Wang, 1994). According to Wang, one of the biggest frustrations of CEOs regarding information technology is that "few CEOs are able to quantify the result . . . the yield from information technology seems to defy measure" (p. 6). Harvard business professor Gary Loveman further revealed that "he found no evidence of any positive relationship between information technology investment and business performance" (Wang, 1994, pp. 104-105). Loveman ultimately concluded that developing and tracking new metrics for measuring the performance of information technology is critical to understanding and affecting productivity improvement in the organization.

Drucker (cited in Tapscott & Caston, 1993) indicated that productivity will continue to be a concern of management for years to come. He stated that the productivity gains of the industrial era resulted from scientific methods developed by Taylor and others. Current productivity gains will be measured, however, with a different group--information workers--using their primary tool--the computer.

Summary

The emergence of the information period was a major change that affected and continues to affect society. This background assists in establishing the foundation for the new paradigm which has occurred and the effect this paradigm has had on business.

The use of information technology continues to increase, as evidenced by the substantial information technology budgets and the trends reflected in the various industries. Although this pattern continues, questions continue to evolve concerning the benefits of information technology.

CHAPTER 7

METHODOLOGY

The methodology for the study describes the procedures that were used to respond to the research questions and achieve the outcomes proposed. In this chapter, the design methodology is described--specifically selection of variables, population and sample selection, data collection, and data analysis procedures.

The purpose of the study was to learn what relationship, if any, exists between efficiency and information technology use in the company. Furthermore, because the foundation of efficiency theory began with the studies of Taylor during the industrial period (1870s through 1920), the relationship between the present-day use or nonuse of his scientific management principles and efficiency was also studied.

The hypothesis of the study was that combined use of scientific management and information technology would produce the most favorable efficiency levels for the company. Research questions were further raised to clarify the understanding of efficiency, information technology, and scientific management within organizations. The questions raised included: (a) Is efficiency a current concern of management? (b) What is the level of efficiency in the company? (c) What factors are currently contributing to inefficient operations? (d) What methods are currently used to improve efficiency? (e) Has information technology improved current efficiency? (f) What is the purpose of information technology? (g) Are Taylor's theories currently being used? (h) What is the current level of information technology use in the company? and (i) What is the current level of efficiency in the company by efficiency ratio?

Design Methodology

The research design used in this study combined survey and historical research methodology. Both primary and secondary data were used to attain the outcomes of the study.

Primary research, using a survey, solicited responses from a sample of managers from selected industries about perceptions of efficiency, information technology, and scientific management application in their respective organizations. Secondary information consisted of actual financial and historical data. Financial information consisted of operating income and expenses necessary to calculate the efficiency ratio. The data were used to test the three hypotheses. Historical information provided background information about the industrial period

(1870 to 1920) in the United States. The emphasis was to identify factors contributing to organizational inefficiency at the time, the development of Taylor's scientific management principles, and the application of these principles. The historical data were derived from primary writings of Taylor and secondary writings about Taylor's theories.

Description of the Population

The population for this research study consisted of business managers who were clients (not necessarily members) of the American Management Association (AMA) and who had inquired about AMA services between August 1995 and July 1996. The database contained approximately 500,000 names.

The population size was reduced by eliminating managers of companies with fewer than 1,000 employees and by limiting the population to the following industries:

- Finance (Standard Industrial Classification [SIC] 60-67),
- Health Services (SIC 80),
- Business Services (SIC 73),
- Retail Trade (SIC 52-59), and
- Manufacturing (SIC 20, 34, 35, 36, 37).

These represent the more labor-intensive industries in the work force and, therefore, those which tend to be management oriented.

The population included only managers with the title of manager, vice president, assistant vice president, senior vice president, and director. These titles were selected because they typically represent positions held by middle- to senior-level managers responsible for the direct supervision of employees. No more than two managers were selected from the same company.

Industries were selected from Bureau of Labor Statistics (1995) data based upon their relative labor intensity. Labor intensity refers to the amount of persons employed in the industry relative to the total industry. The criterion for selection was share of the labor force exceeding 5%. The combined labor force, represented with service-producing and goods-producing industries that exceeded 5% of the total labor force, is presented in Table 7.

Goods-producing (manufacturing) industries represented 45.7% of the total industry, and service-producing industries represented 47.0%. Each group was very close to 50% of the total labor force for the industry grouping. Based upon these criteria, the database produced a population of 6,398 managers.

Table 7

Represented Industries that Exceed 5% of the Total Labor Force

Goods-Producing Industries	Percent of Total Labor Force
Industrial/machinery	10.6
Transportation equipment	10.1
Food products	9.2
Electronic	8.5
Fabricating metal	7.3
Total	45.7
Service-Producing Industries	
Financial services	7.8
Health services	10.1
Business services	6.3
Retail trade services	22.8
Total	47.0

Source: Bureau of Labor Statistics, 1995.

Sample Size

Given a population of 6,398 managers, the sample size was determined (Wunsch, 1986). The confidence level used for determining the sample size is .05, a 95% probability that the sample selected will be representative of the population. Because the level of efficiency has an impact on the number of staff employed, the findings could provide managers with information that could affect staff size. Because managerial action usually involves up-front costs and affects bottom-line revenue, the need to be as accurate as possible is highly desirable. Therefore, a 5% sampling error was selected to ensure that reasonably accurate conclusions could be drawn. Although lower sample sizes at higher error rates are possible, the higher the error rate the lower the representativeness of the sample. A population of 6,398 managers yielded a sample size of 384 managers.

Because surveys do not generate 100% response, the sample size needed to be adjusted to get the desired number of responses. A response rate of 50% was anticipated; therefore, given a sample size of 384 managers the sample was doubled to 768 managers to help maintain the error rate at 5% or below and increase the representativeness of the sample.

Although the sample was selected randomly, the respondents would not respond randomly, creating a concern for response bias. To reduce this concern, two characteristics were identified from the population: gender and location. Gender is defined as the proportion of males to females, and location is defined as the proportion of managers from the Midwest (Illinois, Wisconsin, Indiana, Michigan, Missouri, Iowa, and Minnesota). The population proportions for these two characteristics are presented in Table 8.

The increased size of the sample (768) was selected randomly. Therefore, if these three characteristics remained relatively consistent within the respondent group, the concern for respondent bias could be reduced. The gender and location characteristics between the sample and respondents were compared for consistency.

Table 8

Population Proportions for Gender and Midwest Residence

Characteristic	% of Total
1. Male	72.39
2. Female	27.61
3. Midwest	19.40

A response rate of less than 50% would be biased regardless of the percent difference in characteristics. A response rate of 50% requires a difference in characteristics not to exceed 5% to be considered unbiased (see Table 9).

To ensure that the sample is representative of the population and unbiased, the proportional mix of managers in the sample needs to be the same as the proportional mix of industries in the population. For each industry, the percent of total managers in the population was determined. The sample was randomly selected based upon the industry percentage of the population. Since the sample size was adjusted to 768 managers, the same random selection was used based upon the industry percentage of the population applied to the adjusted sample size (see Table 10).

Table 9

Percentage of Response Differences to Assure Lack of Bias

Percent of Sample Received	Percent Difference Permitted
50%	5%
60%	4%
70%	3%
80%	2%
90%	2%

Table 10

Distribution of Managers by Industry for Population and Samples

Industry	Total No. in Population	Percentage of Total	Original Sample Size	Adjusted Sample Size
Finance	1,479	23.12	89	178
Health services	657	10.27	39	78
Business services	957	14.96	57	114
Retail trade	856	13.38	51	102
Manufacturing	2,449	38.27	148	296
Total	6,398	100.00	384	768

Description and Measurement of Variables

The relationships between two independent variables--

the use of scientific management and the use of information technology--and one dependent variable--efficiency--were examined as the foundation of the quantitative research for the study. In addition, the interrelationship of a moderator variable--industry--was also examined.

Description of Variables

Dependent Variable

Efficiency is the relationship between revenue and operating expenses and is defined as the amount of time and money used to produce $1.00 of revenue; efficiency is measured as a percentage (the efficiency ratio). The financial statements for the respondents' companies were obtained from the Electronic Data Gathering, Analysis, and Retrieval System (EDGAR), the Security and Exchange Commission's online financial information access system, financial statements, and Bloomberg's online financial information system. Efficiency percentages were calculated from financial data that was obtained and averaged over a three-year period (1993, 1994, and 1995).

The components of the efficiency ratio differ by industry. The financial industry (i.e., banks) uses a formula of noninterest expense/net interest income plus noninterest income. Nonfinancial organizations use the formula of general, sales, and administrative expenses/

revenues minus cost of goods sold. In most cases, nonrecurring or acquisition/disposition-related costs are omitted from this formula.

Independent Variables

The two independent variables were the use of scientific management principles and the use of information technology. Scientific management use identified whether the respondent's company applied Taylor's principles of scientific management as determined from all responses to Section VI of the survey (see Appendix A). The variable was measured to determine its relationship to the dependent variable, efficiency. Statements were developed relating to the four core principles of scientific management. The mean response (score) for statements relating to each of the four principles indicated whether the company used scientific management principles in the company. Respondents with average scores indicating agreement or strong agreement with three of the four principles of scientific management were considered to use scientific management, as long as the first principle was one of the three.

The second independent variable--use of information technology--was determined from an index that assigned point values based upon the degree of use in four categories. Section I of the survey (questions 8 through 11 in

Appendix A) was used to determine the level of use from the responses to these four questions. From the responses to the four questions, a total point value was assigned to each respondent. The total point value was evaluated in relation to a range of points in three categories of use--high, moderate, and low. From this index, the level of information technology use was determined and evaluated to determine if it had a relationship to efficiency.

The research study included five separate industries in the sample for analysis. Because these are distinctly different industries, the relationship of the independent variables to efficiency may differ by industry. This may help to highlight differences that can be shared with others toward improved results. Although the primary relationship examined was between information technology and scientific management use and efficiency, the interrelationship of industry was also compared. The industries compared and their respective SIC codes consisted of:

- Finance (SIC 60-67),
- Health services (SIC 80),
- Business services (SIC 73),
- Retail trade (SIC 52-59), and
- Manufacturing (SIC 35, 37, 20, 36, 34).

Industries were identified by and assigned to one of the five industries based upon the SIC code. Comparisons were made between and among industries not only for the independent and dependent variables but also for descriptive information obtained from the survey. Differences noted (if any) were used to identify factors that could be shared across industries dependent upon whether the result indicated a positive or negative relationship.

Measurement of Variables

To improve generalizability of the results, the average of the most recent three years of efficiency ratios was used for each company represented. Averages were used to avoid reliance on single computations that might indicate a one-year phenomenon. When a company invests heavily in information technology for the first time, the efficiency ratio may be higher for that year. Using only this amount could negatively distort the findings.

One of the outcomes of the study was to determine if the efficiency ratio determined from actual financial data was related to the two independent variables. If information technology is utilized and applied, the efficiency ratio should be lower (better) than that of companies not investing or using information technology heavily. The reason for this is that a goal of information technology is to decrease or optimize the quantity of human resources needed to produce the output. This occurs from the changes in work processes that are available, if applied, from the deployment of information technology.

Because the degree of technology use is also a component of operating expense (the numerator in the efficiency ratio calculation) through information technology spending, a reduction in staff should outweigh the cost of the technology, causing a decrease in the efficiency ratio. If, on the other hand, the investment in technology is so costly that it outweighs any staff reductions, the efficiency ratio will reverse. This result is precisely why the analysis must be made. If the efficiency ratio is high, the technology deployed is not achieving the desired result. This raises two questions: (a) Should information technology use be abandoned? and (b) Is information technology being applied to achieve the expected efficiencies? Although the first question is not likely to be answered affirmatively, the second question may produce more discussion.

The application of information technology relates to the methods utilized by the organization to analyze and change work processes because of the introduction of technology. If a company scientifically analyzes work processes and changes in work processes caused by the introduction of technology, the two elements together should drive costs down and thus reduce the efficiency ratio.

The second variable, scientific management use, was determined from questions included in the survey instrument. Responses to these statements indicated if a scientific management orientation existed within the organization. If so, a comparison of the responses from companies to the actual efficiency ratios would yield any potential relationship. Specific combinations of information technology use and a scientific management orientation may yield reduced efficiency ratios. If a scientific management orientation does not exist, other factors may be identified as the basis for further research in explaining the reasons for poor efficiency.

Data Collection Procedures

To respond to the research questions and to achieve stated outcomes, primary data was collected using survey research methodology. Secondary data was collected from existing financial information available from the Securities and Exchange Commission and other sources.

The Survey Research

A survey instrument was developed to collect primary data from the managers in the sample. The survey was organized into six sections and designed to obtain data to address selected subproblems of the study. The six sections of the survey instrument included this sequence:

I. Background information,

II. Corporate/industry efficiency,

III. Factors affecting efficient operations,

IV. Methods for improving efficiency and productivity,

V. Information technology and efficiency, and

VI. Scientific management usage.

Specifically, the survey was used to address the following research questions (subproblems) of the study:

1. Is efficiency a current concern of management?

2. What is the level of efficiency in the company?

3. What factors are contributing to current inefficient operations?

4. What methods are currently used to improve efficiency?

5. Has information technology improved efficiency?

6. What is the purpose of information technology?

7. Are Taylor's theories currently being used?

8. What is the current level of information technology use in the company?

Statements were developed to obtain responses from managers about what currently exists in their company. Table 11 provides a matrix of the type of research, the variables and the pertinent sections/statements, and other information relative to each variable.

Responses were quantified using interval measurement scales. Although Likert-type scales were used in the survey, the responses were converted into nominal categories. Nominal categories were "high," "moderate," and "low" for the variable information technology use and "uses" or "does not use" scientific management principles. The dependent variable, however, relied on interval measurement scales for the variable efficiency.

Table 11

Research Design and Variable Index Chart

Variable	Primary Data	Secondary Data
Efficiency (dependent variable)	Section II, statements 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 (level of efficiency)	EDGAR (Securities and Exchange Commission data), financial statements, Bloomberg--Efficiency ratios calculated as an average of the last three years
Use of information technology (independent variable)	Section I, statements 8, 9, 10, 11	
Use of scientific management (independent variable)	Section VI, statements 1-15	
Industry (moderator variable)		AMA database, Bureau of Labor Statistics (finance, health services, business services, retail trade, and manufacturing)

Three scales are commonly used for this purpose: semantic differential, Likert scales, and Thurston scales (Tuckman, 1988). Likert scales are 5-point scales with equal intervals between each point. These scales were selected because opinions of the respondents are sought for specific statements. In contrast, a semantic differential scale seeks judgments about a single concept based upon bipolar adjectives regarding the concepts. This scale was too limiting for the purposes of the research and did not permit the range of statements needed to obtain answers to the research questions. The Thurston scale, in contrast, does not seek a degree of agreement or disagreement but rather a ranking of attitudes about given subjects. This, too, did not permit the range of opinion needed to assess the statements in this survey. Of the three, the Likert scale was selected for the instrument because it was the least complex to quantify and the simplest for subjects to respond to.

Relationship of Survey Items to Research Questions

The majority of subproblems/research questions previously identified were answered from information produced in the survey. For each section of the survey, individual statements related to the following subproblems.

Section I: Background Information

Background information was requested at the beginning of the survey. The responses to the questions were coded using the coding conventions contained in Appendix B.

Each question in this section served a particular purpose and was used as follows:

A subject code (four digits) was used to identify and protect the anonymity of the respondent. The first digit of the code number indicated the particular industry.

1. Department managing: This information was used to clarify responses to the survey if necessary. The sample selection only included management titles, not the name of the department managed.

2. Position/title: Position within the company was important for analysis. Senior managers may have had different perceptions than line supervisors.

3. Management experience: The length of management experience provided another background dimension to study. Younger managers may have had a differing level of understanding of the type of management theories in operation than those managers with more experience. Descriptive statistics were used to help explain the responses obtained.

4. Educational background: This information was obtained to determine the level of formal education attained as well as the depth of academic knowledge of the respondents.

5. Age: Information obtained for age was used in the same way as that for educational background (Item 4). The data was needed to help explain certain phenomena that

may occur in the responses relating to the chronological age of the respondent.

6 and 7. Work week hours: The amount of hours worked per week for both the manager and the staff were calculated separately by industry. The information was used to determine an average managerial and average staff work week by industry. The purpose for examining work week in hours was to compare the results obtained with perceptions of efficiency that are communicated in the survey. The responses of these managers were also compared to Bureau of Labor Statistics (1995) data to determine the level of difference. Bureau of Labor statistical data are averaged over a large population that is normally distributed. When this occurs, the change in work weeks is not significant from year to year. However, the perceptions of managers may be more acute than that reflected in labor statistics.

Questions 8 through 11 of Section I pertain to the level of information technology use in the company. Responses to these questions were assigned values which were combined into a total point value. An index was used to identify the level of information technology use as high, moderate, or low (see Appendix B for point ranges).

Section II: Corporate/ Industry Efficiency

Subproblem 1 asked, Is efficiency a current concern of management?

Section II of the survey provided statements related to this question. Specifically, statements 1, 2, 3, 4, 5, 6, 8 and 20 related directly to this question, using a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5).

Data were analyzed in terms of these degrees. The total responses by industry were accumulated, and mean responses for all statements in Section II were determined. An average score in the range of 3.50 and above was indicative of an affirmative response that efficiency _is_ a concern today.

The statements outlined in Section II for the first research question were developed based upon research on the topic of efficiency and personal experience to determine what information was indicative of inefficient operations and could be used to assess the respondent's sense of whether a concern exists or not. The survey results were compared to actual efficiency ratios to determine if subject perceptions matched actual efficiency levels, resulting in an assessment of the _criterion validity_ (concurrent validity) of the instrument, as previously outlined.

Subproblem 2 asked, What is the level of efficiency in the company?

Section II, again, identified statements that would be used to respond to this question. Specifically, statements 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19 were developed to respond to this question. As in the first research question, a 5-point range was used to score the responses. The total responses (scores) by industry were accumulated, and mean responses were determined for each of the five industries and combined.

Average responses indicated the following results: an average score of 1.00 to 2.49 indicated that the company was operating inefficiently; an average score of 2.50 to 3.49 indicated that the company was moderately efficient; and an average score of 3.50 to 5.00 indicated that the company was highly efficient. These data were compared with the efficiency ratios determined to compare perceptions to reality. In this way, once again, concurrent validity was reaffirmed.

Section III: Factors Affecting Efficient Operations

Subproblem 3 asked, What factors are contributing to inefficient operations today?

Section III of the survey identified statements that related directly to factors affecting efficient operations. A Likert-type 5-point interval scale was used to obtain responses ranging from very positive (1) to very negative (5). All statements identified in Section III related to this subproblem.

The factors affecting efficiency recorded in Section III of the survey were determined from research on efficiency in business. During the pilot study, the survey instrument was used to capture enough information on factors affecting efficiency to establish content validity, as previously referenced. The distribution of percentage scores was compared to the total as well as among industries represented to ascertain whether there were similarities to factors affecting efficiency among the various industries from which to draw conclusions. Those factors with a score of 2.00 or below were considered to positively affect efficiency.

The information gathered helped to highlight the predominant factors affecting efficiency today. The data collected were compared with historical research to determine if the factors identified today were similar to those considered during the industrial period. If similar factors exist, then theories such as Taylor's, which were successful in the industrial period, may be effective today.

Section IV: Methods for Improving Efficiency/ Productivity

Subproblem 4 asked, What methods are currently used to improve efficiency?

Section IV of the survey identified a series of actions that may be used today to improve efficiency and productivity in the workplace. A 5-point Likert-type interval scale was used for respondents to determine the frequency of use.

The actions identified in the survey were determined from the review of related research and literature on the topic of efficiency, particularly remedies for improving efficiency today. Content validity was established through information obtained from the pilot study. The pilot survey included blank spaces to enable respondents to fill in other methods used, adding to the full cadre of methods in use. All statements in this section (1 through 20) related to Subproblem 4.

The information obtained was compared to information obtained about the industrial period to determine what changes have occurred over the last century in terms of methods used for improving efficiency. Responses with an average of 4.00 and above were considered frequently used methods for improving efficiency in the company.

The distribution of percentage scores was compared to the total sample as well as among the industries represented to learn whether similarities exist. The results of responses to Section IV of the survey were used to develop a list of frequently applied remedies.

Section V: Information Technology and Efficiency

Subproblem 5 asked, Has information technology improved efficiency?

Section V of the survey documented a series of statements regarding whether information technology has improved efficiency in the company. Respondents were asked to select one of five responses in a Likert-type interval scale. Responses were assigned a score in points ranging from 1 to 5 as to the degree of agreement or disagreement.

Data were analyzed in terms of these points. The total responses were accumulated and a mean determined for statements 1 through 10, which related directly to obtaining information for resolving Subproblem 5. An average score of 3.50 and above indicated that information technology had improved efficiency in the organization.

The questions and statements outlined in Section V were developed based upon research on the topic of the impact that information technology had on the work environment and the resulting behaviors of the organization. Concurrent validity (criterion) was established with the comparison of data from actual information technology use and efficiency ratios determined from the Securities and Exchange Commission.

The responses to Section V related to how information technology was used in the organization and whether or not efficiency was achieved. Again, responses to the statements indicated perceptions or observations on the part of the respondent. The results obtained were compared to the level of information technology spending and efficiency--empirically derived--to determine if observations match reality. The objective was to determine if information technology had improved the level of efficiency in the company. This was answered in both the responses to survey questions and the actual data gathered in the statistical analysis.

Subproblem 6 asked, What is the purpose of information technology?

Section V of the survey included statements designed to answer this question. Statements 11 through 20 were directly related to answering this question. Respondents selected one of five responses in the Likert-type interval scale. Answers were assigned a score in points, ranging from 1 to 5, as to the degree of agreement or disagreement.

Information in this section sought to determine managerial perceptions of the purpose for information technology. As such, the information was charted, ranking mean responses for each question to obtain the most prevalent perceptions of management. Although a ranking of responses was analyzed, mean scores for each question (3.50 and above) were used to indicate general agreement with the statement.

The questions and statements outlined in Section V were based upon research on the topic of the impact that information technology had on the work environment and the resulting behaviors of the organization. The results obtained were used to understand managers' perceptions of information technology. This information was then compared to the level of information technology use as well as the efficiency ratio to determine manager perceptions of whether the purpose of information technology has any relation to the level of use. The goal is to understand whether confusion of purpose has a bearing on the effective application of information technology.

Section VI: Scientific Management Use

Subproblem 7 asked, Are Taylor's theories currently being used?

Section VI of the survey outlined a series of statements regarding the respondent company's response to various managerial issues and approaches to issues. The purpose of these statements was to determine whether a scientific management orientation exists in the company.

Construct validity is an issue relative to Section VI statements only, determined based upon responses from pilot study respondents. Once responses were received, interviews were conducted to determine if the responses were consistent with the respondent's application of scientific management principles. Statements were edited based upon these responses. Again, information was sought based upon what is currently occurring and not what the manager believes should happen. Respondents were asked to respond by selecting one of five responses in a Likert-type interval scale. Answers were assigned a score ranging from 1 to 5, dependent upon the degree of agreement or disagreement with the statement.

Data were analyzed in terms of these points. Each statement pertained to one of four basic principles that represent the foundation of scientific management. The four basic principles were:

1. The development of a science for every aspect of a worker's job. This is a replacement for rule-of-thumb management.

2. Workers are scientifically selected, trained, and educated on the work that will be done. In the past, this was developed by the worker himself.

3. Managers work closely with employees to ensure that tasks are completed according to the principles of science previously developed.

4. Management and workers divide work almost equally between them, based upon the individual better suited for the task. (Taylor, 1911b, pp. 36-37)

The statements in Section VI of the survey pertained to one of the four principles as presented in Table 12. Responses for each industry were tallied and combined for the entire sample, and means were determined for each set of statements corresponding to a particular principle. An average score of 3.25 and above (or 3.00 for Principle 3) indicated that the particular principle was being fol-

Table 12

Survey Statements that Related to
Taylor's Four Principles

Principle	Statement Numbers
1. Develop a science for every aspect of a worker's job.	1, 4, 6, and 10
2. Workers are scientifically selected, trained, and educated on the work that will be done.	2, 3, 11, and 14
3. Managers work closely with employees to ensure that tasks are completed according to the principles of science previously developed.	7, 8, and 9
4. Management and workers divide work almost equally between them, based upon the individual better suited for the task.	5, 12, 13, and 15

lowed. The threshold of 3.25 was determined based upon the following:

- For Principles 1, 2, and 4, there were four statements. A positive response (agree with the statement) indicated a rating of 4 or 5 for three of the four statements for it to be positive. Because the lowest possible average for these ratings would be 3.25 (i.e., 4 + 4 + 4 + 1 / 4 = 3.25), this became the threshold for acceptance for Principles 1, 2, and 4.

- For Principle 3 only, three statements are involved. In order for the statement to be a positive response (agree with the statements), two of the three statements must be rated a 4 or 5. The lowest possible average then would be 3.00 (4 + 4 + 1 / 3 = 3.00). This becomes the threshold for Principle 3.

Use of Taylor's principles was only true if Principle 1 was one of the four. Principle 1 was a critical element of scientific management. The statements for this section were determined from research on the principles of scientific management developed by Taylor and were tailored to address specific actions that would relate to each of the four principles of scientific management.

Section VI was a direct contributor to the statistical analysis; that is, the results obtained were used to determine if a statistical relationship existed between scientific management usage and efficiency.

Instrument Validity and Reliability

Both validity and reliability were concerns in the collection of information. Validity is comprised of three components: criterion, content and construct. Criterion validity refers to how well the measures derived actually assess the specific variables being measured (Light, Singer, & Willett, 1990). Two types of criterion validity exist: concurrent validity and predictive validity. For this study, only concurrent validity applies because predictive capabilities are not planned in the overall results.

Concurrent validity indicates whether the responses to the questions are highly correlated to what actually exists. Sections II and V of the survey sought managerial perceptions of organizational efficiency as well as the efficiency of information technology. The secondary financial data obtained about these companies were compared to primary data to determine if a high correlation existed between what the actual efficiency ratio was and the manager's perception of efficiency in his or her company.

Content validity refers to whether the individual items of the instrument, as a group or individually, cover all the domains that are intended to be measured (Light et al., 1990). Sections III and IV of the instrument sought responses regarding factors negatively affecting efficiency and methods used to promote efficiency. Because a finite number of factors and methods does not exist, only the most commonly applied items were included to determine patterns of use. These factors and methods were derived from personal experience, research, and input from pilot-study respondents.

Construct validity refers to whether the measure "actually assesses what it is supposed to assess" (Light et al., 1990, p. 156). Section VI of the survey sought responses to statements to assess the level of scientific management use in the company. Although statements were constructed to indicate scientific management use, the pilot group was used to test respondent reactions to the statements. Respondents for the pilot study were contacted and asked whether the statement had the same meaning as intended by the writer. Suggested changes were incorporated into the survey to improve construct validity.

Reliability of the instrument refers to how well the statements can be relied upon to provide a consistent answer. A test-retest was used with the pilot survey to establish the reliability of the instrument. The consistency of responses between the first and second test was used to determine the level of reliability. The results of the test-retest are identified in the next section.

Pilot Survey

A pilot survey was conducted to assess the usability of the survey instrument and the procedures to be used for conducting the survey. The objectives of the pilot survey were to

1. assess the ease of completion of the survey;
2. assess the reliability of the statements and questions;
3. determine the need for additional questions and statements; and
4. evaluate whether the questions asked achieved the meaning for which they were intended.

Two pilot surveys were sent to a group of 11 business managers. The first survey was designed to obtain information about the time required for completion, clarity, and appropriateness of statements. In addition, space was provided for additional items to be included in the survey.

The second pilot survey consisted of the same statements and sections but in a different order. This survey was sent two weeks after the first to the same managers. The purpose of this survey was to assess the reliability of the statements and questions. By performing a test-retest, the reliability of the statements was determined based upon the pilot group's responses.

The pilot surveys were both mailed in December 1996, two weeks apart. A summary of the results of the pilot surveys follows.

Ease of Completion

A total of 8 of 11 responses were received from the pilot group. The results of this survey produced the following results:

1. Survey length: All of the respondents (eight) indicated that the survey was not too long.

2. Time required: The majority (five of eight respondents) indicated that the survey required 11-15 minutes to complete.

3. Clear/understandable statements: Six of eight

respondents believed the survey statements and instructions were completely clear. Two respondents believed they were partially clear, recommending the following:

a. Some statements appeared redundant between sections. Action: During the editing process redundant items were omitted.

b. Trouble was experienced with explanatory paragraphs before each section. Action: Explanatory paragraphs were simplified and shortened for clarity.

c. Some respondents believed that the sections of the survey should be shorter. Action: Because only two of the eight pilot respondents believed the sections were too long, no changes were made to shorten them. However, each section was reviewed and attempts were made to simplify the appearance of each.

d. The respondents thought that responses in Section II were to be recorded in the lines (between numbers). Action: Sections III and IV have been graphically changed to avoid confusion.

e. The word "organization" as used in statements needs a definition (i.e., use terms such as "my direct responsibility," "my company," or "my division"). Action: The word "organization" was changed to "company."

f. Some statements were too broad in nature.

Assessing the company as a whole was difficult when the respondent was responsible only for a single area. Action: Although efforts were made to make the statements more directly applicable, the original intent was to obtain the perspectives of managers about the company as a whole. Therefore, initial perceptions were still valid.

4. Clear and understandable instructions: Although six of eight respondents believed the instructions were clear and understandable, some suggestions were made:

a. At the beginning of the survey, an overview of the survey contents was recommended to provide advance knowledge of what the survey is about. Action: A separate introductory instructions page was included in the revised survey.

b. Bullet-point explanations on an introductory page to prepare respondents for what follows were recommended. Action: An explanation was incorporated into the introductory page of the survey.

5. Other comments: The following were general comments made about the survey:

a. "I didn't know exactly what types of questions I'd be answering before I began." The respondent was unsure if the responses were truly what he/she thinks. Action: Attempts were made in the introduction of the survey to provide clarity for the types of questions asked with an emphasis on the manager's perceptions.

b. "The different scoring methods kept the survey interesting."

c. "The survey was easy to complete. I might have considered my answers more and been more accurate if I had more background at the start of the survey." Response: The pilot respondents were not given the same introductory letter as the sample received. This letter provided more background about the purpose of the survey. Also, an introductory page was added.

d. "As a respondent I like to learn something too or have an understanding of why I'm completing the survey." Action: More of an explanation has been added to the introductory section.

Reliability

To assess consistency, a test-retest was conducted. The objective was to determine the level of consistency of responses from one test to the other. Table 13 shows the results of the test-retest.

Statements producing a consistency of 33% or less were further analyzed. If statements seemed difficult to respond to, changes were made. Consistency rates above

Table 13

Results of Pilot Survey Test-Retest by Section and Question (Percent of Respondents Answering the Same)

Question Number	Section				
	II (%)	III (%)	IV (%)	V (%)	VI (%)
1	67	33	67	50	67
2	83	50	67	67	50
3	50	67	50	67	50
4	83	50	100	100	50
5	83	67	50	83	83
6	50	50	33	33	50
7	67	33	67	67	67
8	83	50	67	33	50
9	33	83	67	50	83
10	83	67	33	67	67
11	33	67	33	67	100
12	67	50	33		83
13	50	33	67		
14	33	67	33		
15	50	67	83		
16	50	83			
17	50	50			
18	100	33			
19	83	67			
20	50	67			
21		83			
22		50			
Mean	63	57	57	63	67
Overall (all sections) mean: 61%					

50% were considered reliable.

Other Statements to Be Included

Sixty-three percent of the respondents felt that there was no need for "other statements" to be added. Additions by respondents who did request them are presented in Table 14.

Evaluation of Scientific Management Questions

The pilot respondents were telephoned and asked whether the statements in Section VI, "Scientific Management Use," were understood. The results indicated that all managers understood clearly the intent of the statements and the rationale for each. The respondents, however, did not necessarily know the specific elements of Taylor's principles of scientific management.

Secondary Information

Corporate and industry data are available (using the Internet) from the Securities and Exchange Commission's electronic access to financial statements service, EDGAR. For the industries defined in this study, financial information was obtained about the companies represented in the sample. The purpose was to gather information critical to the hypothesis of the research--efficiency ratios. Three years of information was collected for each respondent

Table 14

Additional Statements Requested by
Respondents to Pretest Survey

Section III Statements	Included in Revised Survey
Customers	Included
Work environment	Included
Budget (financial)	Included
Management/staff turnover	Included
Business growth	Included
Investor relationships	Not included
Compliance requirements	Included
Audits/examinations	Included
Section IV Statements	
Ask people who do job	Already included
Dedicated focus	Not included
Task force/focus group	Included
Community projects	Not included
Promotion from within	Not included

organization. The information obtained from EDGAR, and other sources was converted to an efficiency ratio and included in Appendix D.

Efficiency Ratio

Efficiency ratios are not readily available but must be calculated from the financial statement information found in EDGAR, financial statements, and Bloomberg. Data for each responding company was analyzed with the efficiency ratio calculated based upon an average of the last three years of financial information.

Information Technology Use

Information technology use was determined by an index. The index is determined using questions 8 through 11 of Section I of the survey. Responses were scored and assigned point values, as outlined in Appendix B. The aggregate score for each company indicated the level of information technology use as high, moderate, or low as follows: (a) a score of 136-200 indicated high information technology use; (b) a socre of 68-135 indicated moderate information technology use; and (c) a score of 0-67 indicated low information technology use. The point values for this index are presented in Appendix B.

Procedures

Mailings

Survey instruments were coded using the coding methodology defined in Appendix B. Each survey was mailed with a cover letter with a self-addressed, stamped envelope for return (see Appendix A).

Follow-Up Mailings

Follow-up mailings occurred at intervals of three, six and nine weeks. These additional mailings included a follow-up letter (see Appendix A) with an enclosed survey and return envelope. A final notification postcard was also sent as a reminder (see Appendix A). Mailings ceased after the third mailing.

Completed Surveys

Survey responses were coded for data analysis in accordance with the coding conventions in Appendix B.

A data roster (see Appendix D) is used to record completed data. The treatment in effect was determined and recorded for analysis with subject number, treatment, and efficiency rates. The first digit of the subject number indicated the industry, and the last three digits indicated the sequential subject number. Industry codes were as follows:

1 = Finance,

2 = Health services,

3 = Business services,

4 = Retail trade, and

5 = Manufacturing.

The treatment was coded to correspond with the two independent and one moderator variable levels therefrom and adhered to the coding conventions contained in Appendix B as follows:

1: Uses scientific management principles, or

2: Does not use scientific management principles;

1: High information technology use,

2: Moderate information technology use, or

3: Low information technology use;

1: Finance,

2: Health Services,

3: Business Services,

4: Retail Trade, or

5: Manufacturing.

Data Analysis Procedures

The data collected were analyzed in conjunction with the following procedure to achieve the outcome previously identified. Data were analyzed using both descriptive and inferential statistics.

Descriptive Statistics

Descriptive statistics were used in this study to describe the characteristics about information collected (Sapre, 1990). The statistics were used to clarify and answer research questions based upon the data obtained. The research questions analyzed using descriptive statistics were:

1. Is efficiency a current concern of management?
2. What is the level of efficiency in the company?
3. What factors are currently contributing to inefficient operations?
4. What methods are used currently to improve efficiency?
5. Has information technology currently improved efficiency?
6. What is the purpose of information technology?
7. Are Taylor's theories currently being used?
8. What is the current level of information technology use in the company?
9. What is the level of efficiency in the company by efficiency ratio?

For each question, a specific descriptive analysis was performed. The following describes each descriptive analysis used.

Frequency distributions and central tendency (mean) were primarily used to present responses for the research questions above. The frequency distributions indicated the frequency with which specific responses occurred.

For Research Questions 1 and 2 (Is efficiency a current concern of management? and What is the level of efficiency in the company?), histograms, frequency distributions, and central tendency were all developed. These tools provided both graphical and numerical distribution of responses by industry type.

Research Questions 3 and 4 (What factors are currently contributing to inefficient operations? and What methods are currently used to improve efficiency?) were analyzed using frequency distributions only by individual factor and method used. The factors and methods were ranked in descending order from the most positively perceived factor and the most frequently used method in relation to efficiency.

Research Question 5 (Has information technology currently improved efficiency?) was analyzed using a histogram, central tendency, and frequency distribution. The histogram graphically displayed the distribution of respondents by mean score for the 10 statements combined. Central tendency was used to display the overall mean responses by industry type and total. The frequency distribution was used to show the percentage of respondents that either agreed, disagreed, or were neutral with respect to each of the 10 statements in Section V of the survey.

Research Question 6 (What is the purpose of information technology?) relied only on central tendency and frequency distribution for analysis. The reason for this was that this research question was answered from statements 11 through 20 individually, in contrast to a composite average. The frequency distribution showed the percentage of respondents that either agreed, disagreed, or were neutral with respect to each of the 10 statements (11 through 20) in section V of the survey.

Research Question 7 (Are Taylor's theories currently being used?) was analyzed using both frequency distribution and central tendency. The frequency distribution displayed the percentage of total respondents that indicated use, nonuse, or uncertainty with regard to each of Taylor's four core principles of scientific management. Central tendency, on the other hand, was used to present mean responses by industry type and total for statements that related to each of the four principles. A final frequency distribution was used to display whether Taylor's principles were in general use in total and by industry type.

Research Question 8 (What is the current level of information technology use by companies?) was analyzed predominantly by frequency distribution. For each of the four questions in Section I of the survey, a frequency distribution was used to display the percentage of respondents that use information technology at the levels indicated. In addition, the distribution was further arrayed by industry type.

Research Question 9 (What is the current level of efficiency in the company by efficiency ratio?) was analyzed by central tendency only. Mean efficiency ratios were calculated and arrayed by industry type for comparative purposes.

Inferential Statistics

Inferential statistics were used to test the hypothesis. The hypothesis of this study made inferences from the sample for wider generalization to the population (Sapre, 1990). The probability that the relationship identified in the sample could be generalized to the population was determined from the evidence provided by the inferential technique used.

The foundation of hypothesis testing is probability, which is operationally defined as significance level. The significance level provided the threshold from which the hypotheses was accepted or rejected. Tests of significance are organized around two types of data: parametric and nonparametric.

Parametric tests are typically used for ratio and interval-scaled data but have more stringent requirements.

In contrast, nonparametric test requirements are less stringent and focus on nominal and ordinal-scaled data. Because the dependent variable--efficiency ratio--relied on interval-scaled data, parametric tests of significance would appear to be appropriate. Because there was more than one independent variable (including the moderator variable), all of which were nominal, and a single dependent variable that was interval, the appropriate parametric test was the analysis of variance (ANOVA) (Tuckman, 1988).

The ANOVA as a test of significance has merit because it allows for the comparison of two or more independent variables (factors). In addition, the ANOVA permits analysis both between and within groups. For this study, three factors were used--two independent and one moderator variable. This configuration already eliminated the _t_ test from consideration, as the _t_ test permits an analysis only between two means. In addition, the interaction of the effects of both were critical to the effective testing of the hypothesis, which precisely stated that the interaction of the two independent variables had the greatest impact on efficiency.

Another parametric test is the Pearson Product Moment Correlation. This test is used as a means of predicting one variable given another. This test is the most frequently used coefficient of correlation. Correlation focuses on the strength of the relationship between two scores (Lomax, 1992). The coefficient of correlation is a number that indicates the level of correlation, either perfectly positive or no correlation (Sapre, 1990). Perfect correlation indicates that the two variables will move in the same direction. That is, one can be a predicator of the other. Although Pearson Product Moment is a parametric test, it typically is used for only two variables and, therefore, is not as versatile as the ANOVA. Furthermore, correlation is not causation (Lomax, 1992). Although a correlation coefficient can show a quantifiable association from one variable to the other, it does not indicate whether the result occurred by chance or not.

Causation is difficult to confirm. Without conducting a well-planned experiment, the ANOVA was the best technique available for establishing confidence that the result is not due to chance (McCabe & Moore, 1989).

For this study, significance (probability) provided the best assessment of multiple variables from which conclusions were drawn. Parametric tests require three conditions for application: (a) normal distribution, (b) homogeneity of variance, and (c) continuous equal interval measures. Nonparametric techniques are not used due to the nature of the variables in this study. Spearman Rank Order Correlation compares ordinal data for equivalence, chi square only compares nominal variables based upon comparative distributions and their degree of difference, and Mann-Whitney U-Test compares one nominal independent and one ordinal dependent variable (Tuckman, 1988).

The resulting inferential technique used was the ANOVA. Given the variables in the study, a three-factor, fixed-effects ANOVA was used to test the hypothesis. This is characterized as a 2x3x5 ANOVA, consisting of two independent and one moderator variable with two, three, and five levels as follows:

Factor A: Scientific management use.

Level 1: Uses scientific management

Level 2: Does not use scientific management

Factor B: Information technology use.

Level 1: High information technology use

Level 2: Moderate information technology use

Level 3: Low information technology use

Factor C: Industry.

Level 1: Financial services

Level 2: Health services

Level 3: Business services

Level 4: Retail trade

Level 5: Manufacturing

Because nominal independent variables are required for use with the ANOVA, Factor B was converted to nominal using the median-split technique. Factor A was converted to nominal using the equal n-split technique (Tuckman, 1988).

The results of the ANOVA significance test indicated whether relationships between variables were significant. The Tukey Honestly Significant Difference (HSD) post hoc multiple comparison test was used to assess the significance of the interactions among the three variables. For the three-way ANOVA, significance was assessed by both main effects (information technology spending, scientific management use, and industry) and interaction effects. The interactions were pairwise combinations of the levels of each of the three variables. The three factors and their levels are recorded above. The interactions that occurred and were assessed using the Tukey method are displayed later in the chapter.

The criterion (alpha) used was .05. The goal was to determine whether there was a significant row effect (usage of scientific management), a significant column effect (information technology use), and a significant interaction between the two. If the probability was less than alpha (.05), then the difference was significant and the null hypothesis would be rejected.

Given the factors involved, the design of the ANOVA is indicated in Figure 1, which provides the following between-group relationships and interactions:

A. Between groups.

1. Information technology use (high, moderate,

and low)

2. Scientific management use (yes and no)

3. Industry (finance, health, business, retail, and manufacturing)

Information Technology Use	Scientific Management Use	Industry				
		FIN	HLTH	BUS	RET	MFG
High	Yes					
	No					
Moderate	Yes					
	No					
Low	Yes					
	No					

Figure 1. Three-Way ANOVA Model.

B. Interactions.

1. Scientific management use and

- High information technology use
- Moderate information technology use
- Low information technology use
- Finance industry
- Health industry
- Business services industry
- Retail trade industry
- Manufacturing industry

2. No scientific management use and
   - High information technology use
   - Moderate information technology use
   - Low information technology use
   - Finance industry
   - Health industry
   - Business services industry
   - Retail trade industry
   - Manufacturing industry
3. High information technology use and
   - Finance industry
   - Health industry
   - Business services industry
   - Retail trade industry
   - Manufacturing industry
4. Moderate information technology use and
   - Finance industry
   - Health industry
   - Business services industry
   - Retail trade industry
   - Manufacturing industry
5. Low information technology use and
   - Finance industry
   - Health industry
   - Business services industry
   - Retail trade industry

- Manufacturing industry

6. Scientific management use and high information techology use and

   - Finance industry
   - Health industry
   - Business services industry
   - Retail trade industry
   - Manufacturing industry

7. Scientific management use and moderate information technology use and

   - Finance industry
   - Health industry
   - Business services industry
   - Retail trade industry
   - Manufacturing industry

8. Scientific management use and low information technology use and

   - Finance industry
   - Health industry
   - Business services industry
   - Retail trade industry
   - Manufacturing industry

9. No scientific management use and high information technology use and

   - Finance industry
   - Health industry

- Business services industry
- Retail trade industry
- Manufacturing industry

10. No scientific management use and moderate information technology use and
    - Finance industry
    - Health industry
    - Business services industry
    - Retail trade industry
    - Manufacturing industry

11. No scientific management use and low information technology use and
    - Finance industry
    - Health industry
    - Business services industry
    - Retail trade industry
    - Manufacturing industry

The efficiency percentages determined from research were taken from the data roster (see Appendix D) and used in the ANOVA calculation. The following sections describe how the information regarding the independent and dependent variables was analyzed.

Scientific Management Use

From the responses in Section VI of the survey, it was determined by company and industry whether Taylor's scientific management principles were used or not. Individual companies, whether using scientific management or not, were evaluated with the efficiency ratios determined from EDGAR. Two levels were utilized in the ANOVA: 1) using scientific management principles and 2) not using scientific management principles.

Information Technology Use

Levels of information technology use were determined from the questions asked in Section I of the survey. Information technology use was assigned a point value as follows: (a) 136-200 total points indicated high information technology use, (b) 68-135 total points indicated moderate information technology use, and (c) 0-67 total points indicated low information technology use. Information technology use was compared to the efficiency ratio to understand whether there was a relationship between information technology use and efficiency.

Efficiency Ratio

Again, from the information obtained from EDGAR, efficiency ratios were calculated for each company and industry as an average. This was an average over three years. The efficiency ratio was used to compare with scientific management use and information technology use to assess their individual and combined impacts.

The information is recorded in Appendix D using the data roster, which arrays the information gathered by company for ease of use. This information was used in the ANOVA model to determine if the differences between each independent variable (and combined) and the efficiency ratio are real differences and whether a generalization can be made regarding the results.

Summary

Chapter 7 outlined the procedures and the steps necessary to complete the research study. The study was designed to be both quantitative, using survey research, and qualitative, using historical information. Both primary and secondary data were collected to respond to the research questions raised and to test the hypothesis. Descriptive statistics were used to present and analyze primary information (survey research), and inferential statistics were used to test the hypothesis. For this research, the ANOVA was selected because of the multiple variables and levels involved in the study (three independent variables with 2, 3, and 5 levels, respectively).

The independent variables in the study were: information technology use, scientific management use, and industry type (moderator variable). The dependent variable was efficiency, expressed as an efficiency ratio.

The sample was selected randomly from a population of managers taken from the AMA data base. The sample size was determined to be 768 (after adjusting to ensure an adequate return) from a population of 6,398 managers. Managers were selected from five industries: finance, health services, business services, retail trade, and manufacturing. These industries were selected based upon the number of workers employed in these industries. The combined total employees from these industries represented approximately 50% of the total labor force for both the goods-producing and services-producing industry categories.

CHAPTER 8

FINDINGS FROM THE RESEARCH

The purpose of this chapter is to present the findings obtained from both the primary and secondary research conducted. Primary (survey) and secondary (existing) information was used to obtain answers to the following questions:

1. Is efficiency a current concern of management?

2. What is the level of efficiency in the company?

3. What factors are currently contributing to inefficient operations?

4. What methods are currently being used to improve efficiency?

5. Has information technology improved current efficiency?

6. What is the purpose of information technology?

7. Are Taylor's theories currently being used?

8. What is the current level of information technology use in the company?

9. What is the current level of efficiency in the company by efficiency ratio?

Secondary research was also conducted to obtain the efficiency ratios of responding companies. This information was used to test the hypotheses. The relationship between the efficiency ratio and information technology use and scientific management use is presented in the chapter.

Sample

Sample Size

Surveys were mailed to 811 candidates randomly selected from a population of 6,398 managers. The recipients were managers selected from a database obtained from the AMA.

Originally, the sample size was determined based upon an error level of plus/minus 5%. This yielded a sample size of 384 managers. Because response rates rarely exceed 50%, the sample size selected was 768 managers. The database of randomly selected names returned from the AMA actually produced 811 names, hence the sample size.

Sample Selection

Surveys were sent to managers in five industries: financial services, health services, business services, retail trade, and manufacturing. The number of mailings by industry were as follows:

- Financial services 181
- Health services 82

- Business services	119
- Retail trade	105
- Manufacturing	324
- Total	811

The number of mailings differed by industry due to the relative population size of the industry to the entire population. The sample is a stratification of the population of managers for the five industries represented. The percentage of each industry to the total population is maintained in the sample as outlined in Table 10.

Response Bias

Of the three mailings, a total of 196 usable surveys were received for a response rate of 24.17%. In addition, 37 surveys were returned as undeliverable. The response rate of 24.17% was considered adequate for the purposes of this research.

Because the actual number of usable responses received was 196, a sampling error of plus/minus 7% resulted (a 93% chance that the sample will be representative of the population). Unfortunately, because less than 100% of the surveys were received, the actual error limit is unknown. The reason for this is that the respondent group, because less than 100%, could be skewed in one direction or another and not be truly representative of the population. This raises a concern about the generalizability of the data. To reduce this concern and enhance the usefulness and generalizability of the data, respondent bias must be reduced.

According to the table developed by Wunsch (1986), a response rate of between 20% and 30% is required for a sample of 811 to be considered adequate. This means that "a sufficient number have responded to make it possible to use the comparison of selected characteristics to determine possible response bias" (p. 33). Based upon this criterion the response rate of 24.17% is considered adequate. As a result, the selected characteristics can be compared but must not differ from the population by more than 5% to be considered unbiased.

Respondent bias, therefore, was reduced by selecting a characteristic of the population for comparison to the response group. The characteristic, gender, was identified for this purpose. Table 15 shows a comparison of the percentages for the response group and the population for this characteristic.

As shown in Table 15, the characteristic of gender falls within the required 5% range. This is sufficient to satisfy the requirements of the test. Because this characteristic does not differ significantly from the population, the researcher could be 93% confident that the response was unbiased and reflected the population within plus/minus 7% error.

Table 15

Respondent Bias Characteristic Comparative

Gender	Population		Respondent		Difference
	N	%	N	%	
Male	4,631	72.39	138	70.80	-1.59
Female	1,767	27.61	57	29.20	1.59
Total	6,398	100.00	195	100.00	

Sample Stratification

Because five separate industries were studied within the population, the same distribution of managers across industries was held constant between population and sample to increase the representativeness of the data. In addition, the same stratification should be achieved without significant deviation for the response group.

Table 16 compares the proportions of managers by industry from the population to the response group by percent of managers within each category.

In general, the response group conformed to the stratification of the population within a difference of approximately plus/minus 3%. This indicates that the response group is representative of the population, therefore improving the generalizability of the results.

Demographics

In addition to the survey questions, background information was requested about the respondents. This provided demographic information about the respondents to develop a profile of the typical manager responding to the survey. This information included: (a) department managed, (b) title (position), (c) years of experience, (d) educational level, and (e) age (chronological).

Table 16

Comparison of Population of Managers and Response Proportions by Industry

	Population		Respondent		
Industry	N	%	N	%	Difference
Finance	1,479	23.12	41	20.92	-2.20
Health	657	10.27	22	11.22	.95
Business	957	14.96	32	16.33	1.37
Retail	856	13.38	20	10.20	-3.18
Manufacturing	2,449	38.27	81	41.33	3.06
Total	6,398	100.00	196	100.00	

Departments Managed

A distribution of the types of departments managed for the response group by industry is presented in Table 17. Numbers of responses and respective percentages of the total industry response are reflected in each category.

Although the majority of the managers responded to "other" (23.6%), the most frequently represented depart-

Table 17

Distribution of Respondents by Department Currently Managing

Department	Finance		Health		Business		Retail		Manufacturing		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Human Resource	8	19.5	4	8.2	4	12.9	4	20.0	5	6.2	25	12.8
Finance	6	14.6	1	4.5	6	19.4	4	20.0	15	18.5	32	16.4
Operations	7	17.1	7	31.8	0	0.0	5	25.0	11	13.6	30	15.3
Credit	2	4.9	0	0.0	0	0.0	0	0.0	0	0.0	2	1.0
Sales	2	4.9	0	0.0	1	3.2	0	0.0	11	13.6	14	7.2
Information Systems	3	7.3	3	13.6	2	6.5	2	10.0	2	2.5	12	6.2
Marketing	2	4.9	2	9.1	6	19.4	1	5.0	10	12.3	21	10.8
Production	1	2.4	0	0.0	1	3.2	1	5.0	5	6.2	8	4.1
Purchasing	0	0.0	0	0.0	0	0.0	1	5.0	4	4.9	5	2.6
Other	10	24.4	5	22.7	11	35.5	2	10.0	18	22.2	46	23.6
Total	41	100.0	22	100.0	31	100.0	20	100.0	81	100.0	195	100.0

Note: Although 196 usable surveys were returned, one (1) respondent did not complete Section I of the survey. This section is the demographic section and therefore all demographic results are based upon 195 total responses. This does not apply for Sections II through VI of the survey, as the respondent (#3100) completed these properly.

ments included human resources, finance, and operations. These departments accounted for a total of 87 (44.6%) of the responding managers. Departments such as these are typically among the most labor-intensive departments. Only the business services industry was an exception, with 11 respondents (35.5%) in the "other" category and 6 respondents (19.4%) in marketing. Both of these represented the largest percentages for the respondent group.

Position Title

The distribution of respondents by industry as to the title of the position they hold is shown in Table 18.

According to Table 18, 104 (53.3%) of the respondents, the majority, held the title of manager. Because the objective of the research was to study managerial perceptions, knowledge of the titles held helped to add credibility to the responses later examined.

Years of Experience

Years of experience was an important consideration when evaluating managerial perceptions. More experience indicated a greater likelihood of exposure to concepts presented and, therefore, more meaningful responses. The distribution of respondents by the level of experience they had is shown in Table 19. The number of responses is also shown as a percentage of total respondents for each

Table 18

Distribution of Respondents by Title of Position Held

Title	Finance		Health		Business		Retail		Manufacturing		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Manager	16	39.0	8	36.4	14	45.2	12	60.0	54	66.7	104	53.3
Vice President	4	9.8	3	13.6	5	16.1	3	5.0	7	8.6	22	11.3
Assistant Vice President	6	14.6	0	0.0	1	3.2	0	0.0	2	2.5	9	4.6
SVP	0	0.0	2	9.1	0	0.0	0	0.0	0	0.0	2	1.0
Director	7	17.1	6	27.3	4	12.9	3	15.0	7	8.6	27	13.8
Supervisor	4	9.8	1	4.5	2	6.5	1	5.0	9	11.1	17	8.7
Other	4	9.8	2	9.1	5	16.1	1	5.0	2	2.5	14	17.2
Total	41	100.0	22	100.0	31	100.0	20	100.0	81	100.0	195	100.0

Table 19

Distribution of Respondents by Years of Experience

Years of Experience	Finance		Health		Business		Retail		Manufacturing		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
0-3 years	4	9.8	1	4.5	6	19.4	2	10.0	17	21.0	30	15.4
4-6 years	7	17.1	8	36.4	5	16.1	2	10.0	15	18.5	37	19.0
7-10 years	6	14.6	3	13.6	4	12.9	5	25.0	11	13.6	29	14.9
11-15 years	13	31.7	2	9.1	5	16.1	6	30.0	13	16.0	39	20.0
15+ years	11	26.8	8	36.4	11	35.5	5	25.0	25	30.9	60	30.8
Total	41	100.0	22	100.0	31	100.0	20	100.0	81	100.0	195	100.0

industry category.

According to Table 19, a total of 60 respondents (30.8%) had over 15 years of experience. This was the largest number and percentage of respondents for all but two industries--retail trade (11-15 years) and financial services (11-15 years). Overall, however, the majority (99 respondents, 50.8%) had greater than 11 years of experience.

Educational Level

Responses to the next category, educational level, determined the level of formal education attained. Similar to experience, educational level can indicate the presence of higher level skills, which may or may not have an impact on the responses. The number and percentage of respondents by level of education attained for each industry as well as in total is presented in Table 20.

The majority of the respondents had college degrees (162 respondents, 83%), which was relatively consistent across all industries in the sample.

Chronological Age

The last category analyzed was chronological age. The distribution of respondents by age range is provided in Table 21. As with experience and educational level, the chronological age of the respondent can have an effect

Table 20

Distribution of Respondents by Educational Level Attained

Level	Finance		Health		Business		Retail		Manufacturing		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
High school	0	0.0	0	0.0	2	6.5	0	0.0	5	6.2	7	3.6
College	6	14.6	5	22.7	2	6.5	4	20.0	9	11.1	26	13.3
College graduate	17	41.5	5	22.7	14	45.2	11	55.0	30	37.0	77	39.5
Graduate degree	15	36.6	10	45.5	8	25.8	4	20.0	29	35.8	66	33.8
Postgraduate	3	7.3	2	9.1	5	16.1	1	5.0	8	9.9	19	9.7
Total	41	100.0	22	100.0	31	100.0	20	100.0	81	100.0	195	100.0

Table 21

Distribution of Respondents by Chronological Age

Age	Finance		Health		Business		Retail		Manufacturing		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Under 21 years	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
21-29 years	3	7.3	2	9.1	0	0.0	0	0.0	1	1.2	6	3.1
30-39 years	16	39.0	6	27.3	14	45.2	8	40.0	23	28.4	67	34.4
40-49 years	14	34.1	11	50.0	11	35.5	9	45.0	36	44.4	81	41.5
50-59 years	6	14.6	3	13.6	5	16.1	3	15.0	21	25.9	39	19.5
60+ years	6	4.9	0	0.0	1	3.2	0	0.0	0	0.0	195	1.5
Total	41	100.0	22	100.0	31	100.0	20	100.0	31	100.0	195	100.0

on a manager's perception. As shown in the table, the majority (48 managers, 75.9%) of the respondents were 30 to 49 years of age, which was consistent across all industries.

In conclusion, demographic data for the 195 respondents indicated that the average respondent for this study:

1. Managed finance, operations, human resources, marketing, or other;

2. Held the title of "manager";

3. Had over 11 years of experience;

4. Was a college graduate; and

5. Was between 30 and 49 years of age.

Hours Worked

In addition to demographic information, data were collected on the number of hours generally worked by both management and staff. The number of hours worked was surveyed to determine whether work weeks, on average, were increasing or decreasing in length. Respondents were asked to indicate the range of hours they typically worked in a week as well as the typical work week of their staff. Tables 22 and 23 show the distribution of respondents by the number of hours they typically worked in a week. Numbers of respondents for each industry and in total, with respective percentages, are presented. Table 22 reflects

Table 22

Distribution of working Hours per Week for Managers

Hours	Finance		Health		Business		Retail		Manufacturing		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Under 40	2	4.9	0	0.0	0	0.0	0	0.0	0	0.0	2	1.0
40-45	13	31.7	7	31.8	9	29.0	7	35.0	18	22.2	54	27.7
46-50	11	26.8	7	31.8	11	35.5	5	25.0	25	30.9	59	30.3
51-55	8	19.5	4	18.2	6	19.4	5	25.0	26	32.1	49	25.1
56-60	5	12.2	4	18.2	4	12.9	2	10.0	9	11.1	24	12.3
60+	2	4.9	0	0.0	1	3.2	1	5.0	3	3.7	7	3.6
Total	41	100.0	22	100.0	31	100.0	20	100.0	81	100.0	195	100.0

Table 23

Distribution of Working Hours per Week for Staff

Hours	Finance		Health		Business		Retail		Manufacturing		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Under 40	9	21.9	2	9.1	2	6.4	1	5.0	3	3.7	17	8.7
40-45	22	53.7	16	72.7	16	51.6	15	75.0	44	54.3	113	57.9
46-50	8	19.5	2	9.1	10	32.3	2	10.0	26	32.1	48	24.6
51-55	1	2.4	2	9.1	1	3.2	2	10.0	5	6.2	11	5.6
56-60	1	2.4	0	0.0	2	6.5	0	0.0	3	3.7	6	3.1
60+	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	41	100.0	22	100.0	31	100.0	20	100.0	81	100.0	195	100.0

managerial work weeks and Table 23 staff work weeks.

Based upon the results presented in Tables 22 and 23, respondents typically worked more than 40 hours per week. The majority of managers (139 respondents, 71.3%) worked more than 46 hours per week. The majority of staff members (113 respondents, 57.9%), on the other hand, worked between 40 and 45 hours per week. Few staff members (17 respondents, 8.7%) worked more than 51 hours per week, whereas 80 (41.0%) of the managers responding to the survey worked more than 51 hours per week. Finally only 2 (1%) of the managers worked less than 40 hours per week, compared with 17 respondents (8.7%) for staff employees.

Industries were represented fairly consistently among the ranges of hours worked. However, the financial industry for staff employees had the highest number of people working less than 40 hours per week (9 respondents, 21.9%), which is much higher than for other industries in that category.

For both managers and staff, respondents in the manufacturing industry worked the most hours. Sixty-three managers (77.8%) and 34 staff (42.0%) worked 46 or more hours per week. On the other hand, finance managers worked the least hours (26 managers, 63.4%), and health staff worked the least hours for staff (4 staff members, 18.2%), at or above 46 hours per week. The work week profile indicated that managers typically worked more than

46 hours per week and staff less than 46 hours per week.

Statistical Analyses

The research conducted relied principally on information and data obtained from both primary and secondary sources. To analyze these data appropriately, both descriptive and inferential statistical procedures were used. Descriptive statistics were used to answer research questions raised from the responses in the survey instrument. Inferential statistics, using an ANOVA, tested the hypotheses.

In addition, further comparisons using the Tukey HSD post hoc multiple comparison test procedure examined possible differences resulting from the five industries.

Efficiency as a Management Concern

Section II of the survey presented statements that provided an indication of the perception of managers toward efficiency in the organization. To determine whether the respondents believed that efficiency was a current concern, a mean was calculated for all respondents for Questions 1, 2, 3, 4, 5, 6, 8, and 20 of Section II. The threshold score for determining whether efficiency was or was not a concern of management was 3.50. The distribution of total respondents (number and percentage of total) by mean score for the eight questions in Section II is shown in Table 24.

Table 24

Distribution of Total Sample: Perception of
Efficiency as a Management Concern

Analysis	Score Range	N	%
Is a concern	3.50-5.00	104	53.10
No opinion	2.50-3.49	92	46.90
Not a concern	1.00-2.49	0	0.00
Total		196	100.0

As indicated in Table 24, the majority of respondents (104 respondents, 53.1%) perceived that efficiency was a current concern, with mean scores meeting or exceeding the threshold of 3.50. Overall, the mean for the sample is 3.46, with a standard deviation of 0.42. The distribution of scores is shown graphically in the histogram in Figure 2.

The y axis of Figure 2 consists of the number of respondents in the sample. The x axis identifies the mean response for the statements pertaining to efficiency as a management concern in Section II of the survey instrument.

Table 25 shows the respondents distributed by industry and score. This table arrays the percentage of the total respondents for each industry by their perception of efficiency as a current concern of management.

As indicated in Table 25, the majority of the indus-

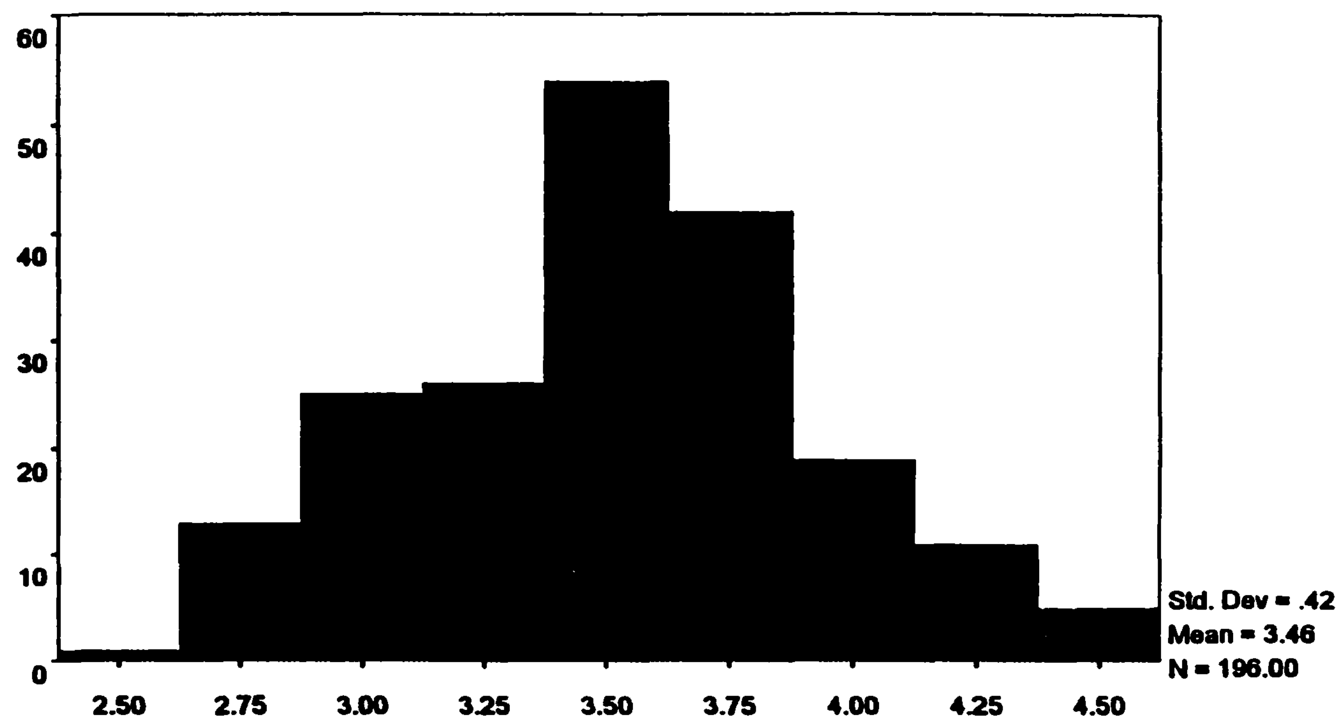

Figure 2. Distribution of Scores: Efficency as a Concern.

Table 25

Distribution of Respondents by Perception of Efficiency as a Management Concern Across Industries

	Finance		Health		Business		Retail		Manufacturing		Total	
Perception	N	%	N	%	N	%	N	%	N	%	N	%
Concern	23	56.2	16	72.9	14	43.6	8	40.0	43	53.1	104	53.1
No opinion	18	43.8	6	27.1	18	56.4	12	60.0	38	46.9	92	46.9
No concern	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	41	100.0	22	100.0	32	100.0	20	100.0	81	100.0	196	100.0
Mean	3.46		3.65		3.41		3.36		3.46		3.46	
Std. Dev.	.36		.44		.41		.30		.46		.42	

tries have indicated that efficiency is a current concern, with more than 50% of the respondents having scores meeting or exceeding the threshold of 3.50. Only respondents from business services and retail trade indicated otherwise.

Perceived Level of Efficiency

The perceived level of efficiency was determined from statements appearing in Section II of the survey. Specifically, questions 7 and 9-19 were designed to ascertain the level of efficiency that the manager perceived currently existing in his/her company. Once again, the threshold score was 3.5. However, for this question an average score of 3.5 or better was indicative of a highly efficient organization, at least from the respondents' perspective.

Table 26 shows the distribution of the total sample by three levels of perception: highly efficient, moderately efficient, and not efficient. The perception category is based upon the mean score for the 12 statements in Section II (identified above).

According to Table 26, the majority of the respondents perceived their companies to be moderately efficient. Few of the respondents indicated a highly efficient organization (17 respondents, 8.7%).

Table 26

Distribution of Total Sample: Perception of Efficiency Level in the Company

Analysis	Score Range	N	%
Highly efficient	3.50-5.00	17	8.70
Moderately efficient	2.50-3.49	125	63.80
Not efficient	1.00-2.49	54	27.50
Total		196	100.00

A distribution of actual mean scores for the entire sample is graphically displayed in the histogram in Figure 3.

The y axis in Figure 3 consists of the number of respondents in sample. The x axis identifies the mean response for statements pertaining to the perceived level of efficiency.

As shown in Figure 3, most of the scores for the sample are clustered in the middle range, yielding an overall mean score of 2.78, with a standard deviation of .48.

Table 27 reflects the distribution of respondents by perceived level of efficiency for each of the five industries included in the study. This table compares industry perceptions of efficiency level within the organization. The findings in the table are consistent across the total sample, with the majority of responses from all industries

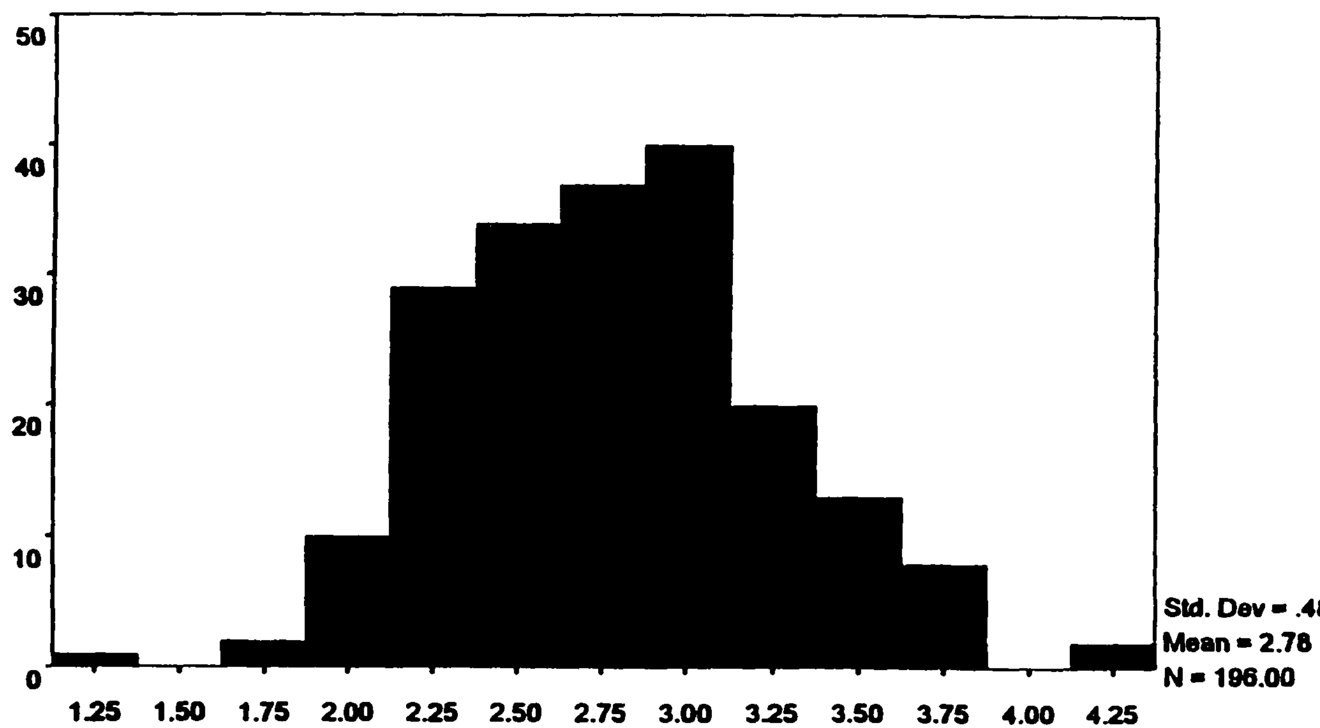

Figure 3. Distribution of Scores: Perceived Level of Efficiency.

Table 27

Distribution of Means by Industry, Perceived Level of Efficiency (Percentage of Total Responses)

Perception of Efficiency	Finance		Health		Business		Retail		Manufacturing		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
High	4	9.8	2	9.5	3	9.1	1	5.0	7	8.8	17	8.7
Moderate	25	68.0	15	68.0	23	72.1	15	75.0	47	58.0	125	63.8
Low/none	12	29.2	5	22.5	6	18.8	4	20.0	27	33.2	54	27.5
Total	41	100.0	22	100.0	32	100.0	20	100.0	31	100.0	196	100.0
Mean	2.74		2.81		2.87		2.88		2.73		2.78	
Std. Dev.	.55		.45		.46		.46		.47		.48	

in the "moderately efficient" category.

Factors Affecting Efficient Operations

Respondents were asked to rate the effect a given factor had on the efficiency of their company. Thirty factors were identified that typically could have an effect on efficiency. Factors were rated on a 5-point scale from very negatively affecting efficiency (5) to very positively affecting efficiency (1). The threshold scores to determine whether the factor negatively or positively affects efficiency were: (a) a score of 4 or above indicated a negative impact, (b) a score of 3 indicated no impact, and (c) a score of 2 or below indicated a positive impact. Each factor was assessed independently to determine the general consensus of whether it positively or negatively affected efficiency. To evaluate this impact, 50% was used as the threshold indicating general consensus (majority opinion) that the factor either positively or negatively affected efficiency.

Table 28 shows each factor based upon the number and percentage of respondents and their perception of impact on efficiency. Factors are arrayed in descending order based upon the number and percentage in the first column--positive impact.

The majority (21 of 30) of the factors were perceived as having a positive effect on efficiency, with the major-

Table 28

Distribution of Total Sample by the Type of Impact the Factor Has on Efficiency (N = 196)

Factor	Positive Impact		Negative Impact		No Impact		Total	
	N	%	N	%	N	%	N	%
Technology	171	87.3	10	5.1	25	7.7	196	100.0
Staff training	154	78.6	6	3.1	36	18.4	196	100.0
Work tools	148	75.5	12	6.1	36	18.4	196	100.0
Management caliber	145	74.0	23	11.7	28	14.3	196	100.0
Amt. tech. available	143	73.0	26	13.2	27	13.8	196	100.0
Communicaton	142	72.4	26	13.3	28	14.3	196	100.0
Management experience	140	71.4	21	10.7	35	17.9	196	100.0
Customers	139	70.9	19	9.7	38	19.4	196	100.0
Management quality	139	70.9	20	10.2	37	18.9	196	100.0
Staff selection	134	68.3	24	12.2	38	19.4	196	100.0
Planning process	131	66.9	30	15.3	35	17.9	196	100.0
Standards	131	66.8	18	9.2	47	24.0	196	100.0
Work environment	125	63.8	22	11.2	49	25.0	196	100.0
Business growth	122	62.3	33	16.8	41	20.9	196	100.0

(continued on following page)

Table 28 (continued)

Factor	Positive Impact		Negative Impact		No Impact		Total	
	N	%	N	%	N	%	N	%
Mgmt. training programs	122	62.2	12	6.1	62	31.6	196	100.0
Incentives	119	60.7	23	11.7	57	27.6	196	100.0
Software changes/upd.	119	60.7	41	20.9	36	18.4	196	100.0
Work process	109	55.6	22	11.2	65	33.2	196	100.0
Policies/procedures	104	53.1	40	20.5	52	26.5	196	100.0
Manuals/documentation	100	51.0	32	16.3	64	32.7	196	100.0
Organization structure	98	50.0	38	19.3	60	30.6	196	100.0
Budget	96	49.0	49	25.0	51	26.0	196	100.0
Management styles	96	49.0	47	24.0	53	27.0	196	100.0
Meetings	81	41.3	75	38.2	40	20.4	196	100.0
Office layout	75	38.2	34	17.4	87	44.4	196	100.0
Compliance requirements	65	33.2	67	34.2	64	32.7	196	100.0
Office furniture	64	32.7	24	12.3	108	55.1	196	100.0
Audits/examinations	61	31.2	55	28.1	80	40.8	196	100.0
Management/staff turnover	54	27.6	88	44.9	54	27.6	196	100.0
Paper volume	27	13.8	122	62.3	52	24.0	196	100.0

ity (50%) of the sample assigning a score of "very positively" (1) or "positively" (2). Paper volume/accumulation was the only factor viewed as negatively affecting efficiency by a majority of the sample (122 respondents, 62.3%). The only other majority perception occurred with the factor "office furniture"; 108 respondents (55.1%) in the sample perceived that this factor had no impact on efficiency. Few of the factors were perceived as negatively affecting efficiency.

Cross-industry perceptions of factors affecting efficiency are compared in Table 29. Factors are ranked for each industry from the factor most positively viewed to the factor least positively viewed. The ranking is made based upon the mean score for each factor determined for each industry and in total. For ease of comparison and presentation, factors were assigned a numeric value from 1 to 30 for each industry. This value represented the ranking within each industry. A ranking of 1 indicated that the factor was viewed as the most positive factor while a ranking of 30 indicated that the factor was viewed as the most negative factor in terms of its impact on efficiency. Although factors may carry the same numeric rank across industries, the mean score was not necessarily the same across industries. The ranking was used simply to compare industry perceptions.

In conclusion, technology appeared to be high on the

Table 29

Ranking of Factors by Impact on Efficiency from Most Positively (1) to Least Positively (30)

Factor	FIN	HLTH	BUS	RET	MFG	TOTAL
Technology	2	4	1	1	1	1
Staff training	3	1	6	5	2	2
Work tools	10	8	7	3	5	7
Management caliber	4	10	8	7	3	4
Amount of technology available	14	14	2	6	8	9
Communication	1	7	3	14	4	3
Management experience	9	12	13	11	10	10
Customers	13	2	9	2	6	5
Management quality	6	5	4	15	7	6
Staff selection	8	9	5	4	9	8
Planning process	11	11	14	8	16	15
Standards	5	3	18	16	15	11
Work environment	16	17	12	10	13	13
Business growth	21	15	15	9	12	16
Management training programs	12	6	10	12	14	12
Incentives	7	24	16	19	11	14
Software changes/ updates	0	9	11	17	20	18
Work process	15	13	19	8	19	17
Policies/procedures	23	16	22	23	22	22
Manuals/ documentation	17	20	23	24	18	19
Organization structure	19	23	21	22	21	21
Budget	24	26	17	18	23	23

(continued on following page)

Table 29 (continued)

Factor	FIN	HLTH	BUS	RET	MFG	TOTAL
Management styles	25	18	20	21	17	20
Meetings	26	22	27	20	28	27
Office layout	22	21	24	27	24	24
Compliance requirements	28	27	26	26	27	28
Office furniture	18	28	25	25	25	25
Audits/examinations	27	25	28	28	26	26
Management/staff turnover	9	29	29	29	29	29
Paper volume/ accumulation	30	30	30	30	30	30

list contributing to the efficiency of the organizations, and paper is viewed unanimously as a negative influence on efficiency.

Methods for Promoting Efficiency in the Organization

Section IV of the survey provided a listing of methods that managers might use to promote efficiency within the organization. The managers responded by indicating methods that were most frequently used to promote productivity and efficiency in the company. Respondents were asked to rate each method on a 5-point scale as to the degree of use from "never" (1) to "always" (5). Those methods most frequently used were represented with scores of four or above, and those least used were represented by scores of two or below. A score of three indicated that the method was sometimes used, representing a neutral posture toward the method.

Table 30 shows the distribution of respondent perceptions in total (most used, least used, and sometimes [neutral] used methods) to promote productivity and efficiency. The actual methods were ranked in descending order based upon the number and percentage of the methods most used. The other numbers and percentages are provided for purposes of comparison.

The methods used most often by the majority of the respondents for improving productivity and efficiency

Table 30

Distribution of Total Sample by the Degree of Use of the Method to Promote Efficiency/Productivity (N = 196)

Method	Most		Least		Neutral		Total	
	N	%	N	%	N	%	N	%
Use performance goals	110	56.1	29	14.8	57	29.1	196	100.0
Ask people who do work	107	54.6	38	19.4	51	26.0	196	100.0
Provide training to users	101	51.5	25	12.7	70	35.7	196	100.0
Develop plans	90	45.9	22	11.2	84	42.9	196	100.0
Establish standards	87	44.4	35	17.8	74	37.8	196	100.0
Use a task force	80	40.9	36	18.4	80	40.8	196	100.0
Increase feedback to staff	79	40.5	26	13.2	91	36.2	196	100.0
Automate tasks	76	38.8	29	14.8	91	46.4	196	100.0
Train managers	73	37.2	49	25.0	74	37.8	196	100.0
Reduce spending	71	36.2	41	20.9	84	42.9	196	100.0
Do it yourself	63	32.2	39	19.9	94	48.0	196	100.0

(continued on following page)

Table 30 (continued)

Method	Most		Least		Neutral		Total	
	N	%	N	%	N	%	N	%
Flowchart work process	61	31.1	80	40.8	55	28.1	196	100.0
Use motivational technology	54	27.6	60	30.6	82	41.8	196	100.0
Hire a consultant	45	22.9	77	39.3	74	37.8	196	100.0
Freeze hiring	43	22.0	69	35.2	84	42.9	196	100.0
Reduce staff	29	14.8	83	42.3	84	42.9	196	100.0
Hire new people	28	14.3	82	41.8	86	43.9	196	100.0
Micromanage	27	13.8	108	55.1	61	31.1	196	100.0
Implement piece-rate	14	7.1	141	71.9	41	20.9	196	100.0
Perform time studies	13	6.6	108	55.1	75	38.3	196	100.0

were: (a) using performance goals, (b) asking people who do the work, and (c) providing training to the users. In contrast, the methods least often used by the respondents were: (a) micro-managing the work process, (b) implementing piece-rate, and (c) performing time studies. The perceptions of the respondents for these methods were obviously clear, indicating very little use. Other methods, unfortunately, did not illustrate as clear a perception in terms of preference.

Table 31 provides a comparison of industry perceptions in terms of the frequency of use for these methods. For each method by industry, a numeric value was assigned from 1 to 20 to indicate the degree of use in descending order. A numeric value of 1 indicated the most frequently used method according to the respondents, and a value of 20 indicated the least frequently used method to improve efficiency in the organization. The rankings are determined for each industry by the mean scores for all respondents for the particular method. The highest mean score received the numeric value of 1 with the lowest mean score the value of 20. Although mean scores are different than distribution of scores as in Table 30, they nevertheless provide a preference perception for each group.

The rankings of methods across industries appears to be consistently arrayed. The implementation of piece-rate, for example, is unanimously ranked last as the least

Table 31

Ranking of Methods by Degree of Use for Improving Productivity and/or Efficiency, from Most Frequent (1) to Least Frequent (20)

Method	Finance		Health		Business		Retail		Manufacturing		Total	
	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean
Use performance goals	1	3.8	3	3.5	4	3.5	7	3.4	1	3.5	1	3.5
Ask people who do work	6	3.5	6	3.3	1	3.7	2	3.7	3	3.4	4	3.5
Provide training to users	4	3.6	1	3.7	2	3.7	5	3.5	5	3.3	2	3.5
Develop plans	5	3.5	8	3.1	6	3.4	4	3.5	2	3.5	5	3.4
Establish standards	3	3.7	2	3.5	11	3.2	1	3.7	9	3.1	6	3.3
Use a task force	7	3.4	7	3.2	8	3.3	10	3.1	6	3.2	7	3.3
Increase feedback	2	3.7	4	3.4	3	3.5	8	3.4	4	3.4	3	3.5
Automate tasks	8	3.3	9	3.1	5	3.5	9	3.3	8	3.2	8	3.3

(continued on following page)

Table 31 (continued)

Method	Finance		Health		Business		Retail		Manufacturing		Total	
	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean
Train managers	11	3.1	10	3.0	9	3.3	3	3.5	11	3.1	10	3.1
Reduce spending	9	3.2	5	3.3	10	3.2	6	3.4	10	3.1	9	3.2
Do it yourself	12	3.0	13	2.9	7	3.4	11	3.1	7	3.2	11	3.1
Flowchart work process	13	3.0	11	3.0	14	2.9	16	2.5	14	2.8	14	2.8
Use motivational technology	10	3.1	14	2.9	12	3.1	12	2.9	13	2.8	12	2.9
Hire a consultant	14	3.0	12	2.6	13	3.1	17	2.5	15	2.7	15	2.8
Freeze hiring	15	2.9	15	2.9	15	2.9	13	2.7	12	2.9	13	2.9
Reduce staff	18	2.4	16	2.7	16	2.8	18	2.5	16	2.7	17	2.6
Hire new people	16	2.8	18	2.6	17	2.6	15	2.7	17	2.7	16	2.7
Micro-manage	19	2.4	19	2.4	18	2.4	14	2.7	18	2.4	18	2.4

(continued on following page)

Table 31 (continued)

Method	Finance		Health		Business		Retail		Manufacturing		Total	
	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean
Implement piece-rate	20	1.9	20	1.7	20	1.7	20	2.1	20	1.8	20	1.8
Perform time studies	17	2.5	17	2.6	19	2.1	19	2.1	19	2.2	19	2.3

used method to promote productivity and/or efficiency. In contrast, although not unanimous, the use of performance goals is consistently at the top of this list, along with asking people who do the work and training of users.

Level of Efficiency Created by Information Technology

Information technology has been heralded as an enabler for empowering employees and providing leverage for existing staff to produce more. Although the "enabler" title is classically used to describe the capability of information technology, one of the questions raised in the study was whether information technology does, in fact, improve efficiency. "Information Technology and Efficiency," Section V of the survey, presented 20 statements designed to obtain respondents' perceptions.

Section V of the survey is used to address two research questions on the perceptions of the efficiency created as a result of information technology and the purpose of information technology. Respondents were asked to indicate agreement or disagreement with statements 1-10 on a 5-point scale, "strongly disagree" (1) to "strongly agree" (5). The overall mean score for all 10 statements was calculated to ascertain whether the utilization of information technology was perceived as improving efficiency in the organization. An overall rating was determined, consistent with the following: (a) a rating of

3.50-5.00 indicated that information technology had improved efficiency, (b) a rating of 2.51-3.49 indicated that there was no impact, and (c) a rating of 1.00-2.50 indicated that information technology had not improved efficiency.

Table 32 shows the mean scores by industry for the first 10 statements in Section V, providing an overall illustration of the respondents' perception of information technology's effect on efficiency.

Table 32

Mean Score by Industry of Respondent Perceptions of Information Technology's Affect on Efficiency

Industry	Mean	Std. Dev.
Finance	2.85	.53
Health	2.96	.55
Business	3.09	.54
Retail trade	3.05	.56
Manufacturing	2.88	.54
Total	2.93	.54

According to Table 32, industry mean scores as well as the total sample fall within the "no impact" range. With average scores clustered around a rating of 3, most respondents had "no opinion" or took a neutral position, indicating a perception of no impact on efficiency.

Figure 4 graphically depicts a distribution of the scores in the form of a histogram. This chart visually shows not only the range of scores but also a comparison of mean scores by respondent preference.

The y axis of Figure 4 consists of the number of respondents in sample. The x axis identifies the mean response for statements pertaining to the perceived effect of information technology on efficiency. The most prominent mean score for the sample was 3.00, indicating no impact and supporting the overall means in Table 32.

Because each of the 10 statements was designed to obtain a perception from the responding manager, the combined statements (mean) served as an indicator of the overall impact of information technology on efficiency. Table 33 presents each of the 10 statements and displays the number of responses and percentage of the total responses for each. This information was obtained from frequency distributions developed for the responses to each statement. The perception categories (agree, disagree, and no opinion) were based upon the score assigned, as follows: (a) a score of 4 or 5 indicated agreement with the statement; (b) a score of 3 indicated no opinion about the statement; and (c) a score of 1 or 2 indicated disagreement with the statement.

As indicated in Table 33, a number of majority opinions (50% or over) existed with regard to individual statements. The majority opinions were either agreement

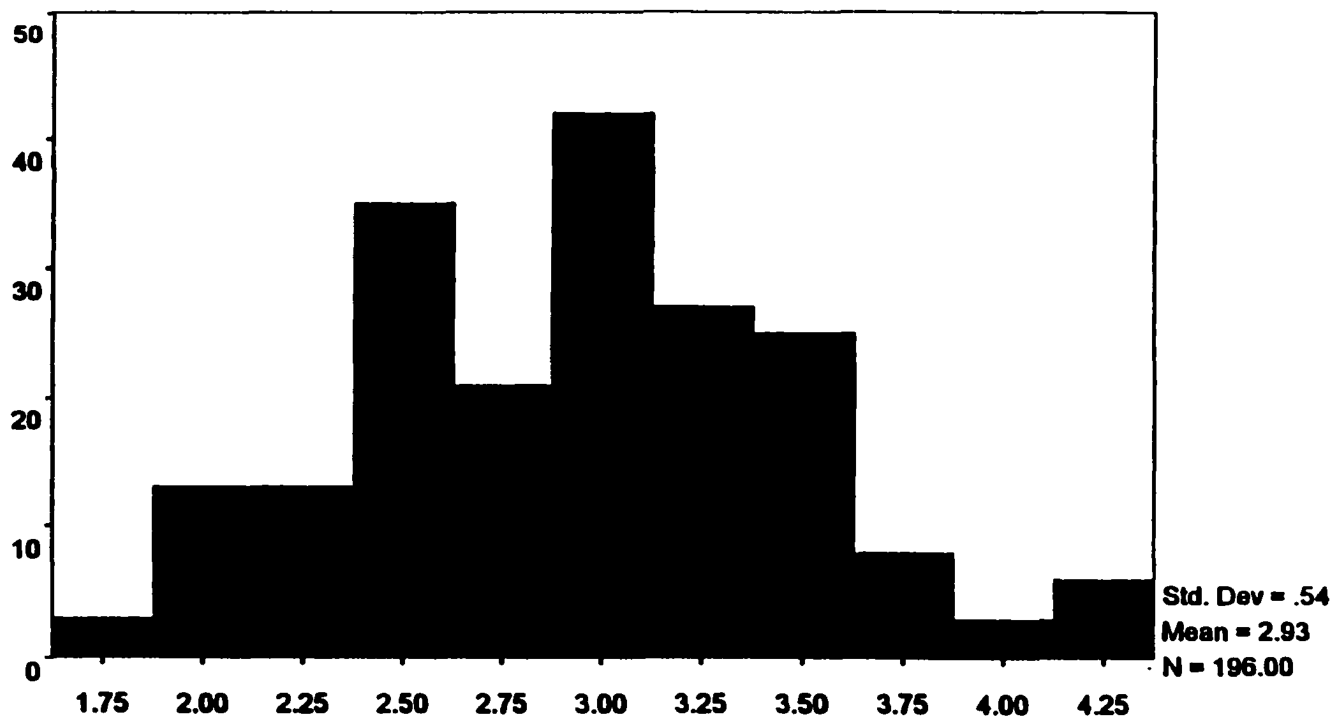

Figure 4. Distribution of Responses by Score: Information Technology Effect on Efficiency.

Table 33

Efficiency and Information Technology: Sample Agreement/Disagreement with Each Statement (% of Total Respondents)

Statement	Agree		Disagree		Neutral		Total	
	N	%	N	%	N	%	N	%
1. When new technology is purchased, more time is available for other duties.	77	39.3	80	40.8	39	19.9	196	100.0
2. When new computer technology is purchased, job behaviors and procedures are changed to use and to apply the new technology.	118	60.2	47	23.9	31	15.8	196	100.0
3. Our company adequately trains employees on all new technologies purchased (software and hardware).	68	34.7	92	47.0	36	18.4	196	100.0
4. We keep up with software upgrades and changes.	102	52.1	51	26.0	43	21.9	196	100.0
5. New technology has permitted us to improve our productivity and efficiency.	143	72.9	17	8.7	36	18.4	196	100.0
6. Computerization has not reduced work week hours.	149	76.0	26	13.2	21	10.7	196	100.0

(continued on following page)

Table 33 (continued)

Statement	Agree		Disagree		Neutral		Total	
	N	%	N	%	N	%	N	%
7. Employees use technology available to them to the fullest.	36	18.4	110	56.1	50	25.5	196	100.0
8. Our company, after purchasing new technology, always follows up to ensure that the benefits proposed in the cost justification are actually obtained.	27	13.7	125	63.8	44	22.4	196	100.0
9. The cost of technology is equal to the value created in efficient operations.	66	33.7	55	28.1	75	38.3	196	100.0
10. The purchase and application of information technology has directly reduced our operating expense.	51	26.0	72	36.7	73	37.2	196	100.0

or disagreement, not neutral or no opinion. Statements 1, 3, 9, and 10 were evenly split among the perception categories, with no specific direction for the response. Most of these questions related to the cost of information technology and/or time.

Purpose of Information Technology

Information technology has been increasing in popularity and usage considerably during recent years. Especially today, with the rate of spending on information technology, usage continues. The second portion of Section V (statements 11-20) was directed specifically at obtaining managerial perceptions about the purpose for information technology. Unlike the previous portion of Section V, an overall mean was not calculated for all responses because the statements were designed and presented to obtain individual perceptions rather than a combined score for all 11 statements.

Table 34 provides an assessment for each of the 10 statements (11 through 20) for the entire sample. For each statement, the percentage of responses for the sample are distributed based upon whether they agreed, disagreed, or had no opinion with regard to the statement. This is determined by the actual score assigned by the respondent. Percentages were determined for each statement by the number of respondents assigning scores, as follows: (a) a

Table 34

Purpose of Information Technology: Distribution of Sample Agreement or Disagreement with Each Statement by Percent of Total Respondents (N = 196)

Statement	Agree		Disagree		Neutral		Total	
	N	%	N	%	N	%	N	%
11. The use of technology creates more work.	54	27.5	78	39.8	64	32.7	196	100.0
12. Computer technology is designed to make us more productive.	154	78.5	14	7.1	28	14.3	196	100.0
13. New software makes our jobs easier.	108	55.1	20	10.2	68	34.7	196	100.0
14. We know the purpose of technology and how to use it.	82	41.8	53	27.0	61	31.1	196	100.0
15. Technology creates access to more information which creates more work for us to manage.	105	53.6	52	26.5	39	19.9	196	100.0
16. The additional information we can now access from technology makes us more efficient.	107	54.6	33	16.8	56	28.6	196	100.0

(continued on following page)

Table 34 (continued)

Statement	Agree		Disagree		Neutral		Total	
	N	%	N	%	N	%	N	%
17. We know exactly what to do with the additional information available as a result of new technology.	34	17.3	91	46.5	71	36.5	196	100.0
18. Technology has created more information from which we must make more decisions and choices.	148	75.5	15	7.6	33	16.8	196	100.0
19. Advances in technology meet our business needs.	102	52.1	29	14.8	65	33.2	196	100.0
20. Our business and personal lives have been improved by technology.	145	74.0	22	11.2	29	14.8	196	100.0

score of 4 or 5 indicated agreement with the statement; (b) a score of 3 indicated no opinion regarding the statement; and (c) a score of 1 or 2 indicated disagreement with the statement.

The majority of the respondents (154 respondents, 78.5%) believed that information technology is designed to make us more productive. Although the largest percentage of managers disagreed with the statement (statement 11) that technology creates more work (78 respondents, 39.8%), this is by no means a majority opinion. Statement 15, in contrast, reflected a majority opinion that information technology does create more work by creating access to more information. This statement was further confounded when the largest percentage of managers believed that they were not certain what to do with the information available (statement 17) as a result of information technology (91 respondents, 46.5%).

In summation, the findings from the entire sample indicated that:

- information technology is a productivity tool;
- information technology creates access to information which requires management;
- uncertainty exists regarding what to do with the information created from information technology; and
- overall, information technology has helped to improve our business and personal lives.

Although this information is for the sample as a whole, a look now at the responses by industry provides further refinement of the information findings.

Table 35 displays the largest percentage of the three categories: "agree," "disagree," or "neutral." A letter is used to designate whether the percentage reflected indicates either agreement (A), disagreement (D), or no opinion (N). In this way comparisons can be made among industries for each statement presented.

According to the results in Table 35, the comparison of industry findings indicated that all statements were unanimous in perception percent. The exceptions to this included statements 11, 16, and 17. For statement 11, the retail and manufacturing industries were unsure whether technology created more work or not. The retail industry was unsure whether the additional work created from information technology created more work, and the business services industry was unsure whether employees knew exactly what to do with the additional information created from technology. Aside from these items, there were no other inconsistencies among the industries represented.

Table 36 shows mean scores for each of the statements by industry. Mean scores are arranged in descending order. This indicates which of the statements had the highest level of agreement to the lowest by industry.

For the majority of industries, statement 12 was most

Table 35

Purpose of Information Technology: Percentage and Number of Total Respondents by Industry

Statement No.	Finance		Health		Business		Retail		Manufacturing		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
11	30	73.2D	10	45.5D	22	68.8D	9	45.0N	32	39.5N	78	39.8D
12	31	75.6A	12	54.6A	27	84.4A	17	85.0A	67	82.7A	154	78.5A
13	25	60.9A	14	63.6A	27	84.4A	13	65.0A	39	48.1A	108	55.1A
14	17	41.5A	9	40.9A	21	65.7A	8	40.0A	32	39.5A	82	41.8A
15	19	46.3A	12	54.6A	19	59.4A	9	45.0A	46	56.8A	105	53.6A
16	21	51.5A	14	63.6A	17	53.1A	9	45.0N	47	58.1A	107	54.6A
17	21	51.2D	13	59.0D	15	46.9N	10	50.0D	35	43.2D	91	46.5D
18	29	70.8A	19	86.3A	23	71.9A	15	75.0A	62	76.5A	148	75.5A
19	20	48.8A	12	54.6A	18	56.3A	14	70.0A	38	46.9A	102	52.1A
20	29	70.8A	17	77.2A	25	78.2A	15	75.0A	59	72.9A	145	74.0A

Note: A = Agree; D = Disagree; N = Neutral.

Table 36

Purpose of Information Technology: Ranking of Mean Scores by Statement and Industry

Finance		Health		Business		Retail		Manufacturing		Total	
Avg.	#	Avg.	#	Avg.	#	Avg.	#	Avg.	#	Avg.	#
3.90	12	3.86	20	3.94	12	3.85	12	3.88	12	3.83	12
3.85	20	3.86	18	3.72	20	3.75	20	3.78	18	3.76	18
3.76	18	3.59	16	3.66	18	3.75	18	3.68	20	3.75	20
3.59	13	3.50	19	3.56	14	3.70	13	3.47	16	3.48	13
3.37	16	3.50	13	3.53	15	3.65	19	3.43	13	3.43	16
3.34	19	3.36	12	3.47	19	3.30	16	3.42	15	3.41	19
3.24	15	3.23	15	3.41	16	3.25	15	3.33	19	3.36	15
3.07	14	3.09	14	3.34	13	3.15	14	3.04	14	3.15	14
2.80	11	2.95	11	2.97	11	2.70	17	2.89	11	2.87	11
2.59	17	2.50	17	2.78	17	2.70	11	2.75	17	2.69	17

often cited with the highest mean, a total average of 3.83. This indicated general agreement that information technology is designed to make business more productive. Only the health services industry did not share this perception.

Statements 11 and 17 produced the lowest mean scores (group average 2.87 and 2.69, respectively). This response clearly indicated uncertainty in both whether information technology created more work and what to do with the additional information made available from information technology.

Use of Taylor's Theories Today

The theories developed by Taylor in the early part of this century were instrumental in improving the efficiency of businesses and the country at that time. To determine whether companies are using Taylor's theories today, 15 statements were developed and included in Section VI of the survey instrument. Each statement was designed to emphasize one of the four key principles of scientific management. A response indicating agreement with the statement was indicative of use of the principle.

The statements related to each of the four principles of scientific management follow:

- Principle 1: Statements 1, 4, 6, and 10;
- Principle 2: Statements 2, 3, 11, and 14;

- Principle 3: Statements 7, 8, and 9; and
- Principle 4: Statements 5, 12, 13, and 15.

Respondents were asked to rate each statement on a 5-point scale as to the degree of agreement or disagreement with the statement. Based upon the ratings (average and individual), use of Taylor's theories could be determined.

Mean scores for each grouping of statements must exceed 3.25 to indicate use of the principle. Usage of three of the four principles was an indication that Taylor's theories were being applied in the organization, as long as the first principle is one of the three.

Table 37 shows the distribution of the responses indicating nonuse or uncertainty of the use of the scientific management principles as determined with this scale: (a) strongly agree (SA) or agree (A) indicated use of the principle; (b) no opinion (N) indicated uncertainty; and (c) strongly disagree (SD) or disagree (D) indicated no use of the principle. Although not a consensus (over 50%) in all cases, the majority or largest percentage of responses indicated agreement with the four statements.

Table 38 presents the mean scores calculated by industry for each of the four groups of statements relating to scientific management use. The purpose of Table 38 is to compare means by industry for each of the principles of scientific management.

Table 37

Distribution of Sample by Degree of Use of the Four Principles of Scientific Management, Percent to Total

Principle	Use		Nonuse		Uncertain		Total	
	N	%	N	%	N	%	N	%
1. The development of a science for every aspect of a worker's job.	79	39.7	76	38.8	41	21.5	196	100.0
2. Workers are scientifically selected, trained, and educated on the work that will be done.	90	45.9	60	30.7	46	23.4	196	100.0
3. Managers work closely with employees to ensure that tasks are completed according to the principles of science previously developed.	101	51.7	58	29.4	37	18.9	196	100.0
4. Management and workers divide work almost equally between them, based upon the individual better suited for the task.	80	40.8	72	36.7	44	22.5	196	100.0

Table 38

Scientific Management Use by Industry

Industry	P1 Mean	P2 Mean	P3 Mean	P4 Mean
Finance	2.98	3.21	3.28	3.09
Health	3.08	3.39	3.39	2.97
Business	3.05	3.32	3.19	3.22
Retail	3.14	3.10	3.27	2.95
Manufacturing	2.86	3.04	3.23	3.00
Total	2.97	3.17	3.25	3.04

As shown in Table 38, the third principle was consistently the highest rated principle for each industry. Principle 3 of Taylor's theories requires management to work closely with employees to ensure that tasks are completed in accordance with how they are defined by management. In addition, Principle 2 showed higher means for both the health and business services industries. Principle 2 refers to the scientific selection and training of workers.

Although all principles for the total sample revealed means in the 3+ range, only the first principle fell below this (2.97 average). This principle is the one that involves Taylor's core philosophy, the scientific analysis of work processes/tasks. The survey findings show that this principle is least used today.

To determine whether Taylor's principles are used today or not, three of the four principles must have scores exceeding 3.25 (those involving four statements). Because Principle 3 only involves three statements in the survey, a threshold of 3.00 must be attained to be counted. To indicate use of Taylor's principles, not only must three of the four principles exceed these thresholds, but one of the three principles included must be Principle 1--Taylor's core principle and the foundation for scientific management. Based upon this explanation, Table 39 shows the distribution of respondents by industry, using Taylor's principles of scientific management.

According to the results of the survey, 38.3% of the responding managers actually use Taylor's principles. This is not a majority, however, indicating that Taylor's principles are only in limited use today.

Information Technology Use

Information technology use is the second independent variable of the research study. Information technology is determined based upon an index from responses to Section I of the survey. Questions 8 through 11 of Section I are used to assess information technology use. For each question, the response checked is assigned a point value as indicated in the coding conventions in Appendix B. The combined total of the points determined for the four questions is compared to an index (also contained in the the coding convention section of Appendix B) that indicates high, moderate, or low information technology use.

Table 39

Distribution of Survey Respondents Using
Taylor's Principles of Scientific
Management by Industry

Industry	N	%	N	%
Finance	17	41.5	24	58.5
Health	11	50.0	11	50.0
Business	11	34.4	21	65.6
Retail	10	50.0	10	50.0
Manufacturing	26	32.1	55	67.9
Total	75	38.3	121	61.7

Four basic categories were evaluated to determine the level of information technology use (either high, moderate, or low):

1. Microcomputer use in the company,
2. Understanding and use of technology,
3. Degree of task automation, and
4. Technology application.

Tables 40 through 43 present the data pertaining to these four categories.

Microcomputer Use by Industry

Table 40 shows the degree of microcomputer use in the company by industry. This percent indicates the ratio of microcomputers to staff.

Table 40

Microcomputer Use in the Company (Percent of Total) by Industry (N = 196)

PC Use	Finance		Health		Business		Retail		Manufacturing		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
100%	22	53.6	5	22.7	25	78.1	8	40.0	59	72.8	119	60.7
75-99%	9	22.0	9	40.9	5	15.7	8	40.0	14	17.3	45	23.0
50-74%	6	14.6	3	13.6	1	3.1	0	0.0	3	3.7	13	6.6
25-49%	1	2.4	3	13.6	1	3.1	2	10.0	3	3.7	10	5.1
0-24%	3	7.4	2	9.1	0	0.0	2	10.0	2	2.5	9	4.6
Total	41	100.0	22	100.0	32	100.0	20	100.0	81	100.0	196	100.0

According to the findings, the combined respondent group indicated that 119 respondents (60.7%) had a ratio of one to one, or 100%, PC deployment, and a total of 164 respondents (83.7%) were at or above 75% of PCs. This indicates that microcomputer use was intensive in the organizations in virtually all industries. The health services industry, however, represented the lowest percentage of the organizations at the 100% level, with only 5 respondents (22.7%).

Level of Understanding and Use of Information Technology

The level of understanding and use of information technology categorized by industry as perceived by respondents is shown in Table 41.

Although Table 40 indicated a high degree of microcomputer deployment, Table 41 indicates that the understanding and use of information technology was not as high. Although 136 of the respondents (69.4%) indicated that understanding and use was in the range of 50% and above, 60 respondents (30.6%) were at or below 50%. This indicates that although PC deployment is high, understanding and use was not at the same levels.

Automation of Tasks

A distribution of the number and percentage of respondents by the types of applications automated is pre-

Table 41

Level of Understanding and Use of Information Technology (N = 196)

Use	Finance		Health		Business		Retail		Manufacturing		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
0-25%	5	12.2	4	18.2	1	3.2	2	10.0	4	4.9	16	8.2
26-50%	10	24.4	10	45.5	3	9.4	4	20.0	17	21.0	44	22.4
51-75%	10	24.4	6	27.3	6	18.7	9	45.0	35	43.2	66	33.7
76-100%	16	39.0	2	9.1	22	68.7	5	25.0	25	30.9	70	35.7
Total	41	100.0	22	100.0	32	100.0	20	100.0	81	100.0	196	100.0

sented in Table 42. A total of five application areas were presented; the sum of the areas checked indicates the degree of automation in the company (maximum of 5). These categories were included on the survey:

1. Manuals online,
2. Communication via electronic mail,
3. Meeting via video conferencing,
4. Word processing, and
5. Document imaging/retrieval.

These technologies, when considered, indicate the level of automation in use in the organization.

The sample revealed a relatively even distribution of respondents for 2 to 5 tasks automated, with the majority between 2 and 3 tasks automated. Few companies had 1 or zero tasks automated (8 respondents, 4.0%).

Technological Sophistication

The degree of technical sophistication in use within the companies represented is shown in Table 43. Respondents were asked to indicate which of the following technologies were used in their companies:

1. Local-area networks (LANs),
2. Wide-area networks (WANs),
3. Data warehouse,
4. Internet/intranets, and
5. Web page for the company.

Table 42

Distribution of Sample by Type of Automated Applications
by Industry (Percent to Total) (N = 196)

Finance			Health			Business			Retail			Manufacturing			Total		
N	%	#	N	%	#	N	%	#	N	%	#	N	%	#	N	%	#
13	31.7	2	8	36.4	2	14	43.8	5	8	40.0	4	24	29.6	4	54	27.6	4
12	29.3	3	5	22.7	3	8	25.0	4	5	25.0	2	22	27.2	3	49	25.0	3
9	21.9	4	4	18.2	4	7	21.9	3	3	15.0	3	18	22.2	2	47	24.0	2
6	14.6	5	4	18.2	3	3	9.3	2	3	15.0	5	12	14.8	5	38	19.4	5
1	2.5	1	1	4.5	1	0	0.0	1	1	5.0	1	5	6.2	1	8	4.0	1
41	100.0		22	100.0		32	100.0		20	100.0		81	100.0		196	100.0	

Table 43

Degree of Technological Sophistication in Use (N = 196)

Finance			Health			Business			Retail			Manufacturing			Total		
N	%	#	N	%	#	N	%	#	N	%	#	N	%	#	N	%	#
12	29.3	4	7	31.8	3	15	46.9	5	6	30.0	4	24	29.6	3	52	26.5	4
10	24.4	3	5	22.7	4	8	25.0	4	5	25.0	3	20	24.7	4	52	26.5	3
9	22.0	5	4	18.2	5	5	15.6	3	4	20.0	5	15	18.5	5	45	23.0	5
8	19.5	1	3	13.6	2	3	9.4	2	4	20.0	2	13	16.0	2	25	12.8	2
2	4.8	2	3	13.6	1	1	3.1	1	1	5.0	1	9	11.1	1	22	11.2	1
41	100.0		22	100.0		32	100.0		20	100.0		81	100.0		196	100.0	

The degree of technical sophistication of each responding company was based upon the number of items checked, with a total of five points possible if respondents checked all five options.

The statistics in Table 43 revealed an even distribution for 3, 4, and 5 technologies used. The financial industry had the largest percentage in 0 to 1 technologies used, at 8 respondents (19.5%).

The other industries appeared to be more consistent with the ranking of the number of technologies used. Business services, however, again led in the degree of technological sophistication in use, with 15 respondents (46.9%) using five technologies of responding companies using all five technologies.

From the information contained in the previous tables (Tables 40-43), points were tallied in accordance with the index developed in the coding conventions section of Appndix B. The level of information technology use was determined by the total amount of points the company produced, indicating high, moderate, or low levels of information technology use. Table 44 shows the distribution of respondents by the level of information technology use and provides a comparison by industry and the total sample as well.

Overall, almost 70% of the responding companies indicated a high level of information technology use.

Table 44

Distribution of Survey Respondents by Level of Information Technology Use by Industry (N = 196)

Industry	High Use		Moderate Use		Low Use		Total	
	N	%	N	%	N	%	N	%
Finance	25	61.0	15	36.6	1	2.4	41	100.0
Health	10	45.5	11	50.0	1	4.5	22	100.0
Business	28	87.5	2	6.3	2	6.2	32	100.0
Retail	15	75.0	4	25.9	1	5.0	20	100.0
Manufacturing	59	72.8	21	27.0	1	1.2	81	100.0
Total	137	69.9	53	27.0	6	3.1	196	100.0

Business services had the highest percentage of managers in the "high use" range (28 respondents, 87.5%) and health services the lowest percentage at 45.5% (10 respondents). Only 6 respondents (3.1%) indicated low information technology use.

Efficiency Ratios

The efficiency ratio was used to measure the level of efficiency, the dependent variable in this study. The efficiency ratio is a measure of the cost to produce $1.00 of revenue. Although the banking industry uses this measure to a high degree, the ratio can be calculated for other industries based upon the ratio of revenues, costs of goods sold, and operating expense.

For this study, efficiency ratios were calculated from information obtained from financial statements and on-line services such as the Security and Exchange Commission's EDGAR and Bloomberg services. Although the efficiency ratio as the dependent variable was used to determine any relationship between efficiency and scientific management use and information technology use, an assessment of the actual ratios across industries provided further information. Unfortunately, efficiency ratios were not able to be captured for every respondent organization in the study. To that degree, those that were able to be obtained (106) were not only analyzed in the ANOVA model (next section) but also descriptively.

Table 45 shows the mean efficiency ratios for each industry and the entire sample. This table provides a comparison among industries and demonstrates the range of average efficiency ratios prevalent in the marketplace. According to the table, the overall mean efficiency ratio is 72.97% with a standard deviation of 18.48; one standard deviation indicates that 68% of the sample will have efficiency ratios between 54.49% and 91.45%. This average efficiency percentage is high in conjunction with the financial and other industries which generally seek ratios less than 60%.

Table 45

Mean Efficiency Ratios by Industry (N = 196)

Industry	Mean Ratio	Std. Dev.
Finance	72.39	15.96
Health	78.78	10.65
Business	82.92	24.34
Retail	72.91	10.91
Manufacturing	67.86	16.78
Total	72.97	18.48

The manufacturing industry reflected the lowest efficiency ratio at an average of 67.86%, which is consistent with industry knowledge. Manufacturing, historically, has been ahead of other industries in terms of monitoring and understanding their cost structures. Other efficiency ratios were consistent, relatively close to the overall mean. These percentages were used in the analysis of variance explained in the next section.

Inferential Statistics

Inferential statistics were used to test the hypotheses of the study, specifically an ANOVA. The criterion (alpha) established for the ANOVA is .05. The effect of the two independent variables on the dependent variable--efficiency--were tested: scientific management use and information technology use. Comparisions by industry were also analyzed.

The hypotheses to be tested are:

1. The level of information technology use has an effect on efficiency,

2. The use of scientific management has an effect on efficiency, and

3. The combined effect of information technology and scientific management use has an effect on efficiency.

Based upon the results of the ANOVA, the null hypothesis will be either accepted or rejected.

The ANOVA model was based upon the actual efficiency ratios captured and arrayed in the matrix as illustrated in Figure 5. This figure illustrates the columns (information technology use) and the rows (scientific management use and industry). These become the main effects (between groups) of the ANOVA analysis.

ANOVA

The first step in determining whether a statistical relationship exists between the variables was to compile the ANOVA summary table. A three-factor, fixed-effects ANOVA was used. Because industry is a moderator variable, two-factor analyses were performed to arrive at the results.

Figure 5 shows graphically the relationship of the independent variables, scientific management, and information technology use and the associated levels. This figure simply illustrates how each of the variables relate to one another. Efficiency ratios--the dependent variable--would be recorded in the appropriate box in the chart.

The initial ANOVA summary tables determine whether a main-effects variation exists that could ultimately establish the significance of the impact of the variable on the dependent variable.

Table 46 is a three-factor ANOVA summary table. This table shows the three independent variables (including the moderator variable--industry) as main effects along with their relative significance. Main effects are categorized as information technology use, scientific management use,

Industry	Scientific Management Use	Information Technology Use		
		High	Moderate	Low
Finance	Yes			
	No			
Health	Yes			
	No			
Business	Yes			
	No			
Retail trade	Yes			
	No			
Manufacturing	Yes			
	No			

Figure 5. Matrix of Row and Column Effects for the ANOVA Independent Variables.

Table 46

Three-Factor ANOVA, Information Technology Use and Scientific Management Use by Industry

Variation	Sum of Squares	DF	Mean Square	F	Sig. of F
Main Effects	3542.286	7	506.041	1.539	.163: NS
IT Use	80.549	2	40.275	.122	.885: NS
SM Use	12.051	1	12.051	.037	.849: NS
Industry	3397.770	4	849.442	2.583	.042: S
Explained	3542.286	7	506.041	1.539	.163
Within	32225.845	98	328.835		
Total	35768.131	105	340.649		

and industry.

As shown in Table 46, there were no main effects for information technology and scientific management use. However, one main effect existed for industry. Because the criterion was set at .05, only industry was significant at this level (less than the criterion). Further analysis was performed to determine where the difference was found.

Because there were no main effects for the two independent variables, both of the null hypotheses were accepted, indicating that neither scientific management use nor level of information technology use had an effect on efficiency. In addition, the interaction between information technology and scientific management use was tested. Because several interactions resulted from a three-factor ANOVA, each interraction was analyzed in a two-factor ANOVA model.

Table 47 displays the findings of the first two-factor ANOVA for the two variables--information technology and scientific management use. In addition, an interaction was also performed between the two main effects. This table shows that the interaction between scientific management and information technology use was not significant. Therefore, the null hypothesis that the combined use of information technology and scientific management has no effect on efficiency was accepted, indicating that

Table 47

Two-Factor ANOVA: Scientific Management and Information Technology Use

Variation	Sum of Squares	DF	Mean Square	F	Sig. of F
Main Effects	449.506	3	149.835	.431	.731: NS
IT Use	6.480	2	3.240	.009	.991: NS
SM Use	429.950	1	429.950	1.236	.269: NS
2-Way Inter.	848.472	2	424.236	1.220	.300: NS
IT use/SM	848.472	2	424.236	1.220	.300: NS
Explained	992.988	5	198.598	.571	.722
Within	34775.143	100	347.751		
Total	35768.131	105	340.649		

the combined effect of scientific management and information technology use had no impact on corporate efficiency.

Table 48 provides another two-way ANOVA displaying further interactions between information technology use and industry. The interaction between information technology use and industry also was not significant. No significant variance remained that could lead to rejection of the null hypothesis.

Table 49 displays the last ANOVA model to be analyzed, the final two-way interaction between scientific management use and industry. Although the final two-way interaction was not significant, the main effects for industry was significant at the .05 level. Because this occurred in Table 46, a one-way ANOVA was conducted to assess this significant variance and to learn more about it.

Table 50 reflects a one-way ANOVA for the variable "industry" on efficiency. Once again, a significant F is determined from the one-way ANOVA. With the significance (.0348) below the criterion of .05, the between-groups (main) effect is significant. However, because industry has five groups, further analysis was required to determine which pairs of means were different.

Specifically, the Tukey HSD test, a multiple comparison test, was run using a significance level of .05. The results of this test indicated that the means for the

Table 48

Two-Factor ANOVA: Information Technology and Industry Interaction

Variation	Sum of Squares	DF	Mean Square	F	Sig. of F
Main Effects	1910.756	6	318.459	.958	.458: NS
IT Use	128.061	2	64.031	.193	.825: NS
Industry	1780.684	4	445.171	1.339	.261: NS
2-Way Inter.	992.740	5	198.548	.597	.702: NS
IT use/Indus.	992.740	5	198.548	.597	.702: NS
Explained	4522.975	11	411.180	1.237	.274: NS
Within	31245.157	94	332.395		
Total	35768.131	105	340.649		

Table 49

Two-Factor ANOVA: Scientific Management and Industry Interaction

Variation	Sum of Squares	DF	Mean Square	F	Sig. of F
Main Effects	3350.900	5	670.180	2.025	.082: NS
Industry	3284.151	4	821.038	2.481	.049: S
SM Use	130.802	1	130.802	.395	.531: NS
2-Way Inter.	539.984	4	134.996	.408	.803: NS
Indus./SM	539.984	4	134.996	.408	.803: NS
Explained	4001.721	9	444.636	1.344	.225
Within	31766.410	96	330.900		
Total	35768.131	105	340.649		

Table 50

One-Way ANOVA: Industry Only

Variation	Sum of Squares	DF	Mean Square	F	Sig. of F
Between groups	3453.768	4	863.442	2.698	.0348: S
Within groups	32314.362	101	319.944		
Total	35768.131	105			

levels of the moderator variable--industry--were significantly different for Business Services (Group 3) and Manufacturing (Group 5). The mean efficiency ratios for these two industries were 82.92% and 67.85% respectively. No other significant differences were found. Therefore, the moderator variable--industry--was significant (with more than two levels). In addition, industry had an effect on the level of efficiency. The Tukey HSD test revealed that the business services and manufacturing industries were significantly different from the other industries.

Finally, individual ANOVAs were run for each industry separately, testing the impact of information technology and scientific management use and interactions for each industry. In all cases, there were no significant main effects nor significant interaction effects. Therefore, this fully corroborates the original results in the overall ANOVA.

Summary

This chapter outlined the results obtained from both the primary and secondary research conducted. Although a large volume of information was obtained and analyzed, the hypotheses presented in the research were rejected. Only the moderator variable--industry--was proven to be significant, indicating a relationship to corporate efficiency.

Upon further analysis, a significant difference between the business services and manufacturing industries was found. This indicated that the difference between the two industries was not a chance difference and that the resulting efficiency ratios should be further studied to understand the reasons for the differences.

Chapter 9 presents a summary of the study, a discussion of the findings and their relationship to prior research, conclusions drawn from the study, and recommendations.

CHAPTER 9

SUMMARY, DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose and the foundation for this research study was to determine whether a relationship exists between information technology use, scientific management use, and efficiency. The subproblems or research questions emanating from the problem statement include:

1) Is efficiency a current concern of management?

2) What is the level of efficiency in the company?

3) What factors are currently contributing to inefficient operations?

4) What methods are currently being used to improve efficiency?

5) Has information technology improved current efficiency?

6) What is the purpose of information technology?

7) Are Taylor's theories currently being used?

8) What is the current level of information technology use in the company?

9) What is the current level of efficiency in the company as shown by efficiency ratio?

The subjects used in the research were managers randomly selected from the database of the AMA. Managers were selected from five industries based upon the industries' relative proportion to the population: financial services, health services, business services, retail trade, and manufacturing.

The study combined both quantitative (survey) and historical research. Primary research was conducted using a survey mailed to a stratified sample of managers in the five industries selected. Secondary research was also performed to gather existing information regarding efficiency metrics (financial data) as well as historical information. The secondary research produced the information used to test the hypotheses.

Three mailings were sent to a total of 811 managers and yielded a response rate of 24.17%. Based upon the mix of males to females in the respondent group as well as the proportion of respondents by industry, the sample was determined to be unbiased.

Using an ANOVA, the findings revealed no significant relationship between information technology use and efficiency, scientific management use and efficiency, or the combined impact of scientific management use and information technology use on efficiency. In this regard, the null hypotheses were all accepted. The moderator variable (industry), however, did reveal a significant main effect at the .05 level. Using the Tukey HSD multiple comparison test, a significant difference did exist between the business services and manufacturing industries for the moderator variable industry.

From the study's findings, the basic conclusion was reached that neither the level of use of information technology nor the use of scientific management principles affects efficiency. Further analysis of primary and secondary information, however, revealed additional insights that are outlined and expanded more fully in the discussion and conclusions sections.

Discussion of Findings

The study identified nine research questions relative to the problem statement. For each of these questions, a discussion of the result and its implications follows.

Research Question 1

Research Question 1 asked, Is efficiency a current concern of management?

Efficiency is a current concern of management and is considered important to managers. Of the five industries surveyed, the health services industry was the most concerned about efficiency. This is not surprising, given the challenges facing health services today. Retail trade, in contrast, as well as the business services industry was less concerned about efficiency. In both cases, these industries were sales oriented rather than production or service oriented, reflecting less of an efficiency orientation in their objectives or management communications.

Overall, efficiency was perceived to be a concern of management. Not only was this a managerial perception, but it also represented a call for action. The perceived importance of efficiency further established a link with the industrial period as Theodore Roosevelt similarly perceived when he proclaimed that "the conservation of natural resources is preliminary to the larger question of national efficiencies" (Taylor, 1911b, p. 5). Additionally, the decline in national labor productivity growth rates has also served to raise concerns for efficiency and productivity in the minds of a number of people.

Research Question 2

Research Question 2 asked, What is the level of efficiency in the company?

Although managers were concerned about efficiency, they generally believed their companies operated in a reasonably efficient manner. This perception indicated that efficiency was perceived to be more of a general or global concern than a concern in their own companies. Such a response may have been a natural reaction or a response by managers.

Of the five industries, managers in the retail trade industry perceived their level of efficiency to be relatively high; however, managers in manufacturing perceived their level of efficiency to be relatively low. The difference in efficiency level between production and sales industries may be evident from this type of response. Sales industries seldom emphasize efficiency over sales. On the other hand, manufacturers, with production as their primary goal, foster an efficiency orientation.

Of greater interest, however, was the actual level of efficiency determined from secondary research (using an efficiency ratio). Efficiency ratios represent fact, not perception. According to secondary data gathered, manufacturing had the lowest (most positive) average efficiency ratio among the five industries, yet they generally perceived themselves as less efficient than the others. The juxtaposition of actual efficiency to perceived levels of efficiency may suggest the possibility of a relationship worth exploring further. Supporting this notion, the business services industry perceived efficiency to be at a high level yet in reality had the highest (poorest) efficiency ratio. This phenomenon may highlight the presence of management complacency (identified in Chapter 5) as contributing to America's poor productivity performance in the last 25 years. Industries perceiving themselves to be generally efficient may be less apt to focus on efficiency improvement measures and/or management techniques, thus becoming less efficient. Therefore, the efficiency orientation of a company may have a relationship or correlation to the actual level of efficiency. United States labor productivity growth rates may lend further credence to this concept in that the manufacturing sector has posted very positive productivity growth rates as compared with the dismal performance of the business services sector.

Research Question 3

Research Question 3 asked, What factors are currently contributing to inefficient operations today?

Information technology was viewed by managers as the most positive factor affecting efficiency. The perception of management, in this scenario, was that technology improves efficiency/productivity. Work processes, however, were relatively low on the list. The work process was a management issue and could be enhanced or impaired by the introduction of information technology based upon how well the process was managed and/or changed. The association between information technology and work processes was not strong.

The factor that was clearly a perception as a contribution to inefficient operations was paper volume and accumulation. Paper continued to be the most negatively perceived factor affecting efficiency in the organization.

When factors were compared across industries, paper volume and accumulation was unanimously viewed as the most negatively perceived factor affecting efficient operations. Paper handling and accumulation, incidentally, was also a recognized issue during the industrial period. Conscious efforts were being made during that time toward efficiently organizing the storage and retrieval of paper documents. The flow and management of paper, unless controlled, represented a concern that ultimately translated into inefficient operations. Technology, on the other hand, was viewed as the most positive factor affecting efficiency for all industries but the health and financial services. Incentives were a more positive factor for financial services than for other industries. The financial services industry is generally not known for paying for production as might be seen in a manufacturing environment. Customers, on the other hand, were viewed as positively affecting efficiency for both health care and retail trade, characteristic of industries that are directly customer focused.

The top five positive and negative factors affecting efficiency are presented in Table 51. Based upon the information in this table, insights can be gained as to problems or challenges the industry may be facing. For example, health services did not view technology as the

Table 51

Positive and Negative Factors Affecting Efficiency by Industry (Top Five Only)

Industry	Positive Factors	Negative Factors
Financial Services	Communication	Paper volume/accumulation
	Technology	Management/staff turnover
	Staff training	Compliance requirements
	Management caliber	Meetings
	Standards	Management styles
Health Services	Staff training	Paper volume/accumulation
	Customers	Management/staff turnover
	Standards	Office furniture
	Technology	Compliance requirements
	Management quality	Budget
Business Services	Technology	Paper volume/accumulation
	Amount of technology	Management/staff turnover
	Communication	Meetings
	Management quality	Compliance requirements
	Staff selection	Office furniture
Retail Trade	Technology	Paper volume/accumulation
	Customers	Management/staff turnover
	Work tools	Audits/examinations
	Staff selection	Office layout
	Staff training	Compliance requirements
Manufacturing	Technology	Paper volume/accumulation
	Staff training	Management/staff turnover
	Management caliber	Compliance requirements
	Communication	Audits/examinations
	Work tools	Office furniture

most positive factor affecting efficiency, although most of the other industries did. The health services industry, with the rising cost of health care, perceived training, customers, and standards to be more immediate improvement needs than incurring additional costs. Furthermore, the cost of technology may be at issue and not easily translated into efficiency, especially in a rising-cost industry. The industry experienced much lower use of information technology as well as the lowest overall information technology spending, as shown in Table 6 (Chapter 6).

A presentation of the top five factors makes a statement about priorities and, therefore, provides a sense of direction or focus. Of the five industries, the factors that are commonly shared by all include: (a) technology (5 of 5 industries), (b) staff training (4 of 5 industries, and (c) communication (3 of 5 industries). These factors, although not necessarily the top perception in each industry, are commonly viewed as positively affecting efficiency in operations. Factors such as these may form the basis for the development of future management fundamentals or success factors for managing efficiency. On the other hand, the factors most commonly shared across industries as negatively affecting operations consist of: (a) paper volume/accumulation (5 of 5 industries), (b) management/staff turnover (5 of 5 industries), and (c) compliance (5 of 5 industries).

When viewing these in totality (by consensus), five factors emerge as important in positively affecting efficiency in operations:

1. Use technology,
2. Train staff,
3. Communicate,
4. Reduce/eliminate paper, and
5. Retain people (minimize turnover).

These results identify a set of priorities for management to focus on in order to improve efficiency in the organization.

Research Question 4

Research Question 4 asked, What methods are currently being used to improve efficiency?

Methods used to improve efficiency in operations did not indicate the same level of consensus as in the previous section. Overall, only three methods were most frequently used by the majority of the respondents: the use of performance goals, asking people who do the work, and providing training to the users. Surprisingly, the automation of tasks, which would indicate technology, was lower on the list with a larger percentage of managers who "sometimes" use this method rather than using it "most of the time." Although technology is perceived to be a positive factor affecting efficiency, task automation is not a method frequently used.

Standard management and motivational tools, such as establishing standards of performance, increasing feedback to the staff, using motivational techniques, and flow-charting the work process, are not the most frequently used methods. Such a departure from the use of more structured or disciplined management techniques may be characteristic of the dominance of knowledge workers in the labor force.

Conversely, the least used methods included performing time studies, implementing piece-rate, and micro-managing the work process. Basic "classical management" techniques, particularly scientific management, were not favored in these industries. In addition, the infrequent use of these techniques in conjunction with others (i.e., flowcharting the work process) demonstrated a lack of focus or concern for the work process itself. Again, the departure from more detailed management techniques may help to explain why labor productivity growth rates in the United States have declined.

Without attention to or an understanding of the work process, combined with a high perception of technology as a positive factor affecting efficiency, management techniques and skills may no longer be considered as important as the deployment of information technology to resolve these concerns. Once again, this reaction may be based on managment complacency. Furthermore, in cases where information technology is applied to work processes that are not well understood, efficiencies are seldom gained because a dysfunctional work process may have been automated creating a dysfunctional "automated" work process. The departure or abdication from attention to the work process may be important. Unfortunately, work processes do not go away as a result of automation; they merely change.

When viewed across industries, the top five most frequently and least frequently used methods to improve efficiency are displayed in Table 52.

Similar to the factors affecting efficiency, the methods most frequently used to promote efficiency in organizations include:

- Providing training to users (5 of 5 industries),
- Using performance goals (4 of 5 industries),
- Increasing feedback to staff (4 of 5 industries),
- Establishing standards (3 of 5 industries),
- Developing plans (3 of 5 industries), and
- Asking people who do the work (3 of 5 industries).

Conversely, the most common least frequently used methods included in the top five ranking are:

- Implementing piece-rate (5 of 5 industries),

Table 52

Methods Most Frequently and Least Frequently Used to Promote Efficiency in the Organization (Top Five Only)

Industry	Most Used	Least Used
Financial Services	Uses performance goals	Implements piece-rate
	Increases feedback	Micro-manages work process
	Establishes standards	Reduces staff
	Provides training to users	Performs time studies
	Develops plans	Hires new people
Health Services	Provides training to users	Implements piece-rate
	Establishes standards	Micro-manages work processes
	Uses performance goals	Hires new people
	Increases feedback	Performs time studies
	Reduces spending	Reduces staff
Business Services	Asks people who do work	Improves piece-rate
	Provides training to users	Performs time studies
	Increases feedback to staff	Micro-manages work processes
	Uses performance goals	Hires new people
	Automates tasks	Reduces staff

(continued on following page)

Table 52 (continued)

Industry	Most Used	Least Used
Retail Trade	Establishes standards	Implements piece-rate
	Asks people who do work	Performs times studies
	Trains managers	Reduces staff
	Develops plans	Hires a consultant
	Provides training to users	Flowcharts work processes
Manufacturing	Uses performance goals	Implements piece-rate
	Develops plans	Performs time studies
	Asks people who do work	Micro-manages work processes
	Increases feedback to staff	Hires new people
	Provides training to users	Reduces staff

- Performing time studies (5 of 5 industries),
- Reducing staff (5 of 5 industries),
- Hiring new people (4 of 5 industries), and
- Micro-managing work process (4 of 5 industries).

According to the Table 52, the detailed work and/or analysis of the work process is seldom, if ever, used (performing time studies, implementing piece-rate). Although these are classical (scientific) management techniques, a focus on the work process is clearly low priority. The diminished focus on the work process and/or the use of more structured management techniques may be indicative of poor labor productivity growth rates in the United States. Without attention to the work process, dysfunctional tasks or elements could continue to dilute the positive effects of the output.

Although today's management attention is placed on value creation and the overall output, efficiency does not disappear in this scenario (Reichheld, 1996). Efficiency remains an integral part of the overall productivity equation and cannot occur without an understanding of or attention to the work process. As organizations seek to use information technology to improve efficiency, an understanding of the work process must occur before any attempts are made to automate processes.

Of the common methods most frequently used (providing training to users, increasing feedback to staff, and use of performance goals), all can claim their origins from Taylor. Training was a core principle of scientific management, and performance goals were implied in the process. Increasing the amount and kinds of feedback was also emphasized in the relationship between worker and boss (Taylor, 1911b). Taylor encouraged interaction between foremen and workers toward improving the process. Even asking people who do the work supports Taylor's theories of encouraging worker participation and improvement of the task.

As shown in the least used methods, the scientific techniques of time study, piece-rate, and flowcharting/ analyzing the work process appear not to be priorities today. Again, given the poor labor productivity growth rates in the United States, the question remains whether this lack of focus on the work process translates into the less than stellar labor productivity performance experienced over the past several decades.

Research Question 5

Research Question 5 asked, Has information technology improved efficiency today?

According to the perceptions of the respondents, information technology, in general, had no discernible impact on efficiency. Managers seemed uncertain as to whether or not information technology affected efficiency.

All industry responses were relatively consistent. Thus, the conclusion can be drawn that information technology had no impact on efficiency.

When analyzing the responses to individual statements contained in the survey, however, uncertainty seemed to prevail based upon the level of inconsistency in responses.

The following conclusions reflect what companies have been able to accomplish:

- Companies keep up with software upgrades,
- Companies change behaviors when information technology is introduced, and
- Companies perceive that information technology has improved their efficiency or productivity.

In addition, the following conclusions demonstrate what companies have not been able or willing to do:

- Work hours have not been reduced,
- Adequate training does not occur,
- Employees don't use information technology to the fullest,
- Information technology application has not reduced operating expense,
- Follow-up is not done after purchasing information technology to assess attainment of benefits as a result of deployment,
- No additional time is created for other duties,

and

- The cost of information technology is not equal to the value created from information technology.

In short, definite confusion exists. On the one hand, managers perceived that information technology helped their organizations be more efficient. On the other hand, the elements that indicated efficiency (i.e., creating more time, reducing operating expenses, achieving benefits) were clearly not occurring. Furthermore, the conclusions that respondents kept up with software upgrades but did not train adequately or acknowledge that people use information technology to the fullest indicated a lack of management attention or action to apply the technology.

Although managers perceived that information technology promotes productivity or efficiency, they were not doing anything to facilitate improvement in productivity nor were they actually seeing the results of this perceived productivity or efficiency improvement.

The confusion of managers may have originated from the misperception that the mere act of installing information technology increases productivity and efficiency, whereas in reality it does not. The Wharton School research study (ARGO Data Resources Corporation, 1996) referenced in Chapter 6 indicated that the management of the work process, in conjunction with information technology, is critical to achieving the benefits of information technology (ARGO Data Resources Corporation, 1996).

The conclusions from the Wharton study (ARGO Data Resources Corporation, 1996) further suggested that the lure of information technology as a means for improving productivity and efficiency in the organization is only half of the equation. The other half is management. If information technology alone were able to improve productivity and efficiency as perceived, United States labor productivity growth rates would likely be different.

The misperception of the capability of information technology may be indicative of a lack of understanding of the purpose and/or how to apply information technology. The belief that information technology has to improve our productivity and efficiency may be a perception that simply is not true. Computer manufacturers and software developers have enormous advertising budgets that are used to convince consumers that their products will do everything. Because no direct evidence exists indicating that information technology has improved efficiency in the organization, the belief that information technology is instrumental in improving productivity and efficiency has to be viewed as a perception. The overall answer to the original question is that information technology has no perceived impact on efficiency and that considerable confusion exists.

Research Question 6

Research Question 6 asked, What is the purpose of information technology?

As indicated in the previous section, much confusion or uncertainty exists as to whether or not information technology influences organizational efficiency. Some of the confusion may emanate from an understanding of the purpose of information technology.

Managers generally agree that information technology creates access to more information which, in turn, creates more work to manage. Yet they do not know exactly what to do with the additional information available as a result of information technology. Further, the additional information accessed from information technology makes managers more efficient. This conflicting response may be very confusing. If managers are not sure what to do with the information, how can they perceive that it makes them more efficient? The conclusion that can be drawn from these differences is that managers simply are not sure how to use information technology to the fullest.

From these statements, the perceptions indicate that:

- New software makes jobs easier,
- Computer technology is designed to increase productivity,
- Advances in information technology meet business needs, and

- Business and personal lives have improved as a result of technology.

In short, managers generally have a positive perception of information technology, perhaps due to the proliferation of advertising and its prevalence in the marketplace. Although information technology is viewed positively, managers are unsure of its purpose and how to use the information created. Managers do not do what is necessary to achieve efficiency.

The confusion, uncertainty, or inconsistenc surrounding information technology may very well be the reason information technology has not been used advantageously. The declining annual labor productivity growth rates in the United States may imply an inability to manage and apply information technology to capitalize on the benefits offered. Because both the nonmanufacturing/nonfarm and business sectors account for most of the decline in labor productivity growth as well as 80% of information technology expenditures, this implication may be accurate (Grayson & O'Dell, 1988).

Of the five industries studied, business services had one of the strongest perceptions that computer technology makes organizations more productive and that new software makes jobs easier. In addition, business services also had stronger perceptions than other industries about the purpose of information technology. Perhaps this is indicative of the fact that the business services industry grew up with information technology and is more technically oriented than industries with longer life spans.

Although managers strongly agree that computer technology is designed to make organizations more productive, health services was lowest of the five industries. The less definitive conviction on the part of health services may be a reaction to their changing environment, the costs involved in information technology, and the uncertainties with which they are confronted. The health services industry is planning to become more computer-intensive but has less technological history than the others.

In summation, managers were uncertain of the purpose of information technology and clearly are not sure how to apply or to attain the benefits available from information technology. They did, however, have a positive view of information technology and believe information technology makes them more productive, although this is not supported by fact. This confusion or misperception is a concern because if managers believe information technology makes them more productive yet United States labor productivity growth rates are declining, a false sense of security may result that could perpetuate negative results.

Research Question 7

Research Question 7 asked, Are Taylor's theories currently being used?

According to the results of the survey, Taylor's principles of scientific management are not in general use today. In some cases, however, a higher, if not majority, opinion for some of the four principles of scientific management exists. The core principle of Taylor's theories, "the development of a science for every aspect of a worker's job," was not accepted by a majority opinion of the principle earning a high opinion and was actually least favored or least used by the respondent group. Managers clearly demonstrated disfavor with classical management tools such as time studies and piece-rate. This principle requires scientific analysis to determine the time and steps required for each task of the work process. The responses to the survey support the trend that managers today are reluctant to perform detailed and structured analyses of work processes.

Of the four principles, managers more strongly favored Principles 2 (scientific selection and training of workers) and 3 (managers and subordinates working closely to ensure that the work is performed according to the principles of science developed). These principles are still very much a part of contemporary theory, particularly reengineering or excellence in management. The fourth principle--division of labor--is used but less frequently. The concept of division of labor is generally less consistent with contemporary theory today which emphasizes group work, matrix management, and a process orientation.

Of the five industries studied, both health services and retail trade adhered most to the principles of scientific management. Surprisingly, the manufacturing industry indicated the least use.

With the proliferation of microcomputer technology, there appeared to be a departure from scientific management in general. As more information technology was introduced into the workplace, less time was spent analyzing or evaluating the work process and/or tasks performed. The decreased time spent analyzing the work process may have been due, in part, to the ability of the computer to absorb some of these tasks. However, seldom were all absorbed.

What was puzzling was that the Taylor principle most used was that managers worked closely with employees to ensure that tasks were completed according to the principles of science previously developed. If less attention is placed on developing a science for each aspect of the job, how can management and staff work closely to ensure that work is carried out according to the science developed? Although a closer relationship between management and worker may exist, an emphasis on the defined steps required appears absent, possibly revealing the root of the productivity and efficiency problem today.

Without adequate definition and clarity of tasks, work processes, or management expectations, a basis for working closely toward a common goal is difficult. Taylor himself came to this realization at Midvale when he declared, "The main trouble . . . is that you have been quarreling because there have been no proper standards for a day's work. . . . the great thing is we do not know what is a proper day's work" (Kakar, 1970, p. 67). This same issue is critical today. Without scientific analysis, the expectations of the job are not clearly known. Given the emergence of both the services sector and knowledge workers, few standards have been developed that govern the role of knowledge workers. Without standards, the result will invariably be lower productivity and increased inefficiency, as Taylor saw first-hand in the late 19th century.

Division of labor is also perceived to be less used today, which, along with developing a science for every aspect of a worker's job, is a fundamental tenet of scientific management. Many contemporary theories do not espouse division of labor as Taylor outlined; they emphasize performance of the work where it makes the most sense.

Research Question 8

Research Question 8 asked, What is the current level of information technology use in the company?

Information technology use today is substantial. Two areas are important in arriving at this conclusion: the ratio of staff to microcomputers and the degree of information technology usage and understanding.

These findings indicate considerable information technology proliferation within organizations supporting the comments that the recent past two decades were extremely prolific in the development and deployment of microcomputer technology. The proliferation of microcomputer use, when analyzed in conjunction with the United States labor productivity growth rates for the same time period, raises more questions than answers. Why, with so much microcomputer proliferation and usage, are labor productivity growth rates declining? Clearly, the increase in microcomputer use should improve this ratio, especially if managers perceive that information technology is designed to improve productivity and efficiency. The declining productivity growth rates indicate that either microcomputer technology is not well applied or the product of the computers--information--is not well understood. This lack of understanding was corroborated in the survey results, with most managers uncertain about what to do with the additional information available from information technology.

In short, companies are expanding their deployment and use of microcomputer technology at considerable expense but with less direction, planning, and knowledge as to its application.

Research Question 9

Research Question 9 asked, What is the current level of efficiency in the company by efficiency ratio?

A comparison of industry efficiency, as measured by an efficiency ratio (formula), has revealed that the manufacturing industry has the lowest efficiency ratio. This low efficiency ratio is consistent with United States Department of Labor productivity growth rates in that the manufacturing sector demonstrated the most promising productivity growth rates of the sectors. Consistently, the business services sector had the highest (poorest) efficiency ratio and also very poor Department of Labor productivity growth rates.

Nonfarm/nonmanufacturing and business sectors have shown poor labor productivity growth rates over the past three decades. The business sector, however, is made up predominantly of services, which generally have the highest efficiency ratios. When compared with manufacturing, the business sector has shown very poor labor productivity growth rates over the last several years in contrast to that of manufacturing, as shown in Table 53. Again, United States productivity growth results corroborate the overall efficiency ratios determined from secondary research showing manufacturing with the most positive efficiency ratio.

Table 53

United States Labor Productivity Growth Rates: Manufacturing versus Business Sector

Year	Manufacturing	Business Sector
1995	3.2	0.1
1996	3.3	1.0
1997*	2.8	2.9

* First quarter 1997 annualized.

Source: Bureau of Labor Statistics, 1995.

The actual results obtained from secondary research for both United States labor productivity growth rates and efficiency ratios are most interesting when compared with the primary research results relative to perceptions of efficiency. Accordingly, Table 54 illustrates a comparative of selected performance indicators and perceptions taken from the survey information.

The statistics contained in Table 54 indicate that managers of business services believed that they were generally efficient but did not perceive that efficiency is an overall management concern. Yet business services

Table 54

Industry Comparative of Primary and Secondary Efficiency/Productivity Results

Industry	Agree Efficiency is a Concern (%)	Perceive They Are High/Moderately Efficient (%)	Believe Information Technology Has Permitted Improved Productivity (%)	Efficiency Rate	Productivity Growth* Rates
Health	72.9	77.5	77.2	78.78	1.8
Finance	56.2	70.8	70.7	72.39	-1.3
Manufacturing	53.1	66.8	67.9	67.86	3.1
Business	43.6	81.2	78.2	82.92	1.3
Retail	40.0	80.0	85.0	72.91	1.3

* 1979 to 1985 average

had the highest efficiency ratio (poorest) and relatively low productivity growth. On the other hand, the managers in the manufacturing industry believed least strongly that they were efficient and were concerned about efficiency (but not to a high degree), yet they had the best efficiency ratio and productivity growth rate of the industries represented. Does this indicate that managers are misperceiving what actually occurs in their organizations, or do the perceptions actually create the result? In the latter case, does a belief that the organization is efficient breed contentment or complacency from management whereby opportunities are missed or intensity does not exist (Belcher, 1987)? The inverse relationship of perception of efficiency level to actual efficiency may appear reasonably accurate in that manufacturing managers believed that they were not the most efficient, yet actual results indicate they were. Is this a management issue, a communication issue, or simply a cultural issue? In any event, the findings revealed information about the industries.

Another possible response to this phenomenon is that the nonmanufacturing/nonfarm and business sectors, which consist predominantly of services, are comprised of knowledge workers. Knowledge workers do not have the long history of efficiency orientation the manufacturing industry has. Much of the development of management theory, certainly scientific management, emanated from the factory or industrial world. The years of attention and focus have generally produced efficiency in this area. However, the new labor force, consisting predominantly of knowledge workers, has not been exposed to the same history or intensity. Because knowledge workers constitute the majority of the labor force today, the declining productivity growth rates result from the dilutive effect the sectors have on the whole. Therefore, new management methods are needed to improve the performance of this group.

Problem Statement

What is the relationship between information technology use, scientific management use (and their combined effect) and efficiency across selected industries? This problem statement sought to find out whether a statistical relationship existed between the two independent variables (information technology use and scientific management use) and the dependent variable, efficiency. A third independent (moderator) variable, industry, was also analyzed in the study.

In contrast to the previous survey perceptions, the inferential statistics, for the most part, relied on factual data (i.e., financial information). Inferential statistics were used to test the hypotheses of the study.

In all cases, the null hypotheses were accepted, indicating that there were no relationships between the variables and efficiency.

For the main effect--information technology--no significant relationship existed in relation to efficiency. Regardless of the level of use (high, moderate, or low), no relationship existed, indicating that the efficiency of the organization was related to unknown variables other than information technology. However, information technology was not eliminated as a potential variable affecting efficiency. The findings may have indicated how information technology is applied rather than only deployed. For instance, if information technology were properly managed and applied, a direct relationship to efficiency may be derived. The application of information technology is beyond the scope of this study but raises important considerations for future research.

The lack of relationship between information technology and efficiency was not particularly surprising because concerns about the deployment of information technology have been continually raised by analysts. The application of information technology, as measured by expenditures, has not improved labor productivity growth rates. Whether information technology has a bearing on efficiency, the perception is that information technology should create improved productivity and efficiency, yet labor productivity growth continues to be low. According to the findings of this study, no relationship existed between the two, which itself provides an answer. A common perception of information technology is that it is designed to make organizations more efficient/productive; however, efficiency does not appear to be occurring. This perception may simply not be true, indicating that other variables should be explored to determine relationships to efficiency.

Managerial perceptions contained in this study indicated that information technology permitted productivity/efficiency to improve. In addition, managers perceived that information technology was not used to the fullest, inadequate training was provided, benefits were not capitalized upon to ensure their attainment, and information technology had not reduced operational expenses. If managers proactively improved these scenarios, would changes occur in efficiency ratios such that information technology use might be related to efficiency? Although this could be tested, the act of improving understanding, training, and utilization suggests or implies guidance, direction, or simply management. Does this mean that more intense management practices should have a relationship to efficiency? The second hypothesis tested this scenario.

The relationship between scientific management use and efficiency was tested. Scientific management is a classical management theory that emphasized efficiency. The hypothesis suggested that there could be a relationship between scientific management theory and efficiency. No significant relationship was proven to exist between scientific management use and efficiency. Therefore, the second null hypothesis was accepted.

Seemingly, it is logical to believe that a management theory may have a relationship to efficiency. This relationship, however, did not occur, leading to a similar conclusion that other undiscovered variables beyond what has been tested may be related to efficiency. In addition, only scientific management, a classical management theory, was tested; other schools of thought were not. The possibility that other management theories could have a relationship to efficiency merits further consideration.

The final hypothesis, the interaction or combined use of scientific management and information technology and efficiency, was also tested. The interaction yielded the same results as before the acceptance of the third null hypothesis. No relationship existed between efficiency level and the combined use of information technology and scientific management orientation in effect. Originally, this interaction was suggested to determine whether scientific management, when applied to the use of information technology, would add discipline and more scrutinized application of information technology, with possible positive results. Because the findings of the survey indicated that information technology was not well utilized, applied or understood, a management focus could potentially change these results. However, there was no indication that a focus such as this had occurred.

As with the other two hypotheses, acceptance of the null hypothesis is not a failed response. The result provides just as much a statement as if the null hypotheses were rejected. Although the interaction produced no significant relationship, another management theory or approach may have a different result.

The critical themes of the problem statement are efficiency and productivity. Analysts remain perplexed as to the reasons for the decline of the United States labor productivity growth rates and the continuance of this decline amid considerable information technology advancement and expenditures. Because Taylor's theories changed the world during the industrial paradigm shift, can they, once again, be instrumental today? Although no statistical relationship was found, various aspects of his theories continue in use today. Quite possibly some of Taylor's individual principles may have a direct relationship to efficiency.

Of all the variables studied, only the moderator variable--industry--produced a significant main effect. When analyzed further, using multiple-comparison procedures, a significant difference was found to exist between the manufacturing and business services industries. Because the difference was not a chance difference, the moderator variable--industry--does have a relationship to efficiency. Where this difference actually originated is between manufacturing and business services. Industry alone, specifically business services and manufacturing, may have a relationship to efficiency; there may be an inherent difference between industries. The difference between average efficiency ratios for manufacturing and business services was shown earlier; the statistical analysis adds another dimension. The relationship existing between these industries is not a chance relationship, indicating a true difference between the two, which may have an impact on efficiency.

When evaluating the companies who comprised the business services group, most were developers of technological products. Given the high cost of development and information technology itself, their efficiency ratios may naturally be high. In this regard, business services may in fact be different than manufacturing.

Interpretation of the Findings

With the null hypotheses being accepted in all cases, a number of issues are raised indicating that, contrary to managerial perceptions, information technology use alone does not guarantee improvement in efficiency. Many people are focused on the labor productivity declines of the country that have occurred over the last several decades and question why or when the benefits are going to be derived from the expenditures for information technology that are being incurred. According to the results of the study, benefits may not occur unless some other variable is introduced that may be instrumental or influential in affecting efficiency/productivity. The concept of another variable is difficult to accept because managers also perceive that information technology is designed to make them more productive and efficient. A potentially false perception exists that the more information technology spending, deployment, and use occurs, the more efficiency and productivity will improve. The correlation between information technology spending and increased efficiency does not seem to occur. Either another variable is necessary to enhance the information technology deployed or information technology has no effect and should not be considered further in relation to efficiency.

A question is raised, however, whether something is missing relative to information technology to enhance its ability to improve or affect efficiency/productivity. To answer this question, a test was conducted by combining respondents using scientific management principles with those who have high levels of information technology use.

Although this too resulted in no effect on efficiency, it was not clear whether scientific management principles were directly applied to the management of information technology or to technical resources.

Most of the respondents agreed that little is done to support the information technology once deployed or to enhance its opportunities for success. The inadequate support is manifested in a lack of training, lack of understanding of the information technology, lack of utilization of information technology to the fullest, and no effect on the bottom line. In short, information technology simply appears to be installed and upgraded without efforts to manage or apply it. A false assumption or perception exists that deployment alone is enough to obtain the productivity/efficiency perceived to be inherent in the information technology. Another possibility is that managers simply do not have enough time to properly manage the technology, given the increasing hours managers are now working.

Logically, a disciplined management regime such as scientific management conceivably could provide the information technology with opportunities for successful application. Information technology should be viewed as a resource to manage just as human resources are, therefore requiring the same level of attention and dedication that people do. The findings indicate that managers are uncertain what the purpose of information technology is and how to use the information obtained from information technology.

Although Taylor's principles were developed for managing people and the tasks they perform, these same principles may be applied to technical resources to determine if similar results occur.

Managers/analysts do not specifically know what is causing the declining labor productivity growth rates. Assumptions are made regarding information technology expenditures and use, but these variables have not been proven to be related. According to this study, information technology use has no real effect on efficiency/ productivity.

As the country shifted toward theories of quality improvement like Deming's in the 1980s, quality emerged from a recognized need. Today, the measures may be inaccurate or a renewed focus on management techniques may be required to improve productivity similar to the campaign to improve quality. The measures may not necessarily be wrong because, when compared to other countries (and with the manufacturing sector), labor productivity growth rates are increasing and are higher than those of the United States. These types of comparisons clearly indicate the importance of management. Management, however, is not just human resources but also technical resources.

If technical resources were effectively managed and/or applied, the result would reveal a more effective application of human resources and, therefore, increased productivity. Effective management would be the key because international measures compare productivity growth with ratios of GDP to number of employees. Therefore, if resources were effectively managed and applied, the ratio of output to employees should show strong growth and be considered an effective management measure.

This interpretation indicates that managing is still important and requires renewed emphasis. What was learned in this study, however, includes a number of issues:

a. Before labor productivity growth rates began to decline (within 10 years), the work force changed in composition from industrial to information workers. Since that time, this new work force has increased in size as labor productivity growth rates have declined.

b. The United States is the leader in the deployment and use of microcomputing technology, with .319 microcomputers per person (Meeker & DePuy, 1996).

c. Information technology produces a wealth of information, but business organizations are unsure what to do with so much information.

d. Working hours per week have not declined. Although more hours are being worked per person, productivity is not improving.

The new work force must focus on these issues when determining reasons for productivity declines. Operating predominantly in a service environment, this work force applies information with computers as the primary work tools. The change from machines to computers suggests that the management of knowledge workers must be different than that of their predecessors, the industrial workers, simply because of the changing tools and output. Furthermore, a conflict possibly exists in the measurement of productivity. The United States labor productivity growth rates began during America's industrial period. Measurement has occurred using this basis ever since, although the labor force and the outputs changed in 1957 and succeeding years.

The manufacturing industry has continued to post exceptional productivity growth rates. These positive results must be a result of the ability of this industry to "leverage" technology (machines, computers, and automation) to enhance production. As machines and processes like these have improved, two events has happened: (a) fewer people were needed to produce the same output, or (b) more output was produced without increasing staff. Taylor accomplished a similar result during the industrial period. If knowledge workers and industrial workers were compared, would there be the same expectation? To post exceptional productivity results, either (a) the number of workers must decrease as output remains constant, or (b) the amount of output must increase as the work force remains constant. In either case, more products or services must be produced by the given work force. Increased production can only occur from technology or new methods of management, both requiring innovation. Because the technology exists, the conclusions that can be drawn include:

1. Information technology is not being used properly, and/or the potential is not being leveraged,

2. Technical resources are not being effectively managed, and

3. Knowledge workers are not being managed effectively, and/or the best way to manage them is unknown.

Because the technology exists, management must prevail in order to ensure that appropriate levels of output result. The implications, therefore, of this conclusion call for:

1. New definitions of management for knowledge workers (techniques and concepts);

2. Improved understanding of information technology in terms of technical maturity (understanding technical basics, accountability, etc.);

3. Training on managing and applying the technology to leverage the use of human resources through technical resources toward enhanced output; and

4. Application of information available from the information technology toward the production of the out-

put.

Appropriate levels of output will depend on the ability of knowledge workers to manage and be managed in the information technology environment.

Conclusions

The major conclusions developed from this research include the following:

1. Neither information technology use nor scientific management use had an effect on the level of efficiency in the organization. The combined effect of information technology and scientific management also had no effect on the level of efficiency. The introduction of a disciplined, structured management methodology on the use of information technology does not appear to affect efficiency. After information technology is deployed, little direct management action is generally taken. Managers do not train adequately, are not using the technology to the fullest, are not aware of the benefits that may be attained as a result of the use of technology, and are skeptical of the impact on operational expense. A false assumption has been made that information technology alone will improve efficiency. By simply installing technology without any management application orientation, information technology becomes disabled and is not able to provide the benefits desired.

2. The nature and magnitude of change affecting the present information period appears to parallel that of the changes that occurred in the industrial period. Both periods experienced substantial and significant technological advancement that affected not only business and industry but also individual lifestyles as well. Some of the more significant changes that took place are identified in Table 55. Given substantially equivalent and pervasive change for both periods, a comparison and/or study of the industrial period as a model for providing insights into today's transition appears reasonable.

3. Taylor's principles of scientific management in their entirety are not generally used today. Although some elements of these principles are used, the core principle (the development of a science for every aspect of a worker's job) is not generally used. The lack of use of scientific management is corroborated by the lack of use of time study, piece-rate, and focus on the work process, as indicated by the respondents (see Table 30). Rather than scientific analysis of a worker's job, more behavioral approaches (i.e., training, consulting, staff, etc.) are favored. This departure may have caused a decreased sensitivity or awareness of the elements of the job. Because jobs have changed dramatically (to knowledge workers), no foundation exists for providing this analysis.

Table 55

Comparison of Significant Changes Taking Place in the Industrial Period and the Information Period

Industrial Period	Information Period
Major change in the labor force from agricultural workers to industrial workers (1920).	Major change in the labor force from industrial workers to information or knowledge workers (1957).
Precipitating factor that created change was the machine.	Precipitating factor that created change was the computer.
Efficiency became a concern resulting from inefficient work processes due to the new technology.	Efficiency became a concern resulting from inefficient work processes due to the new technology.
Late 1800s were defined by major advances and the proliferation of inventions that changed lifestyles: - Telegraph (1844) - Telephone (1876) - Electric light (1879) - Automobile (1885) - A/C (1886) - Radio (1895) - Airplane (1903)	Late 1900s were defined by major technological advances in information technology that changed lifestyles: - Univac (1951) - Television - Sputnik (1957) - Microcomputer (1975) - PC (1981) - Internet (1989) - Java (1996)

Even though no significant relationship was found between scientific management use and efficiency, Taylor's theories are not obsolete. Taylor's theories continue in use today in various forms relative to goal setting, planning, selection of workers, and even the interaction between boss and worker. The predominant issue is whether these theories can be applied to a totally different labor force.

According to the Wharton study (ARGO Data Resources Corporation, 1996), the factors (or practices) that indicated a decided Taylor influence included compensation based upon contribution, careful selection processes, and commitment to employee development. All of these factors directly relate to Taylor's core principles. The practice of involving employees in decision making emanates from Taylor even though Taylor's principles called for management to define how work is to be performed and the worker merely to carry it out. However, in his Principles of Scientific Management (1911), Taylor discussed how workers should work closely with management to hone the completion of the task in the most efficient way possible. The interaction of employers and workers is necessary to develop the one best way of doing work.

Taylor's theories are far from obsolete and remain as applicable today, in principle, as they were in Taylor's time. Unfortunately, Taylor has received such negative criticism for his methods that managers seldom seek to emulate the work he did. Furthermore, many of his theories are so entrenched in standard business practice that managers may be unaware of their origin.

A number of insights and knowledge were gained from this research on the work of Taylor and the development of his principles of scientific management. Among them are the following:

a. Once he became a foreman, Taylor quickly recognized that no one knew what a day's work was supposed to be. No standards were established in order to promote improved output and efficiency. This same issue exists today with knowledge workers. Adequate standards or optimal output is unknown because the type of work and workers have changed, requiring analysis.

b. Taylor emphasized both improving the efficiency of workers as well as engineering the technology (machines) for increasing capacity and output. Computers, similar to the machines of the industrial period, can and should be engineered to promote improved output and capacity. Often this is overlooked today as so much software is available on the market. The development of software and systems engineered for production presents additional opportunities to promote productivity and efficiency.

c. Taylor was a proponent of emphasizing a "mental revolution." He recognized that a different way of thinking was required in contrast to the old way. This same "mental revolution" in management is needed today to determine new methods for achieving efficiency and productivity, given the significant changes that have occurred. Recognition of this "mental revolution" indicates insights drawn from Taylor.

d. Taylor's emphasis on tasks and the scientific analysis of every aspect of a worker's job represents the type of analysis required of the tasks and work processes today. The concept of reengineering emphasizes analyses of the work process for changes similar to what Taylor did with workers of the past.

e. The concepts Taylor developed continue today in various forms. By studying Taylor's theories and their development in depth, a renewed appreciation and understanding of those theories occurs, indicating that Taylor's theories are hardly obsolete today. A recognition of the origin of some of the theories used today occurs.

f. Taylor's fundamental principles emphasized a number of basic management tenets used today. A return to many of these management fundamentals is needed to obtain the functionality and, therefore, the benefits of information technology. Taylor's basic theories of worker/foreman communication and relations, scientific training and selection of staff, and channeling work where it makes the most sense or to the individual best suited remain necessary ingredients of success.

4. Efficiency appears to be very much a topic of management discussion and concern today. As evidenced from the primary research conducted, the majority of respondents believe that efficiency is a concern today. The concern for efficiency has reached national levels, as it was during Theodore Roosevelt's administration in the industrial period, based upon the declining labor productivity growth rates over the last 25 years. This productivity decline has caused considerable concern on the part of economic analysts and businesspeople alike, especially as the decline in labor productivity growth for the United States has been continuing for some time. This longevity may have diminished the urgency or the necessity of action in the workplace.

5. The purpose of information technology is not clear to managers. Confusion appears to exist as to what information technology is designed to accomplish. Although a perception exists among managers that information technology is designed to make people more productive and

efficient, this has not been proven statistically and creates a misperception of what information technology can and will do for the organization. This misperception may result in the lack of action taken to support or manage information technology to aid in achieving the perceived productivity gains.

6. Managers seem confused or misdirected in their perceptions of information technology and improved efficiency due to the technology. Most managers do not believe or are uncertain that information technology has reduced operating expenses, that information technology is used to the fullest, that information technology has reduced work hours, and that adequate training is conducted on all new technologies deployed. Yet managers who were surveyed perceived that information technology permitted them to improve their productivity and efficiency. Statistically, this is not true nor supported by national productivity growth rates. Managers have a misperception or lack of awareness of actual efficiency/productivity results about information technology and efficiency. Therefore, managers have demonstrated a reduced sense of urgency in taking action to achieve efficiency.

7. No specific change in thinking and behaving appears to have occurred in the information period to capitalize on the new technology. The "mental revolution" that Taylor described has not fully occurred as yet. If

anything, managers behave in ways almost without change, yet the technology being deployed has the capability of altering the ways in which business is conducted. Although the labor force has changed significantly to predominantly knowledge workers, management practices have not been analyzed or reassessed to guide the new work force towards improved efficiency and productivity. In short, little effort has been made toward addressing the need to manage both technical and human resources today. The management of technical resources demands new methods of management.

8. Technical resources (i.e., information technology) currently appear not to be managed effectively. Findings from the survey indicated that managers either had little time or did not take action to manage the technology deployed. Little time and attention were provided for ensuring that information technology was understood, that managers knew how to manage it, and that staff took full advantage of information technology.

9. The factors that were perceived to contribute most to efficient operations included:

- Technology,
- Staff training,
- Communication,
- Reduction/elimination of paper, and
- Retaining people.

The methods most used to promote efficient operations were:

- Providing training to users,
- Using performance goals,
- Increasing feedback to staff,
- Establishing standards,
- Developing plans, and
- Asking people who do the work.

In this context, perceptions closely match what is used. Therefore, to develop an orientation toward efficiency in the organization's success, factors that emerge as critical might include:

- Communication and feedback,
- Training,
- Technology use,
- Standards and goals, and
- Staff retention.

10. The manufacturing industry is more efficient and more productive today than other industries. Although this industry appears to perceive technology as positively affecting efficiency, manufacturing is not the leader in terms of information technology expenditures (see Table 6).

11. The current typical worker has changed from that of the typical worker of 50 years ago. Management theories used and applied today must take into account that

knowledge workers use information technology substantially and that their principal output is information. Based upon this change in the labor force, a different type of management appears to be required today to address these differences. Altered methods of management will also affect the use of measurement systems that should take into account the value created from the information produced.

12. Management is still important, if not more than it was. Although no relationship was found between efficiency and scientific management, this research clearly indicates that not enough time or attention is placed on managing.

13. Managers have shifted away from understanding the work process. Not enough attention today is given to the work process.

14. Managers do not appear to know how to use or apply effectively information that becomes available through information technology.

15. Managers are unaware and uninformed about the dramatic decrease in labor productivity growth in the country. This lack of awareness may have perpetuated a false sense of security or complacency that may have perpetuated the poor results.

16. Productivity measurements and efficiency ratios are closely related. Both are measurements of the ratio

of inputs to outputs. The primary difference between the two is the presentation of their result. Efficiency ratios present the cost to produce $1.00 of revenue, whereas productivity formulas reflect the cost per unit of output produced. National labor productivity rates are calculated on the ratio of output (expressed as GDP) in relation to hours worked or number of employees. This, in a broad sense, is the relationship of output (GDP) to inputs (labor) and, therefore, contains the same elements as in the formula.

17. Measurements of labor productivity and effiency should be reevaluated in light of the change in labor-force composition. Emphasis should be placed on what the output should be in the productivity efficiency formula.

Conclusions identified form the basis for the development of implications for management theory and recommendations for further research.

Implications for Management Theory

The primary topic or issue that originated this study was efficiency and productivity and how improvement might occur. Efficiency/productivity is well established in the research as a perceived and real concern of management. However, there still remains no direct link or answer for improving efficiency/productivity today. Information technology draws continued attention as a panacea for productivity/efficiency improvement, yet no research results are able to justify that information technology influences productivity/efficiency improvements.

Because efficiency and productivity have remained management issues for some time and because information technology as well as scientific management have not proved to be influential in the level of efficiency, other variables must exist. Taylor proved that efficiency/productivity could be controlled and improved, using the principles he developed in conjunction with the new technology of the time (machine technology). Similar applications should be possible today.

The principles of scientific management were studied because they were successfully applied during a period of dramatic change that was similar to today's information period. Although some obvious differences exist between the industrial period and the information period, the nature of the dilemma and changes are consistent. To that end, and based upon the findings of the study, a modification of classical management theory, particularly scientific management, may be needed to accomplish the same result as was achieved at the turn of the century.

The findings of this study do not discern what variable(s) may be instrumental in affecting efficiency. Historically, disciplined management practices, when properly applied and used, can influence efficiency and productivity. Therefore, what appears missing today is the disciplined management structure and practices necessary to manage both technical and human resources. Today's workers are not predominantly industrial but rather knowledge workers. This labor force relies heavily on information technology for the tools with which to perform jobs. What may be missing are means to

- manage technical resources,
- manage knowledge workers, and
- apply the technology to the work process to achieve specific benefits.

Because knowledge workers deal with information and use information technology in order to be successful, new or revised management theories must be developed, building on Taylor's success and the application of his theories. In order to achieve success in this environment, the following critical success factors must be present:

1. Understanding of the purpose of information technology,

2. Disciplined/structured management practices for effective management of both technical and human resources,

3. Application of information technology to achieve improved efficiencies,

4. Awareness/orientation toward productivity and

efficiency,

5. Technical maturity and knowledge of information technology at all levels,

6. Analysis and attention to the work process, and

7. Effective monitoring/tracking mechanisms.

Each of these critical success factors are derived from the managerial perceptions obtained from the research conducted as well as from secondary data. In conjunction with these success factors, modified principles of scientific management emerge for management training and education. A suggested set of principles for managing in the information period is outlined below.

1. Understand and improve the work process prior to automation. Scientifically analyze the work process pre- and post-automation for changing behaviors to capitalize on the introduction of information technology.

2. Raise the level of technical maturity and understanding of information technology at all levels in the organization.

3. Manage both technical and human resources so that true application of the technology occurs toward the attainment of benefits. Challenge staff to apply information technology to its fullest potential.

4. Develop an understanding of information technology and how to use/apply the information that results. Integrate information technology into the work process,

allowing workers to participate and take ownership of the results.

5. Scientifically select and assign employees based upon interest, aptitude, and ability.

6. Develop and foster an awareness of the elements that impact results and that relate to production, efficiency, and value creation. Track and report on progress and follow through to ensure benefits are attained.

Recommendations and Applications

Clearly, a quick analysis of United States labor productivity growth rates indicates an obvious concern. Unless action is taken, the United States and its leadership as the most productive nation in the world will end.

One of the predominant uses of the information presented is the knowledge gained from the past. Although Taylor's theories may not be fully used today, what he did during the industrial period is important to understand today. Taylor saw opportunity in change. The change he experienced during the industrial transition was as pervasive and influential as today's information transition. Clearly, he saw a need to develop methodologies to harness the productive potential of the new technologies through the management principles he developed and set in motion.

Although this study revealed that there was no relationship between efficiency and scientific management use today, other theories may be developed concerning the possible relationship between these variables. What can be learned from Taylor and what occurred during the industrial period is his response to such change and how he took advantage of it. Someone like Taylor is needed today to develop methods to harness the power of this new transition. Information technology created the information transition as machines and automation created the industrial transition. Taylor not only improved upon the productive capacity of machines; he did the same with workers and management. This type of guidance and direction is required today.

The information presented in this study should be used to:

1. Sensitize managers to the productivity and efficiency problems prevalent today and create an awareness through a renewed emphasis on the changing labor force and work process;

2. Understand the dynamics and magnitude of change by analyzing what occurred during the industrial period and draw parallels to today's changes;

3. Understand that misperceptions or confusion exist regarding the purpose and use of information technology by challenging organizations (managers) to outline how information technology will be used. This must be addressed in order to garner the benefits of this technol-

ogy; and

4. Provide a foundation for the development of new principles for managing today by outlining critical success factors necessary in a changing labor force using information technology. The development of new principles must evolve or emanate from lessons learned from people like Taylor who responded to an equally changing time.

One of the most important applications of the knowledge contributed in this study is the development of a new set of management fundamentals that applies to the new labor force, i.e., information workers, and that takes into account managing technical resources as well as human resources. Evaluating and developing new management concepts begins with these results emanating from the study:

1. Managers are concerned about efficiency but not overwhelmingly;

2. United States labor productivity growth is the worst in its 100-year history;

3. Managerial perceptions of efficiency are not consistent with reality;

4. Managers are uncertain how to use the information manipulated through information technology;

5. Managers do not analyze work processes scientifically; and

6. Staff are not trained adequately to use the technology, yet companies generally remain current with

software upgrades.

Information technology must be considered a component of any future development of management techniques. Clearly, managers use technology, but the ways in which information technology is applied remains in question. Technology, as Taylor learned, does not create efficiency by itself; it must be managed and applied.

New/revised theories of management are necessary today due to the changing workforce. An understanding of the knowledge worker is important, and new methods must be developed for managing this changing worker. In addition, technical resources are also proliferating in the workplace and must be managed collaboratively with human resources.

Recommendations for Further Research

Based upon the findings and conclusions of this study, a number of recommendations for future research have emerged.

1. Secondary information could be obtained and analyzed to determine if a correlation exists between information technology expenditures and human resource expenditures. If information technology is designed to promote productivity and efficiency (as managers perceive it to be), the more information technology is deployed (manifested in terms of information technology expendi-

tures), the more human resource costs conceivably should decline. These secondary data could be based upon actual financial information of companies over the past 10 years.

2. An experiment could be developed and conducted (with control and experimental groups) to test the effect of information technology knowledge and use on overall productivity. The experimental group would receive extensive training on specific application software (used by both groups); the control group would receive a minimum amount or type of training (considered typical today). A common set of tasks could be assigned for each group to perform. The level of productivity of the groups, as measured by time (output/hours), could then be compared to ascertain whether improved training or understanding of information technology actually influences people to be more productive and/or efficient. In other words, the researcher could attempt to determine whether information technology should be the focus for improving productivity in the country or whether another factor is more influential.

3. A profile of the knowledge worker should be developed through observation (qualitative research). Such a profile should include tools used, furniture, reports, technology, management style, social factors, and outputs. A comparison of this profile with industrial workers would indicate possible differences. Approaches

for developing and understanding standards that might apply to knowledge workers might be suggested.

4. The degree of computerization should be evaluated, by country, to determine if there is a relationship between the level of computerization and national labor productivity growth rates. This research study would be conducted to determine the effect of computerization on productivity. Does increased computerization correlate with increased labor productivity? Do countries with less computer proliferation have better or lower labor productivity growth rates?

5. A study should be conducted to determine if the predominant management school of thought used by industry and/or companies is related to efficiency and/or productivity, as defined by United States labor productivity growth rates. Such a study would reveal which theories may be more influential on overall productivity or efficiency. The study would necessitate either observation or detailed surveys to assess the types of theories in operation.

6. The conclusion that a correlation may exist between management's perceptions of the level of efficiency and actual efficiency should be expanded upon, as measured by financial data. What conclusions can be drawn from this? Does a conservative orientation toward efficiency lead toward increased levels of productivity/

efficiency? The result of this study may indicate whether perception actually influences the result.

7. United States labor productivity growth rates should be studied more fully to gain an understanding of what they measure and how they affect the country's welfare. In addition, exploration of the economic forces affecting this ratio is also important. Much attention is focused on these rates by analysts, especially with the noticeable decline in rates that has occurred. Further analysis will serve to increase credibility, understanding, and action required from the results obtained. To broaden this understanding, further study and research should be conducted to:

a. Understand what elements are correlated with labor productivity growth rates, including various factors that may have an impact on the overall level of productivity;

b. Determine the relationship between productivity growth rates and the growth rate of the number of people employed in information-related professions to establish whether there is a direct relationship between the number of knowledge workers in the work force and the decline of productivity growth rates; and

c. Determine if there is a statistical correlation between United States labor productivity growth rates and efficiency ratios.

8. An experiment should be initiated to assess the level of application of information technology compared with use only to determine if information technology can have an impact on efficiency if properly applied. The purpose for this research is to determine what constitutes application of information technology. Knowledge of these elements may result in a definitive relationship to efficiency, as suggested in this study.

9. An experiment should be conducted to analyze the use of various management theories and their effect(s) on information technology application. Does one management theory promote more effective application of information technology than another? Similar to the manipulations performed by Mayo in the Hawthorne experiments (Stoner, 1978), differing management theories would be applied to similar groups to assess whether a management theory alone has an effect on efficiency. This idea relates to and expands upon the research recommended in number 5.

10. Research should be conducted to determine if managers are actually using a disciplined, structured management theory in their organizations or if management practices and fundamentals have declined in emphasis or use. With less management occurring today than in the past, follow-up research needs to be conducted to determine if, in general, standard management practices have

declined in use or are less emphasized by management.

11. Further study of the manufacturing industry should be undertaken to determine any contributing factors leading to the positive levels of efficiency and labor productivity growth rates experienced by the industry. Management research and development during the 20th century has been focused on industrial workers. The reasons for the manufacturing industry's success possibly may be a result of this intense effort. If so, what information exists that may contribute to the improvement of efficiency and productivity in the nonmanufacturing sector? The results should be compared with other industries to determine opportunities for applications to improve productivity and efficiency.

12. Research should be conducted to assess and determine new measures or elements of existing measures to assess efficiency and productivity more effectively in the information age. Study should proceed with analysis of the output portion of the equation. Rather than GDP or operating income used in this capacity, value should be measured and to whom. The study would include an understanding of what "value" means.

The foregoing suggestions for further research are designed to refine or expand upon the research conducted in this study. Although the results of this study did not produce statistical relationships between the independent and dependent variables, labor productivity growth rates continue to provide enough evidence for concern. Furthermore, information technology has become a major variable in the work environment today. Additional research may help to further understand the relationship between productivity and efficiency and the use of information technology. Existing measurements of productivity, efficiency, or success in general possibly need to change, given the transition of the work force and the role of information technology today.

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APPENDICES

APPENDIX A

CORRESPONDENCE AND SURVEY INSTRUMENT

PILOT SURVEY #1

Mr. Doe
Title
Company
Address
City, State, Zip

Dear Mr. Doe:

Thank you very much for assisting me in my doctoral dissertation research study. I appreciate you taking the time to fill this out at this busy time. The purpose of my study is to analyze efficiency in various industries and determine if there is a relationship to information technology utilization as well as the type of management orientation at work in the organization.

As I described over the phone there will be two (2) surveys I will send you. The first is attached, and the second will be similar and will follow relatively soon after the first. As you will note I have left blank spaces in several sections. The reason for this is I would like you to fill in items based upon your experience that you feel should be considered in a study of this sort. So please don't hesitate to fill in items as you deem appropriate. I plan to follow up after the first survey to question you about one of the sections to determine if it achieves what it purports to achieve. I will call you in regard to this.

If you would please return the completed questionnaire in the enclosed, self-addressed, stamped envelope by December 27, 1996. I am also interested in your candid opinions of the ease of use of the survey and general readability of the questions/statements. This will aid in finalizing the instrument I will use for my sample. The last page of the survey requests comments on this type of information.

If you should have any questions regarding the study, feel free to contact me at 630/875-7270. Should you wish to receive the results of the survey, please indicate this on the completed survey, supplying your name and address where indicated.

Your time and assistance aregeatly appreciated.

Sincerely yours,

Kent S. Belasco

PILOT SURVEY #2

Mr. Doe
Title
Company
Address
City, State, Zip

Dear Mr. Doe:

Once again, thank you very much for assisting me in my doctoral dissertation research study. I appreciate you taking the time to fill this out at this busy time. The purpose of my study remains the same. This second survey is needed to assess the reliability of the instrument. To that end you may note some similarity to the first survey.

If you would please return the completed questionnaire in the enclosed, self-addressed, stamped envelope by January 10, 1997. This will aid in finalizing the instrument I will use for my sample.

If you should have any questions regarding the study, feel free to contact me at 630/875-7270.

Your time and assistance are greatly appreciated.

Sincerely yours,

Kent S. Belasco

NORTHERN
ILLINOIS
UNIVERSITY

COLLEGE OF BUSINESS

DEPARTMENT OF
MANAGEMENT

DEKALB ILLINOIS
60115-2854

(815) 753-1124

FAX
(815) 753-6198

February 25, 1997

Dear Mr.

Managers have long been concerned with improving the efficiency and productivity of employees. Over the last 10 to 15 years information technology has been used as a means of addressing this concern. Unfortunately, because efficiency has not improved commensurate with the deployment of information technology this concern persists.

As a doctoral candidate, I am conducting research to learn the perceptions of seasoned managers regarding efficiency, information technology, and scientific management in the workplace. The objective of this academic research study is to understand the relationship between these variables and to identify factors for effective management in the future.

I am asking for your assistance by participating in this research and completing the enclosed survey. Although your participation is completely voluntary your perceptions and valuable experience are critical to the success of the study.

The survey will take approximately 15 to 20 minutes to complete. All information collected will be held in strict confidence and coded to preserve the confidentiality of the respondent.

Please return the completed survey in the enclosed, self-addressed, stamped envelope by March 14, 1997.

If you should have any questions regarding the study, please contact me at 630/875-7270. Should you wish to receive the results of the research, please indicate this on the last page of the completed survey.

Your time and assistance are greatly appreciated.

Sincerely yours,

Kent F. Belasco
Doctoral Candidate

Enclosures

NORTHERN
ILLINOIS
UNIVERSITY

College of Business

Department of
Management

DeKalb, Illinois
60115-2854

(815) 753-1124

FAX
(815) 753-6198

April 21, 1997

Dear Mr.

Recently a survey was mailed to you on the topic of information technology and scientific management use in the workplace, and its effect on corporate efficiency. This survey is part of a doctoral dissertation and therefore the feedback you provide is vital to the success of the research. Since I have not received your response I have taken the liberty of enclosing another survey for your convenience.

Although I know you are very busy, I would appreciate if you would please take the time to complete this short survey. A self-addressed, stamped envelope has been included for return.

Thank you again for your support. If you would like to receive the results of the study please indicate so on the last page of the survey.

Sincerely yours,

Kent S. Belasco
Doctoral Candidate

Enclosures

POSTCARD NOTE - THIRD MAILING

HAVE YOU RETURNED YOUR SURVEY?

Recently you received a survey as part of a doctoral dissertation. Since your comments are vital to the success of this research, I would appreciate if you would take the time to complete this short survey.

If you have already done so, thank you for your time and cooperation.

If you need another copy of the survey, or have questions, please call me at:
630-875-7270

THANK YOU FOR YOUR SUPPORT

Kent S. Belasco
Doctoral Candidate

MANAGING EFFICIENCY AND PRODUCTIVITY WITH INFORMATION TECHNOLOGY

The following survey asks for your perceptions about a number of topics related to information technology, efficiency, productivity, and scientific management.

Please respond to each statement based upon your experience when managing people in your company. Responses should be your perceptions of what exists today in your company, not what you would like to see in your company.

The sections included in the survey ask for your perceptions about managing today. These sections are entitled:

- I Background information
- II Corporate/industry efficiency
- III Factors affecting efficient operations
- IV Methods for improving efficiency/productivity
- V Information technology and efficiency
- VI Scientific management use

The survey will take approximately 15 to 20 minutes to complete.

The responses provided will be instrumental in developing conclusions which may be used to promote a better understanding of how to manage the challenges of information technology more effectively and profitably.

PLEASE READ THE INSTRUCTIONS FOR EACH SECTION CAREFULLY BEFORE RESPONDING

RETURN ALL PAGES OF THE SURVEY (INCLUDING THIS PAGE) IN THE RETURN ENVELOPE

(PLEASE TURN OVER)

SECTION I

BACKGROUND INFORMATION

Please complete the following information by checking the appropriate box or boxes that pertain to you.

1. Department managing (please check):

1. Human resources ☐
2. Finance/accounting ☐
3. Operations ☐
4. Credit ☐
5. Sales ☐
6. Information systems ☐
7. Marketing ☐
8. Production ☐
9. Purchasing ☐
10. Other ☐

2. Position/title (check box that applies):

1. Manager ☐
2. Vice president ☐
3. Assistant vice president ☐
4. Senior vice president ☐
5. Director ☐
6. Supervisor ☐
7. Other ☐

3. Years of management experience (check box that applies)

1. 0 - 3 ☐
2. 4 - 6 ☐
3. 7 - 10 ☐
4. 11 - 15 ☐
5. 15+ ☐

4. Educational background (check highest level):

1. High school diploma ☐
2. Some college (< 3 years) ☐
3. College graduate ☐
4. Graduate degree ☐
5. Post graduate degree ☐

5. Age:

1. Under 20 years ☐
2. 21 - 29 years ☐
3. 30 - 39 years ☐
4. 40 - 49 years ☐
5. 50 - 59 years ☐
6. 60+ years ☐

6. As a rule, I regularly work:

1. Less than 40 hours per week ☐
2. 40 to 45 hours per week ☐
3. 46 to 50 hours per week ☐
4. 51 to 55 hours per week ☐
5. 56 to 60 hours per week ☐
6. More than 60 hours per week ☐

7. On average, my staff employees work:

1. Less than 40 hours per week ☐
2. 40 to 45 hours per week ☐
3. 46 to 50 hours per week ☐
4. 51 to 55 hours per week ☐
5. 56 to 60 hours per week ☐
6. More than 60 hours per week ☐

8. The percent of staff currently assigned and using personal computers (PCs) in my company is approximately:

1. 100% ☐
2. 75 - 99% ☐
3. 50 - 74% ☐
4. 25 - 49% ☐
5. 0 - 24% ☐

9. To what extent do members of your staff understand and use technology available:

1. 0 - 25% ☐
2. 26 - 50% ☐
3. 51 - 75% ☐
4. 76 - 100% ☐

10. To what extent are tasks in your company automated (please check all that apply):

1. Manuals on-line ☐
2. Communications via E-mail ☐
3. Meetings via video conferencing ☐
4. Word processing ☐
5. Document imaging/retrieval ☐

11. Indicate which of the following technologies are used in your company (check all that apply):

1. Local area networks (LANs) ☐
2. Wide area networks (WANs) ☐
3. Data warehouse ☐
4. Internet/intranet ☐
5. Web page for the company ☐

(GO TO NEXT PAGE)

SECTION II

CORPORATE/INDUSTRY EFFICIENCY

Efficiency is a measure of our ability to minimize time and money in the production of a given output. For each statement below, please circle the response that best fits your perception of your company. Your response should one of the following categories:

SA = Strongly agree with the statement
A = Agree with the statement, generally
N = No opinion or neutral
D = Disagree with the statement, generally
SD = Strongly disagree with the statement

#	STATEMENT	RESPONSE				
1	I am concerned about efficiency.	SA	A	N	D	SD
2	Businesses are efficient today.	SA	A	N	D	SD
3	My company operates efficiently today.	SA	A	N	D	SD
4	My industry is generally efficient.	SA	A	N	D	SD
5	The work I do is never complete, even if I worked 24 hours per day.	SA	A	N	D	SD
6	Efficiency is a major problem and concern of my company.	SA	A	N	D	SD
7	I am constantly understaffed, yet both the amount of work and the costs to produce goods and services continue to increase.	SA	A	N	D	SD
8	Staff additions are tightly scrutinized and not easily approved.	SA	A	N	D	SD
9	My department operates at maximum efficiency.	SA	A	N	D	SD
10	My department can easily take on more work without having to increase staff.	SA	A	N	D	SD
11	My department employees work very hard but are always behind.	SA	A	N	D	SD
12	We always have time for meetings, training, and reading trade publications.	SA	A	N	D	SD
13	Decisions are made timely and efficiently in my organization without spending time on unnecessary paperwork.	SA	A	N	D	SD
14	We seldom waste time.	SA	A	N	D	SD
15	Employees in our company use time effectively.	SA	A	N	D	SD
16	We regularly work considerable amounts of overtime.	SA	A	N	D	SD
17	Work processes in our company are flow charted and analyzed regularly.	SA	A	N	D	SD
18	Standards of performance are used in my company.	SA	A	N	D	SD
19	Employees in our company know exactly what is expected of them.	SA	A	N	D	SD
20	Our company has developed programs and assigned staff to evaluate and improve our level of productivity and efficiency.	SA	A	N	D	SD

(PLEASE TURN OVER)

SECTION III

FACTORS AFFECTING EFFICIENT OPERATIONS

For each item below please circle the number which best fits how you believe the factor affects the efficiency of your company. Responses will range from very negative to very positive in the scale below:

5 = Very negatively
4 = Negatively
3 = No impact
2 = Positively
1 = Very positively

#	FACTOR	RESPONSE				
1	Meetings	5	4	3	2	1
2	Planning process	5	4	3	2	1
3	Standards	5	4	3	2	1
4	Management training programs	5	4	3	2	1
5	Staff training	5	4	3	2	1
6	Management styles	5	4	3	2	1
7	Work tools	5	4	3	2	1
8	Technology	5	4	3	2	1
9	Management quality	5	4	3	2	1
10	Incentives	5	4	3	2	1
11	Communication	5	4	3	2	1
12	Manuals/documentation	5	4	3	2	1
13	Work process	5	4	3	2	1
14	Staff selection	5	4	3	2	1
15	Office furniture	5	4	3	2	1
16	Policies/procedures	5	4	3	2	1
17	Office layout	5	4	3	2	1
18	Amount of technology available	5	4	3	2	1
19	Software changes/updates	5	4	3	2	1
20	Organization structure	5	4	3	2	1
21	Staff caliber	5	4	3	2	1
22	Paper volume and accumulation	5	4	3	2	1
23	Customers	5	4	3	2	1
24	Work environment	5	4	3	2	1
25	Budget (financial)	5	4	3	2	1
26	Management/staff turnover	5	4	3	2	1
27	Business growth	5	4	3	2	1
28	Compliance requirements	5	4	3	2	1
29	Audits/examinations	5	4	3	2	1
30	Management experience	5	4	3	2	1

(GO TO NEXT PAGE)

SECTION IV

METHODS FOR IMPROVING EFFICIENCY/PRODUCTIVITY

Many methods are used to improve efficiency. The following chart lists a number of common methods. For each method circle the response which best fits the degree of frequency with which the method is used in your company to improve efficiency. The responses should be one of five categories:

5 = Always
4 = Most of the time
3 = Sometimes
2 = Seldom
1 = Never

#	METHOD	RESPONSE				
1	Increase feedback to staff	5	4	3	2	1
2	Provide training to the users	5	4	3	2	1
3	Automate tasks	5	4	3	2	1
4	Develop plans	5	4	3	2	1
5	Implement piece rate	5	4	3	2	1
6	Initiate micro-management of work processes	5	4	3	2	1
7	Ask people who do the work	5	4	3	2	1
8	Perform time studies	5	4	3	2	1
9	Flowchart and analyze work processes	5	4	3	2	1
10	Do it yourself	5	4	3	2	1
11	Hire new people	5	4	3	2	1
12	Reduce staff	5	4	3	2	1
13	Use motivational techniques	5	4	3	2	1
14	Hire a consultant/outside help	5	4	3	2	1
15	Establish standards	5	4	3	2	1
16	Use task force/focus groups	5	4	3	2	1
17	Train managers	5	4	3	2	1
18	Reduce spending (budget)	5	4	3	2	1
19	Use performance goals	5	4	3	2	1
20	Freeze hiring	5	4	3	2	1

(PLEASE TURN OVER)

SECTION V

INFORMATION TECHNOLOGY AND EFFICIENCY

For each statement below, please circle the response which best fits how your company reacts with regard to information technology utilization. Please circle the letter(s) that corresponds to the category you select:

SA = Strongly agree with the statement
A = Agree with the statement, generally
N = No opinion or neutral
D = Disagree with the statement, generally
SD = Strongly disagree with the statement

#	STATEMENT	RESPONSE				
1	When new technology is purchased, more time is available for other duties.	SA	A	N	D	SD
2	When new computer technology is purchased, job behaviors and procedures are changed to use and to apply the new technology.	SA	A	N	D	SD
3	Our company adequately trains employees on all new technologies purchased (software/hardware).	SA	A	N	D	SD
4	We keep up with software upgrades and changes.	SA	A	N	D	SD
5	New technology has permitted us to improve our productivity and efficiency.	SA	A	N	D	SD
6	Computerization has not reduced work week hours.	SA	A	N	D	SD
7	Employees use technology available to them to the fullest.	SA	A	N	D	SD
8	Our company, after purchasing new technology, always follows up to ensure that the benefits proposed in the cost justification are actually obtained.	SA	A	N	D	SD
9	The cost of technology is equal to the value created in efficient operations.	SA	A	N	D	SD
10	The purchase and application of information technology has directly reduced our operating expense.	SA	A	N	D	SD
11	The use of technology creates more work.	SA	A	N	D	SD
12	Computer technology is designed to make us more productive.	SA	A	N	D	SD
13	New software makes our jobs easier.	SA	A	N	D	SD
14	We know the purpose of technology and how to use it.	SA	A	N	D	SD
15	Technology creates access to more information which creates more work for us to manage.	SA	A	N	D	SD
16	The additional information we can now access from technology makes us more efficient.	SA	A	N	D	SD
17	We know exactly what to do with the additional information available as a result of new technology.	SA	A	N	D	SD
18	Technology has created more information from which we must make more decisions and choices.	SA	A	N	D	SD
19	Advances in technology meet our business needs.	SA	A	N	D	SD
20	Our business and personal lives have been improved by technology.	SA	A	N	D	SD

(GO TO NEXT PAGE)

SECTION VI

SCIENTIFIC MANAGEMENT USE

Efficiency can be improved or maintained through managing the work process. For each of the statements listed below, please circle the response that best describes how your company would react. Circle the letter(s) that correspond, to the categories you select.

SA = Strongly agree with the statement
A = Agree with the statement, generally
N = No opinion or neutral
D = Disagree with the statement, generally
SD = Strongly disagree with the statement

#	STATEMENT	RESPONSE				
1	When a new work process is begun, we flow chart the process, analyzing each step to determine the best work flow.	SA	A	N	D	SD
2	When new staff are hired, they are immediately trained in all aspects of the job to achieve desired goals.	SA	A	N	D	SD
3	New staff at our company are carefully screened and observed prior to hiring.	SA	A	N	D	SD
4	Our company has very clearly defined job descriptions for each position.	SA	A	N	D	SD
5	Managers in our company work closely with employees to set daily and weekly goals, as well as to determine how to accomplish their goals.	SA	A	N	D	SD
6	Systems are developed to ensure that all employees perform tasks, for the same positions, in the same way.	SA	A	N	D	SD
7	Management accepts responsibility for ensuring that employees perform work functions at standard levels.	SA	A	N	D	SD
8	Managers are always trained first whenever a new system or process is placed under their control.	SA	A	N	D	SD
9	Jobs that are performed poorly are the result of inadequate employees.	SA	A	N	D	SD
10	New work processes are carefully analyzed, tested, and documented prior to putting them into production.	SA	A	N	D	SD
11	Our company and managers carefully evaluate and select individuals who are best suited to perform the tasks at hand.	SA	A	N	D	SD
12	Management accepts equal responsibility for employee work problems.	SA	A	N	D	SD
13	The work to be done by a manager is clearly differentiated from work to be done by non-managers.	SA	A	N	D	SD
14	Staff training is planned in advance by managers for workers according to the skills needed for the job.	SA	A	N	D	SD
15	We actively plan to ensure that managers perform the work they are best suited for and for non-managers to perform the work they are best suited for.	SA	A	N	D	SD

(PLEASE TURN OVER)

**THANK YOU VERY MUCH FOR COMPLETING THIS SURVEY.
YOUR COOPERATION IS INSTRUMENTAL IN THE SUCCESS THIS
OF STUDY**

If you are interested in the results of the study, please provide your name and address in the space below. A copy of the results will be forwarded to you after the study has been completed.

NAME: ______________________________

ADDRESS: ______________________________

____

Kent S. Belasco
138 West Glen Road
Hawthorn Woods, Illinois 60047
630-875-7270

APPENDIX B

CODING CONVENTIONS

CODING CONVENTIONS

Primary Research

Section I

Industry/subject

A five digit subject code. The first digit indicates the industry (1 through 5) and the last three digits indicate the sequential subject number for the respondent. Industry codes are as follows:

1 = Finance
2 = Health Services
3 = Business Services
4 = Retail Trade
5 = Manufacturing

Gender

1 = Male
2 = Female

Midwest

1 = Company is from the midwest (Illinois, Wisconsin, Indiana, Michigan, Missouri, Iowa, and Minnesota)

2 = Company is not from the midwest, defined as above.

Department managing

1 = Human resources
2 = Finance and accounting
3 = Operations
4 = Credit
5 = Sales
6 = Information Systems
7 = Marketing
8 = Production
9 = Purchasing
10 = Other

Position/title

1 = Manager
2 = Vice President
3 = Assistant Vice President
4 = Senior Vice President
5 = Director
6 = Supervisor
7 = Other

Years of experience

1 = 0 to 3 years
2 = 4 to 6 years
3 = 7 to 10 years
4 = 11 to 15 years
5 = 15 plus years

Educational level

1 = High school diploma
2 = Some college (< 3 years)
3 = College graduate
4 = Graduate degree - MBA
5 = Post graduate degree

Chronological age

1 = Under 20 years of age
2 = 21 to 29 years
3 = 30 to 39 years
4 = 40 to 49 years
5 = 50 to 59 years
6 = 60+ years

Working hours - Managers

1 = Less than 40 hours per week
2 = 40 to 45 hours per week
3 = 46 to 50 hours per week
4 = 51 to 55 hours per week
5 = 56 to 60 hours per week
6 = More than 60 hours per week

Working hours - Staff

1 = Less than 40 hours per week
2 = 40 to 45 hours per week
3 = 46 to 50 hours per week
4 = 51 to 55 hours per week
5 = 56 to 60 hours per week
6 = More than 60 hours per week

Percent of staff assigned/using PCs

1 = 100%
2 = 75 - 99%
3 = 50 - 74%
4 = 25 - 49%
5 = 0 - 24%

Understanding and use of technology

1 = 0 - 25%
2 = 26 - 50%
3 = 51 - 75%
4 = 76 - 100%

Tasks automated

1 = 0 - 1 task automated
2 = 2 tasks automated
3 = 3 tasks automated
4 = 4 tasks automated
5 = 5 tasks automated

Technologies used

1 = 0 - 1 task used
2 = 2 tasks used
3 = 3 tasks used
4 = 4 tasks used
5 = 5 tasks used

Section II

Research question #1

An average of responses to statements 1, 2, 3, 4, 5, 6, 8 and 20 was calculated. The average calculation was based upon the points indicated below. The scoring key by number is also included:

5 = Strongly agree
4 = Agree
3 = Neutral
2 = Disagree
1 = Strongly disagree

The actual scoring key due to reversals of positive/negative was as follows:

STATEMENT	SA		SD
1	5	-	1
2	1	-	5
3	1	-	5
4	1	-	5
5	5	-	1
6	5	-	1
8	5	-	1
20	5	-	1

Research question #2

An average of responses to statements 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19 was calculated. The average calculation was based upon the points indicated below:

5 = Strongly agree
4 = Agree
3 = Neutral
2 = Disagree
1 = Strongly disagree

The actual scoring key due to reversals of positive/negative is as follows:

STATEMENT	SA		SD
7	1	-	5
9	5	-	1
10	5	-	1
11	1	-	5
12	5	-	1
13	5	-	1
14	5	-	1
15	5	-	1
16	1	-	5
17	5	-	1
18	5	-	1
19	5	-	1

Section III

Research question #3

An average of responses to each item was calculated. The average calculation for each was based upon the points indicated below:

5 = Very Negatively
4 = Negatively
3 = No impact
2 = Positively
1 = Very Positively

Section IV

Research question #4

An average of responses to each item was calculated. The average calculation for each was based upon the points indicated below:

5 = Always
4 = Most of the time
3 = Sometimes
2 = Seldom
1 = Never

Section V

Research question #5

An average of responses was calculated. Only statements 1 - 10 were included in the average for this question/sub-problem. The average calculation was based upon the points indicated below:

5 = Strongly agree
4 = Agree
3 = Neutral
2 = Disagree
1 = Strongly disagree

The scoring key for actual numbers, due to reversals was as follows:

STATEMENT	SA		SD
1	5	-	1
2	5	-	1
3	5	-	1
4	5	-	1
5	5	-	1
6	1	-	5
7	5	-	1
8	5	-	1
9	5	-	1
10	5	-	1

Research question #6

An average of responses was calculated. Averages are calculated only for the total respondent group, by statement, not as a composite. Statements 11 - 20 were evaluated individually for this question/sub-problem. The average calculations for each statement were based upon the points indicated below:

5 = Strongly agree
4 = Agree
3 = Neutral
2 = Disagree
1 = Strongly disagree

Section VI

Research question #7

An average of response was calculated pertaining to each principle of scientific management (i.e. 1, 2, 3, and 4). The average was determined based upon the point indicated below:

5 = Strongly agree
4 = Agree
3 = Neutral
2 = Disagree
1 = Strongly disagree

The questions which pertain to each principle, as identified and arrayed on the worksheet, were as follows:

PRINCIPLE	QUESTION NUMBERS TO BE AVERAGED
1	1, 4, 6, and 10
2	2, 3, 11, and 14
3	7, 8, and 9
4	5, 12, 13, and 15

The actual scores based upon reversals were as follows:

STATEMENT	SA		SD
1	5	-	1
4	5	-	1
6	5	-	1
10	5	-	1

STATEMENT	SA		SD
2	5	-	1
3	5	-	1
11	5	-	1
14	5	-	1

STATEMENT	SA		SD
7	5	-	1
8	5	-	1
9	1	-	5

STATEMENT	SA		SD
5	5	-	1
12	5	-	1
13	5	-	1
15	5	-	1

Secondary Research

Efficiency ratio

Operating expense and operating income were used for each subject for each of the last, or most recent three years. The ratio of these two items produced the efficiency ratio as shown in Appendix F.

The efficiency ratio was calculated using the following formula:

(Average non-interest expense)/(Net interest income + non-interest income)

or

(Average general and administrative expenses)/(Average revenue - cost of goods sold)

Information technology use (level)

A calculation was required to arrive at the level of use of information technology. This was based upon a profile of information technology application in the company. The following outlines the scoring key, based on points, to arrive at the level of information technology use.

Ratio of staff use of PCs

1	100%	=	50 points
2	77 - 99%	=	40 points
3	50 - 74%	=	30 points
4	25 - 49%	=	20 points
5	0 - 24%	=	10 points

Use and understanding of technology

1	0 - 25%	=	20 points
2	26 - 50%	=	30 points
3	51 - 75%	=	40 points
4	76 - 100%	=	50 points

Percent of tasks automated

1 task	=	10 points
2 tasks	=	20 points
3 tasks	=	30 points
4 tasks	=	40 points
5 tasks	=	50 points

Technologies used

1 technology	=	10 points
2 technologies	=	20 points
3 technologies	=	30 points
4 technologies	=	40 points
5 technologies	=	50 points

Index

136 - 200 points	=	High I.T. use
68 - 135 points	=	Moderate I.T. use
0 - 67 points	=	Low I.T. use

Data Roster

Industry code

Each subject number was recorded on this document, as previously defined.

Treatment number

Based upon the specific procedures in the methodology section of this research study, each subject was coded with a specific treatment (independent variable) code. This was determined from the procedures and indicates what the level of usage of the two independent variables and industry code was for each subject. Three numbers were recorded in this column to correspond with the following:

1 = Uses scientific management principles
2 = Does not use scientific management principles

1 = High information technology use
2 = Moderate information technology use
3 = Low information technology use

1 = Financial services industry
2 = Health services industry
3 = Business services
4 = Retail trade
5 = Manufacturing

Efficiency ratio

The efficiency ratio was taken from Appendix F and recorded in this column to correspond with the subject code.

This worksheet forms the basis for the information that was used in the ANOVA.

APPENDIX C

PILOT STUDY WORKSHEETS

CONVERSION KEY FOR PILOT RELIABILITY

A. INSTRUMENT SECTION CONVERSION

ORIGINAL SECTION PILOT #1	CONVERTED TO IN PILOT #2
I	III
II	IV
III	II
IV	V
V	I

B. INSTRUMENT STATEMENT/QUESTION CONVERSION

ORIGINAL /PILOT #1 STATEMENT/ QUESTION #	STATEMENT # CONVERTED TO IN PILOT #2				
	SECTION I	SECTION II	SECTION III	SECTION IV	SECTION V
1	10	7	13	6	11
2	4	11	11	10	8
3	15	13	7	8	12
4	13	1	4	1	9
5	17	9	1	11	3
6	20	18	15	4	1
7	16	22	14	2	5
8	19	15	9	3	10
9	1	3	2	5	6
10	2	2	5	7	2
11	12	10	6	9	7
12	8	6	8		4
13	3	16	10		
14	5	20	12		
15	11	19	3		
16	9	8			
17	7	5			
18	18	4			
19	14	14			
20	6	17			
21		12			
22		21			
23					
24					
25					

PILOT SURVEY RELIABILITY EVALUATION FORM

ORIGINAL STATEMENT/ QUESTION #	% ANSWERED THE SAME, PILOT #1 TO PILOT #2				
	SECTION II	SECTION III	SECTION IV	SECTION V	SECTION VI
1	67%	33%	67%	50%	67%
2	83%	50%	67%	67%	50%
3	50%	67%	50%	67%	50%
4	83%	50%	100%	100%	50%
5	83%	67%	50%	83%	83%
6	50%	50%	33%	33%	50%
7	67%	33%	67%	67%	67%
8	83%	50%	67%	33%	50%
9	33%	83%	67%	50%	83%
10	83%	67%	33%	67%	67%
11	33%	67%	33%	67%	100%
12	67%	50%	33%		83%
13	50%	33%	67%		
14	33%	67%	33%		
15	50%	67%	83%		
16	50%	83%			
17	50%	50%			
18	100%	33%			
19	83%	67%			
20	50%	67%			
21		83%			
22		50%			
23					
24					
AVERAGE	63%	57%	57%	63%	67%

APPENDIX D

DATA ROSTER

DATA ROSTER

INDSTY. CODE	TREATMENT			EFFY.	INDSTY. CODE	TREATMENT			EFFY.	INDSTY. CODE	TREATMENT			EFFY.
	SMuse	IT Use	Indsty.	%		SMuse	IT Use	Indsty.	%		SMuse	IT Use	Indsty.	%
1005	2	3	1	61.92%	1142	2	1	1	75.68%	2062	2	2	2	
1006	1	1	1	56.87%	1147	2	1	1	79.34%	2066	1	1	2	78.52%
1007	2	1	1		1153	2	2	1		2080	2	1	2	
1011	1	1	1	39.77%	1157	2	1	1	105.72%	3007	2	1	3	87.06%
1030	1	2	1		1159	1	1	1	84.40%	3013	2	1	3	78.19%
1045	1	2	1	85.47%	1160	2	1	1	76.31%	3016	1	2	3	95.43%
1066	1	1	1	58.37%	1162	1	1	1		3017	2	1	3	92.03%
1068	2	1	1	61.63%	1166	2	1	1	67.23%	3020	2	1	3	71.68%
1070	1	1	1	84.40%	1172	1	2	1		3036	2	3	3	
1073	2	2	1	70.29%	1173	1	2	1		3039	2	1	3	102.44%
1074	2	2	1	53.90%	1181	2	2	1	63.91%	3045	1	1	3	
1076	1	1	1		2000	1	1	2		3047	2	1	3	
1078	2	1	1		2007	2	2	2		3053	1	1	3	82.14%
1079	2	1	1		2014	1	3	2		3055	2	1	3	79.45%
1083	2	2	1	62.44%	2016	1	1	2		3056	1	1	3	78.82%
1086	1	1	1	61.80%	2017	1	1	2		3059	2	1	3	73.81%
1090	1	1	1		2021	1	2	2		3062	2	1	3	
1094	1	2	1	63.36%	2032	2	1	2		3063	2	1	3	112.15%
1102	2	2	1	62.68%	2038	2	2	2		3068	1	2	3	
1104	2	1	1	95.51%	2039	1	2	2		3071	1	1	3	63.18%
1106	2	2	1		2041	2	1	2		3072	2	1	3	85.53%
1112	1	1	1		2042	2	2	2	89.55%	3074	2	1	3	82.72%
1113	2	1	1	53.73%	2046	2	1	2		3076	2	1	3	86.91%
1114	1	1	1	79.78%	2047	2	2	2		3077	1	1	3	78.59%
1123	2	2	1		2049	1	1	2	68.26%	3078	1	1	3	41.31%
1126	2	2	1	91.59%	2053	1	2	2		3081	2	1	3	72.74%
1127	2	2	1	90.84%	2054	1	2	2		3084	2	1	3	
1128	2	1	1	95.13%	2055	1	2	2		3088	2	1	3	
1137	2	2	1		2056	2	2	2		3089	1	1	3	
1139	1	1	1		2059	2	1	2		3097	2	1	3	40.87%

INDSTY. CODE	TREATMENT SMuse	IT Use	Indsty.	EFFY. %	INDSTY. CODE	TREATMENT SMuse	IT Use	Indsty.	EFFY. %	INDSTY. CODE	TREATMENT SMuse	IT Use	Indsty.	EFFY. %
3100	2	3	3	52.61%	5034	1	1	5	49.23%	5136	2	1	5	
3101	1	1	3	162.71%	5036	2	1	5		5139	2	1	5	
3104	1	1	3	84.73%	5040	2	2	5	81.07%	5140	2	1	5	
3105	2	1	3	57.14%	5044	2	2	5		5144	2	2	5	
3118	2	1	3	97.53%	5046	2	2	5	55.08%	5146	2	1	5	77.88%
4000	1	1	4		5049	2	2	5	67.02%	5147	1	1	5	73.64%
4005	2	1	4	74.44%	5051	1	2	5		5149	2	1	5	
4013	1	1	4	62.06%	5055	2	1	5	79.77%	5154	2	2	5	56.65%
4032	1	1	4		5056	2	1	5	23.01%	5164	2	1	5	70.74%
4033	1	2	4	73.28%	5057	1	2	5		5168	2	2	5	
4037	1	2	4	62.26%	5059	2	1	5		5170	2	1	5	
4038	1	1	4	62.81%	5064	2	1	5		5171	2	1	5	70.13%
4041	2	1	4	80.37%	5068	1	3	5	85.25%	5176	1	2	5	
4057	2	1	4	62.39%	5069	2	1	5	57.31%	5185	2	1	5	
4059	2	1	4	87.78%	5070	2	1	5	102.26%	5188	2	1	5	64.03%
4060	1	2	4	87.78%	5073	2	1	5		5189	2	1	5	64.03%
4061	1	1	4		5074	1	1	5		5190	1	1	5	
4065	1	1	4	85.48%	5078	1	1	5	94.13%	5191	2	2	5	
4067	2	3	4		5079	2	1	5	69.61%	5197	2	2	5	
4072	2	1	4	76.98%	5086	1	1	5	61.93%	5198	2	1	5	72.13%
4073	2	2	4	55.70%	5093	1	1	5	62.06%	5205	2	1	5	69.57%
4081	1	1	4		5094	2	2	5	45.08%	5210	2	1	5	75.69%
4086	2	1	4	76.56%	5096	2	1	5		5216	2	1	5	72.66%
4091	2	1	4		5098	1	1	5		5222	2	1	5	
4098	2	1	4		5104	2	1	5	75.28%	5226	2	1	5	22.84%
5001	2	1	5		5113	1	1	5	72.17%	5236	2	2	5	
5005	1	1	5	66.97%	5114	1	2	5		5243	2	2	5	
5017	1	1	5		5119	2	1	5	80.58%	5248	1	1	5	
5028	2	1	5		5123	2	1	5	71.68%	5262	1	2	5	
5032	2	1	5		5129	2	1	5		5263	2	1	5	58.08%

INDSTY. CODE	TREATMENT SMuse	IT Use	Indsty.	EFFY. %
5265	1	2	5	
5266	1	1	5	
5269	2	1	5	
5271	2	1	5	92.03%
5276	1	2	5	
5281	2	1	5	
5284	1	1	5	54.75%
5287	1	2	5	
5293	2	1	5	64.03%
5304	1	2	5	
5305	2	1	5	40.30%
5311	1	1	5	86.40%
5313	1	1	5	54.68%
5315	2	1	5	78.13%
5317	2	1	5	92.04%
5320	2	1	5	72.17%

LEGEND:

Treatment:

Scientific Management Use (SMuse)
- 1 = Uses scientific management
- 2 = Does not use scientific management

Information technology use (IT Use)
- 1 = High information technology use
- 2 = Moderate information technology use
- 3 = Low information technology use

Inudstry (Indsty.)
- 1 = Finance
- 2 = Health Service
- 3 = Business Services
- 4 = Retail Trade
- 5 = Manufacturing