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The Effects Of Self-Directed Teams In An Automotive Manufacturing Environment

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THE EFFECTS OF SELF-DIRECTED TEAMS IN AN AUTOMOTIVE MANUFACTURING ENVIRONMENT

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DEDICATION

This work is dedicated to my family and friends and, especially to my wife Angela, my mother Ann, my father Ken, step-fathers Melio and Charles, my Grandparents, my brothers, sister and my extended family.

- To my wife Angela, without whose love and support, I would not have finished this work. Thank you for enduring my educational indulgence.
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TABLE OF CONTENTS

Dedication ii

Acknowledgements iii

List of Tables vii

List of Figures viii

Chapter 1 The Problem 1

Statement of the Problem 1

Purpose of the Study 2

Research Questions 3

Participating Plant Specifications 4

Ford Motor Company Culture and History 6

Definition of Terms 8

Variables 13

Assumptions 14

Significance of the Study 15

Chapter 2 Review of Related Literature 17

Introduction 17

Ford Production System (Quality / Lean Management Systems) 18

Traditional Management Work Structures 20

Team Concepts and Implementation Methods 24

Leadership & Management Support and Political / Union Implications 32

Education and Training 35

Interdependence and Communication 40

Transfer of Authority / Empowerment / Decision-Making …………………. 42

Conclusion ……………………………………………………………………… 43

Chapter 3 Methodology ……………………………………………………..47

Introduction …………………………………………………………………... 47

Research Design …………………………………………………………….. 47

Hypothesis …………………………………………………………………… 48

Population and Participants ………………………………………………… 49

Data Collection ……………………………………………………………… 51

Cost Data ………………………………………………………………... 54

Morale Data …………………………………………………………… 55

Productivity Data ……………………………………………………….. 57

Quality Data …………………………………………………………….. 58

Safety Data …………………………………………………………… 60

Instrumentation ……………………………………………………………… 61

Data Analysis ……………………………………………………………… 64

Chapter 4 Analysis of the Problem ………………………………………… 66

Introduction …………………………………………………………………... 66

Descriptive Statistics ………………………………………………………… 67

Multivariate Analysis of Covariance ………………………………………….. 69

Test of Moderation …………………………………………………………… 72

Hybrid Structural Equation Model ……………………………………………….. 87

Chapter 5 Discussion, Implications and Recommendations 89

Introduction 89

Research Questions 90

Research Question One 91

Research Question Two 95

Research Question Three 100

Research Question Four 104

Research Question Five 107

Research Question Six 111

Research Question Seven 116

Research Question Eight 119

Research Question Nine 120

Limitations 121

Discussion 122

Implications for Performance Improvement and Instructional Technology.. 130

Recommendations for Further Research 134

Appendix A Letter of Participation from Ford Motor Company 136

Appendix B Human Investigation Committee Survey 137

References 140

Abstract 146

Autobiographical Statement 151

LIST OF TABLES

Table 1: Survey Results: Ranking Enablers of Effective Teamwork…. 30

Table 2: Dependent and Independent Variables………………………. 54

Table 3: Research Model for F-150 Truck Plants ……………………… 62

Table 4: Research Model for V-6 Engine Manufacturing Plants …….. 63

Table 5: Descriptive Statistics of Dependent Performance Variable in Predictor Variable Plants…………………………………….. 68

Table 6: Comparison of Plants in Terms of Listed Outcome Variables Taking Effectiveness as a Covariate …………………………. 69

Table 7: Pair-wise Comparisons of Plants Across the Outcome Variables Using Bonferroni Procedure ………………………. 70

Table 8: Truck Assembly Team Effectiveness Predicating Listed Dependent Variables and Moderation Testing ……………… 73

Table 9: Engine Manufacturing Team Effectiveness Predicating Listed Dependent Variables and Moderation Testing ……… 73

Table 10: Regression Coefficients of the Hybrid Structural Equation Model ……………………………………………………………. 87

Table 11: Statistically Significant Findings Summary ………………… 129

LIST OF FIGURES

Figure 1: Research Design: Observations Over Time 48

Figure 2: Bivariate Scatter Plot for Truck Assembly Plant Work Team Effectiveness and Lost Time Case Rate 74

Figure 3: Bivariate Scatter Plot for Truck Assembly Plant Work Team Effectiveness and Severity Rate 75

Figure 4: Bivariate Scatter Plot for Truck Assembly Plant Work Team Effectiveness and Absenteeism 76

Figure 5: Bivariate Scatter Plot for Truck Assembly Plant Work Team Effectiveness and Productivity 77

Figure 6: Bivariate Scatter Plot for Truck Assembly Plant Work Team Effectiveness and Cost Performance 78

Figure 7: Bivariate Scatter Plot for Truck Assembly Plant Work Team Effectiveness and Customer Satisfaction 79

Figure 8: Bivariate Scatter Plot for Engine Manufacturing Plant Work Team Effectiveness and Lost Time Case Rate 80

Figure 9: Bivariate Scatter Plot for Engine Manufacturing Plant Work Team Effectiveness and Severity Rate 81

Figure 10: Bivariate Scatter Plot for Engine Manufacturing Plant Work Team Effectiveness and Absenteeism 82

Figure 11: Bivariate Scatter Plot for Engine Manufacturing Plant Work Team Effectiveness and Productivity 83

Figure 12: Bivariate Scatter Plot for Engine Manufacturing Plant Work Team Effectiveness and Cost Performance 84

Figure 13: Bivariate Scatter Plot for Engine Manufacturing Plant Work Team Effectiveness and Customer Satisfaction 85

Figure 14: Bivariate Scatter Plot for Engine Manufacturing Plant Work Team Effectiveness and Engine Quality 86

Figure 15: Hybrid Structural Equation Model 88

Figure 16: Human Performance Technology Model 133

CHAPTER 1 STATEMENT OF THE PROBLEM

In competitive economic times, corporations seek to identify and operate under the most efficient means. Many large corporations and businesses currently operate using multiple work structures. Traditionally and predominantly, organizations operate using a supervised work structure. A departmentally supervised manufacturing area is a prime example of this type of work arrangement. An alternative that is growing in all areas of business and education is the self-directed work structure. In this structure, peer co-workers are organized into teams that self-manage daily operations, frequently with the support of a coach or facilitator. Many speculate that self-directed work structures foster improved productivity and quality (Rosenthal, 2001).

The team concept has been utilized for decades, but only has become a popular strategy for many US organizations in the past ten years. Surveys indicate that 68 to 70 percent of Fortune 500 firms are using team strategies, and that the trend is growing (Tata, 2000). Autonomous work teams are being utilized in organizations including, but not limited to Motorola, Xerox, Proctor & Gamble, AT & T, Federal Express, Levi Strauss, General Electric and Ford Motor Company (Tata, 2000).

Work teams, as defined in this study, are groups of individuals with common goals and objectives that are empowered to affect decision-making and problem solving processes with accountability. Many surmise that team structures improve morale by considering the diverse opinions of members (Moseley & Dessinger, 2007). Improved morale may in-turn positively affect absenteeism, injuries on the job and productivity. Moreover, work teams could impact product innovations that meet market demands (Tata, 2000). Some companies now invest equally in technology, production methods and work team implementation to achieve the aforementioned benefits that impact the bottom line.

Purpose of the Study

It takes a considerable amount of time and money to facilitate and implement effective self-directed work structures. The keys to making work group principles work effectively are education, training and communication (Harris, 2009). Work groups are most effective when they have the full picture of what needs to be accomplished and the reasons behind why it needs to be accomplished. When this occurs, team members and leadership are able to align objectives and work together to meet them and take ownership in both the process and results. The latest technology, equipment or material is no substitute for the ability and creativity of satisfied people, successfully and safely working together (Ford Motor Company Communications, 1995). Effective work groups are built around capable, motivated and empowered people who trust and rely on each other (Cicerone, 2009). Work group participants offer a broad knowledge base and diverse experiences to better analyze problems and reach solutions (Liccione, 2009).

This proposed study will compare self-directed work structures to more traditional supervised work structures to determine if the expenditures and efforts required to implement self-directed work teams are warranted. Multiple internal performance metrics will be examined in comparing plant work structures in various degrees of implementation between traditional work structures and self-directed work teams.

Research Questions

The proposed research will address the following questions:

1. Does the presence of effectively rated self-directed work teams affect injury frequency?

2. Does the presence of effectively rated self-directed work teams affect injury severity?

3. Does the presence of effectively rated self-directed work teams affect unexcused absenteeism?

4. Does the presence of effectively rated self-directed work teams affect productivity?

5. Does the presence of effectively rated self-directed work teams affect cost performance?

6. Does the presence of effectively rated self-directed work teams affect external quality and customer satisfaction?

7. Does the presence of effectively rated self-directed work teams affect internal engine manufacturing quality?

8. Are Safety LTR, Safety SV, AWOL, Productivity, and Cost statistically significant predictors of Customer Satisfaction?

9. Are Safety LTR, Safety SV, AWOL, Productivity, and Cost statistically significant predictors of Work Team Effectiveness?

Participating Plant Specifications

Two Ford North American assembly plants and two Ford North American engine manufacturing plants will be researched in this study. 2004 production year extant data will be studied. Both assembly plants built the same Ford F-150 pick-up trucks in this year of production. Likewise, both engine manufacturing plants built the same V-6 engine in 2004.

The first plant to be studied and visited within Ford Vehicle Operations or the assembly division is the Norfolk Assembly Plant in Norfolk, Virginia. The plant opened in 1925 and produced the Model-T, full-sized sedans, station wagons, F-350s, F-250s and F-150 throughout the plant's eight decade production history. During the 2004 production year, the plant employed 2,615 hourly employees and 190 salaried employees. Norfolk Assembly was one of the first plants to launch and embrace the Ford Production System in early 2001.

The second Vehicle Operations plant to be visited for research is the Kansas City Assembly Plant in Claycomo, Missouri. This production complex including two assembly facilities opened in 1951 and, over time built a few families of medium sized cars including the Falcon, Comet, Meteor, Maverick, Fairmont, Zephyr, Tempo, Topaz, Contour and Mystique. The complex also produced light trucks, flair side trucks and the Lincoln Blackwood truck on its way to producing the Ford Escape and F150 in separate assembly plants in 2004. During the 2004 production year the plants employed 5,163 hourly employees and 309 salaried employees combined. Kansas City Assembly implemented the Ford Productions System a year later than the Norfolk Assembly Plant.

The Lima Engine Plant is the first of the engine manufacturing plant within Ford Powertrain Operations to be researched and visited. This manufacturing plant is located in Lima, OH and opened in 1957. Since that time the plant produced numerous engines and engine components. In 2004 the plant assembled 3.0 liter V-6 engines, 3.9 liter V-8 engines and produced the D-30 crankshaft and D-30 engine heads. During the 2004 production year the plant employed 1,015 hourly employees and 165 salaried employees. Lima engine launched and embraced the Ford Production System 2002.

The second Powertrain Operations engine manufacturing facility to be researched and visited is Cleveland Engine Plant II. The plant is situated in the Cleveland Powertrain Production Complex located in Brook Park, OH. In 2004 the production complex included Cleveland Casting Plant, a ferrous casting plant, an Aluminum Casting Plant, Cleveland Engine Plant I and Cleveland Engine II. Many engines and engine components were produced throughout the Cleveland Powertrain Complex to support the plants within the complex and power Ford automobiles throughout the world. The Cleveland Engine Plant II opened in 1955. It was the second engine manufacturing facility on the site. In 2004 Cleveland Engine Plant II assembled 3.0 liter V-6 engines, 2.49 liter Duratec engines, 2.0 liter engines and produce engine components. The plant employed 1,041 hourly employees and 143 salaried employees during the production period to be researched. The Cleveland Powertrain Complex including Engine II launched the Ford Production System approximately nine months later than Lima Engine Plant.

Ford Motor Company Culture and History

Henry Ford entered the automotive industry in 1903 with the production of the Model A. The car was designed to provide basic, practical transportation with a rear seating compartment as its only option. Ford advertising stressed strong materials, an efficient engine and most importantly, sound workmanship (Brinkley, 2003). The production system and processes were relatively simple. The daily production goal was fifteen cars per day. Subassemblies and purchased parts were delivered to the factory where they were tested, adjusted and assembled four cars at a time. In Ford's second year of production, the Model A was replaced with three new automobiles and operations began to expand with contributions coming from around the globe.

Ford Motor Company's second auto platform was the model T which was designed for manufacturing. Parts were standardized for interchangeability and designed for easy assembly. Product and part designs were simplified wherever possible to enable more production and quicker movement to more customers with better quality (Brinkley, 2003). As an example, the four cylinder engine block was cast in a single piece for the first time.

Henry Ford developed the moving assembly line and greatly increased productivity through the process. The Rouge Manufacturing Complex located in Dearborn, Michigan became the global benchmark for all manufacturing companies in the 1920's. The best in class manufacturing processes included just-in-time delivery and just-in-time manufacturing. The entire complex was designed to eliminate waste and maximize efficiency (Brinkley, 2003).The Rouge model was replicated by Ford twice in Dagenham, England and Cologne, Germany. The model was later replicated by Toyota in Japan for the creation of Toyota City.

Throughout Henry Ford's work life, he strived for efficiency using the best methods known at the time. Even well after Henry's life ended, his passionate pursuit for efficiency was continued by Ford Motor Company and his heirs (Ford Motor Company Communications, 1995). However, as Ford grew and diversified their continuous improvement efforts narrowed somewhat into organizational or functional initiatives. While each organization, such as Product Engineering, Manufacturing and Marketing and Sales, achieved specific improvement breakthroughs using the best methods known, none were integrated throughout the company. For example, Product development started an innovative styling design revolution with the "aero look" in the early 1980's. In Manufacturing, quality became "Job One" in the late 1970's at Ford and in suppliers' plants around the globe. Ford Marketing and Sales turned their focus toward customer satisfaction and established standards regarding the customer sales experience and aftermarket sales and service. As a final example and a beginning to the team concept at Ford, Human Resources and the United Auto Workers began working together to develop Employee Involvement and Participative Management programs to drive a new culture that recognized team principles and valued individuals and their contribution to the success of the team and Ford Motor Company. All of these efforts ultimately contributed to the vision and implementation of the Ford 2000 Continuous Improvement Plan (Ford Motor Company Communications, 1995).

The overriding goal of Ford 2000 was to be the leading automotive company in the world (Ford Motor Company Communications, 1995). To do so, the following goals were established: 1, be the best in quality, 2, be the low cost producer, 3, be the first to market with vehicles that exceed customer expectations and 4, be the best with regard to customer satisfaction. Ford recognized the need to return to the comprehensive continuous improvement model employed by Henry Ford when the company was in its infancy. Regional, functional or product related chimneys within Ford Motor Company could no longer preclude positive progress throughout the corporation. The Ford Production System (FPS) was the keystone of their comprehensive improvement plan.

Definition of Terms

An understanding of general and automotive industry specific terms is helpful in the review of this literature. Measurables used in the auto industry will be defined in subgroups of cost metrics, morale metrics, productivity metrics quality metrics and safety or injury experience metrics.

Lean Manufacturing is a systematic approach to identifying and eliminating waste through continuous improvement by flowing the product at the demand of the customer (Chilson, 2002).

Self-Directed Work Structure Teams are groups of accountable individuals with common goals that are empowered to affect decision-making and problem solving processes related to operational objectives (Ford Motor Company Communications, 1995).

Supervised Work Structure Departments can be described as individuals directed by management to achieve operational objectives (Brinkley, 2003).

Unexcused Absenteeism is defined as absence without leave (AWOL) or unscheduled absence without prior approval (UAW and the Ford Motor Company, 2003).

***Cost Metrics*:**

Harbour Hours per Vehicle (HPV) is an assembly plant internal metric used to gauge the number of man-hours required to assemble a vehicle versus a time study (i.e., predetermined hours per vehicle target). The measure is calculated and reported as a performance rate of actual hours required versus target hours (Harbour, 2005).

Harbour Hours per Unit (HPU) is an engine manufacturing plant internal metric used to gauge the number of man-hours required to assemble an engine versus a time study (i.e., predetermined hours per engine target). The measure is calculated and reported as a performance rate of actual hours required versus target hours (Harbour, 2005).

Labor & Overhead is an engine manufacturing plant internal metric used to gauge labor and overhead cost management against monthly budget targets. Budget performance is measured and reported in +/- U.S. dollars ($ mils) above or below the planned expenditure (Ford Motor Company Communications, 1995).

Variance to Target is an assembly plant internal metric used to gauge plant responsible four-wall cost management against monthly budget targets. Budget performance is measured and reported in +/- U.S. dollars ($ mils) above or below the planned expenditure (Ford Motor Company Communications, 1995).

Morale Metrics:

AWOL Rate is an absence rate calculated and reported as a percentage of total controllable plant absences. AWOL metrics are recorded and calculated in the same manner in assembly plants and engine manufacturing plants (Ford Motor Company Communications, 1995).

Work Group Effectiveness is a work team effectiveness rating calculated within each plant as a percentage of all teams within the plant. Each self-directed work team rated themselves against benchmarks on a pre-determined scorecard to ascertain their level of effectiveness. Work group effectiveness metrics are recorded and calculated in the same manner in assembly plants and engine manufacturing plants (Ford Motor Company Communications, 1995).

Productivity Metrics:

Production Schedule Gains or Misses is an engine manufacturing plant internal metric used to measure loss or overproduction against a monthly engine output schedule. The measure is reported in +/- engines (000) produced above or below the planned output schedule (Ford Motor Company Communications, 1995).

Production to Schedule is an assembly plant internal metric used to gauge loss or over production against the monthly vehicle output schedule. The measure is reported in +/- percentage above or below the planned output schedule (Ford Motor Company Communications, 1995).

***Quality Metrics*:**

3 Months In Service (MIS) Warranty is a vehicle assembly quality metric designed to gauge customer experience with regard to defects encountered in the first three months in service. Monthly claims were compiled and calculated as a performance rate of warranty claims reported at dealerships within 3 MIS versus an anticipated and predetermined warranty claims target (Ford Motor Company Communications, 1995).

Engine Cost per Unit (CPU) @ 3 MIS is an engine plant specific manufacturing quality metric designed to gauge the average external cost of repairs experienced at dealerships after consumer sales within the first three months in service versus an anticipated and predetermined engine warranty claim cost target. The measure is calculated and reported as a performance rate of actual engine repair cost versus repair cost target (Ford Motor Company Communications, 1995).

Engine R/1,000 @ 3 MIS is an engine plant specific manufacturing quality metric designed to capture the number of repairs required per 1,000 engines produced within the first three months in service versus an anticipated and predetermined engine repair target. The measure is calculated and reported as a performance rate of actual engine repairs versus repair target (Ford Motor Company Communications, 1995).

Parts Per Million (PPM) @ Customer is an engine plant specific manufacturing quality metric designed to capture the number of engine defects PPM received at vehicle assembly plants. The measure is calculated and reported as a performance rate of defect PPM reported by assembly plants versus a defect containment target (Ford Motor Company Communications, 1995).

Things Gone Wrong (TGW) @ 3 MIS is a vehicle assembly quality metric designed to gauge customer satisfaction with regard to vehicle performance within the first three months in service (MIS). Monthly customer complaints were compiled and calculated as a performance rate of TGWs reported at dealerships within 3 MIS versus an anticipated and predetermined TGW target (Ford Motor Company Communications, 1995).

Warranty Cost Per Unit is a vehicle assembly quality metric designed to gauge the average external cost of repairs experienced at dealerships after consumer sales within the first three months in service versus an anticipated and predetermined vehicle warranty claim cost target. The measure is calculated and reported as a performance rate of actual vehicle repair cost versus repair cost target (Ford Motor Company Communications, 1995).

***Safety Experience Metrics*:**

First Time Occupational Visit (FTOV) Rate is an injury or illness experience rate calculated for each criterion group. FTOV is a Ford internal metric that captures employees' initial visit for medical attention. FTOV metrics are recorded and calculated in the same manner in assembly plants and engine manufacturing plants (Occupational Health and Safety Administration, 2009).

Lost Time Case Rate (LTR) is an injury or illness experience rate of Lost Time Cases (LTR) calculated for each criterion group. LTR recording and reporting is regulated by the Occupational Safety & Health Administration (OSHA). OSHA LTR's account for work-related injuries and illnesses that require employees to miss work. LTR metrics are recorded and calculated for all employers in the United States with 10 or more employees. This metric is recorded and calculated in the same manner in assembly plants and engine manufacturing plants (Occupational Health and Safety Administration, 2009).

Severity Rate (SR) is an Injury / illness experience rate regarding injury severity calculated for each criterion group. Severity Rate (SR) reporting is regulated by the Occupational Safety & Health Administration (OSHA). OSHA SR's account for the severity of work-related injuries and illnesses by capturing the number of deaths and lost workdays experienced for each incident. Like the LTR rate, this metric is pertinent to all US employers with 10 or more employees. SR metrics are recorded and calculated in the same manner in assembly plants and engine manufacturing plants (Occupational Health and Safety Administration, 2009).

Variables

Five areas of performance will be examined using seven separate dependent variable metrics in different work structure environments. The first independent variable work structure involves self-directed work teams in a truck assembly plant and an engine manufacturing plant that rate themselves as effective work teams. The second independent work structure involves a different truck assembly and different engine manufacturing plants that rate themselves ineffective regarding team work and follow a more traditional supervised work structure.

The seven dependent variable metrics will explore performance in the areas of safety, quality, productivity, cost and employee morale. Two separate safety metrics will be used to study injury frequency and severity. The independent and dependent variables will be examined in more detail and graphically in Chapter 3 and Table 2 respectively.

Assumptions

Five significant assumptions will be made regarding the populations and operations within each engine manufacturing and truck assembly plant. First, the demographics of employees within the four plants shall be assumed to be a reflection of their local community population in terms of age, gender, race and sexual orientation as defined by Ford hiring practices, the Equal Employment Opportunity Commission and Affirmative Action directives. Standard hiring practices are followed by all Ford facilities, although admittedly local politics and nepotism may influence some hires and job placements. Second, basic and operational training that employees receive shall be assumed equal throughout all plants since the training programs are developed and delivered based on Ford corporate training guidelines and operational division guidelines. Third, the assembly processes in both Ford F-150 truck assembly plants shall be assumed to be similar based on like products built at sister plants. Likewise, the manufacturing processes in both Ford V-6 engine plants shall be assumed to be similar based on like products built at sister plants. Fourth, supplied parts and sub-assembly quality shall be assumed to be of similar quality based on like products being supplied from the same original equipment manufacturers (OEMs) to each of the sister plants. Fifth and finally, self-directed work structure effectiveness ratings and performance metrics relative to cost, morale, productivity, quality and safety reported by Ford Motor Company are presumed to be accurate and valid.

Significance of the Study

The findings from this study including performance metrics and customer impact data will provide useful considerations for organizations when establishing or re-instituting work structures within business or educational institutions. Successfully managing customer satisfaction is essential for the long-term growth of a company (Cicerone, 2009). By comparing the performance metrics and customer satisfaction data between like plants with separate and different work structures, this study will isolate the impact that work structures have on safety, cost, productivity, quality and employee morale. This research study will support or fail to support the time, effort and financial venture that go into facilitating effective self-directed work teams in lieu of traditional work structures. The statistical analysis may also provide some indication of whether or not the total outlay involved in self-directed teams may yield a justifiable return on investment (ROI). The use of ROI methodology to demonstrate the value of performance improvement projects has spread over the past decade. Some perceive ROI as inappropriate for human performance improvement, while others see it as the ticket to additional funding and executive support (Phillips & Phillips, 2008).

Human performance technology (HPT) or human performance improvement (HPI) practitioners may find this research and statistical data of particular interest when selecting and designing interventions intended to bring about positive cultural change. The utilization of multiple performance metrics that examine relevant financial and customer satisfaction data may help HPI practitioners in formulating and justifying organizational design and development interventions in the workplace or in educational institutions.

This first chapter has introduced the topic and stated the problem or opportunity to be addressed in the study. The purpose of the study was proposed and the research questions to be answered were outlined. The assembly and manufacturing plant participants were introduced and, pertinent terms were defined to frame the context of the study. The dependent and independent variables were classified and the assumptions of the study were disclosed. Finally, suggestions were made regarding the significance of the study relative to industry, educational settings and for the practice of human performance improvement.

We turn now to a review of the literature which supports the body of this study.

CHAPTER 2 LITERATURE REVIEW

Introduction

To achieve operational excellence in the manufacturing industry, companies are shifting their investments upstream to improve product creation and process innovations through team based work structures (Messmer, 2001). The payoff downstream is expected through quality attainment and cost efficiency in every step of production throughout the automotive supply chain that ultimately delivers value to auto owners. Sustained success in an increasingly competitive global market requires a company's management team to shift from being product or service driven to being customer driven (Cicerone, Sassaman & Swinney, 2007). Harnessing employee involvement from a diverse workforce to solve problems and improve products is an initial step toward connecting with customers and end-users.

Establishing or re-instituting a work structure within an organization is a complex undertaking. Organizational structure can be the foundation upon which companies aspire to greatness or a downward spiral leading to extinction. Strategic plans and performance objectives define the desired results to be achieved, but selecting a suitable set of performance technologies including an appropriate work structure for an organization requires more than just knowing the intended benefits (Watkins, 2007). Traditional management work structures and alternative self-directed work structures will be examined in this literature review. Critical implementation elements and potential pitfalls in developing self-directed work structures will also be investigated in this review.

The key variables of this study are related to Ford Motor Company Culture and History, Ford Production System (Lean Engineering and Quality Management System), Team Concepts and Implementation Methods, Leadership & Management Support and Political or Union Implications, Education and Training, Interdependence and Communication, the Transfer of Authority, Empowerment and Decision-Making. An understanding of these subjects is essential to appreciate the context of the environment and the interrelationship of the variables that may facilitate the implementation and utilization of effective self-directed work teams. The following is a review of the literature related to each topic.

Ford Production System (Lean Engineering & Quality Management System)

The Ford Production System (FPS) is a continuation of Henry Ford's vision by driving efficiency and eliminating waste in all aspects of Ford Motor Company's business (Ford Motor Company Communications, 1995). With the implementation of Ford 2000 and FPS, Ford made the conscious decision to cease operating as a collection of independent companies and advance the corporation as a whole. In short, FPS required the elimination of duplicate effort and the achievement of greater investment efficiency. FPS looked to integrate all company functions and processes into a smooth running system that provided the best value to customers and the Company.

As more automotive companies compete for global market share, quality production and cost efficiency are minimum prerequisites to contend. The purpose of FPS was to establish and implement best practices in the methods that Ford uses to engineer, manufacture and work with people, materials and equipment to produce products as an order-to-delivery product per the specifications of the customer in a timely manner.

The Ford Production System vision was to have a lean, flexible and disciplined common production system that is defined by a set of principles and processes that employs groups of capable and empowered people who are learning and working safely together to produce and deliver products that consistently exceed customer expectations in quality, cost and time (Ford Motor Company Communications, 1995). Successful companies manage customer satisfaction. However, management processes are seldom subjected to process improvement. FPS takes the management process into consideration. It is just as important to improve the process of management as it is to improve the processes used create products and deliver services (Cicerone, 2009).

FPS is Ford's version of a total quality management (TQM) and value engineering system designed to improve quality and efficiency. TQM and lean or value engineering interventions focus on the economical production of high quality goods using minimal resources. It includes doing things right the first time, striving for continuous improvement, and addressing customer needs and ultimately customer satisfaction (Van Tiem, Moseley & Dessinger, 2001). FPS is Ford's approach to systematically and systemically defining performance gaps. Appropriately, TQM and lean management systems like FPS measure performance and set reasonable and measurable goals in terms of quantity, quality, time and costs (Chevalier, 2009).

Implementing TQM in the workplace is a multifaceted process that involves the utilization of many tools and techniques. Sometimes the many tools and techniques applied become the focus of the intervention rather than the overall commitment to quality. Human performance technologists are equipped to help organizations avoid these pitfalls and, assist traditional businesses in transforming into TQM organizations (Van Tiem et al. 2001). When workers and management view TQM and continuous improvement as a constant and uninterrupted process, the desired cultural shift is achieved that may deliver the desired quality and efficiency throughout the organization.

Traditional Management Work Structures

The traditional work structure in the United States automotive industry and most US manufacturing industries is a hierarchical structure with vertical reporting in both management and union organizations (Attaran & Nguyen, 2000). Ford Motor Company has many corporate and division administrative organizations that set strategic vision and provide guidance and assistance to Ford production facilities. Likewise, the United Auto Workers union has executive and regional administrations to guide and assist local union activities. Plant management and local Union leaders report up through these leadership organizations and ultimately to Ford's chief executive officer and UAW's national director respectively.

At the plant level the traditional work structure is evident. UAW hourly employees, sometime referred to as blue collar workers, are paid to perform work by the hour, and report to white collar production line supervisors who are paid a salary (Brinkley, 2003). The line supervisors oversee the work activities of small production or maintenance areas. A line supervisor may supervise ten to fifty employees depending upon the complexity of the operation. They are in charge of all activities in their areas regarding production, emergency maintenance, materials and personnel. The supervisors assign work to hourly employees and give specific direction regarding what is to be done. Line supervisors make the decisions, adjustments and corrective actions to keep pace with production goals.

Hourly employees and line supervisors are supported within the plant by local union leadership, production management and support service organizations. Hourly employees can turn to their union representatives for guidance and support when dealing with work assignment or employment concerns (UAW and the Ford Motor Company, 2003). The union hierarchy in the plant is such that hourly employees get assistance from district union committee people who represent employees working in specific departments within a plant. District committee people muster support from bargaining committee people who negotiate agreements with plant middle management. Bargaining committee people are supported by the plant chairperson and/or by the president of the local union. The local union chairperson typically oversees all issues regarding the health and welfare of UAW worker in the workplace and the fair implementation of the local UAW contract within the plant (Brinkley, 2003). In large UAW local unions, a president is elected separate from the chairperson, to run the business of the union as well as provide support to local UAW retirees. In smaller local unions the chairperson also runs the day to day business of the union.

All of the UAW positions described earlier are elected offices that local union members vote upon. UAW local elections occur every three years. Locally elected chair people are granted the power to appoint union employees to specific employee support functions in large plants with many employees. UAW appointed positions in large plants may include health and safety representatives, quality representatives and employee education, training and development representatives (UAW and the Ford Motor Company, 2003).

Traditionally, Ford plant management has a top down hierarchy starting at the top with the plant manager and concluding at the bottom with line supervisors (Brinkley, 2003). Many management levels and administrative departments exist between the line supervisor and plant manager. Line supervisors report to department supervisors or superintendents. The superintendents oversee multiple interrelated production areas and line supervisors within a department. Superintendents report to department or area managers. The area managers are responsible for all activities and production interaction between supporting production lines or departments. Large automotive assembly plants may employ more than 1,000 employees within a single production department. Area managers play a critical role in maintaining production to keep all other departments within the plant running efficiently. As many as eight to ten area managers could be assigned in large or diverse automotive manufacturing operations. The area managers report to the plant manager who is ultimately accountable for the entire operation and for the quality of the products being shipped to consumers.

The production management team described previously is supported by many organizations within the plant (Brinkley, 2003). Engineering managers tackle technical concerns to maintain production. Human resource personnel deal with staffing, training and employee performance management. Material planning and logistics staff ensure that raw materials and inventory are in place to facilitate efficient production. Finally, the quality control department inspects finished products to catch any quality defects missed throughout the production process under the traditional management work structure.

An understanding of an organization's culture, organizational structure and external or market conditions is critical to the selection and implementation of performance improvement interventions and change management process (Van Tiem, Moseley, Dessinger, 2004). Human performance improvement (HPI) practitioners must be sensitive to organizational and business performance agendas, and not narrow the scope to departmental or individual performance (Jang, 2008). Rose, Kumar and Ibrahim (2008) added that subjective evaluations of organizational performance such as external economic factors may be as important as objective measures of performance. Organizational and market research provide human performance technologists with information to create processes and tools for communicating expectations, giving feedback, rewarding good or improved performance, and selecting employees who possess the capabilities and motivation to perform as internal and external customers expect (Cicerone, Sassaman & Swinney, 2007).

The identification of all actual causes of unacceptable performance through analysis is critical to the selection of relevant interventions used to achieve desired performance (Cicerone, 2009). Input from key groups of individuals from all levels throughout an organization must be solicited in the performance analysis, cause analysis, intervention selection, design and development and in the implementation and management of the change to bring about the performance desired and net financial results (Van Tiem, et al, 2004).

Team Concepts and Implementation Methods

Team-based performance improvement intervention is an old concept that has received new attention and commitment in recent years. Experiments in team concepts have been around for thirty-plus years. Teamwork has been around since the beginning of time. Self-directed work teams are a continuation of quality circles and worker participation programs that have proven successful in Japan and in the U.S. (Harper & Harper, 1991). Team concepts are referred to by many names like workforce empowerment, participative management, self-managing teams, high involvement workforces and self-directed work teams.

For the purposes of this study, self-directed work structures or teams are defined or described as groups of accountable individuals with common goals that are empowered to affect decision-making and problem solving processes related to operational objectives. The definition of teams can change dramatically given the context and type of challenges being faced by an organization. In 2005 the Duke Corporate Education, Inc. offered five general guidelines that define the make-up of a team. First, teams involve a small group of people. Too few or too many make it difficult to manage or get results. Second, the team is committed to a shared purpose or goal. Third, the team has complementary skills that facilitate core capabilities. Fourth, the team and team members have mutual and individual accountability respectively. Finally, teams work interactively and interdependently so individuals rely on each other to achieve their objectives.

Teams, or at least the jargon associated with team concepts, have been implemented in some organizations simply because it is a popular and an employee friendly concept. However, some researchers forewarn that if teams are implemented poorly, it may disrupt or diminish the performance the concepts sought to improve. In 2002 Chilson suggested that the team concept is sometimes ill-received because of poor preparation or the lack of established goals and purpose. When this occurs, employees are subsequently grouped together and asked to function as a team, frequently without guidance or understanding of the rationale or subsequent expectations associated with this change. Being appropriately warned of pitfalls, serious team advocates engage human performance improvement professionals to design and facilitate appropriate team-based interventions.

A choice to implement teams, especially in a multinational corporation, is not entered into haphazardly. Intervention sponsors must understand the time, effort, financial support and commitment that will be required to effectively implement teams and achieve a sustainable competitive advantage through the process and well into the future (Duvall & Singer, 2000).

Team based concept interventions require a comprehensive design of sub-interventions that range from broad goals to invasive performance management systems. Effective designs should include instructional and non-instructional performance support interventions and take a systems approach to tackle performance issues at four organizational levels: individuals, processes, workgroups and business units. A good model of a human performance technology (HPT) intervention addresses eight categorical areas including performance support, job analysis, personal development, human resource development, organizational communication, organizational design and development, work design and financial systems (Van Tiem, et al, 2004).

The overall goal of any team-concept performance intervention is to improve the effectiveness of a group that must work together to achieve meaningful results. In the 1977 Dyer cited three conditions that characterize an effective organizational unit or team. The ability to gather and organize relevant data is the first and prerequisite condition. The ability to make sound and informed decisions freely is the second condition. The final condition is the ability to implement those decisions with commitment. Many team interventions focus appropriately on the process and internal dynamics of the team (Parker, 1996).

While implementing performance improvement interventions, organizations must be able and willing to adapt to adverse pressures. Healthy organizations recognize changing conditions and adjust proactively. Change management necessitates sensitivity toward managers, workers, their culture and their respective capabilities. There are two common and basic methods for adapting to change in the workplace. One way is to empower employees as problem solvers, as with self-directed work teams. A second way is to have solutions designed by internal or external process consultants. (Van Tiem, et al, 2004). Both methods are used in tandem frequently to manage the change process. In the context of the workplace, workers, management and other stakeholders such as consultants or coaches join together formally and informally to discover, share and grow the knowledge and skill they will need collectively to transform into a high performance self-directed team (Moseley & Dessinger, 2007).

Team members must understand why teams are being implemented, what the rationale is behind the groupings, and what is required of them individually and collectively. Goals must be very specific and challenging. In 2002 Nelson warned that before implementing the team concept in the workplace, precise goals must be established, understood, and supported by management and employees. William Liccione (2009) suggested that a strong positive correlation exists between employee's commitment to their goals and the probability of their goal achievement.

Measurable results that are agreed upon by the team and that will achieve the team's purpose must be established. Rosenthal (2001) added that the most successful teams always have a purpose that outlines the work necessary to achieve the desired goals and the potential consequences if the team does not succeed. Key deliverables and time constraints must be met when pursuing goals. Team members must be accountable for their performance. In 2007 Darlene Van Tiem suggested that workers have become accustomed to sharing or deflecting responsibility to the extent that no one is responsible or accountable for organizational performance. This sentiment must be overcome in a team based work environment (Van Tiem, 2007).

Self-directed work teams (SDWT) also need a purpose that compliments the team's goals. Axelrod, in 2002 asserted that a compelling purpose allows people to put forth effort in service of issues larger than themselves. Given a common purpose, cultural differences in the global workforce can be overcome (Nathan, 2008). Purpose answers the questions: What will be different because of our having worked together? What will we create for the organization, this team, and ourselves as a result of our work? If the answers to these questions provide the team members with a sense of being part of something larger than they are, they join in. If not, they stand on the sidelines or at best give a minimal effort (Axelrod, 2002).

Rosenthal (2001) further explained that individual team members need clear roles. Each team member must be made aware of the responsibilities and duties for the specific team functions, who will be assigned to these functions, and what tasks will be distributed to each function. Team members must understand their role on the team and what function they will serve individually to accomplish the team objectives. A collaborative approach is necessary to achieve these objectives, which should be supported by a project plan that outlines the collective methods used (Rosenthal, 2001).

To maintain work team effectiveness over long periods, Axelrod (2002) emphasized that assigned tasks must be important and interesting. Task significance is also important because if team members recognize that their work has significant consequence to themselves and the team, they are more likely to pull together and subsequently be more effective in accomplishing the task (Axelrod, 2002).

As discussed in this review, many factors influence work team effectiveness. Balanced interventions strategically address as many factors as necessary based upon a comprehensive performance and cause analyses. HPT practitioners must take a multidisciplinary systems approach and avoid shortcomings in evaluation and falling for quick fixes (Pershing, Lee & Cheng, 2008). In 1993 Colin Coulson-Thomas surveyed 100 organizations in the UK to select enabler characteristics that are very important to facilitate effective teamwork. The table of survey results was reprinted on page 227 in *Performance Improvement Interventions: Enhancing People, Processes, and Organizations through performance technology* (Van Tiem, et al, 2001). The very important enablers range from operational factors to organizational and individual factors. See Table 1.

Table 1

Survey Results: Ranking Enablers of Effective Teamwork

Enablers	**% of Organizations that Ranked Enablers as Very Important**
Clear and measurable objectives	71%
Personal commitment	66%
Management attitudes	63%
Teamworking skills	54%
Accountability	49%
Empowerment	48%
Overcoming departmental barriers	41%
Roles and responsibilities	37%
Project management skills	36%
Supporting software, e.g., groupware	36%
Supporting hardware, e.g., network connectivity	34%
Management processes	33%
Tackling vested interests	30%
Role model behavior	29%

Van Tiem, Moseley & Dessinger (2001)

Successful self-directed work teams differ from traditional work structures in many ways. In 1991 Harper & Harper offered ten distinct differences. Teams are responsible for the whole job and are accountable for the results. Quality control and maintenance functions are integrated into the team. Task assignment and rotations are handled within the team. Leadership is shared and support is provided by coaches or facilitators. Business metrics and customer satisfaction feedback is provided frequently. Teams meet regularly to solve problems and manage their business. Members receive training to develop technical skills, team skills and inter-personal skills. Team members develop trust and candor in communication. People are paid for skills and productivity rather than for time on the job. Finally, teams develop a “can do” attitude by making an impact through their committed involvement.

According to Lee Colan, the author of *Passionate Performance*, (2004) employees who buy into the team process with their minds and their hearts exhibit discretionary behaviors that payoff organizationally. Evidence of discretionary employee or team effort includes:

- choosing to work late or on their own time to complete a project;
- asking how they can better serve another team member or department;
- inquiring about how their actions affect another function or the customer;
- making a connection between their decisions and the company’s financial results;
- treating company resources like their own;
- looking beyond their own roles for improvement opportunities; and
- pursuing self-development on their own time.

Colan (2004) uses the behaviors listed above to describe what passionate team performance looks like.

Leadership and Management Support and Political or Union Implications

One of the most important elements of self-directed work team success is leadership and management support of the process (Gordon, 2002). Long-term change to the work team process requires strong and committed leadership. Commitment starts at the top, and the employees must know that the team has upper management's complete support. Leaders who align human resources (HR) and related improvement initiatives with strategic organizational priorities, enjoy greater financial results as well as intangible results including increased employee retention, greater employee engagement, and improved competitive advantage (Frangos, 2007).

Studies have shown that employee frustration increases when management does not provide the support needed for their teams (Chaney & Lyden, 2000). This may be because many managers do not know how to facilitate the team concept and avoid common pitfalls (Hoover, 2000). Additionally some lower level managers may feel that the team concept presents a threat to their authority and job security and, therefore, resent and resist the team process. These managers realize that their jobs and positions are potentially threatened, because successful work teams require less supervision and more decision-making in groups (Kirkman, Shapiro & Shapiro, 2000). In dealing with lower management resistance, top management must anticipate and deal with this perception by immediately and clearly defining management's new role, by showing how career progress is still possible, and by presenting reward and recognition systems linked to team success benchmarks.

In 2002 Nelson recommended that reward systems should be cascaded to the work team itself to be used as a device for promoting work team success, allowing employees to see that more work and responsibility does not come without recognition. A reward system for teamwork is very important. To motivate group-oriented behavior, Chaney & Lyden (2002) added that a group's performance should be rewarded, but it is also just as important to reward individual members for exceptional efforts as well. Compensation plans with incentive value are growing in popularity with team based environments. In 2007, William Liccione claimed that incentive based compensation plans should deal with two critical components. First, it should address an individual's commitment to team goals, and second, it should offer a relative reward value that individuals receive for accomplishing their goals (Liccione, 2007).

Management roles must also include the support of team learning. Team learning is more successful when management is open to change, encourages innovation and supports the taking of risks within reasonable limits. It makes a big difference when a work environment encourages employees to challenge the status quo and involves them in changes that could benefit the organization, as reported under the title Five Rules for Team Learning in the *Canadian HR Reporter*, 2001. Team learning can be a success if there are managers who are committed to the process and are willing to spend regularly scheduled time with the teams to review work related issues or concerns, and past successes and failures. It is important to involve employees in the analysis or work problems to ensure they learn from their own experiences and those of their team members (*Canadian HR Reporter*, 2001).

Furthermore, team performance is facilitated by development of trust within the team. In 2001 Bandow summed up "structured trust" as a framework around which teams and team members can function when they have little knowledge of others in the group. Standardized processes, contracts and other verbal and written agreements can all serve as forms of structured trust, and managers can facilitate teams to help establish trust structures (Bandow, 2001). Strong social bonds and good working relationships among team members, strengthened by trust are essential for effective team performance. Trust must exist before people can successfully work together. Taking time to establish good working relationships which foster trust can eliminate potential future problems and avoid team disagreements which can eventually lead to distrust, decreased productivity, communication inhibitions, and higher costs for teams and the organizations in which they function (Bandow, 2001).

The United Auto Workers participated in the establishment and implementation of the Ford Production System from the executive union leadership level and the local plant union levels. They supported the FPS change process as a way to educate and enhance the skill levels of the union workforce. There were, however, challenges breaking down the “us and them” mentality on both sides, that is, UAW employees, leadership and Ford Motor Company management. Regularly there are many personnel issues, work conditions, quality and sourcing concerns that can divide the UAW and Ford at the leadership and plant levels. These disagreements sometimes cause disruptions in cooperation that setback mutual progress, especially in change management (Ury, 1993).

One of the most significant changes involved eliminating front line supervisors. By eliminating the line supervisor or small department supervisors, management was entrusting the day to day departmental production operations management to UAW employees. This was a significant hurdle for both the UAW and Ford. Traditionally Ford management ran the business and the UAW officials held the company accountable to resolve production and personnel concerns within the confines of the national and local UAW-Ford contract agreements. Under the team concept, UAW hourly employees became participants in the concern resolution process and, sometimes UAW officials were left to deal uncomfortably with personnel conflicts within the teams. Kelly and Hounsell (2007) surmised that managers and workers want to make decisions that are in the best interest of the client and the company, which may lead to higher profits, less inventory, reduced costs, better quality or more reliable service. Ultimately many local unions successfully embraced the team concept to advance the FPS process to the benefit of the UAW employees and the Ford Motor Company (Ford Motor Company Communications, 1995).

Education and Training

Employees who are expected to perform successfully in a team-based environment require carefully designed general and task specific training as well as a supportive learning environment. The establishment of organizational learning objectives and strategies is critical when implementing team concepts in the workplace. Instructional technology (IT) and human performance technology (HPT) professionals need to push their organizations to embrace a performance improvement agenda and push to have a seat at the table for the strategic development process to include a learning officer (Frangos, 2007). Hwan Young Jang (2008) projected that organizational leaders and sponsors increasingly acknowledge the value of instructional design because they are concerned about developing intellectual capital, which delivers true competitiveness in a global economy.

The strategic creation of a learning organization is ideal for facilitating a team-based improvement initiative. Organizational learning occurs as an outgrowth of collaborative teamwork and group problem solving. Team learning is a process that team members go through as they experience and organize new content, new work arrangements and new relationships. Team learning encourages and thrives on collaboration (Moseley & Dessinger, 2007).

Learning organizations are described as groups or companies that facilitate the learning of members or employees to continually transform or improve within the context of the business (Senge, 2006). Learning organizations make an overt commitment to using learning as a strategy and place value on capturing and sharing learning. In 1990 and again in 2006, Peter Senge described learning organizations that have five main disciplines including systems thinking, personal mastery, mental models, a shared vision and team learning.

Action learning is a concurrent strategy frequently employed in implementing a learning organization. The concept of action learning was developed nearly seven decades ago to help busy organizations improve performance while learning simultaneously (Van Tiem, Moseley, Dessinger, 2001). It is a way to integrate learning with doing that impacts performance results in real time. Action learning is a small group process where team members share, question, experience, reflect, make decisions and take action. The application of action learning involves problem solving, organizational learning, team building, leadership development, and professional and career development. Many large corporations use action learning to promote continuous learning, to facilitate learning transfer and to adapt to turbulent times by accelerating positive organizational changes (Van Tiem, Moseley, Dessinger, 2001).

Instructional technology professionals frequently rely upon adult learning theory and research to develop successful training programs and materials for working populations. The foundation of adult learning theory is set in andragogy, self-directed learning, informal or incidental learning and transformational learning (Moseley & Dessinger, 2007). Andragogy is the art and science applied to helping adults learn. Self-directed learning principles involve giving mature individuals the opportunity to diagnose their learning needs and prepare their own study plan. Interactive and participative learning strategies are examples of self-directed learning principles applied in adult working environments. Informal and incidental learning theory is especially relevant to workplace learning since it is centered on lessons learned by workers in their daily operational context. Incidental learning strategies need to be supported by formal training to reinforce positive learning and extinguish inappropriate learning. Transformational learning focuses on the adult learners' ability to change learning into performance by digesting new information relative to past experiences and reflecting upon both to empower renovation.

In 2009 Kathleen Iverson suggested that the engaging principles and practices that go into strategic training program development must also be applied to the educational materials used. Training materials should be presented in a conceptual framework that encourage learning, motivation, retention and knowledge transfer (Iverson, 2009). The presentation of facts is not enough to draw learners in and keep them interested. Iverson claimed that learner-centered writing methodology that merge cognitive and learning theory with creative and technical writing techniques create educational materials that teach rather than just inform. Written materials that engage readers, make a connection, facilitate metacognitive strategies, enhance learning and memory, and use practice and application to deliver effective learning, skill transfer and improved performance across multiple organizational levels (Iverson, 2009).

Team training programs and materials must teach employees the general and task specific skills they need to operate effectively in the new structure, so the relevance and comprehensiveness of the training are essential. Lack of training, inadequate or inappropriate training can be a significant contributing factor to the failure of work team concept implementations (Sesa, 2000).

In 2000, Nichol suggested that team awareness training should be the first stage of training, which should include the entire organization. This training is simply a basic educational course explaining the team concept, the required changes in the organization, the stages of team maturation, and how the process will benefit team members, and the organization as a whole (Nichol, 2000).

The second stage of training involves team-building exercises. Most employees do not know how to gain all the benefits and advantages of a team-based atmosphere (Nichol, 2000). In this stage of training, teams will establish codes of conduct and measurable team objectives that are aligned with departmental and organizational goals. Team and individual recognition upon achievement of established objectives help employees recognize benefits to the team and to themselves. Later in 2000, Chaney and Lyden proposed that team building exercises have the greatest potential to impact effective participation and collectivism and promote activities, which strengthen team bonds and trust.

In 2007 Moseley and Dessinger contended that the achievement of collectivism requires the successful crossing of a critical bridge between the second and third stages of training to integrate young and old workers. Different generations of workers learn differently and accept or adapt to change differently (Moseley & Dessinger, 2007). New and young workers bring openness, new ideas and confidence with technology while older and more experienced workers deliver tactical knowledge and experience in relevant problem solving. Drawing the strengths out of each age or experience group can assist in transition and benefit the team collectively.

The third stage of training is skills development. Many employees are uncomfortable with making decisions without formal supervision. Avery (2000) suggested that employees may be apt to struggle for control, even though the main purpose of the team concept is to add creativity and productivity through group decision-making processes. Skills training will help employees overcome these obstacles by teaching "team player" and "leadership" skills including interpersonal communication, decision making, problem solving, assertion, negotiation, conflict resolution, change management, facilitation, and coaching (Nichol, 2000).

Supplementary training can include technical and administrative skills necessary for the maintenance of team activities. The key is to train employees only in content areas that have the greatest impact and avoid unnecessary expenses and non-value add time away from work (Hoover, 2000). Performance supports or job aids offer an inexpensive repository for information and processes that can inform and guide team members through appropriate tasks and actions (Paino & Rossett, 2008). Often teams are asked to take on tasks that were once performed by management, such as administrative tasks, inventory control, purchasing, scheduling, and budgeting. Additional training should coincide with these new assignments as teams are given more responsibility.

Interdependence and Communication

The feeling of interdependence among team members is crucial. Spann (2000) concluded that when team members depend upon each other to accomplish tasks and goals, motivation and group effectiveness are increased because individuals feel responsibility for the work. Interdependence is considered a structural feature of the instrumental relations that exist between team members (Spann, 2000). The degree of task interdependence typically increases as the work becomes more difficult and the personnel require greater assistance from others to perform their jobs (Emans, Van De Vilert, Van Der Vegt, 2001).

Furthermore, the concept of team learning, reviewed previously, benefits from the spirit of cooperation and trust that develop within effective self-directed work groups. Team learning benefits both the team and the organization. Organizational learning also occurs during the process as knowledge and skills generated within learning teams, extend throughout the entire organization (Van Tiem et al., 2001).

Resistance is normally encountered when teams are implemented. Good and proactive communications are essential to avoid and manage resistance (Bain, 2001). If communication is avoided or handled in an insensitive manner, there will most certainly be problems advancing the overall team process and within the team interactions. An atmosphere of communication, not only inside the team, but also among different teams, must exist to enhance coordination toward organizational goals. A cornerstone of benefits arising from the use of teams is member communication. In 2000 Chaney and Lyden suggested that, in order to reap the benefits generated from the inherent design of self-directed work groups, fear leading to introversion or self-limiting behavior must be minimized. Open communication must not only be existent, but must also be well perceived by all team members (Chaney & Lyden, 2000). Teamwork when based upon effective communications and sharing of critical business information can contribute significantly toward enhancing work team performance. Honest and upfront dialog within teams can reduce anxiety regarding job security among team members and promote positive working relationships (Casner-Lotto & Friedman, 2002).

Moreover, all members within an organization operating under the team concept have an individual responsibility to communicate effectively. Every team member must be open and remain approachable to answer questions from other team members thereby helping them learn and advance the team process. This includes recognizing that team success can bring greater gains than individual success, and that offering information or resources, often without solicitation, will help others (Casner-Lotto & Friedman, 2002).

Transfer of Authority, Empowerment and Decision-Making

Successful self-directed work teams have the authority and responsibility to manage their business operations. If the work team process is going to work, the authority to make decisions must be relinquished by management and granted to the teams (Caldwell & Lawson, 2000). Too often managers or front line supervisors surrender responsibility, without really providing the team with actionable authority. Teams must not be dominated by the employer and should be allowed to function with minimal interference. Teams should even be allowed to make mistakes and learn from them collectively through self-assessment.

Nichol in 2000 claimed that effective self-directed work teams (SDWTs) must be empowered to take action, rather than ask for permission from management. Yandrick (2001) cited that, “the essence of a work team is empowerment”. Individual team members assume responsibility and make all decisions regarding workplace operations as opposed to just making employee suggestions (Yandrick, 2001). This process takes time for both management and hourly employees. Management is reluctant to give up authority and hourly employees are concerned about taking on responsibly. Over time in a healthy team-based environment, these tenuous conditions work themselves out. Teams and individuals get comfortable making decisions. Management also grows comfortable with team and individual decisions as most all of them are made in the best interest of the team and organization. When performing the essential work of the team, the members want their voices heard and want to influence outcomes positively (Axelrod, 2002). This sentiment is supported by research trends that indicate that employees are increasingly drawing a stronger connection to work and life satisfaction (Joyce, Nohria, & Roberson, 2003).

Conclusion

There are fourteen major factors that must be proactively managed to successfully implement self-directed work teams. Left unaddressed these same factors will inhibit work team development and achievement. Before implementing the team concept, precise goals should always be established and supported by management, and be completely understood by the employees who will eventually form the teams.

In addition to precise goals, teams require a compelling and challenging purpose that outlines key measurables to be attained. In order to achieve desired objectives, team members must recognize what their individual roles will be within the team, what individual tasks are required to function within the team, and how their individual responsibilities contribute to the team's efforts and net effect. Teams must be formed by groups of individuals who function together as a cohesive group. Individuals must feel responsible for their own tasks, while at the same time depend on one another for support. Communication among these groups is critical. If team members are interdependent of one another, they must be approachable by other team members and share information to help each other learn and grow as a group.

In order for the work team process to be successful, the authority of management must be relinquished to the team. Teams must be provided the opportunity to make important decisions regarding workplace operations within their team parameter, without interference.

Trust and relationships among team members are important, both on a work-related and also a social level. Trust must always exist before people can successfully work together; otherwise, team members hold back their true feelings and ideas thereby restricting the progress of the team. Social bonds and working relationships are commonly strengthened by trust, and lead to effective team performance.

Long-term success of the work team process depends largely upon management support of the process. Upper management must be truly committed to the work team process and establish credibility with the teams by providing the necessary resources, motivation, recognition, encouragement, and financial support. Work teams must receive continuous education and training to develop and maintain the knowledge and skills necessary for work team success. Training should be initiated in stages, the first stage beginning with overall awareness of the work team concept, directed at all levels of the organization. Secondly, team-building exercises should be conducted on a regular basis that emphasizes effective participation and collectivism while promoting team bonding and trust. Thirdly, skill training is necessary to help teach employees the basic skills necessary for long-term team success including, but not limited to interpersonal communication, decision making, problem solving, assertion, negotiation, conflict management, change management, facilitation, coaching and others.

This chapter has reviewed essential literature related to Ford's company culture and lean engineering, quality management system and the importance of understanding the context therein. Team concepts and implementation practices and pitfalls were discussed. Management and political leadership support requirements and their implications were examined. The education and training literature reviewed offered stepwise processes for team and skill development. The importance of interdependence and communication within and among teams was established. Empowerment and decision making within teams was deemed essential in the literature. Finally, proactive change management and a systems approach remain vital to implementing effective self-directed work teams.

We turn now to the methodology of this study which will explain the research design, propose the hypothesis, describe the participants and explain the data collection process and statistical analysis techniques.

CHAPTER 3 METHODOLOGY

Introduction

Large organizations and businesses frequently operate using multiple work structures. This is more often than not the case in multi-national firms with numerous facilities but, may also be the case within a plant or even a small office. Traditionally and predominantly organizations operate using a supervised work structure. Departmentally supervised functional areas typify this type of work arrangement. Alternatively a self-directed work structure involves co-workers who are organized into teams that self-manage daily operations. Many speculate that self-directed work structures foster improved productivity and quality (Cicerone, 2009). This proposed study will compare effectively rated self-directed work structures with more traditional work structures to determine the impact on multiple performance metrics. The following section describes the research design, the hypothesis and the participant populations. It also addresses the data collection methods and data analyses techniques that were used in the study.

Research Design

A longitudinal time series, post-test only, non-equivalent control group experimental design was employed for this study (see Figure 1) (Fitz-Gibbon & Morris, 1987). The two separate treatment groups include effectively rated self-directed work teams and traditionally supervised work structures. This design was applied to two separate and different comparisons in two truck assembly plants and two engine manufacturing plants. The treatment in itself includes all elements of the Ford Production System with the keynote of the system being the implementation of effectively rated self-directed work teams or the lack thereof.

Figure 1

Observations Over Time

	1	2	3	4	5	6	7	8	9	10	11	12
X1	O	O	O	O	O	O	O	O	O	O	O	O
X2	O	O	O	O	O	O	O	O	O	O	O	O

Hypothesis

Significant performance differences may exist between effectively rated self-directed work teams and more traditionally supervised work groups in automotive assembly and engine manufacturing plants. Data from this research may statistically support the position that self-directed work teams out perform supervised work groups in all seven separate but interrelated performance measures including unexcused absenteeism, injury experience, productivity, cost and, internal and external quality.

The Null hypotheses suggest that no difference exists in performance between plants with different work structures. Alternative hypotheses H1 through H7 predicts that there is a significant difference in performance between effective self-directed work teams and supervised work groups. For research questions eight and nine, the Null hypothesis suggests that none of the dependent performance variables predict customer satisfaction or work team effectiveness.

The alternative hypotheses H8 and H9 predict that the dependent performance variables significantly predict customer satisfaction and work team effectiveness.

Population and Participants

The participating plants identified through collaborative and concentrated research with Ford executive sponsors have similar plant populations with regard to like products produced, like production processes and like employee populations, but with separate and different work structures. Ford Motor Company leadership and UAW International leadership endorsed the comparison design as the most relevant comparison of work structure impact that could be made within Ford Motor for the production period. Two Ford North American truck assembly plants and two Ford North American engine manufacturing plants were researched in this study during the 2004 production year.

The Vehicle Operations Division assembly plants studied included Norfolk Assembly Plant located in Norfolk, Virginia and, Kansas City Assembly Plant located in Claycomo, Missouri. Both assembly plants built the same Ford F-150 pick-up trucks. The sister F-150 truck assembly plants receive the identical component parts and follow a parallel assembly process.

During the 2004 production year studied, Norfolk Assembly employed 2,615 hourly employees and 190 salaried employees while Kansas City Assembly employed 5,163 hourly employees and 309 salaried employees. The plant population comparison is actually much closer than indicated when considering that two separate assembly plants exist within the Kansas City production complex. Norfolk Assembly was one of the first plants to launch and embrace the team based work structure within the Ford Production System (FPS) in early 2001. Effective implementation at Norfolk included the implementation of team concepts and the replacement of company department supervisors with peer team leaders. Kansas City lagged Norfolk on FPS implementation by one year and was slow to implement and embrace the team based work structure.

The Powertrain Operations engine manufacturing plants studied included Lima Engine Plant located in Lima, Ohio and, Cleveland Engine Plant II located in Brook Park, Ohio. The two Ohio based engine manufacturing plants are sister plants which assemble 3.0 L V-6 engines. Both engine plants receive the same component parts and build engines following a similar process.

During the 2004 production year studied, Lima Engine employed 1,015 hourly employees and 165 salaried employees while Cleveland Engine Plant II employed 1,041 hourly employees and 143 salaried employees. The workforce in each plant in terms of employment numbers is comparable. Lima Engine launched and productively embraced the team based work structure in 2002. At Lima Engine Plant, engines were manufactured under the Ford Production System (FPS), which included the effective implementation of the team concept and the replacement of company department supervisors with peer team leaders. Cleveland Engine II launched the Ford Production System approximately nine months later than Lima Engine and did not adopt the team based work structure enthusiastically. Cleveland Engine Plant II manufactured engines using the more traditional work structure where employees receive direction from and report to a department supervisor.

The sister assembly plants and sister engine manufacturing plants were selected to best isolate the impact of employees participating in team based work structures. Because the employee populations, training, parts and the manufacturing processes were the same in both sister plant comparisons, differences in cost, morale, productivity, quality and safety may be attributed to the work structures in the separate plants.

Data Collection

Access to records and the data collection process was authorized by Ford Motor Company executive management and the UAW International Committee (see Appendix A). The data collection process involved delving into multiple Ford Motor Company corporate administrative organization. Performance metrics specific to each organization were studied. Statistical data were collected from the Ford Production Systems (FPS) Staff Analysts, Ford Corporate Safety Staff, the Ford UAW National Joint Committee on Health & Safety and, each separate Plant's leadership team including executive management, UAW Operating Committees, human resource staff and safety leadership teams. The data were analyzed in conjunction with each Ford organization to ensure that explicit metrics were used to reflect organizational and plant performance accurately. The extant data and data collection process for this research study did not require the Wayne State University Human Investigation Committee (HIC) review since it did not involve personal intervention nor identifiable private information as outlined in the HIC 2009 qualifications (see Appendix B).

The FPS organization was charged with leading and managing the change management process at Ford Motor Company. All of the dependent variables to be evaluated in this study reflect the FPS group's performance directly or indirectly. The most pertinent metric reflecting upon the FPS organizational performance is work group effectiveness ratings which indicate how well work groups believe they are functioning.

Ford Corporate Safety and the UAW National Joint Committee on Health & Safety drive safety programs and processes to eliminate injuries and illness within the workplace. Fittingly, organizational performance metrics for these leadership groups involve United States Federal and State Occupational Safety and Health Administration mandated statistics. Lost Time Case (LTC) rates and Severity Rates (SV) fairly define performance with regard to employee injury frequency and injury severity respectively.

Each plant management team and respective organizational departments are responsible and accountable for the efficient execution of production processes in their manufacturing operations. Multiple metrics were evaluated to differentiate each plant's performance relative to cost, delivery, morale, quality and safety. The cost metrics compare actual hours to produce a vehicle or an engine to industry standard performance projections. Ford 's productivity metrics are defined by delivery performance which compare vehicle or engine production to the unit output schedule. The quality metrics utilized measure the customer experience or customer satisfaction by accumulating product concerns reported to Ford dealerships within three months of ownership. A second quality metric was added for engine manufacturing plants to analyze internal quality metrics on engine concerns identified at vehicle assembly plants. Plant leadership teams are responsible and accountable for employee safety and, are judged on the same safety statistics described earlier for the corporate safety organization. Two metrics were used to gauge the morale of plant employees. First, absenteeism reported as a controllable absence percentage is the responsibility of the plant human resource departments. Secondly, work group effectiveness ratings weigh team member opinions regarding the effectiveness of the work groups within each plant.

The seven dependent variable metrics explore performance in the areas of safety, quality, productivity, cost and employee morale (see Table 2). Two separate safety metrics were used to study injury frequency and severity separately.

Table 2

<table>
<tr><th>Dependent Variables</th><th>Independent Variable 1</th><th>Independent Variable 2</th></tr>
<tr><td>Safety</td><td rowspan="12">Effectively Rated Self-directed Work teams
- Norfolk Truck Assembly Plant
- Lima V-6 Engine Manufacturing Plant</td><td rowspan="12">Supervised Work Groups
- Kansas City Truck Assembly Plant
- Cleveland Engine II Manufacturing Plant</td></tr>
<tr><td>Lost Time Case Rate</td></tr>
<tr><td>Severity Rate</td></tr>
<tr><td>Quality</td></tr>
<tr><td>3 MIS Warranty Performance Rate</td></tr>
<tr><td>PPM@Customer Engine Quality</td></tr>
<tr><td>Productivity</td></tr>
<tr><td>Production to Schedule Variance</td></tr>
<tr><td>Cost</td></tr>
<tr><td>Hours Per Vehicle Performance Rate</td></tr>
<tr><td>Morale</td></tr>
<tr><td>Absentee (AWOL) Rate</td></tr>
</table>

Cost Data

The metrics examined to analyze cost performance in this study are used universally throughout the automotive manufacturing industry, including metal stamping, engine and transmission manufacturing, and car and truck assembly. Comparable trends across the auto industry are collected and reported annually by Harbour Consulting in the *Harbour Report*. The internationally recognized consulting firm specializes in competitive analysis of manufacturing productivity among all major auto manufacturers. The report has been published annually since 1981 and provides comprehensive analysis of automotive manufacturing, including productivity, sourcing and capacity utilization (Harbour, 2005). Raw data are supplied directly by each major manufacturer.

Specifically the metric of Harbour Hours per Vehicle (HPV) are related to automobile and truck assembly efficiency and Harbour Hours per Unit (HPU) are related to engine and transmission manufacturing efficiency. These data were collected from the Ford Production Systems (FPS) group at their division office in the Rouge office building in Dearborn, MI. The FPS group monitors and compares these cost metrics for all automotive assembly and manufacturing operations throughout Ford Motor Company.

Harbour hours per vehicle and hours per unit, are collected and reported by each plant's production engineering group. They report the average number of hours required to produce a vehicle or automotive part such as an engine on a monthly basis. For the purposes of this study, cost is a dependent variable and, the actual hours reported were converted to a ratio of actual production hours versus target production hours to reflect actual cost performance variance above or below the monthly cost performance target.

Morale Data

Morale metrics are at the center of this study. Two separate morale related metrics were examined and analyzed. The first, which is an independent variable in this study, is a rating of work group effectiveness. Members of each work group within participating plants and all Ford Motor Company plants rate their own performance against established company benchmarks to self-assess their effectiveness verses expectations. The second morale metric, which is a dependent variable, addresses absentee rates within each participating plant. Absentee data provides an indication with regard to employee commitment and job satisfaction. Controllable absence statistics are critical dependent variables in this study.

Work group effectiveness rate information is collected by the Ford Production Systems (FPS) group for all Ford plants. Each work group within all

Ford plants rate themselves weekly and monthly. Plant FPS personnel report the monthly effectiveness rating averages to the corporate FPS group. The FPS group compresses all plant group data down to a single effectiveness rating percentage for each plant. The FPS group validates these self-assessments through periodic audits. These standardized ratings are collected to track and compare work team progress within each plant and division throughout Ford Motor Company. The FPS group provided the work group effectiveness data for this research study.

Employee absence information is evaluated by tracking and analyzing Absence Without Leave (AWOL) data. AWOL days are described as days that employees “no show” at work without advance notice and permission. Employees are permitted five AWOL days annually before their attendance comes under the attendance improvement management program which has employment consequences. AWOL’s are reviewed daily by Labor Relations personnel in each plant and penalties are enforced, within the constraint of the United Auto Workers (UAW) contract, upon the employees return from absence. Employee absence information is collected and evaluated within the Labor Relations function at each Ford plants’ Human Resource Department. This metric is reported as a percentage of all controllable absences as defined by Ford’s Corporate Human Resources Department. The absence data were provided by each participating plants’ Labor Relations personnel.

Productivity Data

The productivity metrics used in this study measure actual plant output in finished goods verses defined production targets within established plant capabilities. Separate productivity metrics were used for engine manufacturing plants and vehicle assembly plants.

Production to schedule gains and misses is an internal operational metric used within engine and transmission manufacturing plants to track performance on a daily, weekly and monthly basis. For the purposes of this study, production gains and misses are dependent performance variables for engine plants. The metric is reported daily for each production shift and manpower adjustments are made within each plant to adjust for overages and especially unmet production commitments. Production gains and misses are a plant based metric that is reported monthly to the Ford Production Systems group from compilation and comparison. The FPS group provided the data for this research study. The information was presented as raw numbers of engines above or below the monthly performance target. The raw data verses target performance were converted to a rate for purpose of comparison.

Similar to the production gains and misses metric used within Powertrain Operations, encompassing engine and transmission manufacturing plants, the production to schedule metric is a vehicle assembly plant specific operational metric. The production to schedule metric is a dependent variable for assembly plant productivity for the purposes of this study. The metric is reported daily for each production shift and manpower adjustments are made within the assembly plants to adjust for vehicle production overages or un-built vehicle commitments. Production to schedule is a plant based metric that is reported monthly to the Ford Production Systems group for compilation and comparison. The FPS group provided these data for this research study in percentages of vehicles produced above or below the monthly production performance target.

Quality Data

The quality metrics used in this study measure and tell the tale of consumer satisfaction. Separate quality metrics were used in engine manufacturing plants and vehicle assembly plants. Both metrics examine the customers' experience after three months of vehicle ownership. An additional quality metric explored for engine production to capture internal repairs before the engines reach the consumer and end-user. All three metrics serve as dependent variables for this research study.

Things gone wrong at three months in service (TGW@3MIS) is a quality metric collected by Ford car and truck dealerships around the globe. Customer experience data are collected by dealers throughout the first three months of new vehicle ownership. Any consumer complaint, correction or repair is recorded. The metric is reported monthly to the Ford Production Systems group. The FPS group in turn provides feedback to the vehicle assembly plants for trend analysis and corrective actions. The information is sometimes the genesis of consumer alerts, product recalls or mandatory repairs. TGW@3MIS data were provided by the FPS group for this research study. The statistics were uploaded in raw numbers as TGW@3MIS verses a control target. The raw monthly TGW numbers verses performance targets were calculated into a rate for the purposes of comparison.

Engine Repairs per thousand at three months in service (Engine R/1,000@3MIS) is the engine specific quality metric tracked by Ford car and truck dealers. Like the new vehicle TGW@3MIS metric above, this a consumer experience metric that reflects only customer concerns regarding their engine performance. Engine problems or failures negatively impact consumer confidence significantly regarding newly purchased vehicles. All complaints, corrections and repairs are recorded throughout the first three months of new vehicle and engine ownership. The metric is reported monthly to the Ford Production Systems group. The FPS group directs feedback to the appropriate engine manufacturing plant for trend analysis and corrective actions. Engine R/1,000@3MIS data were provided by the FPS group for this research study. The statistics were reported in raw numbers as Engine R/1,000@3MIS verses performance control targets. The raw monthly numbers verses performance targets were calculated into a rate for the purposes of comparison.

The second engine quality metric is an internal metric designed to measure engine quality as it arrives at the vehicle assembly plant. The metric is called “parts per million at customer” (PPM@Customer). In this instance the assembly plant is being referred to as a customer of the engine manufacturing plant. Vehicle assembly plants report defects on a daily basis to engine manufacturing plants. The assembly plants also report this information to the Ford Production Systems group on a monthly basis. The statistic is calculated and reported as a rate of defect parts per million (PPM) reported by vehicle assembly plants verses a defect containment target. The FPS group provided the data for this research study as a monthly rate verses a performance target. It should be noted that these engine defects should not impact consumer satisfaction since the deficiencies are caught and corrected prior to engine and vehicle release to car and truck dealerships. The metric does however impact productivity in engine and assembly plants and, ultimately impacts the cost of the engines and new vehicles.

Safety Data

Two separate metrics were used to evaluate Ford's safety performance relative to this study. The first metric Lost Time Case Rate (LTR), examines the frequency with which employees get injured or become ill. The second metric Severity Rate (SR), probes further to determine the seriousness of the injury or illness. Both metrics are regulated by the U.S. Occupational Safety and Health Administration (OSHA). Ford and all American employers with 10 or more employees must follow strict guidelines when reporting injuries and illnesses to OSHA.

A lost time case becomes OSHA recordable or reportable when an employee experiences a work-related injury or illness requiring them to miss work. LTC rates are calculated and reported as a ratio of the number of recordable lost time injuries and illnesses that occurred multiplied by 200,000, which is the approximate number of hours that 100 employees would work in a single year, divided by the actual number of hours worked for the time period in question. This calculation allows OSHA to compare employers' safety performance within and across broad industries.

Occupational deaths and lost time workdays are the inputs into the severity rate. OSHA uses the severity rate to judge the severity or seriousness of work-related injuries and illnesses by capturing the number of deaths, total lost workdays days experienced from recordable lost time cases. Severity rate is calculated by dividing the total number of lost time workdays by the total number of recordable incidents for comparison and OSHA compliance enforcement activities.

Ford plant safety personnel are required to investigate all occupational injuries and illnesses and record them appropriately based on OSHA guidelines. The injury performance information for each plant is submitted regularly to corporate safety, who compare plant performance and provide injury and illness reducing guidance to all plants. The corporate safety department is housed in Ford's World Headquarters on American Road in Dearborn, MI. Global Occupational Health and Safety Director Greg Stone, M.D. championed and supported this study and provided the injury and illness data for all participating plant production facilities.

Instrumentation

Data tables were created for the collection and organization of required information. Data conversions to rates, percentages or ranks were necessary to apply statistical instruments. Relevant and imperative comparisons for the purposes of this study were made from the data conversions presented in Tables

3 and 4. Table 3 describes the metrics, units of measure, sources of data and statistical tools utilized in analyzing performance in truck assembly plants. Likewise, Table 4 describes the metrics, units of measure, sources of data and statistical tools utilized in analyzing performance in engine manufacturing plants.

Table 3

Research Model for F-150 Truck Assembly Plants				
Research Questions	**Metric**	**Unit of Measure**	**Data Source**	**Statistical Tool**
1. Does the presence of effectively rated self-directed work teams affect injury frequency?	LTCs x 200,000 / Man-hours Worked	Rate	Ford Corporate Safety (OSHA Regulated Metric)	MANCOVA & Moderation Testing
2. Does the presence of effectively rated self-directed work teams affect injury severity?	Lost Workdays / Recordable Incidents	Rate	Ford Corporate Safety (OSHA Regulated Metric)	MANCOVA & Moderation Testing
3. Does the presence of effectively rated self-directed work teams affect unexcused absenteeism?	AWOL Days Reported as a % of Total Controllable Absence	Percentage	Plant Labor Relations Metric	MANCOVA & Moderation Testing
4. Does the presence of effectively rated self-directed work teams affect productivity?	Production Units Reported vs. Schedule	Variance	Ford Production Systems Metric	MANCOVA & Moderation Testing
5. Does the presence of effectively rated self-directed work teams affect cost performance?	Hours per Unit Produced vs. Target Hours	Variance	Harbour Report	MANCOVA & Moderation Testing
6. Does the presence of effectively rated self directed work teams affect external quality / customer satisfaction?	Actual TGWs / Target TGWs reported at 3 MIS	Rate	Ford Production Systems Metric	MANCOVA & Moderation Testing
7. Are Safety LTR, Safety SR, AWOL, Productivity, and Cost statistically significant predictors of Customer Satisfaction?	Compare dependent variable impact on customer satisfaction	Correlation Coefficient	All sources listed above	Hybrid Structural Equation Modeling
8. Are Safety LTR, Safety SR, AWOL, Productivity, and Cost statistically significant predictors of Work Team Effectiveness?	Compare dependent variable impact on work team effectiveness	Correlation Coefficient	All sources listed above	Hybrid Structural Equation Modeling

Table 4

Research Model for V-6 Engine Manufacturing Plants				
Research Questions	**Metric**	**Unit of Measure**	**Data Source**	**Statistical Tool**
1. Does the presence of effectively rated self-directed work teams affect injury frequency?	LTCs x 200,000 / Man-hours Worked	Rate	Ford Corporate Safety (OSHA Regulated Metric)	MANCOVA & Moderation Testing
2. Does the presence of effectively rated self-directed work teams affect injury severity?	Lost Workdays / Recordable Incidents	Rate	Ford Corporate Safety (OSHA Regulated Metric)	MANCOVA & Moderation Testing
3. Does the presence of effectively rated self-directed work teams affect unexcused absenteeism?	AWOL Days Reported as a % of Total Controllable Absence	Percentage	Plant Labor Relations Metric	MANCOVA & Moderation Testing
4. Does the presence of effectively rated self-directed work teams affect productivity?	Production Unit Gains or Losses Reported vs. Schedule	Variance	Ford Production Systems Metric	MANCOVA & Moderation Testing
5. Does the presence of effectively rated self-directed work teams affect cost performance?	Actual Hours / Target Hours Per Unit (HPU)	Rate	Harbour Report	MANCOVA & Moderation Testing
6. Does the presence of effectively rated self directed work teams affect external quality / customer satisfaction?	Target Repairs/ Actual Repairs	Rate	Ford Production Systems Metric	MANCOVA & Moderation Testing
7. Does the presence of effectively rated self directed work teams affect internal quality / assembly plant satisfaction?	Target Repairs/ Actual Repairs	Rate	Ford Production Systems Metric	MANCOVA & Moderation Testing
8. Are Safety LTR, Safety SR, AWOL, Productivity, and Cost statistically significant predictors of Customer Satisfaction?	Compare the impact the dependant variables have on each other	Correlation Coefficient	All sources listed above	Hybrid Structural Equation Modeling
9. Are Safety LTR, Safety SR, AWOL, Productivity, and Cost statistically significant predictors of Work Team Effectiveness?	Compare the impact the dependant variables have on each other	Correlation Coefficient	All sources listed above	Hybrid Structural Equation Modeling

Data Analysis

Organizational performance cannot be viewed along a single dimension, but must always be assessed within a multidimensional context and must capture both successes and failures (Harbour, 2009). Several statistical procedures were used in conjunction with this experimental design. First, causal comparisons were drawn between plants with effectively rated self-directed work teams and plants with more traditionally supervised work structures to explore the relationship that the dependent performance metrics have with the independent work structures. Multivariate regression analysis techniques were used for this statistical comparison. Multivariate analysis of covariance (MANCOVA) takes into account several predictive variables simultaneously (Hair, Anderson, Tatham & Black, 1998). In this study the statistical tool permits the testing of correlation between two independent predictor variables and several dependent variables.

Second, a Hybrid Structural Equation Model (SEM) was used not only to further test and predict relationships between dependent and independent variables, but also within the dependent performance metrics. Structural equation modeling is a statistical technique for testing and estimating casual relationships using a combination of statistical data and qualitative casual assumptions (Hair, et al, 1998). The technique allows both confirmatory and exploratory modeling that is well suited for theory testing and theory development (Hair, et al, 1998). The Hybrid SEM statistical procedure may reveal the magnitude of performance variable interrelationships and predict their potential impact on customer satisfaction and work group effectiveness.

This chapter has discussed the methodology in answering the nine research questions posed in this study. The objective overall is to understand variables that may predict or inhibit successes in work team effectiveness and customer satisfaction.

Chapter 4 will discuss the results of the study and the statistical analysis in detail.

CHAPTER 4 ANALYSIS OF THE PROBLEM

Introduction

Chapter four presents the results of the data analysis examined to answer each of the research questions that were posed for this study. These research questions were developed to determine if effective self-directed work teams had an effect on seven separate performance metrics in automobile assembly and engine manufacturing plants. Data from this proposed research may statistically support the position that self-directed work teams out perform supervised work groups in all seven separate but interrelated performance measures including unexcused absenteeism, injury frequency, injury severity, productivity, cost and, internal and external quality. If this occurs the Null hypothesis is rejected in support of the alternative hypothesis in each instance.

The Null hypothesis (H_0) suggests that there is no significant difference in performance between plants with self-directed work teams and plants with traditionally supervised workgroups. On the other hand, the alternative hypotheses (H1) through (H7) imply that self-directed work teams perform differently than supervised work groups.

This study compares self-directed work structures to more traditional supervised work structures in an attempt to deduce if the differences in performance justify the expenditures and efforts required to implement self-directed work teams. Multiple internal performance metrics were examined in comparing plant work structures in various degrees of implementation between traditional work structures and self-directed work teams. The results of the study may help performance improvement and organizational development professionals select and develop effective organizational work structure strategies within their respective businesses or organizations.

To answer the research questions comprehensively the statistical data was analyzed and compared in several ways. In seven of the nine research questions, descriptive statistics are examined, multivariate analyses of covariance (MANCOVA) are executed, univarite tests are performed, pair-wise comparisons are carried out and, tests of moderation are completed. The final two questions were answered using a Hybrid Structural Equation Model (SEM), which further tests and predicts relationships between and among dependent and independent variables.

Descriptive Statistics

Descriptive statistics provide a raw look at the mean for each dependent variable to determine if the independent variables made a difference in the dependent performance metrics (Hair, et al, 1998). Relevant and imperative descriptive statistics for all variables are presented in Table 5 below.

Table 5

Descriptive Statistics of Dependent Variable Performance in Predictor Variable Plants

Dependent Variable	Independent Variable	Plants	Mean	Std. Deviation	N
Safety LTR	Self-Directed	1 Norfolk	2.50	0.36	10
	Traditional	2 Kansas City	4.17	0.43	10
	Self-Directed	3 Lima	1.22	0.82	12
	Traditional	4 Cleveland	0.72	0.32	12
		Total	2.04	1.43	44
Safety SR	Self-Directed	1 Norfolk	52.68	4.85	10
	Traditional	2 Kansas City	77.84	23.45	10
	Self-Directed	3 Lima	21.05	20.18	12
	Traditional	4 Cleveland	8.50	4.34	12
		Total	37.72	31.17	44
AWOL	Self-Directed	1 Norfolk	1.73	0.41	10
	Traditional	2 Kansas City	2.79	0.60	10
	Self-Directed	3 Lima	1.07	0.33	12
	Traditional	4 Cleveland	1.33	0.22	12
		Total	1.68	0.76	44
Productivity	Self-Directed	1 Norfolk	2.60	3.31	10
	Traditional	2 Kansas City	2.09	3.31	10
	Self-Directed	3 Lima	-0.92	1.78	12
	Traditional	4 Cleveland	-1.53	1.87	12
		Total	0.40	3.10	44
Cost	Self-Directed	1 Norfolk	0.98	0.08	10
	Traditional	2 Kansas City	0.96	0.06	10
	Self-Directed	3 Lima	1.19	0.14	12
	Traditional	4 Cleveland	0.93	0.10	12
		Total	1.02	0.15	44
Customer Satisfaction	Self-Directed	1 Norfolk	1.14	0.03	10
	Traditional	2 Kansas City	1.29	0.17	10
	Self-Directed	3 Lima	1.44	0.06	12
	Traditional	4 Cleveland	0.82	0.03	12
		Total	1.17	0.25	44
Engine Quality	Self-Directed	3 Lima	0.98	1.03	12
	Traditional	4 Cleveland	12.81	14.00	12
		Total	6.90	11.44	24

Multivariate Analysis of Covariance

When performing the multivariate analysis of covariance (MANCOVA) or testing between subjects effects, regression-like procedures remove extraneous variations in the dependent variables due to uncontrolled independent variables (Hair, et al, 1998). This allows for more sensitive tests of the treatment effects. Two separate analyses were performed that describe the dependent variable outcomes with work team effectiveness as the covariate. The first addresses all variables common in truck assembly and engine manufacturing plants. The second addresses only engine quality within engine manufacturing operations. Table 6 addresses all dependent performance variables with the exception of engine quality. The comparison of Lima Engine and Cleveland Engine II in terms of engine quality performance taking work team effectiveness as a covariate was not significant. The F value for engine quality is 3.16 and the Partial Eta Squared is 0.11 ($F = 3.16$, $df = 1, 21$, $p > .05$).

Table 6

Comparison of plants (Norfolk Assembly, Kansas City Assembly, Lima Engine and Cleveland Engine II) in terms of the listed outcome variables taking Effectiveness as a Covariate

Dependent Variables	Univariate Tests (df = 3, 39)	
	F	η^2
Safety LTR	94.28**	0.88
Safety SR	49.47**	0.79
AWOL	35.44**	0.73
Productivity	5.52**	0.30
Cost	15.83**	0.55
Customer Satisfaction	120.22**	0.90

Note. ** $p < .01$

η^2 = Partial Eta Squared

Multivariate test (Pillai's Trace = 2.001, F=12.01, df = 18, 108, p = .000, n2 = .67).

The covariate (Effectiveness) was not statistically significant (F = 2.13, df = 6, 34, p= .075).

Pair-wise comparisons examine the mean difference between all dependent variables, not just for the opposed independent variables. In comparing the dependent performance variables across and within independent variable groups pair-wise, the magnitude of the positive or negative mean difference is revealed (Hair, et al, 1998). The pair-wise comparisons also indicate if the difference in each comparison is statistically significant. While the size of the difference is of interest, the measure of statistical significance indicates how meaningful the difference is. Pertinent pair-wise comparisons for all variables are presented below in Table 7.

Table 7

Pair-wise Comparisons of Plants Across the Outcome Variables using Bonferroni Procedure

Dependent Variable	(I) Plants	(J) Plants	Mean Difference (I-J)	Std. Error	Sig.[a]
Safety LTR	1 Norfolk (Self-Directed)	2 Kansas City	-2.27*	0.44	0.00
		3 Lima	.91*	0.32	0.05
		4 Cleveland	1.24*	0.41	0.03
	2 Kansas City (Traditional)	1 Norfolk	2.27*	0.44	0.00
		3 Lima	3.18*	0.26	0.00
		4 Cleveland	3.51*	0.23	0.00
	3 Lima (Self-Directed)	1 Norfolk	-.91*	0.32	0.05
		2 Kansas City	-3.18*	0.26	0.00
		4 Cleveland	0.33	0.24	1.00
	4 Cleveland (Traditional)	1 Norfolk	-1.24*	0.41	0.03
		2 Kansas City	-3.51*	0.23	0.00
		3 Lima	-0.33	0.24	1.00
Safety SR	1 Norfolk (Self-Directed)	2 Kansas City	-51.86*	12.47	0.00
		3 Lima	14.94	9.14	0.66
		4 Cleveland	19.96	11.48	0.54
	2 Kansas City (Traditional)	1 Norfolk	51.86*	12.47	0.00
		3 Lima	66.80*	7.45	0.00
		4 Cleveland	71.83*	6.39	0.00
	3 Lima (Self-Directed)	1 Norfolk	-14.94	9.14	0.66
		2 Kansas City	-66.80*	7.45	0.00
		4 Cleveland	5.03	6.71	1.00
	4 Cleveland (Traditional)	1 Norfolk	-19.96	11.48	0.54
		2 Kansas City	-71.83*	6.39	0.00
		3 Lima	-5.03	6.71	1.00

AWOL	1 Norfolk (Self-Directed)	2 Kansas City	-1.12*	0.34	0.01
		3 Lima	0.63	0.25	0.10
		4 Cleveland	0.35	0.32	1.00
	2 Kansas City (Traditional)	1 Norfolk	1.12*	0.34	0.01
		3 Lima	1.74*	0.21	0.00
		4 Cleveland	1.47*	0.18	0.00
	3 Lima (Self-Directed)	1 Norfolk	-0.63	0.25	0.10
		2 Kansas City	-1.74*	0.21	0.00
		4 Cleveland	-0.27	0.19	0.88
	4 Cleveland (Traditional)	1 Norfolk	-0.35	0.32	1.00
		2 Kansas City	-1.47*	0.18	0.00
		3 Lima	0.27	0.19	0.88
Productivity	1 Norfolk (Self-Directed)	2 Kansas City	-1.63	2.19	1.00
		3 Lima	2.18	1.61	1.00
		4 Cleveland	2.18	2.02	1.00
	2 Kansas City (Traditional)	1 Norfolk	1.63	2.19	1.00
		3 Lima	3.81*	1.31	0.04
		4 Cleveland	3.81*	1.12	0.01
	3 Lima (Self-Directed)	1 Norfolk	-2.18	1.61	1.00
		2 Kansas City	-3.81*	1.31	0.04
		4 Cleveland	0.01	1.18	1.00
	4 Cleveland (Traditional)	1 Norfolk	-2.18	2.02	1.00
		2 Kansas City	-3.81*	1.12	0.01
		3 Lima	-0.01	1.18	1.00
Cost	1 Norfolk (Self-Directed)	2 Kansas City	-0.08	0.09	1.00
		3 Lima	-.28*	0.06	0.00
		4 Cleveland	-0.05	0.08	1.00
	2 Kansas City (Traditional)	1 Norfolk	0.08	0.09	1.00
		3 Lima	-.19*	0.05	0.00
		4 Cleveland	0.03	0.04	1.00
	3 Lima (Self-Directed)	1 Norfolk	.28*	0.06	0.00
		2 Kansas City	.19*	0.05	0.00
		4 Cleveland	.23*	0.05	0.00
	4 Cleveland (Traditional)	1 Norfolk	0.05	0.08	1.00
		2 Kansas City	-0.03	0.04	1.00
		3 Lima	-.23*	0.05	0.00
Customer Satisfaction	1 Norfolk (Self-Directed)	2 Kansas City	-0.01	0.07	1.00
		3 Lima	-.21*	0.05	0.00
		4 Cleveland	.44*	0.06	0.00
	2 Kansas City (Traditional)	1 Norfolk	0.01	0.07	1.00
		3 Lima	-.20*	0.04	0.00
		4 Cleveland	.45*	0.04	0.00
	3 Lima (Self-Directed)	1 Norfolk	.21*	0.05	0.00
		2 Kansas City	.20*	0.04	0.00
		4 Cleveland	.65*	0.04	0.00
	4 Cleveland (Traditional)	1 Norfolk	-.44*	0.06	0.00
		2 Kansas City	-.45*	0.04	0.00
		3 Lima	-.65*	0.04	0.00

Engine Quality	3 Lima (Self-Directed)	4 Cleveland	-8.12	4.56	0.09
	4 Cleveland (Traditional)	3 Lima	8.12	4.56	0.09

Note. Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

Test of Moderation

The test of moderation permits the investigation of the relationship between dependent and independent variables when a third interactive variable is included and held constant (Hair, et al, 1998). In this instance the traditional work group independent variables are held constant and applied to see if the relationship between the self-directed team independent variables and the dependent performance metrics change given the interaction. For the test of moderation, unstandardized coefficients were used to allow direct comparison of coefficients relative to their explanatory power of the dependent variables. The t statistic in this test demonstrates the predictive statistical significance that the separate independent variables have on each dependent variable (Hair, et al, 1998). Scatter plot graphs were prepared from these data to demonstrate the linear line of fit and the bivariate effect on dependent performance variables (see Figures 2 – 14). Finally, a Z-test was performed to determine if the regression lines are significantly different. Significance infers a statistical difference in terms of the expected change in the outcome for a unit change in the predictor variable (Clogg, Petkova & Haritou,1995).

Separate tables are presented for automobile assembly (see Table 8) and engine manufacturing (see Table 9) below. Each table provides statistics relative to the test of moderation and the Z test.

Statistics relative to the test of moderation and the Z tests results in F-150 truck assembly plants are presented below in Table 8.

Table 8

Truck Assembly Team Effectiveness Predicting the Listed Dependent Variables and Moderation Testing

Dependent Variables	Norfolk			Kansas City			Regression Line Difference Test
	B	SEB	T	B	SEB	t	Z
Safety LTR	0.02	0.01	2.01	0.04	0.01	4.63**	-1.41
Safety SR	0.23	0.18	1.33	2.02	0.36	5.63**	-4.46*
AWOL	0.03	0.01	3.69	-0.03	0.01	-2.24	3.98*
Productivity	-0.04	0.06	-0.66	-0.05	0.11	-.43	.06
Cost	0.0003	0.001	-0.34	0.002	0.001	1.86	-1.63
Customer Satisfaction	-0.002	0.001	-1.53	-0.007	0.002	-2.68	2.24*

Note. * = p < .05, ** = p < .01

Statistics relative to the test of moderation and the Z tests results in engine manufacturing plants are presented below in Table 9.

Table 9

Engine Manufacturing Team Effectiveness Predicting Listed Dependent Variables and Moderation Testing

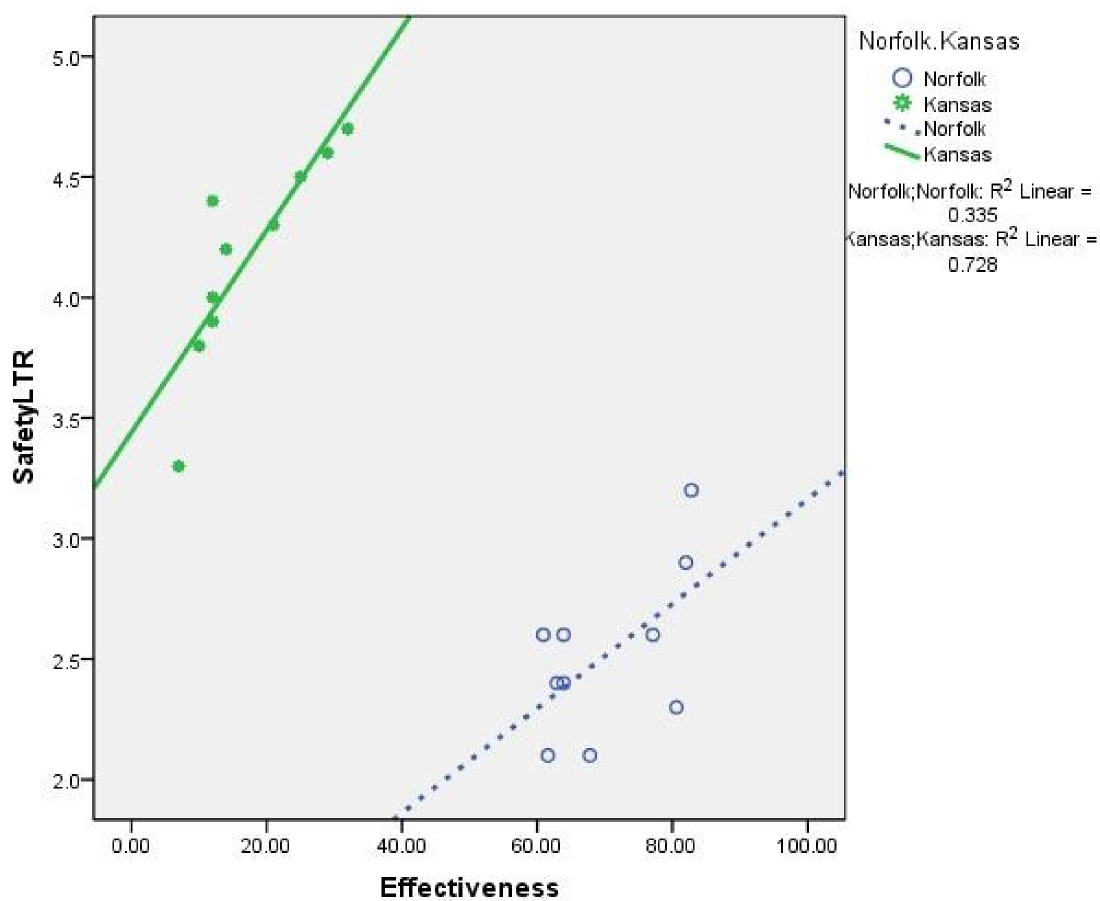
Dependent Variables	Lima			Cleveland			Regression Line Difference Test
	B	SEB	T	B	SEB	t	Z
Safety LTR	0.02	0.03	0.18	-0.001	0.005	-.19	.76
Safety SR	-0.75	0.40	-0.19	-0.72	0.02	-3.59**	-.008
AWOL	-0.01	0.01	-1.46	0.00	0.01	.79	-1.65*
Productivity	0.02	0.04	0.39	0.06	0.04	1.63	-.75
Cost	0.003	0.003	0.96	0.002	0.001	2.67*	.32
Customer Satisfaction	-0.003	0.002	-1.60	0.0002	0.0001	-2.12	-1.40
Engine Quality	-0.034	0.017	-2.03	-0.35	0.09	-3.76**	3.33*

Note. * = p < .05, ** = p < .01

The scatter plot graph below demonstrates the linear line of fit and the bivariate effect that truck assembly plant work structure has on lost time case rate (see Figure 2).

Figure 2

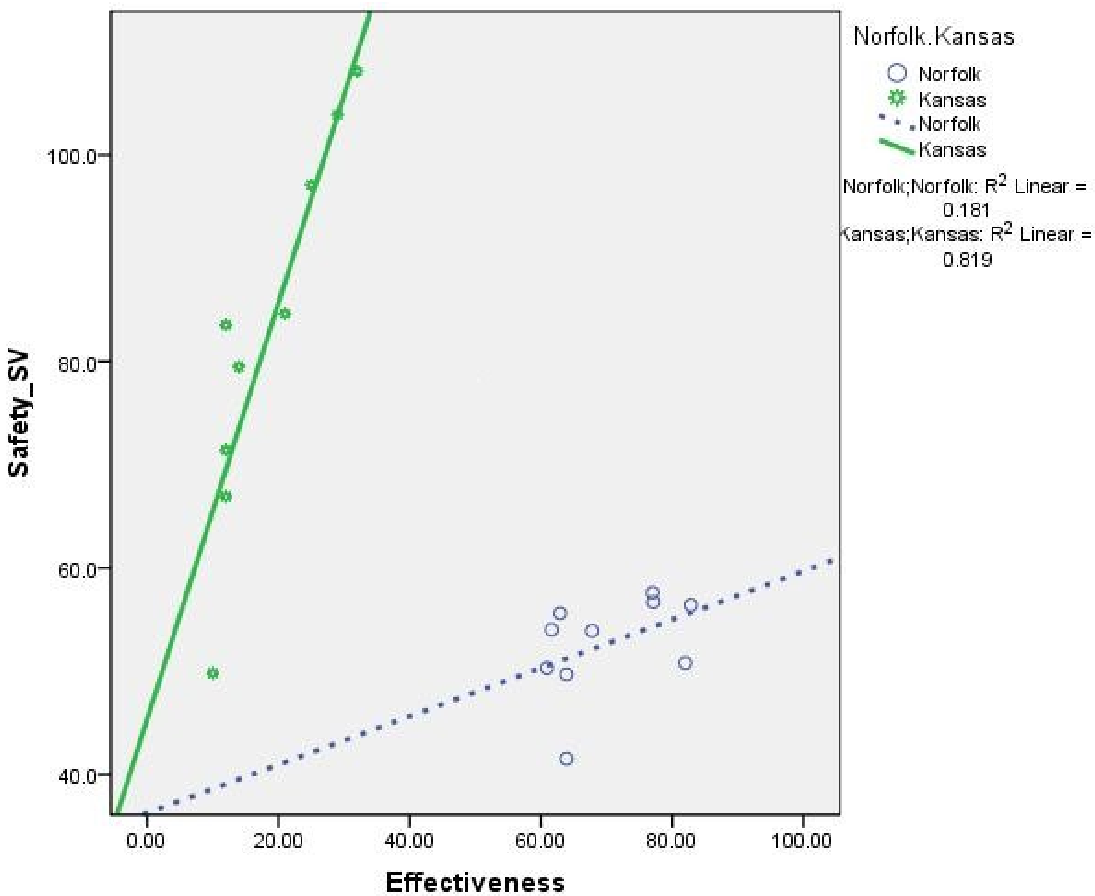
Bivariate Scatter Plot Regression Lines of Best Fit for Truck Assembly Plants – Work Team Effectiveness with Safety Lost Time Case Rate



The scatter plot graph below demonstrates the linear line of fit and the bivariate effect that truck assembly plant work structure has on injury severity rate (see Figure 3).

Figure 3

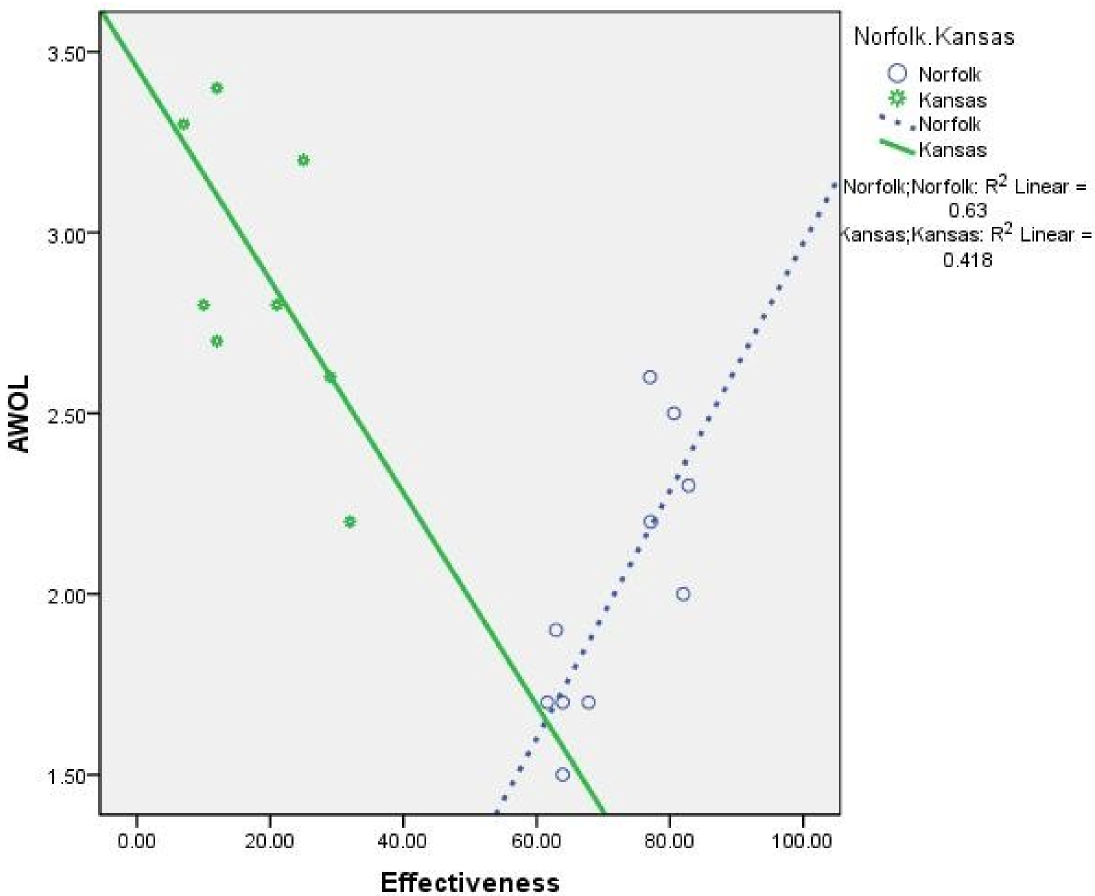
Bivariate Scatter Plot Regression Lines of Best Fit for Truck Assembly Plants – Work Team Effectiveness with Safety Severity Rate



The scatter plot graph below demonstrates the linear line of fit and the bivariate effect that truck assembly plant work structure has on employee absenteeism (see Figure 4).

Figure 4

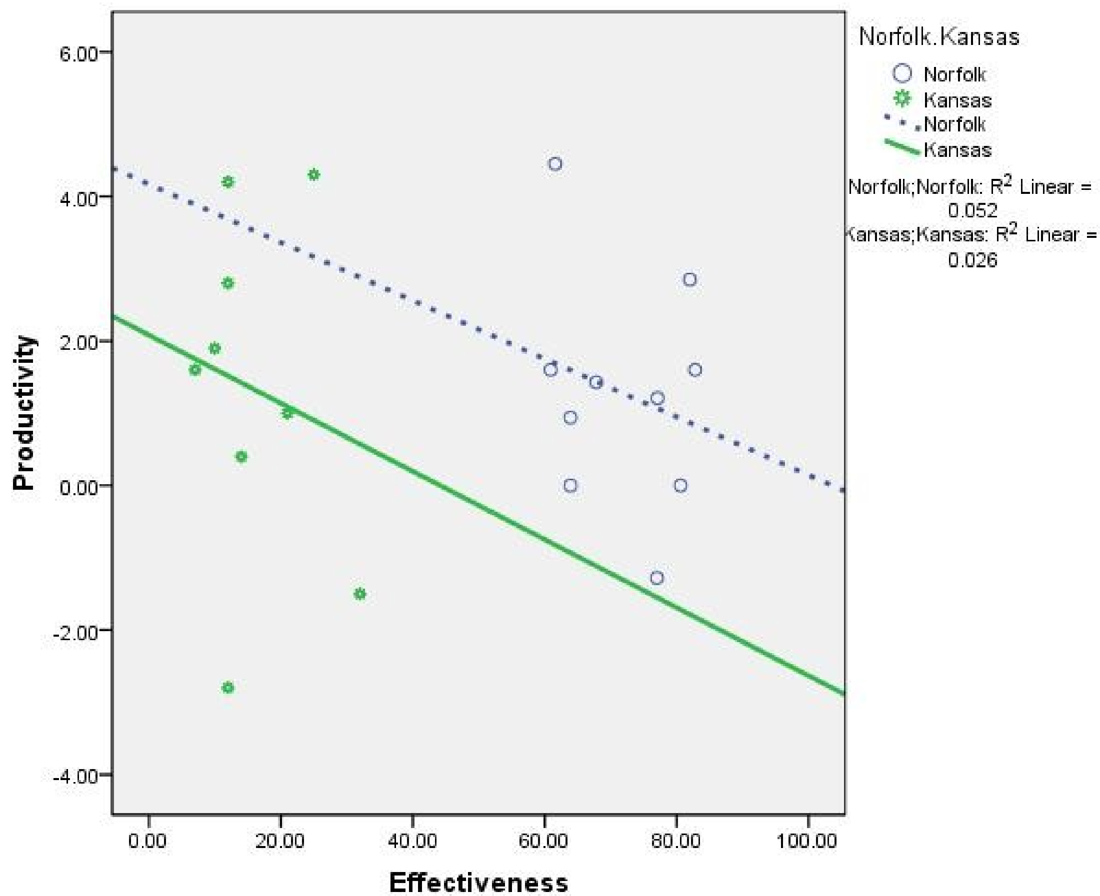
Bivariate Scatter Plot Regression Lines of Best Fit for Truck Assembly Plants – Work Team Effectiveness with Absence Without Leave Percentage



The scatter plot graph below demonstrates the linear line of fit and the bivariate effect that truck assembly plant work structure has on productivity (see Figure 5).

Figure 5

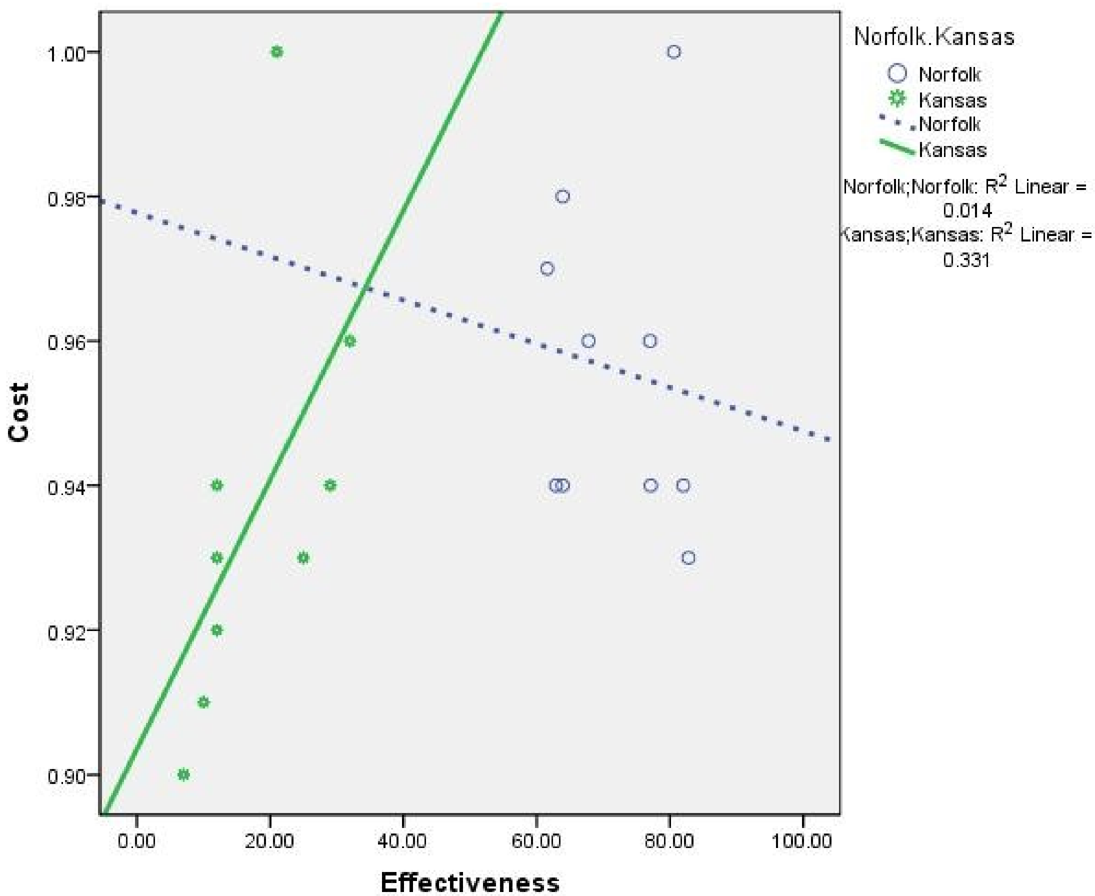
Bivariate Scatter Plot Regression Lines of Best Fit for Truck Assembly Plants – Work Team Effectiveness with Productivity Performance



The scatter plot graph below demonstrates the linear line of fit and the bivariate effect that truck assembly plant work structure has on cost performance (see Figure 6).

Figure 6

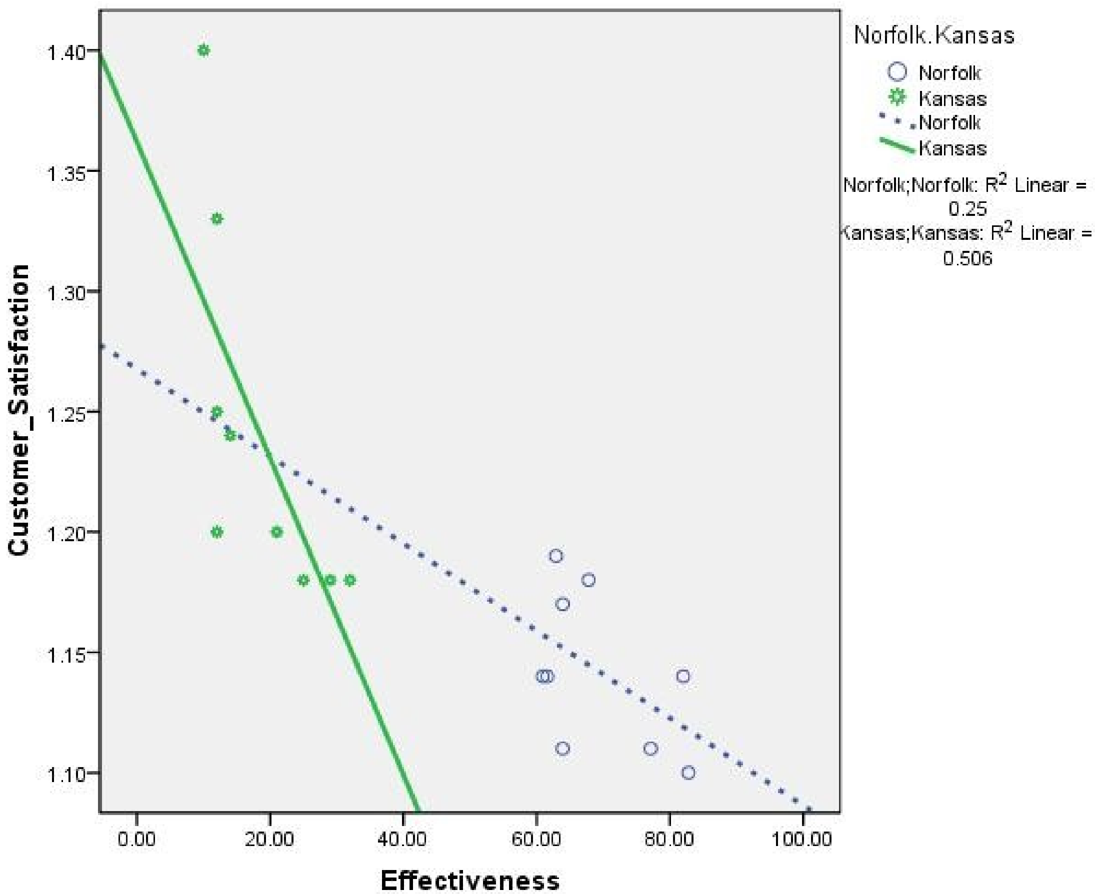
Bivariate Scatter Plot Regression Lines of Best Fit for Truck Assembly Plants – Work Team Effectiveness with Cost Performance



The scatter plot graph below demonstrates the linear line of fit and the bivariate effect that truck assembly plant work structure has on customer satisfaction (see Figure 7).

Figure 7

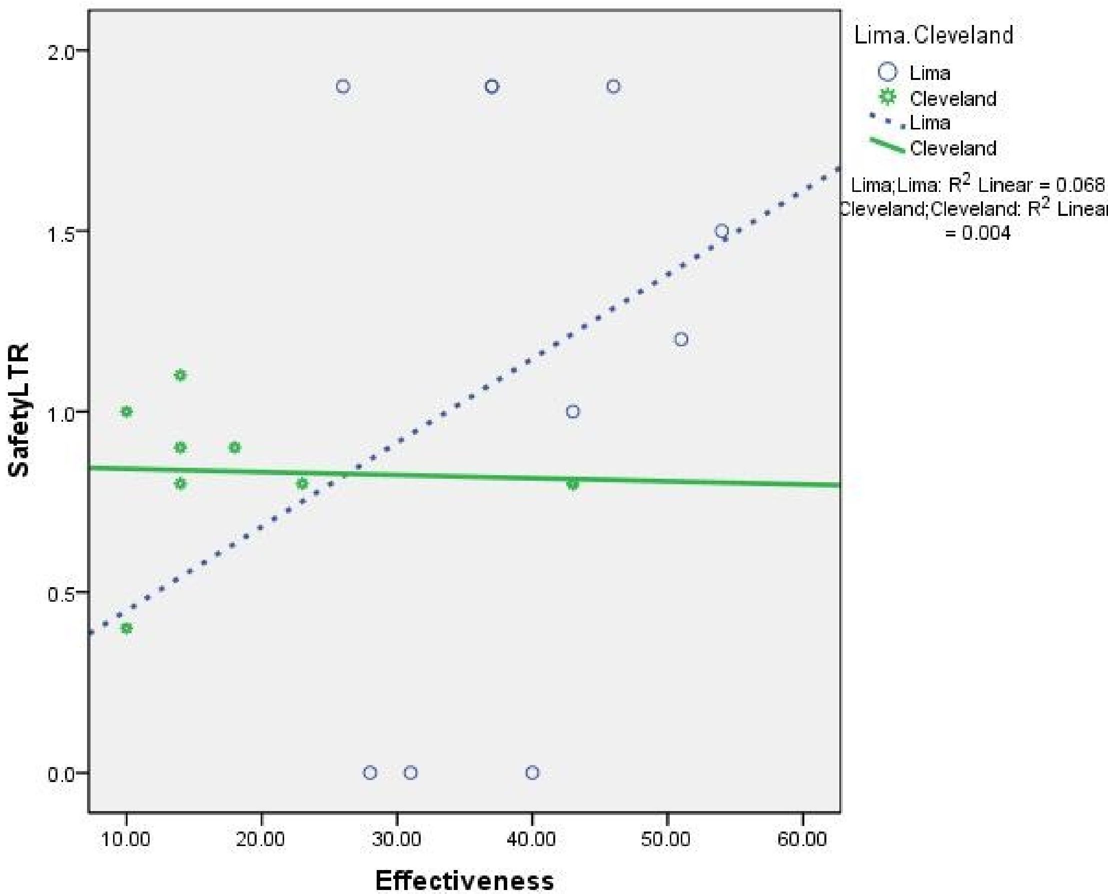
Bivariate Scatter Plot Regression Lines of Best Fit for Truck Assembly Plants – Work Team Effectiveness with Customer Satisfaction



The scatter plot graph below demonstrates the linear line of fit and the bivariate effect that engine manufacturing plant work structure has on lost time case rate. (see Figure 8).

Figure 8

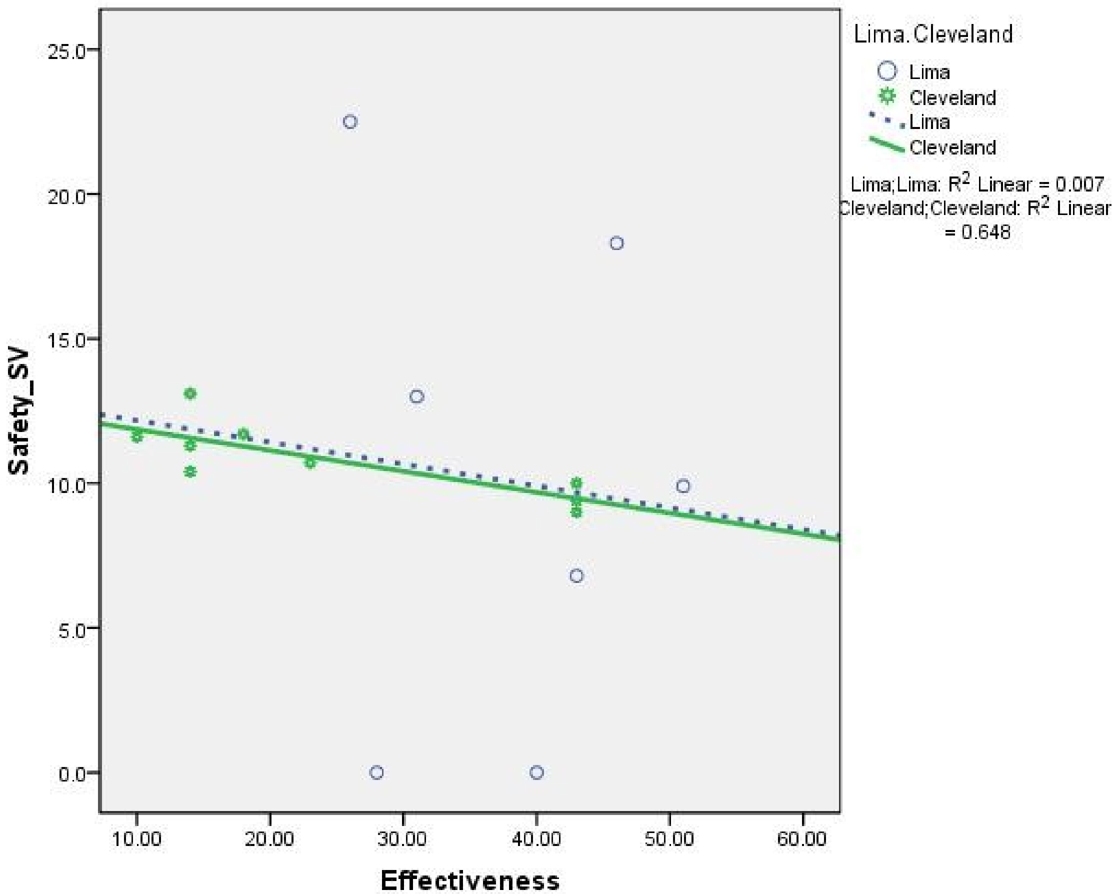
Bivariate Scatter Plot Regression Lines of Best Fit for Engine Manufacturing Plants – Work Team Effectiveness with Safety Lost Time Case Rate



The scatter plot graph below demonstrates the linear line of fit and the bivariate effect that engine manufacturing plant work structure has on injury severity rate. (see Figure 9).

Figure 9

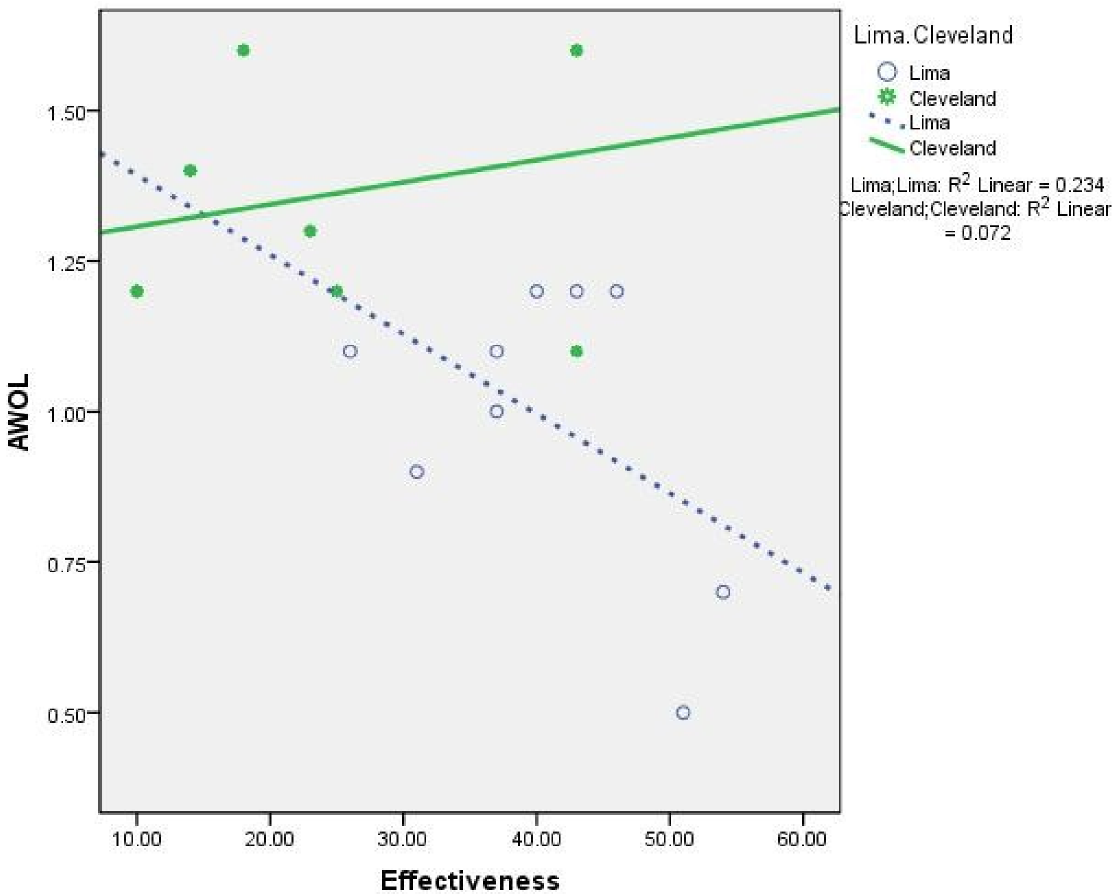
Bivariate Scatter Plot Regression Lines of Best Fit for Engine Manufacturing Plants – Work Team Effectiveness with Safety Severity Rate



The scatter plot graph below demonstrates the linear line of fit and the bivariate effect that engine manufacturing plant work structure has on employee absenteeism. (see Figure 10).

Figure 10

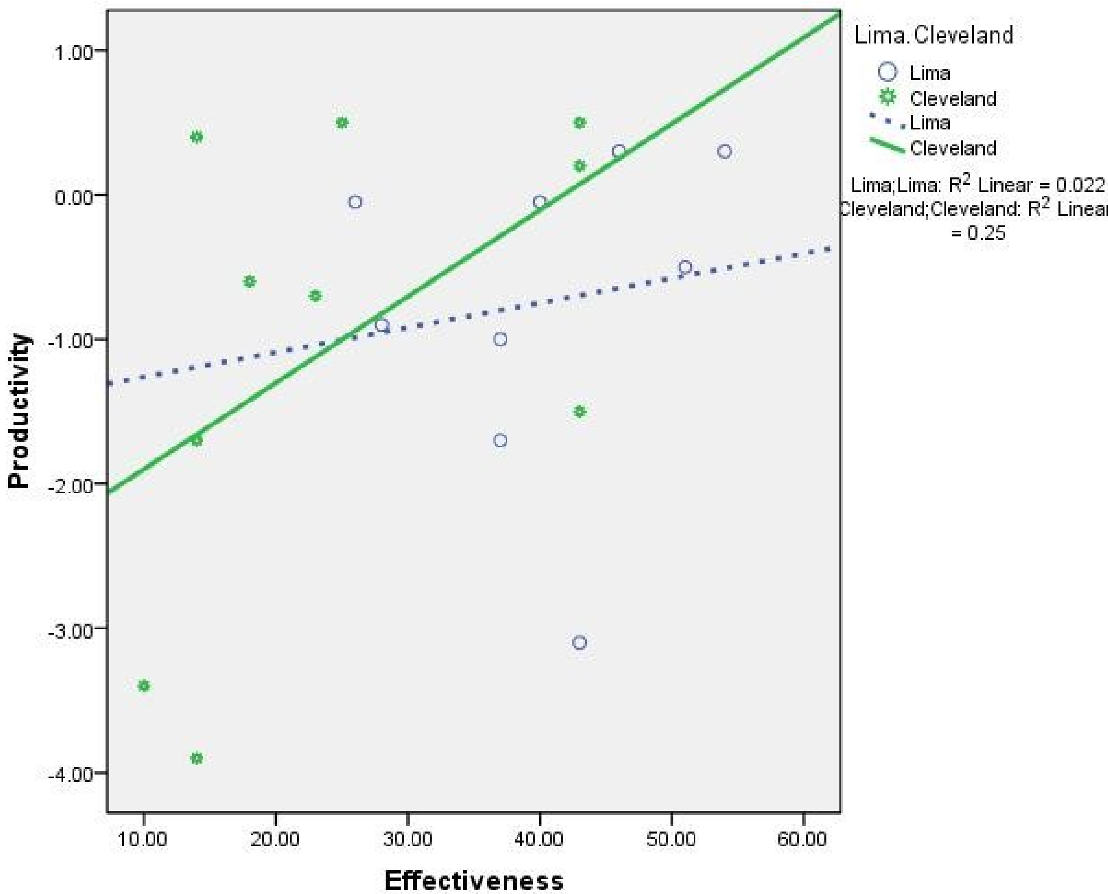
Bivariate Scatter Plot Regression Lines of Best Fit for Engine Manufacturing Plants – Work Team Effectiveness with Absence Without Leave Percentage



The scatter plot graph below demonstrates the linear line of fit and the bivariate effect that engine manufacturing plant work structure has on productivity (see Figure 11).

Figure 11

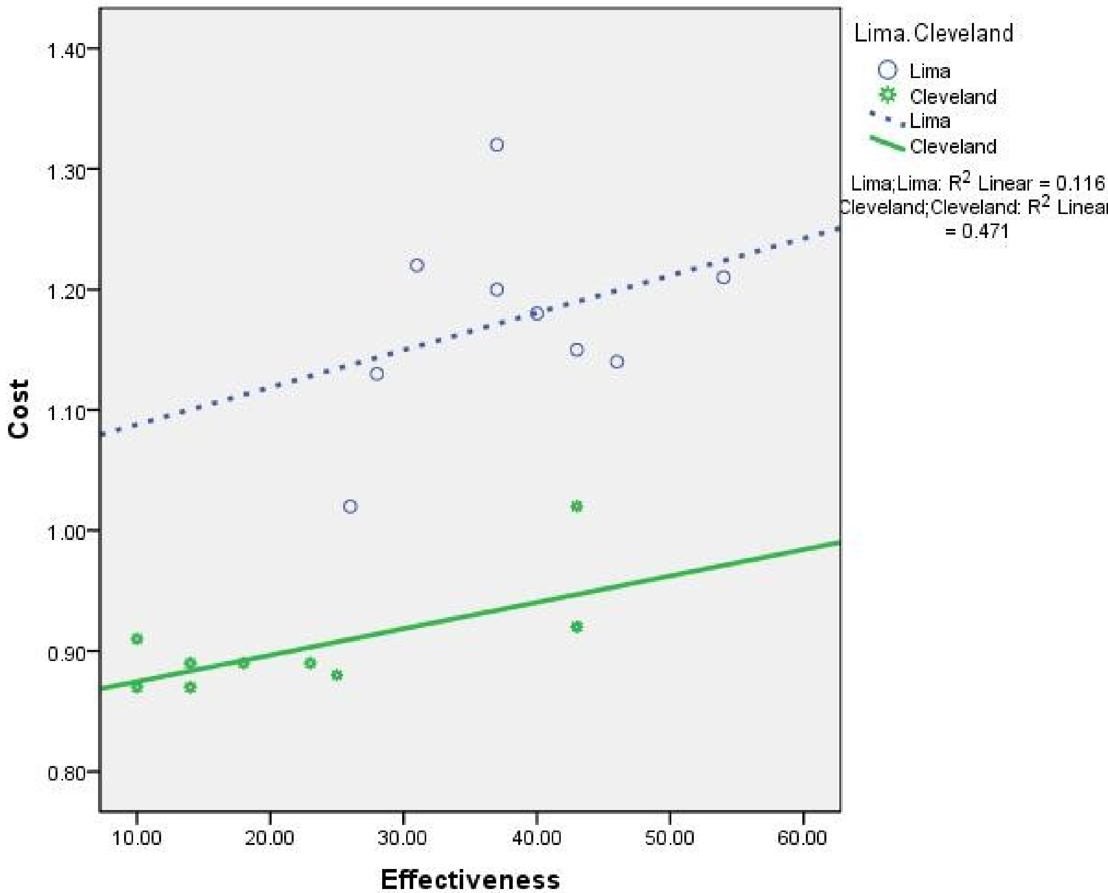
Bivariate Scatter Plot Regression Lines of Best Fit for Engine Manufacturing Plants – Work Team Effectiveness with Productivity Performance



The scatter plot graph below demonstrates the linear line of fit and the bivariate effect that engine manufacturing plant work structure has on cost performance (see Figure12).

Figure 12

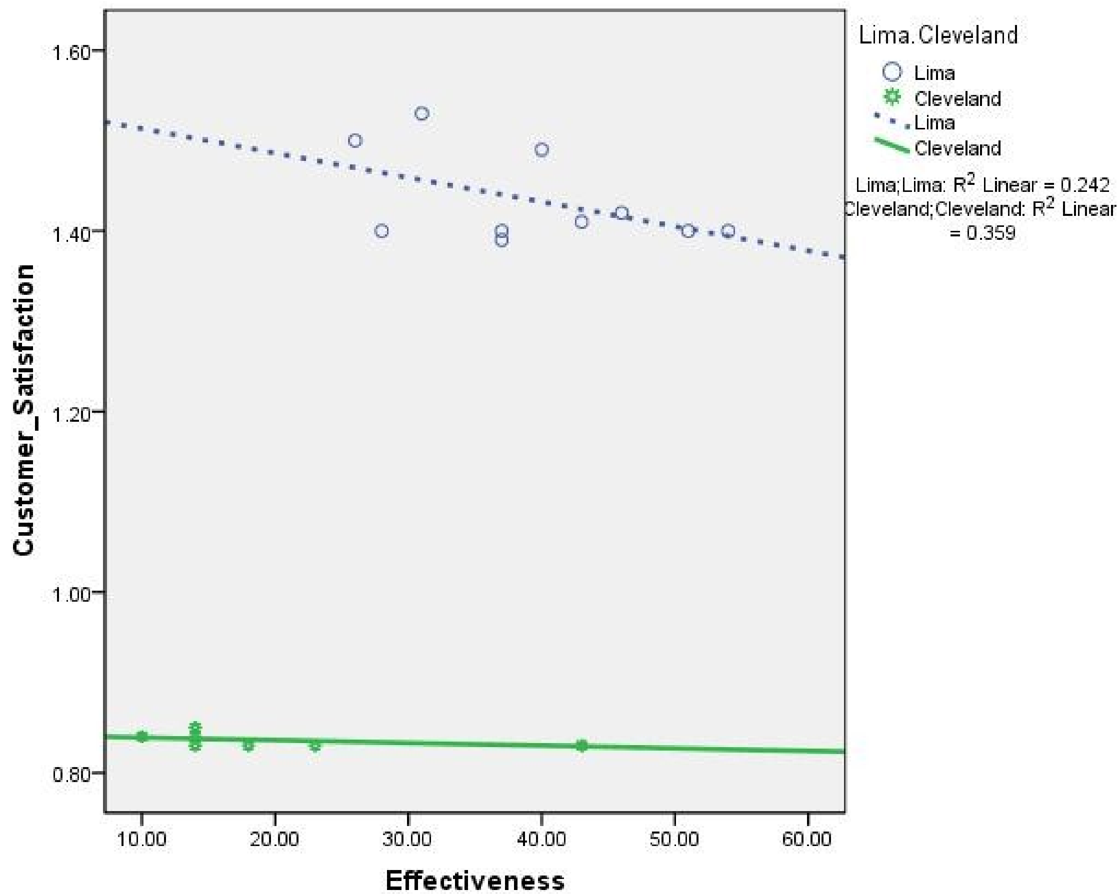
Bivariate Scatter Plot Regression Lines of Best Fit for Engine Manufacturing Plants – Work Team Effectiveness with Cost Performance



The scatter plot graph below demonstrates the linear line of fit and the bivariate effect that engine manufacturing plant work structure has on customer satisfaction (see Figure13).

Figure 13

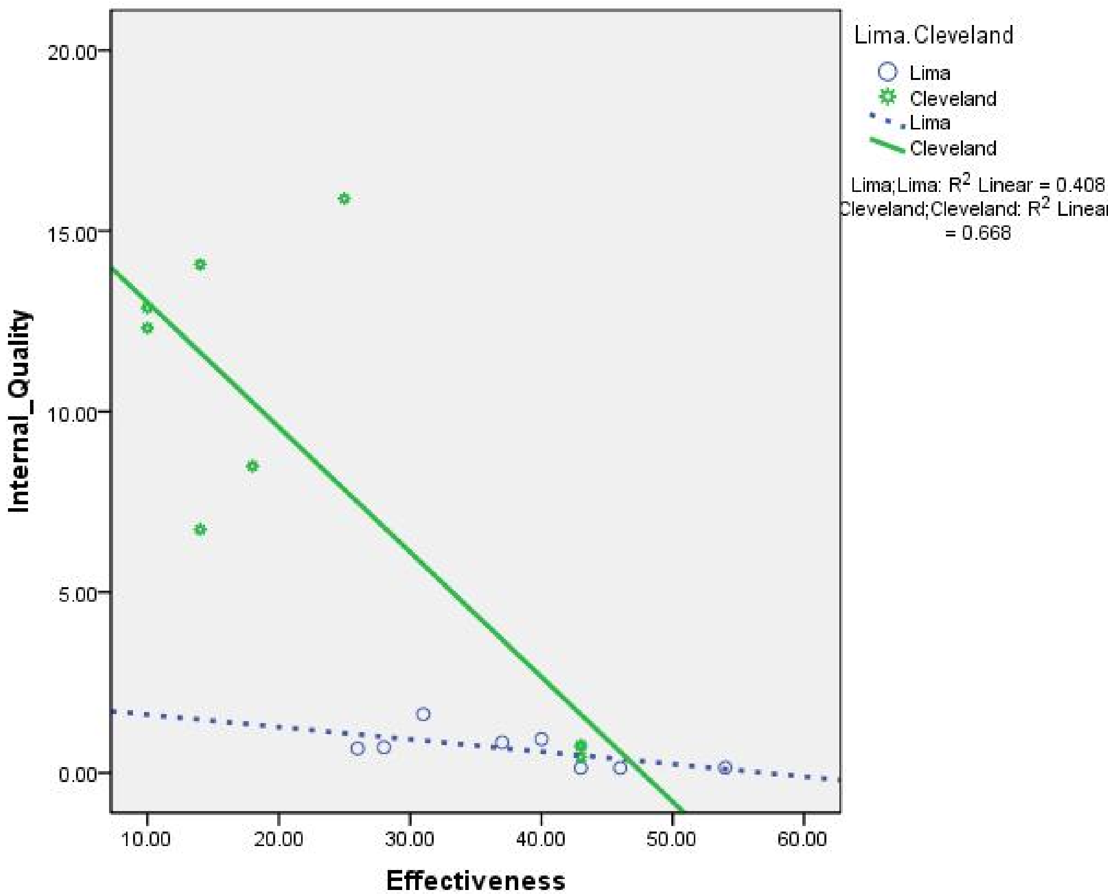
Bivariate Scatter Plot Regression Lines of Best Fit for Engine Manufacturing Plants – Work Team Effectiveness with Customer Satisfaction



The scatter plot graph below demonstrates the linear line of fit and the bivariate effect that engine manufacturing plant work structure has on engine manufacturing quality (see Figure14).

Figure 14

Bivariate Scatter Plot Regression Lines of Best Fit for Engine Manufacturing Plants – Work Team Effectiveness with Engine Quality



Hybrid Structural Equation Model

A Hybrid Structural Equation Model (SEM) is used to further test and predict relationships between dependent and independent variables as well as relationships within dependent performance variables. Structural equation modeling is a statistical technique that permits the estimation of causal relationships by combining statistical data and qualitative causal assumptions posed by the researcher (Hair, et al, 1998). In this instance the Hybrid SEM statistical procedure will reveal the predictive magnitude that each interrelated performance variable has on customer satisfaction and work group effectiveness. The statistical performance data and structural model are displayed below respectively in Table 10 and Figure 15. The raw path coefficient for AWOL, a morale metric which means absence without leave, was set at 1.0 to establish the model identification and eliminate unidentified model errors. Fitness tests for the model were performed and the results are acceptable. The Comparative Fit Index (CFI) is .901 and the Root Mean Square Error of Approximation is .200.

The statistical data from the hybrid SEM are displayed below in Table 10.

Table 10

Regression Coefficient Estimates of the Structural Model

Performance Variable	Standardized Beta Coefficients	*P*
Safety LTR	1.07	.00*
Safety SR	0.83	.00*
AWOL	0.72	
Productivity	0.64	.00*
Cost	0.00	.55
Customer Satisfaction	0.53	.00*
Work Team Effectiveness	0.12	.21

Note. * $p < .05$

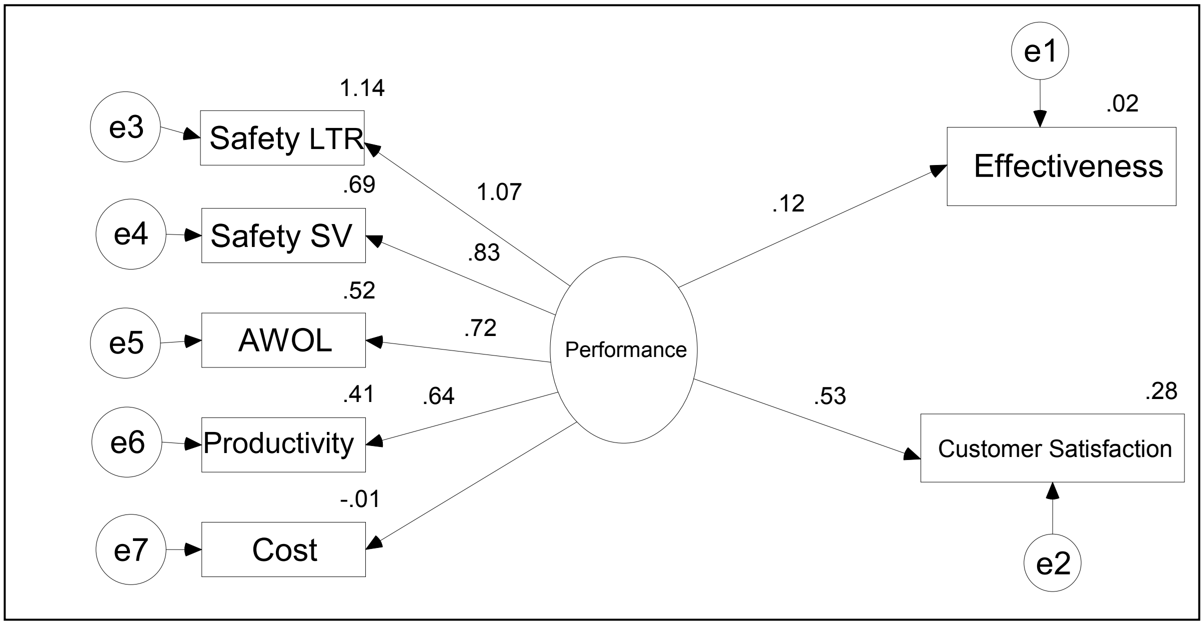
The AWOL raw path coefficient is set at 1.0 for model identification.

Model fit tests are acceptable (CFI = .90, RMSEA =.20).

The structural equation model below (Figure 15) displays the predictive relationships that each interrelated performance variable has on customer satisfaction and work group effectiveness.

Figure 15

Hybrid Structural Equation Model



Chapter 4 presented the statistical results from the research methodology applied in preparing answers to the nine research questions posed in this study. The tables and figures prepared for this chapter will be most helpful in the meaningful interpretation and application of the data in answering the questions and drawing evocative conclusions regarding work team effectiveness and customer satisfaction.

Chapter 5 will discuss the findings of the study based on statistical significance or the lack thereof. Potential improvements or expansion for future research will also be reviewed.

CHAPTER 5 DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

Introduction

Many companies and organizational development professionals speculate that self-directed work structures foster improved productivity and quality (Rosenthal, 2001). Some surmise that team structures improve morale by considering the diverse opinions of its members (Moseley & Dessinger, 2007). Improved morale could in-turn positively affect absenteeism, injuries on the job and productivity. Furthermore, work teams could impact product innovations that meet market and customer demands (Tata, 2000). Some companies now invest equally in technology, production methods and work team implementation strategies to achieve the aforementioned benefits that impact the bottom line. The latest technology, equipment or material is no substitute for the ability and creativity of satisfied people, successfully and safely working together (Ford Motor Company Communications, 1995).

Work teams, as defined in this research, are groups of individuals with common goals and objectives that are empowered to affect decision-making and problem solving processes with accountability. Effective work groups are built around capable, motivated and empowered people who trust and rely on each other (Cicerone, 2009). The keys to making work group principles work effectively are education, training and communication (Harris, 2009).

It takes a considerable amount of time and money to facilitate and implement effective self-directed work structures. This study compared self-directed work structures to more traditional supervised work structures to determine if they perform differently. Four separate North American Ford Motor Company manufacturing plants were examined to compare the impact that plant work structures have on critical internal performance metrics. By comparing performance metrics and customer satisfaction data from similar plants with distinctly different work structures, this research isolated the impact that work structure has on performance in the areas of safety, cost, productivity, quality and employee morale.

The findings discussed in this chapter are useful for organizations when establishing or re-instituting work structures within business or educational institutions. The statistical analysis and conclusions may help organizational leaders determine if the time, effort and financial commitment that go into facilitating effective self-directed work teams in lieu of traditional work structures deliver a worthwhile return on investment in terms of performance and customer satisfaction.

Research Questions

1. Does the presence of effectively rated self-directed work teams affect injury frequency?

2. Does the presence of effectively rated self-directed work teams affect injury severity?

3. Does the presence of effectively rated self-directed work teams affect unexcused absenteeism?

4. Does the presence of effectively rated self-directed work teams affect productivity?

5. Does the presence of effectively rated self-directed work teams affect cost performance?

6. Does the presence of effectively rated self-directed work teams affect external quality and customer satisfaction?

7. Does the presence of effectively rated self-directed work teams affect internal engine manufacturing quality?

8. Are Safety LTR, Safety SV, AWOL, Productivity, and Cost statistically significant predictors of Customer Satisfaction?

9. Are Safety LTR, Safety SV, AWOL, Productivity, and Cost statistically significant predictors of Work Team Effectiveness?

Question Number 1

Does the presence of effectively rated self-directed work teams affect injury frequency or OSHA lost time case rate (LTR)?

Two separate U.S. Occupational Safety and Health Administration (OSHA) metrics were used to evaluate Ford's safety performance. The first metric is Lost Time Case (LTR) Rate that examines the frequency with which employees get injured or become ill. The second metric is Severity Rate (SR) which probes further to determine the seriousness of the injuries or illnesses. The same metrics are used in the safety performance analysis in assembly plants and engine manufacturing plants.

The Null hypothesis suggests that no difference exists in lost time case rate performance between plants with different work structures. The alternative hypothesis (H1) predicts that there is a significant difference in Lost Time Case

(LTR) Injury Rate experience between effective self-directed work teams and supervised work groups.

A review of the descriptive statistics for safety lost time case rate (LTR) indicates that the raw mean for self-directed work teams in Norfolk Truck Assembly Plant are lower than the LTR for more traditional work groups in Kansas City Truck Assembly Plant. This is the result that was anticipated since self-directed work teams have the ability to affect change and make improvements in their work environment (Nichol, 2000). Oppositely self-directed teams in Lima Engine Plant experienced more lost time cases than did the more traditional workforce at Cleveland Engine Plant II.

The multivariate test of covariance (MANCOVA) was performed to uncover the main and interactive effects of the work group independent variables on the dependent performance variables. The key statistic is the F-test that indicates if the differences in group means are different enough not to have occurred by chance (Hair, et al, 1998). Pillai's Trace multivariate test for all groups demonstrates a large effect size and accounts for sixty-seven percent of the mean differences between plants (Pillai's Trace = 2.001, F = 12.01, df = 18, 108, p = .000, η^2 = .075). This test result justifies additional multiple comparison tests for the safety lost time case rate performance variable. In the comparison of LTR performance in all plants taking effectiveness as a covariate, the performance difference among plants remains significant (F = 94.28, df = 3, 39, $p < .01$, η^2 = .88). This univariate test result validates further comparison to explore which independent variable has the most influence on the dependent variables (Hair, et al, 1998).

In comparing the dependent LTR performance variables across and within independent variable groups pair-wise, conclusions can be drawn that Norfolk is generally different than Kansas City, Lima and Cleveland. The largest mean difference between Norfolk and Kansas City is the most statistically significant difference. Differences with Cleveland and Lima are also significant; however, the difference with Lima has the weakest significance in this pair-wise comparison. Lima, like Norfolk, has a self-directed workforce.

When comparing the dependent LTR performance variables for Kansas City against Lima and Cleveland pair-wise, Kansas City is widely different from both. The differences for both plants are also statistically significant.

The final pair-wise comparison to be made, before this four-way comparison becomes redundant, compares Lima Engine Plant and Cleveland Engine Plant II. A narrow mean difference exists between these two engine manufacturing plants and the difference between the two is not statistically significant.

The test of moderation permits the investigation of the relationship between the LTR dependent variable and Norfolk's work team effectiveness independent variable while applying Kansas City's effectiveness rating in the interactive analysis. This allows comparison of the relative explanatory power of work team effectiveness predictors on dependent LTR performance variables (Hair, et al, 1998). The t statistic for Norfolk Assembly does not statistically support the predictive power of work team effectiveness on injury frequency. However, the t statistic supports that Kansas City's work team effectiveness is a good predictor of injury frequency or LTR ($p < .01$).

The scatter plot diagrams prepared from the 2004 data from Norfolk and Kansas City Truck Assembly Plants show bivariate linear lines of fit for the effects of work team effectiveness on lost time case rate. Both lines of best fit similarly trend which indicates that injury frequency increases as team effectiveness ratings improve. Although not the intended effect, in both Norfolk and Kansas City it appears that higher work team effectiveness predicts higher lost time case rates.

Finally, a Z-test was performed on the regression lines to determine if the projections are significantly different (Clogg, et al, 1995). In this instance the regression lines were not significantly different. Although effectively rated self-directed teams in Norfolk Truck Assembly Plant experienced fewer lost time cases than Kansas City Assembly throughout 2004, statistically there is no difference in the expected change in the outcome for a unit change in the predictor variable.

The test of moderation results from interactions between the LTR dependent variable and Lima Engine's work team effectiveness independent variable with Cleveland Engine's performance as an independent moderator variable do not predict similar results found in truck assembly plants. The interactive analysis of effectiveness ratings on LTR performance and subsequent scatter plot diagrams display a negative effect when comparing Lima and

Cleveland. This suggests that as work team effectiveness increases in Lima so does the frequency of injuries. Alternatively, injuries rates remain relatively constant as team effectiveness increases in Cleveland. Statistically, however, the interaction between these engine plants is not significant. Neither plant has a t statistic that supports the predictive power of work team effectiveness on LTR. The Z-test further confirms the insignificance of any difference in terms of expected change in the outcome for a unit change in the predictor variable.

It is counter intuitive to speculate that work team effectiveness could somehow increase the frequency of lost time injuries, although that is what statistical tests suggest. However, when taking the source of the effectiveness ratings into consideration, one might see a contradictory influence. In this study plant team members rated themselves on a monthly basis with regard to team effectiveness. Injuries or crisis in the workplace can provide a battle call for team members to rally around and bring attentive care to situations. Both could influence the perception of work team effectiveness. This sentiment is supported by research trends indicating that employees are increasingly drawing a stronger connection to work and life satisfaction (Joyce, et al, 2003).

Question Number 2

Does the presence of effectively rated self-directed work teams affect injury frequency or OSHA severity rate (SR)?

The second metric used to evaluate Ford’s safety performance is Severity Rate (SR). Severity rate provides an indication of the seriousness of the injuries or illnesses. The same metric is used in the analysis of safety performance in assembly plants and engine manufacturing plants.

The Null hypothesis suggests that no difference exists in severity rate performance between plants with different work structures. The alternative hypothesis (H2) predicts that there is a significant difference in injury and illness severity rate experience between effective self-directed work teams and supervised work groups.

The descriptive statistics for safety severity rate demonstrate that the raw mean for self-directed work teams in Norfolk Truck Assembly Plant are lower than the SR for more traditional work groups in Kansas City Truck Assembly Plant. To the contrary self-directed teams in Lima Engine Plant experienced a slightly higher severity rate than did the more traditional workforce at Cleveland Engine Plant II; thus, suggesting that Cleveland experienced less serious injuries than did Lima Engine.

To uncover the main and interactive effects of the work group independent variables on dependent performance variables, a multivariate test of covariance (MANCOVA) was performed. The F-test statistic for all scenarios indicates that the differences in group means are different enough not to have occurred by chance (Hair, et al, 1998). Pillai's Trace multivariate test for all groups demonstrates a large effect size (Pillai's Trace = 2.001, F = 12.01, df = 18, 108, $p = .000$, $\eta^2 = .075$). The results justify additional multiple comparison tests for the safety severity rate performance variable. In comparing SV rate performance in all plants taking effectiveness as a covariate, performance differences among plants remain significant (F = 49.47, df = 3, 39, $p < .01$, $\eta^2 = .79$), which validates further comparisons to explore which independent variable has the most influence on the dependent variables (Hair, et al, 1998).

In the pair-wise comparison of dependent severity rate (SR) performance variables across and within independent variable groups, one finds that the mean difference between the like assembly plants of Norfolk and Kansas City is quite large and statistically significant. This points out that Kansas City experienced more lost time days per recordable incident in 2004 than did self-directed work teams in Norfolk Assembly. The Norfolk mean difference comparison to Lima and Cleveland Engine Plants are sensibly different but are not statistically significant.

In comparing the dependent SR performance variables for Kansas City against Lima and Cleveland pair-wise, one can see that Kansas City is vastly different from both plants indicating that KC assembly had more lost time workdays per incident than both engine plants. The differences in both circumstances are also statistically significant.

In the last pair-wise comparison for the SR dependent variable, Lima Engine Plant and Cleveland Engine Plant II are compared. The mean difference in severity rate in the like engine manufacturing plants is narrow. Although traditional work groups in Cleveland had fewer lost time days per incident than self-directed teams in Lima, the difference between the two plants is not statistically significant.

To compare the relative explanatory power of work team effectiveness predictors on dependent SR performance variables in Norfolk and Kansas City assembly plants, a test of moderation was performed. The t statistic for Norfolk Assembly does not statistically support the predictive power of work team effectiveness on injury severity. However, the t statistic for work team effectiveness in Kansas City is statistically supported ($p < .01$) as a fine predictor of injury severity or SV performance.

The scatter plot diagrams comparing Norfolk and Kansas City Truck Assembly Plant regression lines show similar trends though Norfolk had a lower severity rate within self-directed work teams. The trend indicates that as injury severity rate increases, work team effectiveness ratings improve. Z-test results of the regression line projections confirm that difference in the expected change in SR for a unit change in truck assembly plant work team effectiveness is statistically significant.

To conclude the analysis of safety performance, the test of moderation was performed on the relationships between the SR dependent variable and Lima Engine Plant's work team effectiveness independent variable when applying Cleveland's effectiveness rating in the interactive analysis. While the t statistic for Lima does not statistically predict a change in severity rate performance based on work team effectiveness, the t statistic for Cleveland Engine II does. Work team effectiveness in Cleveland is a good predictor of injury severity or SR ($p < .01$).

Scatter plot diagrams prepared from Lima and Cleveland Engine Plants depict nearly identical lines of fit. The trends suggest that work team effectiveness increases as the severity rate decreases in both plants, which is optimal. However, the Z-test challenges the significance of any difference in terms of the expected change in the SV rate for a unit change in the work group effectiveness.

The results from the severity rate analysis in the truck assembly plants and engine manufacturing plants are contradictory. In engine manufacturing the desired effect of injury severity rate reduction was observed as work team effectiveness improves. This supports the premise that team members want to influence outcomes positively (Axelrod, 2002). In the truck assembly plants, severity rate increased while work team effectiveness improved. This result is similar to trend results observed for lost time case rate in truck plants.

Throughout this evaluation of work team effectiveness and its impact on injury experience, differing levels of safety performance were observed. As metrics were tested with more specificity some differences that appeared significant in descriptive, covariate and pair-wise comparisons fell away. Without question Norfolk's self-directed work teams enjoyed fewer lost time injuries (LTR) and lower severity rate (SR) than did Kansas City's more traditional work groups. Yet only KC's t statistics supported the negative predictive power that work team effectiveness has on injury experience. When evaluating the difference between engine manufacturing plants the dissimilarity is more subtle. Only Cleveland Engine's t statistic demonstrated a positive predictor that work team effectiveness can reduce injury severity rate. In the end only one Z test confirmed that the severity rate performance difference between self-directed teams in

Norfolk and more traditional work groups in Kansas City Truck Assembly Plants was statistically significant.

Question Number 3

Does the presence of effectively rated self-directed work teams affect unexcused absenteeism?

The issue of employee morale is clearly the center of this study. Two separate morale related metrics were examined with the key variable being work team effectiveness which is an independent predictor variable. Employee absenteeism or absence without leave (AWOL) rate is the second morale metric and is a dependent performance variable. Absentee rates provide an indication of employee commitment and job satisfaction. The same absentee metrics are used in the morale performance analysis in assembly plants and engine manufacturing plants.

The Null hypothesis suggests that there is no difference in AWOL rate performance between plants with different work structures. The alternative hypothesis (H3) predicts that there is a significant difference in unexcused absenteeism between effective self-directed work teams and supervised work groups.

The descriptive statistics for morale measured by controllable employee absence or absence without leave (AWOL) data demonstrate that the raw mean for self-directed work teams in Norfolk Truck Assembly Plant are lower than the AWOL mean for more traditional work groups in Kansas City Truck Assembly Plant. Likewise, self-directed teams in Lima Engine Plant had a lower AWOL mean than did the more traditional workforce at Cleveland Engine Plant II. In both instances this suggests descriptively that plants with effective self-directed work teams experience better employee attendance than more traditional supervised workforces.

A multivariate test of covariance (MANCOVA) was performed to uncover the main and interactive effects of the work group independent variables on the dependent AWOL rate performance variables. The F-test indicated that the differences in group means are different enough not to have occurred by chance (Hair, et al, 1998). Pillai's Trace multivariate test for all groups demonstrated a large effect size (Pillai's Trace = 2.001, F = 12.01, df = 18, 108, $p = .000$, $\eta^2 = .075$). This test result justifies additional multiple comparison tests for the AWOL rate performance variable. In the comparison of AWOL performance in all plants taking effectiveness as a covariate, the performance difference among plants remains significant (F = 35.44, df = 3, 39, $p < .01$, $\eta^2 = .73$), which validates further comparison to explore which independent variable has the most influence on dependent AWOL performance variables.

In comparing the dependent AWOL performance variables pair-wise within and across independent variable groups, we find that Norfolk is generally different from Kansas City, and slightly different from Lima and Cleveland. The largest mean difference exists between Norfolk and Kansas City and is statistically significant. The negative relationship infers that Norfolk has fewer controllable absences. Positive differences between Norfolk and the engine plants in Cleveland and Lima indicate that the engine plants have few AWOLs than both Norfolk and Kansas City assembly. Neither of these differences is statistically significant.

Upon comparing the dependent AWOL performance variables for Kansas City against Lima and Cleveland pair-wise, evidence is revealed suggesting that Kansas City is broadly different from both. The positive differences indicate that both of the engine plants enjoy fewer controllable absences than Kansas City assembly. Both differences are statistically significant.

Finally, the pair-wise comparison between Lima Engine Plant and Cleveland Engine Plant II demonstrate the narrowest mean difference in the comparison sets with self-directed teams in Lima having a lower AWOL rate than Cleveland. The narrow difference between like engine manufacturing plants is not statistically significant.

In the test of moderation between the AWOL dependent variable and Norfolk's work team effectiveness independent variable, Kansas City's effectiveness rating is applied in the interactive analysis. Similarly a test is performed between the AWOL dependent variable and Lima's work team effectiveness variable while applying Kansas City's effectiveness rating in the interactive analysis. These tests of moderation permit comparison of the relative predictive power that work team effectiveness has on dependent AWOL performance variables (Hair, et al, 1998). The t statistics for all four plants fail to statistically support the predictive power of work team effectiveness on AWOL rate.

The scatter plot diagrams prepared from the 2004 AWOL data in Norfolk and Kansas City assembly plants and Lima and Cleveland Engine manufacturing plants display opposing bivariate linear lines of fit for the effects of work team effectiveness on absentee rates. In Norfolk and in Cleveland, the AWOL rate increases as work team effectiveness improves. Alternatively in Kansas City and Lima, as work team effectiveness improves AWOL absence is reduced. While self-directed work teams in Norfolk and Lima had fewer absences and higher effectiveness ratings overall than Kansas City and Cleveland, only Lima and KC demonstrated the desired outcome of absence reduction with work team effectiveness improvements. This result supports the suggestion that a positive correlation exists between employee's commitment to their goals and the probability of their goal achievement (Liccione, 2009). The Z-test performed on the regression lines between Norfolk and KC truck assembly and between Lima and Cleveland Engine manufacturing both designate respectively that the projections are significantly different (Clogg, et al, 1995). The significance suggests that a unit difference in the expected AWOL rate change can be anticipated for a unit change in the work team effectiveness predictor variable.

In the analysis of AWOL rate performance descriptive and pair-wise comparison statistics illustrate that plants with higher work team effectiveness ratings have fewer unexcused absences. The t statistic, nevertheless, failed to confirm the predictive power that work team effectiveness has on plant AWOL rates. The Z test did however indicate that significant regression line difference exists between matched engine plants and assembly plants. This means that a change in work team effectiveness could bring about change in employee absenteeism.

Question Number 4

Does the presence of effectively rated self-directed work teams affect productivity?

Productivity is measured as actual plant output in finished goods versus defined production capability targets. Separate but similar metrics were used for engine manufacturing plants and for vehicle assembly plants. Production to schedule gains and misses is an internal operational metric used to measure engine plant productivity. Similarly, production to schedule is the metric used to assess truck assembly plant productivity.

The Null hypothesis suggests that no difference exists in productivity performance between plants with different work structures. The alternative hypothesis (H4) predicts that there is a significant difference in productivity between effective self-directed work teams and supervised work groups.

A review of the descriptive statistics for productivity performance indicates that the raw mean for both truck assembly plants is positive and is, therefore, productive above output goals. The performance in self-directed work teams at Norfolk Assembly appears to be more productive than in more traditional work groups at Kansas City Assembly Plant. Productivity performance in both engine manufacturing plants is negative and is less productive than desired. Lima Engine Plant's productivity is less negative and closer to production goals than is the more traditional workforce at Cleveland Engine Plant II.

The main and interactive effects of the work group independent variables on dependent performance variables were uncovered by performing a multivariate test of covariance (MANCOVA). The F-test statistic for this scenario indicates that the differences in group means are different enough not to have occurred by chance (Hair, et al, 1998). Pillai's Trace multivariate test for all groups demonstrate a large effect size (Pillai's Trace = 2.001, F = 12.01, df = 18, 108, p = .000, η^2 = .075). These results justify supplementary comparison tests for the productivity performance variable. In comparing productivity performance in all plants taking work group effectiveness as a covariate, performance differences among plants remain significant (F = 5.52, df = 3, 39, $p < .01$, η^2 = .30), which validates additional comparisons to explore which independent variable has the most influence on the dependent variables (Hair, et al, 1998).

When performing pair-wise comparisons of dependent productivity performance variables across and within independent variable groups, conclusions can be drawn that Norfolk Assembly is diversely different from Kansas City Assembly and Lima and Cleveland Engine plants. However, none of the mean differences are statistically significant.

The pair-wise comparisons of dependent productivity performance variables between Kansas City Assembly versus Lima and Cleveland Engine plants reveal wider differences than the comparisons to Norfolk Assembly. The differences between KC and both engine plants are also statistically significant.

In the final pair-wise comparison Lima Engine Plant and Cleveland Engine Plant II are directly compared. A very slim mean difference exists between these two engine manufacturing plants and the difference between the two is not statistically significant.

A test of moderation was performed to compare the relative explanatory power of work team effectiveness predictors on dependent productivity performance variables in between sister truck assembly plants and sister engine manufacturing plants. None of the tests revealed a t statistic in any plant that statistically supports the predictive power of work team effectiveness on productivity.

The scatter plot diagrams comparing Norfolk and Kansas City Truck Assembly Plant regression lines illustrate very similar trends though Norfolk is more productive and has higher work team effectiveness ratings. Both trend lines seem to indicate that as work team effectiveness ratings improve, productivity declines, which in not the intended outcome. The Z-test results for the regression line projections fail to show a statistical difference in the expected change in productivity for a unit change in truck assembly plant work team effectiveness.

Scatter plot diagrams prepared from Lima and Cleveland Engine Plants portray a different story than the diagrams for assembly plants. These trends demonstrate an ideal environment where as work team effectiveness improves, productivity increases. However, the Z-test challenges the significance of any difference in terms of the expected change in the productivity for a unit change in work group effectiveness.

In the basic statistical analysis of work team effectiveness and its impact on productivity, we can generally conclude that plants with effective work teams are more productive than more traditionally supervised work groups. However, as we further test the data the significance of the difference between plants is called into question. Without a doubt Norfolk's self-directed work teams were more productive than Kansas City's more traditional work groups in 2004 but, statistically it cannot be proved that work group effectiveness was a contributing factor. The positive trend lines in Lima and Cleveland engines plants linking productivity increase to work team effectiveness improvements were exciting although Norfolk and KC showed an opposite negative trend. Neither result was statistically significant.

Question Number 5

Does the presence of effectively rated self-directed work teams affect cost performance?

Metrics used universally throughout the automotive manufacturing industry were examined to analyze cost performance in this study. Harbour Consulting reports comparable trends from comprehensive analysis across the auto industry annually (Harbour, 2005). The specific metrics studied were Harbour Hours per Vehicle (HPV) for truck assembly cost and Harbour Hours per Unit (HPU) for engine manufacturing cost.

The Null hypothesis suggests that no difference exists in cost performance between plants with different work structures. The alternative hypothesis (H5) predicts that there is a significant difference in cost performance between effective self-directed work teams and supervised work groups.

Reviews of descriptive statistics for cost performance indicate that the raw mean was below 1.0 for all plants, with the exception of Lima Engine Plant. A mean below 1.0 demonstrates that plants operated below budget targets in 2004. Norfolk Assembly Plant's costs were slightly higher than KC's costs. Lima Engine's costs exceeded Cleveland's cost by a wider margin. This descriptive analysis suggests that effective self-directed work teams add a cost per unit produced over costs incurred in traditional work groups. Though not the desired effect, one might anticipate some additional cost in terms of time for teams to meet and concur as a group on operational matters. Taking time to establish good working relationships can foster trust and eliminate potential future problems such as team disagreements (Bandow, 2001).

The multivariate test of covariance (MANCOVA) was performed to uncover the main and interactive effects of the work group independent variables on dependent cost performance variables. The key F-test indicates that the differences in group means are different enough not to have occurred by chance (Hair, et al, 1998). A large effect size is demonstrated by Pillai's Trace multivariate test for all groups (Pillai's Trace = 2.001, F = 12.01, df = 18, 108, p = .000, η^2 = .075). Test results justify additional multiple comparison tests for the cost performance variable. In comparing cost performance in all plants taking effectiveness as a covariate, the cost performance difference among plants remains significant (F = 15.83, df = 3, 39, $p < .01$, η^2 = .55). This univariate test result rationalizes further comparison to determine which independent variable has the most influence on cost performance.

In comparing the dependent cost performance variables across and within independent variable groups pair-wise, one can deduce that Norfolk's mean difference on cost is fractionally higher than Kansas City and Cleveland but lower than in Lima where similar effective self-directed teams exist. The comparison between Norfolk and Lima yielded the largest and only statistically significant mean difference in this comparison set.

When comparing the dependent cost performance variables for Kansas City against Lima and Cleveland pair-wise, Kansas City is marginally higher than Cleveland and considerably lower Lima Engine Plant. Only the difference between KC and Lima are statistically significant in this comparison.

The final pair-wise comparison made compares Lima Engine Plant and Cleveland Engine Plant II. A wide mean difference exists between these two engine manufacturing plants and the difference between the two is statistically significant. Cleveland exhibited the lowest cost between all plants while Lima displayed the highest cost performance overall.

The test of moderation permits the investigation of the relationship between the cost dependent variable and Norfolk's work team effectiveness independent variable in an interactive analysis with Kansas City's effectiveness variable. The test facilitates relative comparison of explanatory power for work team effectiveness predictors on dependent cost performance variables (Hair, et al, 1998). Neither of the t statistics for Norfolk or Kansas City Assembly Plants are statistically significant. This indicates that work team effectiveness has no predictive power on cost performance in truck assembly.

The scatter plot diagrams of 2004 data in Norfolk and Kansas City Truck Assembly Plants demonstrate opposing bivariate linear lines of fit for the effects of work team effectiveness on cost. The regression lines trend oppositely indicating that a contradictory relationship exists between plants. In Norfolk it appears that as team effectiveness ratings improve, cost go down but, in KC as effectiveness ratings improve, costs go up. The difference in cost performance could potentially be explained by the maturity of the work teams. Norfolk's teams have been in place longer than Kansas City's and, Norfolk teams self-rate themselves as more efficient than KC. If buying into this notion, the trend in Norfolk may be beginning to show that teams can reduce cost, while Kansas City is incurring cost to establish effective work teams. The Z-test performed on these regression lines did not confirm that they are significantly different (Clogg, et al, 1995).

Similar to the test of moderation above, the relationship between the cost dependent variable and Lima's work team effectiveness independent variable in an interactive analysis with Cleveland's effectiveness variable was investigated. The t statistics for Lima was not statistically significant; however, the t statistic for Cleveland was. Statistical significance in this test indicates that work team effectiveness is a fair predictor of cost performance in Cleveland but not Lima Engine.

The interactive analysis of effectiveness ratings on cost performance and the subsequent scatter plot diagrams display negative trends when comparing Lima and Cleveland. This suggests that as work team effectiveness increases in both Lima and Cleveland so do costs. Statistically, however, the interaction between these engine plants is not significant. The Z-test failed to prove significance of any difference in terms of expected change in the cost for a unit change in the engine plant work team effectiveness.

The analysis supports the Null hypothesis that no difference exists in cost performance between plants with different work structures. If a significance difference were found, one would argue in three of four circumstances that costs increase as a result of work team effectiveness improvements. Most organizations understand the time and financial commitment involved in establishing effective self-directed work teams before they engage in the process. They know that employees who are expected to perform successfully in a team-based environment require carefully designed general and task specific training as well as a supportive learning environment. The establishment of supportive programs does not come without cost. The strategic creation of a learning organization is ideal for facilitating a team-based improvement initiative. Learning organizations make an overt financial commitment to using learning as a strategy and place value on capturing and sharing learning (Senge, 2006). Some believe that investment in developing intellectual capital delivers true competitiveness in a global economy (Jang, 2008).

Question Number 6

Does the presence of effectively rated self-directed work teams affect external quality and customer satisfaction?

The primary quality metrics used in this study were generated by owners of Ford vehicles that were built in 2004. The metrics examine the customers' experience after three months of vehicle ownership. Things gone wrong at three months in service (TGW@3MIS) is the quality metric by which truck assembly plants were evaluated. For engines manufacturing plants, Engine Repairs per thousand at three months in service (Engine R/1,000@3MIS) were evaluated. Although these quality metrics are separate and different, they collect similar concerns over the same time from the same sources. An additional internal quality metric will be explored for engine production quality to capture internal repairs before the engines reach the vehicle owners. The metric is called "parts per million at customer" (PPM@Customer). In this instance Ford assembly plants were considered the customers of Ford engine manufacturing plants.

The Null hypothesis suggests that no difference exists in customer satisfaction performance between plants with different work structures. The alternative hypothesis (H6) predicts that there is a significant difference in customer satisfaction between effective self-directed work teams and supervised work groups.

A review of the descriptive statistics for customer satisfaction performance indicates that the raw mean for both truck assembly plants is greater than 1.0; therefore, customers experienced more product concerns than Ford anticipated in 2004. Trucks assembled by self-directed work teams in Norfolk Assembly Plant generated fewer customer complaints than trucks assembled by the more traditional supervised workforce in Kansas City.

The descriptive statistical review of engine manufacturing plants shows that Lima Engine experienced the most customer complaints of all plants studied, while Cleveland Engine had the fewest number of complaints. Cleveland's performance also achieved their customer satisfaction goal by producing fewer customer concerns than anticipated. In this comparison, engines built by the more traditional workforce in Cleveland were less likely to produce a customer concern within three months of vehicle ownership.

Main and interactive effects of the work group independent variables on dependent customer satisfaction performance variables were exposed by performing a multivariate test of covariance (MANCOVA). The F-test statistic for all groups indicates that the differences in group means are different enough not to have occurred by chance (Hair, et al, 1998). Pillai's Trace multivariate test for the groups demonstrate a large effect size (Pillai's Trace = 2.001, F = 12.01, df = 18, 108, p = .000, η^2 = .075). Results justify supplemental comparison tests for the customer satisfaction performance variable. When comparing customer satisfaction in all plants taking work group effectiveness as a covariate, performance differences among plants remain significant (F = 120.22, df = 3, 39, $p < .01$, η^2 = .90), validating additional comparisons to discover which independent predictor variable has the most influence on customer satisfaction dependent variables.

When performing pair-wise comparisons of dependent customer satisfaction performance variables across and within independent variable groups, one can see the mean differences for Norfolk and Kansas City Assembly are slightly different. The difference, however, is not statistically significant. Norfolk's mean differences with Lima and Cleveland engine are more pronounced since the plants are the worst and the best in the set regarding customer satisfaction. The differences are statistically significant. The pair-wise comparisons of dependent customer satisfaction performance variables between Kansas City Assembly versus Lima and Cleveland engine plants reveal similar and significant results for both engine plants like the comparison with Norfolk Assembly. The final comparison of Lima and Cleveland Engine Plant demonstrates the widest and most significant mean difference in the pair-wise sets. The two engine manufacturing plants performed very differently in 2004. The more traditional workforce in Cleveland achieved their quality goals while self-directed teams in Lima fell below expectation by having too many quality concerns reach the customer.

A test of moderation was carried out to compare the relative explanatory power of work team effectiveness predictors on dependent customer satisfaction variables in between like truck assembly plants and like engine manufacturing plants. The moderation tests failed to reveal a t statistic in any plant that statistically supports the predictive power of work team effectiveness on customer satisfaction performance.

The scatter plot diagrams drawn to compare Norfolk and Kansas City Truck Assembly Plants display similar trends though Norfolk has fewer quality defects and higher work team effectiveness ratings. Both trend lines show that as work team effectiveness ratings improve, fewer quality defects occur thus resulting in greater customer satisfaction. Kansas City's trend line is very steep suggesting that minor improvements in work team effectiveness improve customer satisfaction performance. The Z-test results for the regression line projections demonstrate a significant statistical difference in the expected change in customer satisfaction for a unit change in truck assembly plant work team effectiveness.

Scatter plot diagrams prepared from Lima and Cleveland Engine Plants show similar but less pronounced results than the diagrams for assembly plants. The trends demonstrate that work team effectiveness improvements make a minor improvement in customer satisfaction. The Z-test, however, fails to support the significance of any difference in terms of the expected change in the customer satisfaction for a unit change in work group effectiveness.

In the basic statistical analysis of work team effectiveness and its impact on customer satisfaction, it was evident that effectively rated work teams had higher customer satisfaction in truck assembly plants but not in engine manufacturing plants. As data were tested further, neither independent variable had statistically significant predictive power to effect customer satisfaction performance. Ultimately, however, the Z-test results demonstrated a significant statistical difference in the expected change in customer satisfaction for a unit change in truck assembly plant work team effectiveness. This result supports the premise that team success can bring greater gains than individual success (Casner-Lotto & Friedman, 2002).

Question Number 7

Does the presence of effectively rated self-directed work teams affect internal engine manufacturing quality?

A second internal quality metric was added to analyze engine production quality to capture internal repairs before the engines reach vehicle owners. The metric of PPM@Customer reports the number of reject parts per million arrive at Ford vehicle assembly plants. It should be noted that these engine defects should not impact consumer satisfaction data previously evaluated since the deficiencies are caught and corrected prior to vehicle release for customer purchase. The metric does, however, impact productivity in engine and assembly plants and ultimately impacts the cost of the engines and new vehicles.

The Null hypothesis suggests that no difference exists in engine quality performance between plants with different work structures. The alternative hypothesis (H7) predicts that there is a significant difference in engine manufacturing quality between effective self-directed work teams and supervised work groups.

The descriptive statistics for engine quality demonstrate that the raw mean for self-directed work teams in Lima Engine Plant was much lower than the mean for the traditional workforce at Cleveland Engine Plant II. This suggests descriptively that plants with effective self-directed work teams produce engines with fewer quality defects than plants with more traditionally supervised workforces. Lima's mean is slightly below 1.0 which indicates that plant produced engines with fewer defects than anticipated in 2004. Meanwhile Cleveland's mean was over 12 demonstrating a defect rate well above target.

The final multivariate test of covariance was performed to uncover the main and interactive effects of work group independent variables on the dependent engine quality performance variable. The F-test result indicated that the differences in group means are different enough not to have occurred by chance (Hair, et al, 1998). Pillai's Trace multivariate test for all groups demonstrated a large effect size (Pillai's Trace = 2.001, F = 12.01, df = 18, 108, $p = .000$, $\eta^2 = .075$). This test result justifies multiple comparison tests for the engine quality performance variable. In comparing quality performance in the engine plants taking effectiveness as a covariate, there is no significant performance difference among plants (F = 3.16, df = 1,21, $p > .05$, $\eta^2 = .11$).

In comparing the dependent engine quality performance variables pair-wise within and across independent variable groups, a wide mean difference can be found between Cleveland and Lima engine plants. Despite the large difference in engine quality performance, the difference between Lima and Cleveland Engine is not statistically significant.

In the test of moderation between the engine quality dependent variable and Lima's work team effectiveness independent variable, Cleveland's effectiveness rating is asserted in the interactive analysis. This permits the comparison of relative predictive power that work team effectiveness has on dependent engine quality performance. The t statistic for Lima Engine was not statistically supportive. Cleveland Engine, however, had a t statistic that indicted that work team effectiveness was a good predictor of higher engine quality.

The scatter plot diagrams prepared from 2004 Lima and Cleveland Engine manufacturing plant data display similar but different bivariate linear lines of fit for the effects of work team effectiveness on engine quality. Both plant trend lines demonstrate the desired effect of reducing engine quality defects while improving work team effectiveness. While Lima had higher team effectiveness ratings and better engine quality metrics overall, Cleveland displayed a sharp improvement in engine quality when team effectiveness was high. A positive correlation exists between employee's commitment to their goals and the probability of their goal achievement (Liccione, 2009). A Z-test performed on the regression lines between Lima and Cleveland Engine manufacturing plants distinguish that the projections are significantly different (Clogg, et al, 1995). Therefore, a unit difference in the expected engine quality change should be anticipated for a unit change in the work team effectiveness.

In the analysis of engine quality performance, descriptive and pair-wise comparison statistics showed large but insignificant differences. Additional post-hoc testing identified significance in this comparison. The t statistic for Cleveland confirmed the predictive power that work team effectiveness has quality and, the Z test indicated a significant difference between matched engine plants. These results suggest that work team effectiveness can bring about improvement in engine manufacturing quality.

Question Number 8

Are Safety LTR, Safety SV, AWOL, Productivity, and Cost statistically significant predictors of Customer Satisfaction?

The Hybrid Structural Equation Model (SEM) was used to further test and predict relationships between multiple dependent performance variables and customer satisfaction, which was also a dependent variable in this research. Structural equation modeling allows the estimation of underlying relationships by combining statistical data and qualitative causal assumptions (Hair, et al, 1998). In this instance the SEM procedure reveals the predictive magnitude that each interrelated performance variable has on customer satisfaction. The raw path coefficient for the AWOL morale metric was established at 1.0 to set the model identification and eliminate unidentified model errors.

The Null hypothesis suggests that none of the dependent performance variables are significant predictors of customer satisfaction. The alternative hypothesis (H8) predicts that dependent performance variables significantly predict customer satisfaction.

This statistical model reveals the contributory and complementary effects of dependent variable performances in safety LTR, safety SR, AWOL, productivity and cost on customer satisfaction. The results indicate that four dependent variables significantly impact performance and influence customer satisfaction in a positive fashion. In order of predictive power, Safety LTR was the most significant predictor followed by AWOL which was set at 1.0 as the basis for this model. Safety SR and productivity likewise significantly predict good performance. The overall impact of the dependent variable contributions on customer satisfaction is also significantly significant. This is nirvana based on the hybrid structural equation model. Positive work performance improves customer satisfaction.

Question Number 9

Are Safety LTR, Safety SV, AWOL, Productivity, and Cost statistically significant predictors of the Work Team Effectiveness?

A Hybrid Structural Equation Model (SEM) was used to test and predict relationships between multiple dependent performance variables and work team effectiveness, which was an independent variable in this research. SEM models estimate the magnitude of predictive power that each interrelated dependent performance variable has on work team effectiveness. This analysis looks at the study in reverse or questions which came first - the chicken or the egg. Did the work team effectiveness differences deliver multiple performance improvements or did improved performance metrics result in higher team effectiveness ratings?

The Null hypothesis suggests that none of the dependent performance variables are significant predictors of work team effectiveness. The alternative hypothesis (H9) predicts that dependent performance variables significantly predict work team effectiveness.

The hybrid statistical equation model turns this study inside out by inspecting the relationships that dependent performance variables, namely safety LTR, safety SR, AWOL, productivity and cost, have on work team effectiveness. Results demonstrate that the same four dependent variables that impacted customer satisfaction also impact work team effectiveness in the same order of predictive power. However, the overall impact of the dependent variable contributions on work team effectiveness is not statistically significant. Good work performances do not predict work team effectiveness. Although it seems intuitive to believe that good performance in multiple and critical areas would lead to improved work team effectiveness it did not. The employee self-rating systems for work team effectiveness should be taken into consideration here. Curiously, employees may not have considered themselves engaged or effective during times of good performance. Instead employees may have felt more engaged or more effective when challenged to improve performance in one or more of the dependent performance variable areas examined in this model.

Limitations

The study was conducted within the automotive industry and is limited to two automotive assembly plants and two engine manufacturing plants in North America within a single corporation, Ford Motor Company. Other limitations or challenges are imposed by the assumptions in the research, which raise validity issues that must be accounted for in the study. While the focus of the study is to compare human performance in separate work structures, the metrics used for comparison cannot isolate differences that occur only as a result of work structure. Internal validity challenges expected to encroach on the measures of performance include part quality, machinery function, and local or political occurrences. As a comparative control, two separate assembly plants that build Ford F-150 trucks were studied and two engine manufacturing plants that build

V-6 engines were studied separately. Studying identical or sister plants account for some of the internal validity concerns regarding part quality and manufacturing process differences. There is no way to control the influence of local political dynamics within the plants, since each production facility has its own personality much like most towns have individual character based on the population in the community.

Discussion

Several questions were posed in this study. Originally seven research questions sought nine answers. The two additional responses were required because multiple and more specific data were available to provide more precise answers in safety and quality performance arenas. The study employed numerous statistical analysis techniques which ranged from basic to theoretically experimental procedures. The techniques increasingly dissected data with the goal of answering each research question with error-free statistical analysis results.

Many inferences can be made from the analysis of descriptive statistics in this study, most of which indicate that the performance metrics are different between plants with effective self-directed work teams and plants with more traditional work forces. In fact, most of the inferences would suggest that every organization should rush to implement self-directed work teams to enjoy benefits in terms of cost, morale, productivity, quality and safety. However, basing the decision to implement self-directed teams on descriptive statistics alone would be irresponsible; therefore, basic findings were challenged statistically. The multivariate test of covariance (MANCOVA) proved that the main and interactive effects of work group independent variables on dependent performance variables were different. Moreover, they are significantly different enough in each circumstance not to have occurred by chance.

With encouragement from descriptive statistics and the statistical significance green light from the MANCOVA F-test, research proceeded with univariate testing. Pair-wise comparisons performed within and across independent variable groups yielded mixed results in terms of significant differences. Six comparisons were made for each dependent performance variable across all plant types and work structures with the most critical being the like plant with opposite work structure comparisons. Lost time case rate performance was significantly different in five of six comparisons and, the truck assembly plant performances were also significantly different. Self-directed work teams in Norfolk had fewer injuries than KC's more traditional workforce. In comparing injury severity rate, three of six comparisons were statistically significant and again truck plant performances were likewise significantly different. In this instance self-directed work teams in Norfolk had a lower severity rate than KC's more traditional workforce. Employee absenteeism was compared by reviewing AWOL rates. Three of the six comparisons were significant and Norfolk enjoyed fewer employee absences and had a lower and statistically significant difference in AWOL rate. Productivity comparisons only yielded two significant differences and neither was from like plant comparisons. Cost comparisons also displayed two significant differences. One direct comparison demonstrated a significant difference between the engine manufacturing plants where the traditional workforce in Cleveland operated at lower costs than effectively rated self-directed work teams in Lima. In terms of customer satisfaction, five of six comparisons were significantly different. The direct comparison between engine manufacturing plants revealed that the traditional workforce in Cleveland achieved their quality goals and experienced fewer customer complaints than effectively rated self-directed work teams in Lima.

The test of moderation was performed to analyze the interactive effect of independent workgroup variables on each dependent variable and compare the predictive power that the independent variables have on the performance variables. In the test of moderation for truck assembly plants, work team effectiveness had a predictive effect on lost time case rate and severity rate in Kansas City Assembly Plant. The predictability on LTR is not desirable since it appears that injury frequency increases as work team effectiveness improves. The effect on injury severity rate is also adverse since severity rate seems to increase slightly as work team effectiveness improves. This finding is further supported by significance in the Z test which was performed to test the difference in regression lines to see if a change in work team effectiveness ratings resulted in a predictable change in severity rate.

While the tests of moderation did not identify any other significant predictors of dependent performance variables in truck assembly plants, the Z test did find significance separately in employee absenteeism and in customer satisfaction regression lines. Z test results for employee absenteeism or AWOL rate in truck assembly plants indicate a conflicting predictive effect; whereas, Norfolk Assembly anticipates an increase in AWOL rate while Kansas City anticipates a reduction in AWOL rate as work team effectiveness ratings improve. The Z test for customer satisfaction demonstrates that a desirable predictive effect exists in truck assembly plants where customer quality concerns decrease as work team effectiveness improves.

The test of moderation performed to analyze the interactive effect and compare predictive power in engine manufacturing plants indicate that work team effectiveness had a predictive effect on severity rate, cost and engine manufacturing quality in Cleveland Engine Plant. The predictive power on injury severity was ideal since the severity rate decreased as work team effectiveness improved. Cost predictions were adverse because costs seem to increase as work team effectiveness improved. Finally, work team effectiveness was a good predictor of engine manufacturing quality in view of the fact that quality improved as work team effectiveness increased. This particular finding is supported by significance in the Z test which showed a difference in regression lines and a change in predictable engine quality as a result of work team effectiveness rating improvements.

One additional Z test identified a significant difference in the regression lines for employee absenteeism or AWOL rate in engine manufacturing plants. The result indicates a conflicting predictive effect where Cleveland Engine expects a slight increase in AWOL rate while Lima Engine expects a reduction in AWOL rate as work team effectiveness ratings improve.

The Hybrid Structural Equation Model (SEM) tested relationships between all of the dependent performance variables and the vital metrics of work team effectiveness and customer satisfaction. The model estimated that three variables significantly influence good performance including safety lost time case rate, safety severity rate and productivity. Employee absenteeism is also significant though it was set as the basis for the model since it showed predictable effects in all plants. The interactions of all dependent variables resulted in a significant and positive prediction in customer satisfaction.

The pair-wise comparisons revealed five significant results to highlight in truck assembly plants. Effectively rated self-directed teams in Norfolk significantly outperformed their more traditionally supervised rivals in Kansas City in lost time case rate, severity rate and controllable employee absence. Therefore, the Null Hypotheses for questions 1, 2 and 3 are rejected in favor of the alternative hypotheses. Work team effectiveness ratings effect safety and employee attendance in truck assembly plants. Furthermore all of the effects are positive in nature and justify the effort required to implement self directed teams. Oppositely in engine manufacturing plants, the more traditional workforce in Cleveland outperformed effectively rated self directed teams in Lima in terms of cost and customer satisfaction. Both findings were statistically significant and demonstrate adverse effects where improvements in work team effectiveness result in higher costs and lower customer satisfaction. In these two circumstances the Null hypotheses are also rejected in favor of alternative hypotheses 5 and 6 since work team effectiveness made a difference in performance, although not a desirable difference.

The tests of moderation and subsequent Z tests for truck assembly plants support four significant findings. In Kansas City work team effectiveness had explanatory power for lost time case rate and severity rate. The predictive nature of work team effectiveness on lost time case rate was adverse since injuries rates increased in Kansas City. Similarly, severity rate increased marginally as work team effectiveness improved. Both findings support alternative hypotheses 1 and 2 although not desirably. Z tests also revealed significant differences in the regression lines for employee absenteeism and customer satisfaction. Significance in both circumstance led to the rejection the Null hypothesis for question 3 and question 6. Results for absenteeism show mixed predictions where the traditional workforce in Kansas City saw a favorable reduction in absence while self-directed work teams in Norfolk saw increased absence as work team effectiveness improved. The Z test for customer satisfaction reveals a shining moment for self-directed work teams in both truck assembly plants. As work team effectiveness improved, quality defects decreased which improved customer satisfaction feedback.

Tests of moderation and subsequent Z tests for engine manufacturing plants supported four significant findings. In Cleveland work team effectiveness demonstrates explanatory power for severity rate, cost and engine manufacturing quality. Therefore, the Null Hypotheses for questions 2, 5 and 7 are rejected in favor of the alternative hypotheses. Work team effectiveness displayed a positive predictive nature over severity rate since injuries severity decreased as work team effectiveness improved. Likewise, work team effectiveness predicted optimistic results as quality defects diminished as work team effectiveness improved. Conversely, cost predictably increased as work team effectiveness improved. Z tests also revealed significant differences in the regression lines for employee absenteeism and engine manufacturing quality. Significance in each circumstance supports the rejection of the Null hypothesis for question 3 and question 7. Results for absenteeism show mixed predictions where the traditional workforce in Cleveland anticipated an unfavorable increase in absence while self-directed work teams in Lima anticipated absence reductions as work team effectiveness improved. The Z test for engine manufacturing quality flaunts positive predictions for self-directed work teams in both engine manufacturing plants. As work team effectiveness improved, engine quality defects were minimized.

The statistically significant findings from the research are summarized below in Table 11.

Table 11

Statistically Significant Finding Summary									
	Pair-wise Comparisons			Moderation Tests (Predictions)			Regression Line Difference Tests		
Research Questions	Null	Positive Alternative	Negative Alternative	Null	Positive Alternative	Negative Alternative	Null	Positive Alternative	Negative Alternative
1. Does the presence of effectively rated self-directed work teams affect injury frequency?		Lower Lost Time Case Rate at Norfolk Truck				Lost Time Case Rate increased in KC Truck	X		
2. Does the presence of effectively rated self-directed work teams affect injury severity?		Lower Severity Rate at Norfolk Truck			Severity Rate decreased in Cleveland Engine	Severity Rate increased in KC Truck			Higher Severity Rate predicted in Norfolk & KC Truck
3. Does the presence of effectively rated self-directed work teams affect unexcused absenteeism?		Lower AWOL Rate at Norfolk Truck		X				Lower AWOL Rates predicted at KC Truck & Lima Engine	Higher AWOL Rates predicted at Norfolk Truck & Cleveland Engine
4. Does the presence of effectively rated self-directed work teams affect productivity?	X			X			X		
5. Does the presence of effectively rated self-directed work teams affect cost performance?			Cleveland Engine operated at lower costs			Cleveland Engine's cost increased	X		
6. Does the presence of effectively rated self directed work teams affect external quality / customer satisfaction?			Cleveland Engine had fewer customer complaints	X				Fewer Quality Concerns predicted in Norfolk & KC Truck	
7. Does the presence of effectively rated self directed work teams affect internal quality / assembly plant satisfaction?	X				Cleveland Engine had fewer engine defects			Reduction in quality defects predicted in Lima & Cleveland Engine	

The final two research questions were not addressed in the table above. Question eight asked, are Safety LTR, Safety SV, AWOL, Productivity, and Cost statistically significant predictors of Customer Satisfaction?" Question nine asked the same of the variables in predicting Work Team Effectiveness. The results from the Hybrid Structural Equation Model were used to answer these questions. The Beta Coefficients in the model estimated that three variables influenced performance including safety lost time case rate, safety severity rate and productivity. The multivariable interaction of these dependent variables resulted in a statistical prediction that positive internal performance affects customer satisfaction but not work team effectiveness ratings.

Implications for Performance Improvement and Instructional Technology

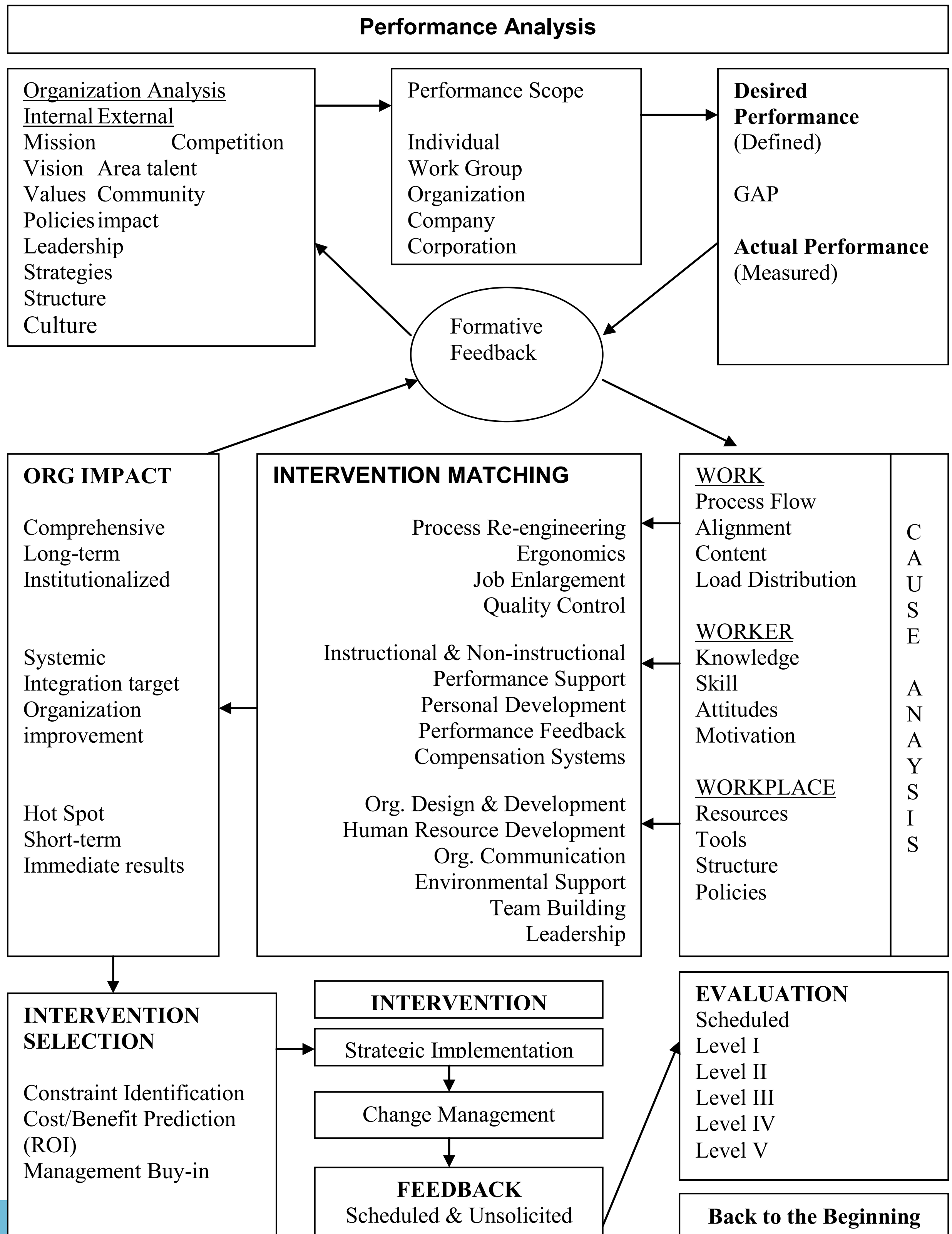
The review of related literature highlighted many relevant issues in human performance improvement and instructional technology. Historical, cultural and local plant specifications within the Ford organization were inspected, quality and lean management systems were reviewed, traditional management work structures were compared to self-directed work team structures, team implementation methods were examined, management and union support implications were appraised, the importance of strategic education and training were emphasized, employee interdependence and communication were accentuated and the transfer of authority to empowered employees was made paramount. Individuals contemplating an intervention involving teams or a work structure change are well served using this work as a resource.

This research conferred important issues related to instructional technology and performance improvement. To the extent possible the research followed Ford Motor Company's path along the human performance technology (HPT) model (Van Tiem, Moseley, Dessinger, 2004). The researcher's human performance improvement model, which is based on the 2004 HPT model endorsed by International Society for Performance Improvement (ISPI) is displayed below in Figure 16. In terms of performance analysis, Ford was examined organizationally and the work environment was scanned for job settings, work processes and worker capabilities. A performance gap was identified for each dependant performance variable versus a desired achievement level. Assumptions were made in the cause analysis since formative, summative and confirmative evaluation data were not provided retroactively. The assumption was that plants lacked teamwork and a comprehensive lean quality management system. The intervention design and development came in the form of the Ford Production System that addressed personal and human resource development, quality management systems, communications and especially organizational design and development in the formation of self-directed work teams. The intervention or change management process was observed as teams self-rated their effectiveness levels throughout 2004. Finally, in the evaluation phase of the HPT model, the research examines confirmative performance results influenced by work group effectiveness and the meta validation results in terms of customer satisfaction.

The researcher's human performance improvement model below is adapted from the 2004 HPT model endorsed by ISPI (Van Tiem, Moseley, Dessinger, 2004).

Figure 16

Human Performance Improvement Model (Adapted)



Human performance and instructional technologists acknowledge the individual and organizational culture complexities that exist in the workplace. Understanding interrelationships between work behavior and reciprocal patterns of workplace culture and individual factors is essential to successful multidisciplinary performance interventions (Van Tiem, Moseley, Dessinger, 2004). This research attempted to analyze and compare performance outcomes of employees engaged in organizational cultural change. The comparisons between like assembly plants and like engine manufacturing plants are meaningful because of the distinct similarities that eliminated nuisance factors from the comparisons. The results portray differences that may be expected based on separate and distinctive work structures. Comparisons across all groups are also intriguing since changes in team effectiveness self-assessment ratings influence performances directionally. While comparisons are not direct, the broader association displays a positive or negative directional influence that self-directed work teams exerted on performance variables.

Recommendations for Further Research

The following recommendations for further research should be considered to enhance self-directed team implementation resources for use by all organizations:

- Extend this study longitudinally to determine if performance improved or regressed as self-directed work teams matured.
- Replicate similar studies with larger and broader populations.

- Explore the cost and time required for implementation and measure the resultant financial impact or return on investment.
- Evaluate the reward and recognition programs designed to motivate individuals and teams to achieve personal and teams goals.
- Investigate and measure the effectiveness of employee training in each participating facility in terms of formative, summative and especially confirmative viewpoints.
- Compare team building efforts in other countries to gain a global prospective.

This chapter draws a conclusion to this work by answering the nine research questions posed in this study with results from sound statistical analyses. Limitations were disclosed and the meanings of the results were discussed. The implication for performance improvement and instructional technology were explored. Finally, recommendations were provided for future research.

APPENDIX A

Occupational Health and Safety

January 6, 2010

To Whom It May Concern,

Ford Motor Company has agreed to participate in a doctoral study proposed by Wayne State University doctoral candidate David Shall. The proposal is of interest to Ford as it will compare effectively rated self-directed work teams with more traditional work structures to determine the impact on multiple performance metrics in our manufacturing environments.

Access to necessary records and data has been approved by Ford Motor Company. The extant data collected and data collection process for this proposed research study does not use personally identifiable information and may be shared freely within the company and academically.

The data collection process will require data from multiple Ford Motor Company administrative systems. Performance metrics will be collected from the Ford Production System (FPS) staff analysts, Ford Corporate staff, the relevant UAW-Ford Joint Programs and each plant's leadership, human resource and safety leadership teams.

At the conclusion of this research, it is expected that the study will be presented formally to an audience of Ford's choosing.

Our organization is pleased to participate in this study and we look forward to the valuable presentation of findings.

Dr. Greg Stone
Director, Occupational Health & Safety
Ford Motor Company

APPENDIX B

WAYNE STATE UNIVERSITY

Human Investigation Committee

Human Participant Research
How is it Defined?

Is this research? The decision process:

Yes 1. The first question a principal investigator (PI) must ask is whether or not a "research activity" is being proposed.

No 2. The second question is whether or not the "research activity" involves interacting or intervening with living individuals or their identifiable private information (see Part A #3).

No 3. If the activity involves the FDA, Part B provides the appropriate definition.

4. When the questions in Part A or Part B can be answered "yes," a research proposal must be submitted to the IRB for review.

	A.	The activity is "Human Participant" (subject) research according to the Department of Health and Human Services (DHHS) regulations when either 1 and 2 below are true Or 1 & 3 below are true.
No	1.	The activity is a systematic investigation including research development, testing and evaluation and is designed OR contributes to generalizable knowledge **AND**
No	2.	The data the PI is planning to obtain are about living individuals obtained through any or all of the following means: o Physical procedures performed on individuals o Manipulation of individuals o Manipulation of individuals' environments o Communication with individuals, or o Interpersonal contact with individuals **OR**

No

3.	The data is individually identifiable because: ○ The identity of the participant is or may readily be ascertained by the PI or ○ The identity of the participant is or may readily be associated with the information **And** the data is private because: ○ It is about behavior that occurs in a context in which the individual can reasonably expect that no observation or recording is taking place or ○ The individual has provided information for specific purposes and can reasonably expect that the information will not be made public (i.e., medical record).

No

B.	An activity is "Human Research" according to the FDA regulations when it involves an FDA regulated test article because one or more of the following are true:
1.	The activity involves the use of a drug other than the use of a marketed drug in the course of medical practice, with "drug" meaning: ○ An article recognized in the official United States Pharmacopoeia, official Homeopathic Pharmacopoeia of the United States, official National Formulary, or any supplement to any of them; ○ An article intended for use in the diagnosis, cure, mitigation, treatment, or prevention of disease in humans or other animals; ○ An article other than food that is intended to affect the structure or any function of the body of humans or other animals, **AND** ○ The drug is either **not approved** by the FDA for marketing, **or** the drug is **not being used in the course of medical practice**. OR

No	2.	The activity involves the use of a medical device, other than the use of a marketed medical device in the course of medical practice, with "device" meaning: o The device is recognized in the official National Formulary, the United States Pharmacopoeia, or any supplement to them; o The device is intended for use in the diagnosis of disease or other conditions; or in the cure, mitigation, treatment, or prevention of disease in humans or other animals; o The device s intended to affect the structure or any function of the body of humans or other animals, and which does not achieve any of its intended purposes through chemical action within or on the body of humans or other animals and which is not dependent upon being metabolized for the achievement of any of its primary intended purposes; **AND** o The medical device is **not approved** by the FDA for marketing or the medical device is **not being used in the course of medical practice.** **OR**
No	3.	The activity is otherwise subject to FDA regulations because: o Data from the activity will be submitted to, or held for inspection by the FDA; o The activity involves an FDA regulated article of one or more of the following: Food or dietary supplement that bears a nutrient content or health claim Food or color additive for human consumption Infant formula Biological product for human use Electronic product for human use Other article subject to the FD&C Act **AND**
No	4.	The activity involves human participants because one or more of the following are true: o The test article will be used on one or more humans; or o The test article is a medical device, used on human specimens, the activity is done to determine the safety or effectiveness of the device, and data from the activity will be submitted to, or held for inspection by the FDA.

REFERENCES

Attaran, M., & Nguyen, T. (2000). Creating the right structural fit for self-directed teams. *Team Performance Management,* 6(1/2), 25-33.

Avery, C.M. (2000). How teamwork can be developed as an individual skill. *Journal for Quality& Satisfaction,* 23(4), 6-13.

Axelrod, R. (2002). Making teams work. *Journal for Quality & Participation,* 25 (1), 10-11.

Bain, V. (2001). Are you underestimating your team members? *Journal for Quality & Participation,* 24(4), 39-41.

Bandow, D. (2001). Time to create sound teamwork. *Journal for Quality & Participation,* 24(2), 41-47.

Brinkley, D. (2003). *Wheels for the world – Henry Ford, his company, and a century of progress 1903 – 2003.* New York: Penguin Group.

Caldwell, K., & Lawson, L. (2000). The new self-directed work teams. *Business Review,* 27(2), 30-34.

Canadian HR Reporter. (2001). *Five rules for team learning.* 14(16), 21.

Casner-Lotto, J., & Friedman, W. (2002). The power of teamwork. *Worklife Report: HR Magazine,* 45(11), 183-184.

Chaney, L. & Lyden, J. (2000). Making U.S. teams work. *Supervision,* 61(1), 6-8.

Chevalier, R. (2009). Analyzing performance: An example. *Performance Improvement,* 48(7), 15-19.

Chilson, E. (2002). Lean magnivision: Improvements made by the clearly lean team. *Quality Congress. ASQ's Annual Quality Congress Proceedings.* 251-255.

Cicerone, B. (2009). Improving customer satisfaction: a lesson learned by finding the reason a car engine does not start. *Performance Improvement,* 48(7), 5-9.

Cicerone, B., Sassaman, R.F. and Swinney, J.M. (2007). The important contribution of market research to human performance technology. *Performance Improvement,* 46(2), 22-25.

Clogg, C. C., Petkova, E. and Haritou, A. (1995). Statistical methods for comparing regression coefficients between models. *American Journal of Sociology 100.* 1261-1293.

Colan, L. E. (2004). *Passionate performance: Engaging minds and hearts to conquer the competition*. Dallas, TX: Baldwin Group.

Duke Corporate Education, Inc. (2005). *Building effective teams.* Chicago, IL: Dearborn Trade Publishing.

Duvall, S., & Singer, J. (2000). High-performance partnering by teams in manufacturing. *Engineering Management Journal,* 12(4), 9-15.

Dyer, W. G., (1977). *Team building: Issues and alternatives.* Reading, MA: Addison-Wesley.

Emans, J., Van De Vilert, E., & Van Der Vegt, G. (2001). Patterns of interdependence in work teams: A two level investigation of the relations with job and team satisfaction. *Personnel Psychology,* 54(1), 51-69.

Fitz-Gibbon, C. & Morris, L (1987). *How to design a program evaluation*. Newbury Park, CA: Sage.

Ford Motor Company Communications. (1995). *Ford Production System, The concept and the definition*. Dearborn, Michigan.

Frangos, C. A. (2007). Using strategy maps to prioritize learning and performance improvement agendas. *Performance Improvement,* 46(2), 26-29.

Gordon, J. (2002). A perspective on team building. *Journal of American Academy of Business, Cambridge,* 2(2), 185-188.

Hair, J. E., Jr., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis* (5th ed.). Upper Saddle River, NJ: Prentice-Hall.

Harbour, J. L. (2009). Integrated performance management: A conceptual, system-based model. *Performance Improvement,* 48(7), 10-14.

Harbour, R. E., (2005). *The Harbour Report 2005.* Troy, MI: Harbour Consulting.

Harper, B. & Harper, A. (1991). *Succeeding as a self-directed work team: Twenty important questions answered* (4th ed.). Hudson, NY: MW Corporation.

Harris, T. (2009). Assessments' role in team building. *Talent Management Magazine*, 5(11), 20-23.

Hoover, S. (2000). Continuous improvement teams succeed with training aid. *Quality,* 39(1), 59-61.

Iverson, K. M. (2009). The write brain: How to educate and entertain with learner-centered writing. *Performance Improvement,* 48(7), 20-25.

Jang, H. Y. (2008). Reconsidering human performance technology. *Performance Improvement,* 45(6), 25-33.

Joyce, W. F., Nohria, N. & Roberson, B. (2003). *What really works: The 4 + 2 formula for sustained business success*. New York: HarperCollins.

Kirkman, B., Shapiro, G., & Shapiro, L. (2000). Why do employees resist teams? *International Journal of Conflict Management,* 11(1), 74-92.

Liccione, W. J. (2007). A framework for compensation plans with incentive value. *Performance Improvement,* 46(2), 16-21.

Liccione, W. J. (2009). Goal commitment. *Performance Improvement,* 48(7), 26-30.

Messmer, M. (2001). Encouraging employee creativity. *Strategic Finance,* 83(6), 16-18.

Moseley, J. L., & Dessinger, J. C. (2007). *Training older workers and learners, Maximizing the performance of an aging workforce*. San Francisco: Pfeiffer.

Nathan, E. P. (2008). Global organizations and e-learning: Leveraging adult learning in different cultures. *Performance Improvement,* 45(6), 18-24.

Nelson, B. (2002). Making teamwork work. *ABA Bank Marketing,* 34(6), 10-11.

Nichol, B.L. (2000). Top ten reasons teams become dysfunctional. *Finance,* 83(6), 16-18.

Occupational Health and Safety Administration (2009). *29 CFR 1910 General Industry.* Davenport, IA. ManComm Printing.

Paino, M. & Rossett, A. (2008). Performance support that adds value to everyday lives. *Performance Improvement,* 47(1), 37-44

Parker, G. M. (1996). *Team players and teamwork*. San Francisco, CA: Jossey-Bass.

Pershing, J. A., Lee, J. E. & Cheng, J. L. (2008). Current status, future trends, and issues in human performance technology, part 1: Influential domains, current status, and recognition of HPT. *Performance Improvement,* 47(1), 9-17.

Phillips, J. J., & Phillips, P. P. (2008). Distinguishing ROI myths from reality. *Performance Improvement,* 45(6), 12-17.

Piszczalski, M. (2000). *Teamwork: Tools, techniques & troubles.* 34(6).10.

Rose, R. C., Kumar, N. & Ibrahim, H. I. (2008). The effect of manufacturing strategy on organizational performance. *Performance Improvement, 47*(1), 18-23.

Rosenthal, M. (2001). High-performance teams. *Executive Excellence, 18*(10), 6.

Senge, P. M. (2006). *The fifth discipline: The art and practice of the learning organization*. New York: Broadway Business.

Sesa, V. (2000). Supporting work team effectiveness: Best management practices for fostering high performance. *Personnel Psychology,* 53(2), 457-460.

Spann, K. (2000). How do you rate your team's teamwork? *Nursing Management,* 31(1), 45-47.

Tata, J. (2000). Autonomous work teams: An examination of cultural and structural constraints. *Work Study,* 49(5), 183-187.

UAW and the Ford Motor Company. (2003). *Agreements between the UAW and the Ford Motor Company*. Detroit, MI: Allied Printing.

UAW and the Ford Motor Company. (2003). *Letters of Understanding between the UAW and the Ford Motor Company*. Detroit, MI: Allied Printing.

Ury, W. (1993). *Getting Past No.* New York: Bantom Books.

Van Tiem, D. M. (2007). Accountability: A new performance improvement paradigm. *Performance Improvement,* 46(2), 5-8.

Van Tiem, D. M., Moseley, J. L., & Dessinger, J. C. (2004). *Fundamentals of performance technology: A guide to improving people, process and performance* (2nd ed.). Silver Spring, MD: International Society for Performance Improvement.

Van Tiem, D. M., Moseley, J. L., & Dessinger, J. C. (2001). *Performance improvement interventions: Enhancing people, processes, and organizations through performance technology*. Silver Spring, MD: International Society for Performance Improvement.

Watkins, R. (2007). Designing for performance, Part 2: Selecting your performance technologies. *Performance Improvement,* 46(2), 9-15.

Yandrick, R. (2001). A team effort. *HR Magazine,* 46(6), 136-141.

ABSTRACT

THE EFFECTS OF SELF-DIRECTED TEAMS IN AN AUTOMOTIVE MANUFACTURING ENVIRONMENT

by

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August 2010

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Major: Instructional Technology

Degree: Doctor of Philosophy

This study compares self-directed work structures to more traditional supervised work structures in order to determine if the expenditures and efforts required to implement self-directed work teams are warranted. Multiple internal performance metrics are examined in comparing plant work structures in various degrees of implementation between traditional work structures and self-directed work teams. The researcher collected data from multiple organizations within Ford Motor Company and four participating North American Ford production plants. Two Ford assembly plants and two Ford engine manufacturing plants were researched. Performance data from the 2004 production year were examined in each facility. Both assembly plants built the same Ford F-150 pick-up truck and both engine manufacturing plants produced the same V-6 engine in 2004. Data were collected to answer several questions including: 1) Does the presence of effectively rated self-directed work teams affect injury frequency; 2) Does the presence of effectively rated self-directed work teams affect injury severity; 3) Does the presence of effectively rated self-directed work teams affect

unexcused absenteeism; 4) Does the presence of effectively rated self-directed work teams affect productivity; 5) Does the presence of effectively rated self-directed work teams affect cost performance; 6) Does the presence of effectively rated self-directed work teams affect external quality and customer satisfaction; 7) Does the presence of effectively rated self-directed work teams affect internal engine manufacturing quality; 8) Are Safety LTR, Safety SV, AWOL, Productivity, and Cost statistically significant predictors of customer satisfaction and, 9) Are Safety LTR, Safety SV, AWOL, Productivity, and Cost statistically significant predictors of work team effectiveness.

By comparing the performance metrics and customer satisfaction data between like plants with separate and different work structures, the researcher isolated the impact that work structures have on safety, cost, productivity, quality and employee morale. The hypothesis in this research suggests that significant performance differences exist between effectively rated self-directed work teams and more traditionally supervised work groups in automotive assembly and engine manufacturing plants. Furthermore the hypotheses suggest that dependent performance variables predict customer satisfaction and work team effectiveness.

Several statistical procedures were used to answer the nine research questions which ranged from basic to theoretically experimental procedures. First, causal comparisons were drawn between plants with effectively rated self-directed work teams and plants with more traditionally supervised work structures to explore the relationship that the dependent performance metrics have with the independent work structures. Multivariate analysis of covariance was used to simultaneously test correlation between two independent predictor variables and several dependent variables. Second, a Hybrid Structural Equation Model (SEM) was utilized to further test and predict relationships between dependent and independent variables, but also within the dependent performance metrics. The technique allowed confirmatory and exploratory modeling to reveal the magnitude of performance variable interrelationships and predict their potential impact on customer satisfaction and work group effectiveness. Statistical techniques increasingly dissected data with the goal of answering each research question with error-free statistical results.

Many inferences can be made from the analysis of descriptive statistics in this research, most of which indicate favorable performance results in plants with effective self-directed work teams over plants with more traditional work forces. The basic assumptions are challenged statistically with multivariate test of covariance, univariate tests, pair-wise comparisons, test of moderation, Z-tests and a hybrid structural equation model.

Pair-wise comparisons reveal five significant results in truck assembly plants. Effectively rated self-directed teams in Norfolk significantly outperformed their more traditionally supervised rivals in Kansas City in lost time case rate, severity rate and controllable employee absence. Furthermore, all of the effects are positive in nature and justify the effort required to implement self directed teams. Oppositely, in engine manufacturing plants, the more traditional workforce in Cleveland outperformed effectively rated self directed teams in Lima in terms of cost and customer satisfaction. Both findings were statistically significant and demonstrate adverse effects since improvements in work team effectiveness resulted in higher costs and lower customer satisfaction.

Tests of moderation and subsequent Z tests for truck assembly plants support four significant findings. In Kansas City work team effectiveness had explanatory power for lost time case rate and severity rate although the predictive nature of work team effectiveness on lost time case rate and severity rate are adverse since both rates increased. Z tests reveal significant differences in the regression lines for employee absenteeism and customer satisfaction. Results for absenteeism show mixed predictions where the traditional workforce in Kansas City experience favorable reductions in absence while self-directed work teams in Norfolk experience increased absence as work team effectiveness improved. The Z test for customer satisfaction reveal promise for self-directed work teams in both truck assembly plants since quality defects decrease as work team effectiveness improved.

Tests of moderation and subsequent Z tests for engine manufacturing plants support four significant findings. In Cleveland work team effectiveness demonstrates explanatory power for severity rate, cost and engine manufacturing quality. Work team effectiveness demonstrates positive predictive power over severity rate and engine manufacturing quality since injury severity and quality defects decrease as work team effectiveness improves. Conversely, cost predictably increases as work team effectiveness improves. Z tests revealed significant differences in the regression lines for employee absenteeism and engine manufacturing quality. Absenteeism results display mixed predictions where the traditional workforce in Cleveland anticipate an unfavorable increase in absence while self-directed work teams in Lima anticipate absence reductions as work team effectiveness improves. The Z test for engine manufacturing quality flaunted positive predictions for self-directed work teams in both engine manufacturing plants. As work team effectiveness improves, engine quality defects are minimized.

The two final research questions asked if the dependent performance variables in the study were statistically significant predictors of customer satisfaction and work team effectiveness. Beta Coefficients from the Hybrid Structural Equation Model estimated that three variables influenced performance including safety lost time case rate, safety severity rate and productivity. The multivariable interaction of these dependent variables resulted in a statistical prediction that positive internal performance affects customer satisfaction but not work team effectiveness ratings.

This work adds relevant research findings to the body of literature in human performance improvement and instructional technology. Individuals contemplating an intervention involving teams or a work structure change are well served using this dissertation as a resource. To the extent possible the research follows Ford Motor Company's path along the human performance technology (HPT) model (Van Tiem, Moseley, Dessinger, 2004) that is endorsed by the International Society for Performance Improvement.

AUTOBIOGRAPHICAL STATEMENT

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Mar 1999 - Mar 2000	Ford Motor Co., Powertrain Operation, HR, Dearborn, MI Human Resource Business Operations Manager
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