Leadership in Reaching Global Consensus on Technologic Standardization

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LEADERSHIP IN REACHING GLOBAL CONSENSUS ON TECHNOLOGICAL STANDARDIZATION

A Dissertation
Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

by
Carol Oak Tierney
July 2003
LEADERSHIP IN REACHING GLOBAL CONSENSUS 
ON TECHNOLOGICAL STANDARDIZATION 

A dissertation 
presented in partial fulfillment 
of the requirements for the degree 
Doctor of Philosophy 

by 
Carol Oak Tierney 

APPROVAL BY THE COMMITTEE:

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Dean, School of Education 
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Date approved 
7/23/03 

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ABSTRACT

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ON TECHNOLOGICAL STANDARDIZATION

by

Carol Oak Tierney

Chair: Hinsdale Bernard

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ABSTRACT OF GRADUATE STUDENT RESEARCH

Dissertation

Andrews University

School of Education

Title: LEADERSHIP IN REACHING GLOBAL CONSENSUS ON TECHNOLOGICAL STANDARDIZATION

Name of researcher: Carol Oak Tierney

Name and degree of faculty chair: Hinsdale Bernard, Ph.D.

Date completed: July 2003

Problem

Today there is an environment in our organizations represented by “islands” of information. Information cannot be exchanged easily. The information is stored in computers that cannot talk to each other. Archaic paper processes, lack of non-proprietary international standards, and computer interoperability deficiencies have created cumbersome industry productivity problems.

The purpose of the study was to determine whether differences exist between organizations in the acceptance and implementation of non-proprietary international standards and the required processes for change. This purpose was addressed through an
examination of one example of a model for the exchange of data–The Standard for the Exchange of Product Model Data–Numerical Control (STEP NC).

Methodology

Both quantitative and qualitative methods were used in this study. The quantitative aspects utilize a researcher-developed instrument to assess the perceptions of a select group of respondents. The qualitative portion of the survey used varying degrees of the qualitative analysis procedures on issues related to international standards adoption and implementation and categorized to support the quantitative responses. The qualitative responses were open-ended. The qualitative response themes are discussed. Each qualitative question was analyzed separately and then grouped with quantitative response themes.

The design of the study centered around analyzing the responses to survey items developed on the following research issues:

1. Processes to implement change within organizations
2. The impact that development of non-proprietary international standards has on organizations
3. The change required to lead consensus for adoption and implementation of STEP NC
4. Who will lead the change necessary to adopt STEP NC within an organization.
Findings and Conclusions

1. Organizations have change processes in place. Organizations do not have a process in place to institutionalize new international STEP standards.

2. Large organizations have scattered groups conducting international standards implementation.

3. The automotive industry segment is not empowered to act on STEP implementation. The other industry segments are empowered.

4. Implementation of STEP is important for the manufacturing process in organizations.

5. Industry believes that non-proprietary international standards are important to the organization for competitive advantage.

6. Industry believes there are leaders within their organizations promoting STEP and STEP NC.
To my family, who has supported me in all my endeavors.
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CHAPTER I

INTRODUCTION

The majority of large organizations have moved from the traditional way of doing business to the electronic commerce way of doing business. To “E” or not to “E”? That is the question many organizations face today. Archaic paper processes, lack of international standards, and computer interoperability deficiencies have created cumbersome industry productivity problems. Organizations want to move from traditional isolated islands of information into large interconnected networks. According to Solomon (2001), in an era of globalization, rapid technological changes, and intense competition, new forms of organizational designs and networks have replaced traditional forms of organizations.

Large and small traditional organizations are realizing that they have the opportunity of entering the national and international marketplace by leveraging their strengths in the development of an “E” approach to conducting business. Organizations are responding to a new set of global challenges in a rapidly changing business environment. Marks (2000) suggests traditional companies that adopt E-business are better off than the web “upstarts” because the traditional companies have a broader, more entrenched, business foundation. The research conducted by Nembard, Shi, and Park (2000) corroborates the need to examine the dynamics of change using electronic commerce. The manufacturing environment is becoming increasingly dynamic with
upsurges in electronic commerce, supply chain management, forecasting, and procurement and resource planning. These drivers lead to opportunities for companies to collect and use information to identify changes that will affect their manufacturing system.

**Statement of the Problem**

Today there is an environment within organizations represented by “islands” of information. Information cannot be exchanged easily. The information is stored in computers that cannot talk to each other. Outdated paper processes, lack of non-proprietary international standards, and the lack of computer interoperability have created costly industry productivity problems. Millions of dollars are lost each day due to inefficiencies caused by paper processes and the inability of computers to talk to each other.

Increasingly, firms in the aerospace and defense sectors are turning to electronic commerce alternatives such as electronic data interchange and technical data interchange to make these partnerships more efficient. Many companies want to share the complex technical data output of computer-aided design (CAD), computer-aided manufacturing (CAM), and product data management (PDM). Much of the promise of technical data interchange remains unrealized. Technical data, a crucial resource of any enterprise, is captive to the software system in which it was first created. The different platforms, electronic languages, and formats used hinder economic expansion. In other words, computers cannot talk to each other – computers cannot share information.

There is work in the global international standards community to resolve the product data life cycle interoperability problems with the creation and implementation of
a series of standards under the broad auspices of the Standard for the Exchange of
Product Model Data (STEP). One of the STEP standards under the “umbrella” of STEP is
STEP Numerical Control (STEP NC). STEP NC will link engineering and manufacturing
data flows. This study is focused on STEP NC.

Purpose of the Study

This study examined the process for the implementation of a system for creating
reciprocity between international design standards and new international manufacturing
standards. In other words, how can designers and manufacturers share the same data on
several diverse computer platforms for enhancing efficiency and effectiveness in
production? Can designers and manufacturers create an environment where computers
and software can talk to each other? This purpose was addressed through an examination
of one example of a model for the exchange of data: The Standard for the Exchange of
Product Model Data -- Numerical Control (STEP NC).

A secondary purpose was to examine the characteristics of the change process that
accompanies the implementation of STEP NC and the impact those standards have on an
organization. What are the changes in the manufacturing environment due to
technological innovations? Burrus and Gittines (1998) discuss how sweeping
technological innovations have changed the rules. A survey examined the changes
required to lead consensus in the adoption and implementation of international standards.

Research Questions and Related Hypotheses

The following four research questions and related hypotheses examined the
overall effect of international standards on an organization and then specifically focused
on one standard, STEP NC, in the process of becoming an international standard. The study examined processes in place for implementation of change and who in an organization can lead the change required for adoption of STEP NC.

1. Do respondents have a process in place to implement change that will benefit the adoption of new international standards within their organization?

There is a significant difference in the organization’s processes in place to implement change, which will benefit the adoption of new international standards according to three independent variables: (a) industry segment, (b) size of the organization, and (c) length of service. This umbrella hypothesis will be addressed by sub-hypotheses defined by individual items of the survey outlined in chapter 3.

2. Do respondents believe their organization has a sense of urgency to create a vision focusing on the importance and value of adopting non-proprietary international Standards for the Exchange of Product Model Data (STEP)?

There is a significant difference in the respondents’ beliefs that their organization has a sense of urgency to create a vision focusing on the importance and value of adopting non-proprietary international STEP according to three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. This umbrella hypothesis was addressed by sub-hypotheses defined by individual items of the survey.

3. Do respondents believe there are organizational change processes in place that familiarize and educate management about benefits of STEP Numerical Control preceding adoption and implementation of the standard?
There is a significant difference in the respondents’ beliefs that there are organizational change processes in place that familiarize and educate management about benefits of STEP Numerical Control preceding adoption and implementation of the standard according to three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. This umbrella hypothesis was addressed by sub-hypotheses defined by individual items of the survey.

4. Are respondents able to identify a leader in their organization who will promote the changes required for the use of STEP standards?

There is a significant difference in the respondents’ abilities to identify a leader in their organization who will promote the changes required for the use of STEP standards according to three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. This umbrella hypothesis was addressed by sub-hypotheses defined by individual items of the survey.

**Background of STEP and STEP NC**

The National Institute of Standards and Technology (NIST) (1999) agrees that most companies find it difficult to enforce the use of a common set of CAD/CAM tools within their organization, much less across (multiple) supply chains and among joint venture partners. Because of the lack of any common set of tools, a common format for neutral file exchange is needed. It is exactly this common format, as well as data access mechanisms, that STEP hopes to provide.

Because STEP standards have been developed and approved by the international community and certified by ISO, they are recognized globally as an interoperable form of
communication. STEP will create the interoperable environment that is lacking in most organizations.

The solution to many of these problems can be resolved by using tools based on this evolving standard called STEP. STEP is internationally recognized and based on a public data model, an open (non-proprietary) architecture that allows sharable data. It is very important that the solution to these problems be an international solution.

Canadian CANSTEP, the Integrated Manufacturing Technology Institute, and the National Research Council Canada (1999) find that because STEP is an international standard, it gives it a distinct advantage over company, industry, and national standards. As such, a corporation executing product design can transmit all the information required for manufacturing to branch plants or subcontractors anywhere in the world.

The STEP standards will be used for the electronic transfer of technical information using computers. STEP is an international standard for exchanging data between different CAD, CAM, and PDM systems. It represents a viable alternative to the current chaos of multiple, fragmented standards, and proprietary data formats. STEP is a proven way to ensure fast, reliable data exchange between partners and suppliers using different systems. The unique feature of STEP is that it integrates product data. Adopting these standards requires changing the way business is done by allowing interoperable electronic delivery of information. This means the culture of business environments must be changed.

Design standards and manufacturing standards are established or prescribed by an International Organization for Standards (ISO) body of authority that applies definite rules and principles for how computer data are formatted. In the environment of the
2000s, the data for a product are managed in many different systems, often with little integration and with a great deal of data redundancy. For example, engineering drawings may be maintained in a proprietary CAD, CAM, or PDM system format, whereas the information on material composition, surface finishing, packaging, and electrical connections is likely to be contained in a variety of documents and stored in a variety of different computer formats.

STEP can alleviate this problem by providing a single product data storage standard that integrates the data and creates interoperable databases (databases that can talk to each other and computers that can talk to each other). STEP conformant software tools will enable companies to effectively exchange and share product information with their worldwide partners, customers, subcontractors, and suppliers, as well as internally.

The development of the STEP standards is accomplished by global working groups. Over 32 countries worldwide participate in developing the non-proprietary formats/application protocols for the standards. Representatives of the countries meet in working groups to develop the computer data formats, agree on format content and structure, and vote their countries’ acceptance of the resulting consensus. The flow of information from engineering to manufacturing using international design standards and the new international manufacturing standards is under development in the ISO community.

This study investigated and compared the effects of developing a part using the new information flow from design to manufacturing versus the traditional information flow of paper and the use of proprietary data formats. The change process necessary for implementation of those standards was explored.
There was an examination of perceptions of the participants in a consensus-rendering group chartered with changing business environments by implementing international standards that allow computer interoperability. The dynamics of instituting this change in an organizational environment was documented. In addition to the dynamics of change, the study analyzed leaders who promote the acceptance of those standards in organizations. Who are those leaders? This study assisted in identifying leaders within an organization who champion standards implementation. This study focused on creating new international standards in a global environment and implementing new international standards in an organization.

The research specifically looked at the development, implementation, and change required for one international standard that is part of the STEP standard family. This research focused on the expansion of STEP to include a new additional STEP application (AP 238) for machining. The product is machined in a large production environment using the Internet. This research moves development and implementation of STEP NC from a lab environment into a production environment.

In addition to examining process and cultural changes, the Standard for the Exchange of Product Model Data for Numerical Control Application Protocol 238 (STEP NC AP 238) was prototyped, using STEP NC as the basis and the enabling standard that underlies the potential for using the digital product model as machine tool input. The focus was on the development and implementation of the STEP NC standard in a prototype production plant system.

STEP NC allows a complete database of machining information to be built around it. The database then dictates what capabilities must exist in the machine tool controller.
to cut the part. STEP NC contains a sequence of manufacturing tasks intended to be capable of describing all operations necessary to transform a “raw” piece into a finished part.

The new STEP NC data model supports a well-structured hierarchical interface and the use of CAD data without conversion, uses splines (the connection of two pieces) directly for improving surfacing, provides feedback of information to planning, and is compatible with STEP standards. This capability will replace the 50-year-old RS 274 (M&G) codes. M&G codes tell the machine to cut a straight line from point A to point B. M&G codes are archaic and very limited in their usefulness. STEP NC allows cutting on curves and angles.

**Research and Development Program**

Independent Research and Development

Within the defense community there are programs which encourage the initiation of new technology. Defense contractors research advanced technological developments to determine which technologies will enhance their current and future programs. Once these technologies are identified by the defense-contractor lead engineering-program managers, the program managers undertake the task of convincing the defense community to test and implement the technologies. A business case and proposal is developed and presented to upper management at the defense contractor site and the corresponding Department of Defense office. Once the proposal is accepted and a shared funding arrangement between the contractor and government is in place, the research program begins.

I am leading a research team consisting of members from General Dynamics Land Systems (GDLS), National Institute for Standards & Technology (NIST), Gibbs &
Associates, Lawrence Livermore Labs (LLNL), Louisiana Center for Manufacturing Sciences (LCMS), STEP Tools, and Numerical Control Services (NCS). While leading the STEP NC implementation team, I am representing my company (GDLS) and the United States in the U. S. Technical Advisory Group (U.S. TAG) creation and voting approval of the global STEP standards.

I presented a business case to the Department of Defense (DoD) and obtained funding for the program from the National Automotive Center (NAC) at the Army Tank Automotive and Armaments Command (TACOM) and General Dynamics Land Systems Independent Research and Development (IR&D) funding. This IR&D program garnered significant media attention during the implementation phase. Media interest (newspapers, magazine articles) promoted the technology and reached the entire industrial community (Albert, 2000; Hardwick, 2000; Waurzyniak, 2001; Weyrich, 2001; Wichmann, 2000) along with understanding of the standard and its capabilities.

Kocakulah, McGuire, and Sievern (2000) discovered that business environments in the last decade have changed dramatically in the U. S. They state that competition from companies with established world-class techniques have placed heavy pressure on companies that are not quite as prepared for new realities.

In the last 10 years, leading companies with traditionally high market shares and profits have found themselves in a panic, implementing radical changes and new ways of doing things in order to survive in an environment where seemingly only the leanest, most responsive, survive. The survival of a company depends on how fast they can implement new technologies and how adaptive their workforce to those new technologies. The fear of adapting to new technologies can be eased with appropriate
training. Contrary to early predictions that innovation and new technology implementation would lead to a de-skilling of the workforce, current manufacturing employers are demanding a higher-skilled workforce with broad general and technical skills. In fact, lack of a sufficiently skilled and trained workforce has often been a stumbling block in automation and modernization projects (Adler, 1992, p. 5). New technology places a premium on higher technical skills and broader general skills. The key to achieving these skill levels is effective technical training and education.

With the implementation of international standards and the necessary software for implementation, organizational productivity will significantly increase. The STEP standards and specifically STEP NC have proven gains in decreasing product development cycles. The workforce training necessary for implementation is as close as the employee's computer.

Development of STEP—Cycles of Consensus

STEP acts as an “umbrella” over many applications. Below is a list of all the areas the global STEP community has addressed or is in the process of addressing (Hardwick, 2001; South Carolina Research Authority [SCRA], 2001). This study focused on Part 238 CNC Machining (STEP NC).

STEP Application Protocols

These are some of the STEP application protocols available or currently under development:

Part 201 Explicit Drafting
Part 202 Associative Drafting
Part 203 Configuration Controlled Design

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Part 204 Mechanical Design Using Boundary Representation
Part 205 Mechanical Design Using Surface Representation
Part 206 Mechanical Design Using Wireframe Representation
Part 207 Sheet Metal Dies and Blocks
Part 208 Life Cycle Product Change Process
Part 209 Design Through Analysis of Composite and Metallic Structures
Part 210 Electronic Printed Circuit Assembly, Design and Manufacturing
Part 211 Electronics Test Diagnostics and Remanufacture
Part 212 Electrotechnical Plants
Part 213 Numerical Control Process Plans for Machined Parts
Part 214 Core Data for Automotive Mechanical Design Processes
Part 215 Ship Arrangement
Part 216 Ship Molded Forms
Part 217 Ship Piping
Part 218 Ship Structures
Part 219 Dimensional Inspection Process Planning for CMMs
Part 220 Printed Circuit Assembly Manufacturing Planning
Part 221 Functional Data and Schematic Representation for Process Plans
Part 222 Design Engineering to Manufacturing for Composite Structures
Part 223 Exchange of Design and Manufacturing Product Information for Casting Parts
Part 224 Mechanical Product Definition for Process Plans using Machining Features
Background to Leadership and Change

During the last 150 years the entire view of the universe and its inhabitants has undergone a radical re-formation. Like yesterday’s news, Newtonian thinking now gives way to quantum and string theories of physics and reality. Further, technology consistently changes the fabric of everyday living. Similarly, philosophical underpinnings once thought unshakeable are readily dismissed as “antiquated and irrelevant.” Walter Anderson notes, “Humpty-Dumpty is not going to be put back together again” (1990, p. 78). The postmodern world has arrived.
As with most historical transitions, the postmodern transition exerts tremendous pressure on human life and organization. Leonard Sweet notes, "A sea of transitions and transformations is birthing a whole new world and a whole new set of ways of making our way in the world. We have moved from the solid ground of terra firma to the tossing seas of terra aqua" (1999, p. 109).

New millennium leadership is fluid, stormy, and, most of all, uncharted. Because of this, theorists and practitioners alike are currently seeking a new language by which to define leadership and a new map to navigate it. But as is true of most everything in this emerging era, one description or overarching definition of leadership seems illusive, if not impossible (Fleming, 2002).

The "aqua metaphor" points out something essential about 21st-century living and leadership. That is, it (postmodern life and leadership) is "based on the assumption that history is the unfolding of simultaneous or sequential elements of both reason and irrationality" (Bergquist, 1993, p. 42). This assumption is essential because it reveals how one must go about defining leadership in the new era. Leadership in the postmodern world is more about knowing "how" to proceed than "where" to proceed. The "where" of an organization changes too rapidly in today's economy and culture to be the focus of a leader's vision. A map of an organization's current situation will not provide adequate or even reliable information for a 21st-century leader to move it forward.

Twenty-first-century leaders must rely more on the "how" of leadership. The leader of the future is more concerned with process, relationship, and continuous learning, than he/she is with finding the Promise Land and settling there forever. Because of this, leadership must be defined in terms of broad wisdom principles. As the leader
cultivates these qualities, he/she finds both the wisdom and the competencies necessary to navigate the waters that lie ahead. For the purpose of this musing, it is suggested that we can combine all the competencies of wisdom into two overarching qualities. These qualities transcend specific situations, but can be localized to any situation the leader encounters. These two qualities also form a definition of 21st-century leadership. That is, 21st-century leadership is the art and science of seeing what is ahead without negating what is current as well as stewarding what is current without restricting what is ahead (Fleming, 2002).

**Sea Worthy Leaders**

In the postmodern world, leaders earn the right to lead. Though the position of leadership is valid, it is no longer the sole factor in determining appropriate leader influence. Leaders, in the new era, grow and learn as much as their followers. In fact, the learning leader is the leader of the future. This learning leader is both seer and steward. In becoming a learning leader, the leader develops his/her own unique “leader style” while maintaining the qualities that nurture, create, and transcend it. Just as a seasoned sea captain earns trust and respect through years of experience, so the leader of tomorrow earns both followers and their trust as he/she navigates years of situations and relationships (Daft & Lengel, 1998).

Ultimately the postmodern leader understands that leadership begins and ends with self-leadership. Seeing and stewarding one’s own life is the foundation of leading any organization. The leader of the future understands the wisdom inherent in the ancient proverb, “As within, so without.” This ancient wisdom must be re-ignited in the uncharted and risky waters of the postmodern organization.
Most organizations lack leaders with appropriate leadership skills to move their organizations forward in this rapidly changing business environment as argued by Kotter (1999). After conducting 14 formal studies and more than a thousand interviews, directly observing dozens of executives in action, and compiling innumerable surveys, Kotter (1999) was completely convinced that most organizations today lack the leadership they need. Mann (1989) felt the aim of leadership should be to help people and machines and gadgets to do a better job.

Electronic commerce has created the “push” for global interaction. This interaction has created an awareness and concern for human rights and living conditions worldwide. Kennedy (2001) discussed in a study of 55 companies that corporate and social responsibility, once a fringe interest, is now being actively addressed by influential advisory bodies.

Senior executives can learn how to monitor public criticism of their industries and find out what activities are being directed in their company on the Internet. This electronic connection also created an avenue of opportunities for electronic economic expansion. To succeed in this expansion and to succeed in the global marketplace, organizations in highly competitive fields must be able to form alliances and partnerships rapidly across geographic and cultural barriers.

It is becoming less and less viable for organizations of any size to operate only locally, regionally, or even nationally. There are many differences in consensus building due to cultural and national differences. An empirical case study by Fritsch (2000) analyzed the differences in innovation activities of manufacturing enterprises in 11 European countries. He found a number of differences in decision making. These
differences may, however, be primarily the result of factors at the national level and not of determinates that are region specific.

Business opportunities are global; access is global; competition is global. In the United States businesses are not only competing with each other but also with worldwide enterprises. Survival and prosperity depend on a business's ability to reinvent itself to be able to digitally connect and digitally interact with local and remote opportunities. To be able to reinvent itself requires the ability to change the organizational environment. Goss, Pascale, and Athos (1998) found that incremental change is not enough for many companies today. Companies need to create new processes, not improve old processes.

Some of the models researched for this study were participatory leadership models, which rely on interdependence and collective efforts, necessitate that campus participants feel included in the leadership process and emphasize communication throughout the organization as critical for organizational success (Astin & Leland, 1991; Bensimon & Neumann, 1993; Rosener, 1990; Tierney, 1989). Similar to hierarchical leadership models, participatory models assume a common leadership reality for all individuals within the organization.

Senge (2000) approaches leadership from the learning community within the organization. He believes there are three types of leaders. Local line leaders are the employees who can undertake meaningful organizational experiments to test whether new learning capabilities lead to improved business results. Executive leaders provide support for the line leaders, develop learning infrastructures, and lead by example. Internal networkers or community builders (the seed carriers of the new culture) are those who can move freely about the organization to find others who are predisposed to
bringing about change. I admire the Senge approach, as I see this beginning to happen
within my own organization. I see myself as a local line leader and sometimes an internal
networker. The learning organization is a concept I believe is not new. Senge was able to
encapsulate the concept and study it. A productive organization has to incorporate the
learning community within its walls and extend outward into the global economic
environment.

This study examined the leadership necessary to build group consensus for
adoption and implementation of new international standards. I discussed why there needs
to be a leader to implement change. Hammer and Champy (1993) talk about leaderless
organizations that can do some paper studies and can even come up with new process-
design concepts. Without a leader, no reengineering will actually happen.

This research examined the dynamics of business and cultural changes required
for the acceptance and implementation of international standards. The major leadership
concerns that impact this study is the leadership approach that will energize organizations
to create the global vision for consensus on how and in what formats information will be
transferred across dissimilar organizational infrastructures. The learning organization
approach best represents the full participation that is required to create and sustain the
consensus building that is required for the implementation and success of international
standards for product model data.

Rationale for the Study

Not only is there an organizational information disconnect, but to be even more
specific there is a serious dis-connect between engineering and manufacturing. The
manufacturing environment is “disconnected” from the engineering design environment.
This disconnection is not only evidenced by a "stovepipe" organization, where the design culture and the manufacturing culture are most often physically and geographically isolated from each other, but also sometimes "at war" by the varying degrees of mistrust each "stovepipe" has for each other (Brunnermeier & Martin, 1999). To exacerbate this problem, there also is the problem of computers in the "stovepipe" that do not talk to each other. Information that is on one type (or commercial brand) of computer cannot be easily transferred to another computer without a lot of manual rework of output and input data. The time and effort it takes to do all the rework and the additional errors caused by the rework cost industry billions of dollars in lost time and lengthened product development cycles.

The process for most product information exchange is still through paper or proprietary data formats. The majority of product cost today results from lack of prime contractor and supplier system and data interoperability (the ability of information to flow from one computer to another). Computer platforms are based on proprietary source codes that will not allow transfer of information from one commercial brand of computer to another. This lack of data interoperability results in delayed production. Each time data files encounter a different computer, the data require human and software interfaces to "fix" the file so it can input to another computer.

The current data exchange process severely limits the ability of engineering and manufacturing to produce quality products in an efficient manner. The lack of data interoperability severely limits product manufacturing/production. A few examples are based on a study by Brunnermeier and Martin (1999) which found the lack of interoperability imposes costs of at least $1 billion per year on members of the U.S.
automotive supply chain. By far, the greatest component of these costs is the resources devoted to repairing or reentering data files that are not usable for downstream applications. As the volume of PDE grows, members of the automotive supply chain spend more and more resources translating and transferring product data and solving the technical problems associated with these exchanges.

These technical problems have therefore taken on greater importance, because they affect the cost and time required to design and manufacture an automobile. One OEM estimates that as many as 453,000 product data exchanges occur each year within their company and among their company and their suppliers. Another OEM reported that downstream functions, such as rapid prototyping, finite element analysis, or CNC programming (for machining), spent a great deal of their time—as much as 50%—working with CAD data files that were not constructed properly for use in these downstream purposes (Brunnermeier & Martin, 1999).

They asked the Original Equipment Manufacturers (OEMs) and the suppliers to estimate the amount by which development time for their products would fall if interoperability problems did not exist. Although the answers differed among the respondents, the average for the suppliers weighted by their revenue shares was about 4 months (from an average 36-month development time), and the OEMs estimated a reduced development time of about 2 months. Producers can also lose market share and revenues if a new vehicle is delayed (Brunnermeier & Martin, 1999). In about 15% of all cases, these errors were not discovered until after the part tooling had already been cut. However, producers can incur significant losses even if market share and revenues are not lost, but simply put off, due to discounting. Clark, Chew, and Fujimoto (1987)
estimated that the discounted present value of the profits from the introduction of a new
vehicle could fall as much as $1 million for each day of delay of the product introduction.
Martin (1998) verified this estimate via interviews with industry officials.

Fleischer, Phelps, and Ensing (1991) surveyed members of the Detroit, Mid-
Michigan, and Grand Rapids chapters of the National Tooling and Machining
Association (NMTA) to determine the nature and frequency of problems incurred when
tool and die shops received CAD/CAM data from their customers. The survey revealed
that in about 51% of the jobs, the CAD data had to be repaired. The job shop had to
completely recreate CAD data in an additional 25% of the cases.

Even though rework costs and delayed production costs are tremendous due to
using traditional data processing methods, changing the way business is done and
implementing new technology is a difficult endeavor. Change is the only constant in life,
yet people resist change with a vengeance. People like to watch change, but they do not
like to do change. Creating new international standard formats requires the consensus of at
least seven countries. This consensus requires agreement not only among different
countries but also their differing cultures. Each culture has its own way of forming
consensus agreements. Once the format for a standard is approved and moves along the
ISO path for final approval as an international standard, it is only the beginning of that
standard's life. Now the job is to implement the standard. This requires change on the
part of the implementing organization.

**Significance of the Study**

This was the first time STEP NC had been used in a production environment in
the United States. Once STEP NC is implemented on a broad basis, it will revolutionize
the industrial community by linking engineering and manufacturing electronically. This electronic link will allow for a smooth flow of information to the shop floor for creation of quality parts. The cost to produce parts will be greatly reduced.

The changes and consensus required to implement a global economic information exchange will become a template for future global consensus activities. For the first time there is work currently in process that addresses engineering and manufacturing interoperability in an electronic/digital environment. This work is the development of global standards that require the consensus of over 32 countries to reach decisions on how and what it will take to accomplish these difficult tasks.

The majority of product costs today results from the lack of government, prime contractor and supplier data interoperability (Brunnermeier & Martin, 1999). Computer platforms are based on proprietary source codes that will not allow transfer of information from one commercial brand of computer to another. This lack of data interoperability results in delayed production. Each time data files encounter a different computer, the data require human and software interfaces to “fix” the data file so it can input to another system.

Rework costs industry an estimated $1 million per day, and data-related problems cost industry millions. The goal is to provide an interoperable digital data environment to allow data flow across dissimilar platforms. This will be accomplished by building a three dimensional (3D) data file for each design that will flow uninterrupted from CAD through CAM and into the machine on the shop floor to cut parts. The 3D data file will contain all the information that would otherwise have to be entered by the user. The file
will flow from design to manufacturing without stops on the way to re-enter data for each different brand of computer the file encounters.

In the automotive industry suppliers spend at least $200 million annually reworking data files. Tooling suppliers spend more than $450 million. Automotive suppliers believe they could reduce their delivery by 4 months if they received perfectly interoperable data from the OEMs for each new design. Automotive OEMs believe they can reduce the design to production time by 2 months if using perfectly interoperable data. Suppliers will save at least $200 million annually by not reworking files; tooling suppliers will save more than $450 million. OEMs will reduce design to production by months using interoperable data. Suppliers could reduce delivery time by 4 months if they receive interoperable data from OEMs for each new design. Many of these savings will occur by using ISO STEP NC to link design, manufacturing, and the machines on the shop floor (Hardwick, 2001).

**Delimitation**

There is a STEP NC Industrial Review Board and the extended STEP community is made up of approximately 110 people representing companies worldwide. The survey of the GDLS STEP NC project was limited to the members of the STEP NC Industrial Review Board and the extended STEP community.

**Limitation**

I used only surveys that were completed from the survey website and returned.
Definition of Terms

*Application Protocol (AP):* A set of characters at the beginning and end of a message that enables a computer to communicate the system or problem with another computer.

*Computational Type or Data Type:* A part of the international standard that specifies an application-interpreted model satisfying the scope and information requirements for a specific application.

*Application Programming Interface (API):* A standard API specifies a mapping between a programming language and the features of a particular service, and thereby provides access to that service from applications written in a particular programming language.

*Computer Aided Design (CAD):* Design using three dimensions or line drawings on a computer.

*Computer Aided Manufacturing (CAM):* Manufacturing processes and the manufacturing aspects of design using a computer.

*Computer Numerically Controlled (CNC):* A computer-controlled machine operation that provides high repeatability for multiple process steps.

*Data Exchange:* The storing, accessing, transferring, and archiving of data.

*General Dynamics Land Systems (GDLS):* A company that is a defense contractor, GDLS integrates and manufactures weapon systems and their supporting systems.
Integrated Manufacturing Systems (IMS): The concept of manufacturing that incorporates and is influenced by design/engineering, quality, support, etc. This includes all of the activities included in the development of the product.

Interoperability: The ability of systems, units, or forces to provide services to or accept services from other systems, units, or forces and to use the services so exchanged to operate effectively together.

Industrial Review Board (IRB): The Industrial Review Board is made up of leading members of the Aerospace and Automotive industries, their software suppliers, and small to mid-sized machine shops that are their manufacturing suppliers. They include 51 organizations and approximately 110 people from those organizations.

International Organization for Standards (ISO): A worldwide federation of national standards bodies from some 100 countries, one from each country. ISO is a non-government organization established in 1947. The mission of ISO is to promote the development of standardization and related activities in the world with a view to facilitating the international exchange of goods and services, and to developing cooperation in the spheres of intellectual, scientific, technological, and economic activity.

Numerical Control (NC): Tape-controlled machine operation, which provides high repeatability for multiple process steps.

National Institute for Standards and Technology (NIST): A United States government organization devoted to the design and implementation of national and international standards.

Product Data: A representation of information about a product in a formal manner.
suitable for communication, interpretation, or processing by human beings or by computers.

*Product Data Management (PDM):* A software tool that manages engineering information, and supports managing the product configuration and the product engineering process.

*Product Data Sharing:* The access of and operations on a single copy of the same product data by more than one application, potentially simultaneously. STEP is designed to support the interfaces between the single copy of the product data and the applications that share it. The applications do not hold the data in their own preferred forms. The architectural elements of STEP may be used to support the realization of the shared product data itself. The product data of prime interest in this case is the integrated product data and not the portions that are used by the particular product data applications.

*Proprietary:* One that possesses, owns, or holds exclusive right to something; used, made, or marketed by one having the exclusive legal right to ownership.

*Simulation:* A method for implementing a model. It is the process of conducting experiments with a model for the purpose of understanding the behavior of the system modeled under selected conditions or of evaluating various strategies for the operation of the system within the limits imposed by the developmental or operational criteria. Simulation may include the use of analog or digital devices, laboratory models, or “testbed” sites. Simulations are usually programmed for solution on a computer; however, in the broadest sense, military exercises and wargames are also simulations.

*Standards:* A term applied, in work measurement, to any established or accepted rule, model, or criterion against which comparisons are made.
Standard for the Exchange of Product Model Data (STEP): The informal name for the international standard, ISO 10303, “product data representation and exchange.”


System: The organization of hardware, software, material, facilities, personnel, data, and services needed to perform a designated function with specified results, such as the gathering of specified data, its processing, and delivery to users; a combination of two or more interrelated equipments (sets) arranged in a functional package to perform an operational function to satisfy a requirement.

Stovepipe: A term used for the practice within organizations of being concerned only with issues within the particular department where a person works. The personnel within that department are not cognizant of the “big” picture of the organization.

Technical Data: Recorded information, regardless of the form or method of recording, of a scientific or technical nature (including computer software documentation).

Organization of the Study

Chapter 1 deals with the introduction of the study. Background information is provided along with a statement of the problem. It includes the purpose of the study and research questions. There is a rationale for the study, and the significance of this study is addressed. Study delimitations and limitations are addressed along with the definition of terms.
Chapter 2 contains a literature review of previous work on the topic of the study. An intense review of literature was conducted to research current and past theory on the presented topics.

Chapter 3 details the methodology used in the study. This chapter describes the participants of the study research questions, the procedures used to conduct the study, the surveys, variables and measurement of data, and data analysis methods.

Chapter 4 deals with the analysis of data and depicts the data in various tables dealing with the variables of the study such as industry segments, size of the organization, and length of employment.

Chapter 5 contains a summary of findings, discussion, conclusions, and recommendations for further study. Industry comparisons are discussed regarding their relevancy to current organizational processes.
CHAPTER II

LITERATURE REVIEW

Review of Relevant Literature

The literature review begins with an examination of the impact of change on corporations, the significance of change within different cultures, and how the success of change is measured. The argument continues with articles of leadership in the change process. The review narrows the topic of change to electronic commerce with specific focus on change in the community of international standards development and implementation within the electronic commerce environment.

Dynamics of Corporate Change

Nembard et al. (2000) conducted a case study that highlights four major manufacturing transitions: new product introduction, moving a product from research and development (R&D) to commercialization, new plant location, and starting or restarting production of existing products. This case study is similar to my study in regard to moving technology from the research and development or laboratory environment into a production environment. This study was done in a high volume home-fashion product industry. Most of the findings pertain to change processes in general but these specifics do not pertain to low volume plant activity as in the defense industry.
Solomon (2001) studied the interconnections among businesses and their various stakeholders including suppliers, customer providers, employers, and others as being more rapid and complex as they are facilitated by advanced information technology and systems. Implications of the findings are discussed regarding process changes and reengineering within organizations and business networks. With the emergence of network economy and an information-rich environment, traditional hierarchies have been replaced by groups of interconnected organizations, with blurred boundaries and loose and often temporary alliances connecting customers, suppliers, employees, with stakeholders and competitors. These blurred boundaries are found within many organizations. I found within my own organization that once electronic interchange became viable for all departments, that indeed department boundaries became blurred. Thus, the issue of their dynamic interactions and mutual impact acquires greater significance. This study contributes to the understanding of the role played by different stakeholder groups, an issue which may be particularly important when these entities are in the midst of change and restructuring. Within the boundaries of my research I found that defining stakeholder groups was quite difficult when people did not want to change their business processes.

Corporate social influences and responsibilities are discussed and surveyed by Kennedy (2001). The survey was conducted of 55 companies on corporate anti-globalization and pro-globalization. The most likely key to corporate change will be the growing power of ethical investment. Globalization is evident in most organizations if they want to be competitive. To incur globalization effectively, standard international formats are important. My study encompasses agreement of formats for international
standards by a minimum of five different countries. This requires multinational cooperation and ethical practices for the good of all countries involved. Moderate protesters against global business practices are not looking to see capitalism destroyed but made more accountable—and not only to shareholders, staff, and domestic customers, but to the people who work for multinationals in underdeveloped countries. Today capitalism is on the increase as nations struggle to produce business practices that will allow them to join the world markets. International standards working groups are examples of effective international cooperatives.

According to Hammer and Champy (1993), “America’s business problem is that it has entered the 21st century with companies designed during the 19th century” (p. 122). Reengineering the corporation requires challenging assumptions and embracing change. This requires leaders who are brave enough to “start over.” The reengineering leader makes reengineering happen. He or she is usually a senior executive with enough clout to cause an organization to turn itself inside out and upside down and to persuade people to accept the radical disruptions that reengineering brings. Without a leader, an organization can do some paper studies, and the organization can even come up with new process design concepts; but in the absence of a leader, no reengineering will actually happen. Even if it gets started, a leaderless reengineering effort will run out of steam or hit the wall by the time it is ready for implementation.

This work is based on findings for overall corporate reengineering strategies. Strategic planning is important for new technology implementation. I find in my own work, which is implementing new technology, that I sometimes have to retain old systems and run them parallel to the new systems. This eliminates some of the fear of
change. Once the systems are working, the employees embrace the change and reject the "old ways." This study addresses reengineering processes within a segment of the organization using a groundswell (people at mid-level management creating change) approach.

Davis (1982) relates that the way in which people perceive a problem, a question, or an event determines what they will be able to know about it. The three steps are the following: (a) they do not know what they do not know, (b) they know that they do not know, and (c) they know. Stock market analysts discuss these perceptions and how some analysts do not know, and some analysts do not know that they do not know. The people who “don’t know that they don’t know” can sabotage change. These people are part of many of our teams. It is up to the leader to educate.

Champy (1995) delves into changing the management culture in addition to changing the processes. Most often the commitment from top management does not seep down to middle management. Most often middle management “digs in” and waits for the “flavor of the month” management change to go away. They then go back to the way they have always operated. This study examined instituting change with the user. Once the user accepts and implements the change, the acceptance from other users will spread.

Re-engineering is about doing things differently (not a little bit different, but radically differently) (Volkurken, 1998). The problem is, business structure and its associated tasks are still modeled after the way Adam Smith outlined the pin factory example in *The Wealth of Nations* (1776). Smith told us that if we divided work into tasks, and assigned these tasks to specialists, we would get more efficiency out of our organizations. This model has created the functional islands that we are struggling to
overcome. Our corporations are divided into tasks and specialties that inhibit interoperability and communication.

Burrus and Gittines (1998) discuss how sweeping technological innovations have changed the rules. In order to be successful, one must know how to deal with the new business rules, which will transform decision making and management processes worldwide. Many people viewed as leaders are successful managers. They are very good at managing but are not leaders. Consequently, as managers advance to executive positions, they keep managing. This led me to scrutinize the executives in my company. Most of the executives are managers and not leaders. I found that it is difficult to lead change. It is much more comfortable to maintain the status quo. When one leads change, one subjects oneself to the possibility of failure and sometimes ridicule. Implementation of my research has sometimes failed. It has only been through perseverance that I have achieved success.

How can leaders achieve deliberate strategic change in organizations where strategic leadership roles are shared, objectives are divergent, and power is diffuse? Such situations are becoming increasingly common as organizations in many industries enter into various forms of collaborative arrangements, as the workforce becomes increasingly diversified, as internal markets, matrixes, and networks penetrate organizational structures, and as knowledge workers play an increasingly important economic role (Lowendahl & Revang, 1998; Van de Ven, 1998). Denis, Lamothe, and Langley (2000) tackled this research question using a replicated case study method (Eisenhardt, 1989; Leonard-Barton, 1990; Yin, 1994). Specifically, they examined the dynamics of leadership and strategic change in two sets of case studies conducted in the Canadian
health-care sector. Health care is a classic pluralistic domain involving divergent objectives (individual patient care, population health, and cost control) and multiple actors (professionals, administrators, community groups, and politicians) linked together in fluid and ambiguous power relationships (Bucher & Stelling, 1969; Bunderson, Lofstrom, & Van de Ven, 1998; Scott, 1982). The sector has become more dynamic and complex in recent years as a variety of factors has led to the breakdown and opening up of organizational boundaries (Meyer, Brooks, & Goes, 1990; Shortell, Gillies, Anderson, Erickson, & Mitchell, 1996).

It has been argued that the inherent tensions between economic values and noneconomic professional values in "value-rational" (Satow, 1975) or professional organizations such as health-care institutions can be resolved through "segmentation," a phenomenon in which different parts of an organization function autonomously with minimal linkage between them (Thompson, 1967; Weick, 1976). However, while professional autonomy and loose coupling may encourage local incremental adaptiveness, they do not necessarily facilitate concerted collective action (Cohen & March, 1986).

The first set of three case studies dates from the late 1980s and early 1990s, a time when many hospitals in Canada were undergoing what could be described as "first-order" strategic change (Fox-Wolfgang, Boal, & Hunt, 1998): There were attempts to alter their internal practices and to redefine their missions, but their integrity and existence were not threatened. The second set of two studies examines the dynamics of leadership and change during two mergers involving three hospitals each and taking place in the late 1990s. These events can be seen as representing "second-order" change because the
nature, existence, and boundaries of the organizations were more fundamentally questioned.

Organizational changes and mergers affect organizational/corporate culture whether it is higher learning, nursing, automotive, defense, etc. There is the anxiety people experience as they wonder about the effects the merger will have on their position in the organization—e.g., uncertainty about the degree of influence one will have in the new situation. Who will be on the board? Who will continue to be employed? Will I be respected and listened to? Will my friends stay? etc. In a business when mergers take place, there is usually the assumption that increased size will bring greater effectiveness. Usually employees will be terminated to reduce costs and increase efficiency. In the non-profit, the assumption is that we merge to increase the total number of people we serve and to decrease redundant functions and in so doing to increase our capacity for mission and survival. There are usually staff cuts and changes in leadership positions. As changes begin to take place (e.g., some people do decide to leave the organization or not move to a new location, familiar staff are "retired" or fired, awkward power-sharing arrangements are attempted, etc.), the anxiety builds.

While leaders may attempt to ease or cover it with comforting words or sentimentality, what most people experience is that one organization has "won" and the other has "lost." There will be the obvious issues of position and status, such as which managers are maintained what locations are kept; there will also be the question of organizational culture. After several years the culture of the "winners" takes hold.

The cultural ways and assumptions that come into play as a result of a merger will vary from one case to another. Even if there is a high degree of cultural alignment in
many areas, there is likely to be tension in areas with less alignment. So, for example, if the merging organizations have leaders that come from the same class and professional background and share many similarities in personal style, they may find that they collide over approaches to decision making or how informally people dress at organizational gatherings. This leads to merging systems that were the proprietary development of each organization. Not only do the people have to merge their corporate cultures, but the systems are now deemed incompatible. One of the solutions for system incompatibility is the development of standards to eliminate the incompatibility.

Never was a field of research such as organizational change better placed to deliver combinations of "what is" and "how to" knowledge. But the "how to" knowledge is a question of not just the more rigorous exposure of continuous change processes through time and in context, but also of a more sophisticated and demanding engagement with practice. One of the fondest dichotomies in modernistic conceptions of science has been that of theory and practice. Recently, in examining the future of strategy research in management, Whittington, Pettigrew, and Thomas (2001) asked their readers to regard theory and practice as a more tightly linked duality. They argued that this "greater sensitivity towards practical complexity will prompt a more comprehensive notion of rigour" (Whittington et al., 2001, p. 486). There is no softness of academic standards here, but a considerable raising of the stakes in terms of the social production of knowledge. Woodman (1993) argued that the schism between the science of organizational change and the practice of changing organizations is the single biggest impediment to progress in effective change management.
The action steps to resolve the old dichotomy of theory and practice have often been portrayed with a request for management researchers to engage with practitioners through more accessible dissemination. But dissemination is ineffective, or even possibly irrelevant, if the wrong questions have been asked. A wider and deeper form of engagement between management researchers and practitioners would entail experimentation with the cofunding, coproduction, and codissemination of knowledge. Examples of this kind of partnership research already exist—witness Bartlett and Ghoshal's (1989) research on transnational firms, Porter's (1990) government-sponsored work on national competitiveness, and even closer to the theme, the recent INNFORM program on innovative forms of organizing (Pettigrew & Fenton, 2000).

Further, the *Academy of Management Journal* recently published a special research forum on knowledge transfer between practitioners and academics (Rynes, Bartunek, & Daft, 2001). The work in that forum should serve to advance our knowledge about the dynamics surrounding the research partnerships needed in the field of organizational change and development.

Cultural Significance of Change

Fritsch's (2000) case study analyzed the differences in the innovation activities of manufacturing enterprises in 11 European countries. A number of differences in decision making could be identified. These differences may, however, be primarily the result of factors at the national level and not of determinates that are region-specific. This research concentrates on European countries and their innovation processes. It does not include the United States or Asia. My research examines a global approach to consensus in
leading technological standardization. I have found while representing my country in the
international standard groups that each country reaches consensus in different ways.

Everyone brings cultural prejudices to the bargaining table. Rost (1993) argues
the cultural changes that are imminent in the 21st century will impact the understanding of
leadership, which he calls the industrial leadership paradigm. It is industrial because it
accepts almost all the major characteristics of the industrial paradigm: (a) A structural-
functionalist view of organizations, (b) a view of management as the preeminent
profession, (c) a personalistic focus on the leader, (d) a dominant objective of goal
achievement, (e) a self-interested and individualistic outlook, (f) a male model of life, (g)
a utilitarian and materialistic ethical perspective, and (h) a rational, technocratic, linear,
quantitative, and scientific language and methodology.

The problem with the industrial leadership paradigm is that it increasingly ill
serves the needs of the world rapidly being transformed by a massive paradigm shift in
societal values. There is more and more evidence to conclude that the industrial paradigm
is losing its hold on the culture of Western societies (and perhaps all societies in the
world). Some kind of post-industrial paradigm will dominate these societies in the 21st-
century. In this view of paradigmatic change, the 1980s and 1990s are seen as a transition
period wherein the dominant values and cultural norms shift from an industrial to a post-
industrial frame.

While no one knows with certainty when the post-industrial paradigm will
achieve dominance, many analysts assume it will be sometime in the early 21st century.
No one knows with certainty, either, what values will prevail for the core of the post-
industrial paradigm, but if the shift is going to have any significance of note, the values
will have to be quite different from, and even opposed to, the core values of the industrial paradigm. These cultural shifts in the world impact people’s concepts of how the organization should function and evolve. It might take time, but the changes will eventually take place.

I agree with Rost that the core values of the industrial world are indeed (a) a structural-functionalist view of organizations, (b) a view of management as the preeminent profession, (c) a personalistic focus on the leader, (d) a dominant objective of goal achievement, (e) a self-interested and individualistic outlook, (f) a male model of life, (g) a utilitarian and materialistic ethical perspective, and (h) a rational, technocratic, linear, quantitative, and scientific language and methodology.

The core values of the post-industrial world should be:

1. To create a supportive environment where people can thrive, grow, and live in peace with one another;

2. To promote harmony with nature and thereby provide sustainability for future generations; and

3. To create communities of reciprocal care and shared responsibility—where every person matters and each person’s welfare and dignity is respected and supported.

These values, once permeated within organizations, will extend into the communities that sustain the organization. As one can see, the values differ in the respect that the diversity of the community is valued in post industrial. The learning organization is a good model for implementation of the post-industrial ideal.
With regard to the question, “Do regions matter for R&D?” (Kleinknecht & Poot, 1992), their results clearly suggest that this is the case. Specifically, there are clear indications that agglomeration economies may be conducive to innovation activities and, consequently, agglomerated areas or 'centers' indeed have some advantage over remoter areas (the “periphery”) in this respect as is stated in the literature.

However, demonstrating that locational factors play a significant role for innovation activities is only the first step. We need to know what factors are responsible for the differences between regions and how to create conditions conducive to innovation activities at any given location. Particularly, knowledge of such factors should enable us to explain the diverse results attained that do not fit neatly into the center-periphery pattern. An analysis of the anatomy of these factors should focus on the transfer mechanisms of knowledge spillovers within a region in order to arrive at a better understanding of the importance of agglomeration economies for innovation processes.

**Educational Cultures**

During the past two decades higher education in America has attempted a number of reforms. Reform efforts are predicated on the assumption that proactive, intentional change efforts in colleges and universities can succeed despite the predilection for tradition and maintaining the existing culture. Culture proves to be a critical component in understanding the process of planned change and transformation in colleges and universities today. The significance of organizational culture becomes particularly clear as we operationalize institutional transformation. The concept of transformation described borrows from the work of Eckel, Hill and Green (1998), who make reference to organizational culture as one of four primary elements of planned change. They state that
institutional transformation: "(1) alters the culture of the institution by changing select underlying assumptions and institutional behaviors, processes, and products; (2) is deep and pervasive, affecting the whole institution; (3) is intentional; and (4) occurs over time" (p. 68).

Keup, Walker, Astin, and Lindholm (2001) reviewed the research on institutional transformation, as it is relates to organizational culture. The discussion of organizational culture's importance in institutional transformation was organized around three primary aspects of the change process: (a) readiness for, and responsiveness to, institutional transformation, (b) resistance to planned change, and (c) the results of the transformation process.

Organizational Culture

An organization's culture can be understood as the sum total of the assumptions, beliefs, and values that its members share and is expressed through "what is done, how it is done, and who is doing it" (Farmer, 1990, p. 76). However, members of an organization often take its culture for granted and do not truly evaluate its impact on decisions, behaviors, and communication or consider the symbolic and structural boundaries of organizational culture until external forces test it. Therefore, when initiating transformation efforts, it becomes critical to understand and explicate the values and personal meanings that define organizational culture. According to Farmer, "Failure to understand the way in which an organization's culture will interact with various contemplated change strategies thus may mean the failure of the strategies themselves" (p. 89). Case studies of corporations undergoing change (Wilms, 1996; Zell, 1997) and institutions engaging in transformation efforts (Kezar & Eckel, 2000) reveal that
organizational culture can either facilitate or inhibit institutional transformation, depending on the fit between existing culture and the proposed change.

Other research (Kabanoff, Waldersee, & Cohen, 1995) found that the type of institutional culture (e.g., elite, meritocratic, leadership, or collegial) predicted perceptions of change in the organization. Similar to Farmer, Kabanoff et al. (1995) emphasize the importance of understanding organizational culture in change initiatives. In their study of organizational values and institutional change, they found that organizations characterized by collegial values (i.e., teamwork, participation, commitment, and high levels of affiliation) looked at change enthusiastically and in positive terms as opposed to organizations characterized by elite, meritocratic, or leadership-style value structures, which were more likely to view change negatively. Although characteristics of all four value structures can be found in educational environments, the researchers found that the majority of colleges and universities included in their study were classified as collegial organizations and, therefore, perhaps surprisingly, viewed change positively.

I have found that industry/corporations tend to display elite, meritocratic, or leadership-style value structures, as opposed to collegial values (i.e., teamwork, participation, commitment, and high levels of affiliation). This style creates a dichotomy in the international standards community. The international standards body is made up of participants mostly from corporations with a smaller number from universities. Added to the mix is the representation from many diverse countries. There is much painstaking consensus-building among the groups. This is one of the reasons that the creation of international standards is a lengthy process.
While culture clearly affects how the members of the organization perceive change, the elements of culture are usually unspoken tenets that are often taken for granted. Therefore, in order to gain a better understanding of culture within the organization and as a component of the transformation process, the question becomes, How can we talk about that which is unspoken? Further, if culture is to be considered in strategic planning and/or institutional transformation, which aspects of the culture are most conducive to change, and which aspects of culture are themselves in need of change?

Schein (1996) believes that every organization develops an internal culture based on its operational success, what he calls the "operator culture." But every organization also has, in its various functions, the designers and technocrats who drive the core technologies. He calls this the "engineering culture"; their fundamental reference group is their worldwide occupational community. Every organization also has its executive management, the CEO and his or her immediate subordinates--what he calls the "executive culture." CEOs, because of the nature of their jobs and the structure of the capital markets, also constitute a worldwide occupational community in the sense that they have common problems that are unique to their roles.

These three cultures are often not aligned with each other, and it is this lack of alignment that causes the failures of organizational learning. We might have misconceived the initial problem by focusing on organizational learning, when, in fact, it is the executive and engineering communities that must begin their own learning process if we are to meet the challenges of the 21st-century.

According to Kashner (1990), "Readying an institution to reply to the conditions that call for change or to innovate on the institution's own initiative requires a clear
understanding of its corporate culture and how to modify that culture in a desired direction" (p. 89). The W.K. Kellogg Foundation provides some insight into how to gain a clearer understanding of culture through assessment in their *Evaluation Handbook* (1998). Context assessment, particularly in the form of organizational assessment, provides the most information regarding organizational culture and proves to be a useful tool for institutional transformation.

Organizational assessment includes questions regarding the characteristics of institutional leadership, resource allocation, institutional structure, the flow of decision-making, and ties to external organizations. When conducted prior to transformation efforts, such an exercise provides rich information about the environment, the fit between the change initiative and existing organizational culture, and institutional readiness for change. Therefore, assessment represents one of the primary means to develop readiness. Two other ways to develop institutional readiness for transformation efforts are: (a) developing a culture of trust, and (b) open, participative planning strategies.

Research on institutional transformation indicates that an important cultural condition for change is the existence of trust among the various members of the campus community. While trust is most readily achieved through open communication between individuals and groups on campus, trust is also enhanced when there is a history of "making decisions in a way that reflects a clear and sensitive understanding of the culture of a campus" (Farmer, 1990, p. 10). A second condition that is necessary for an effective change environment is the use of planning strategies that are open, participative, aligned with campus culture and goals, and long-term. Strategies characterized by these values also facilitate the development of trust, can help develop institutional "buy-in," and
reflect the proper scope for innovative and transformational change efforts (Farmer, 1990; Rowley, Lujan, & Dolence, 1997; Steeples, 1990).

Frameworks

Frameworks for examining cultures and understanding a culture’s basic assumptions are important for understanding the culture itself. Researchers have developed frameworks to classify the cultures of the world. These frameworks are averages or norms of the value systems that compose a culture rather than exact descriptions. In other words, they represent approximate expected behavior in a culture.

Obviously, not everyone in a particular culture behaves in the same way. In fact, there is often greater variation within single cultures than across cultures. The following represent the various frameworks that purport to explain cultural differences. First of all, American anthropologists Kluckhohn and Strodtbeck (1961) developed a framework of six dimensions to describe the values orientation of a culture. The values orientation represents how different societies cope with various issues or problems. In the Kluckhohn and Strodtbeck framework, a culture may favor one or more of the variations or approaches associated with a particular values orientation. These orientations are: relation to nature, time orientation, basic human nature, activity orientation, relationship among people, and space orientation.

Hofstede’s Dimensions of Cultural Values

A more recent study of culture focuses specifically on work-related values. In a large-scale research program of 40 countries, Geert Hofstede (1980), a Dutch researcher, collected data from IBM employees on work-related values and attitudes. In analyzing
the data from more than 116,000 employees, Hofstede extracted four dimensions of values to explain the differences among cultures: individualism-collectivism, power distance, uncertainty avoidance, and masculinity/femininity. Using the average scores for each country, Hofstede developed national profiles that explain differences in work behaviors. Because Hofstede’s study presents a Western view of values, some researchers thought that his European values influenced his findings and theory.

To prevent Western values from influencing another study, Chinese social scientists developed the Chinese Value Survey (CVS) in Chinese (Chinese Culture Connection, 1987), then translated it into other languages and administered it to students in 23 different countries on five continents. Twenty of the countries were also in Hofstede’s study. Four dimensions of culture emerged from the study, three similar to Hofstede’s dimensions of power distance, individualism-collectivism, and masculinity/femininity. The fourth dimension, however, represents Chinese values related to Confucianism. Originally called Confucian work dynamism, it was eventually labeled long-term/short-term orientation by Hofstede.

**Trompenaars’ Seven Dimensions of Culture**

Fons Trompenaars (1993), a Dutch economist and consultant, also developed a framework to examine cultural differences. Using Kluckhohn and Strodtbeck’s theory (1961) described previously, Hampden-Turner’s dilemma theory (1983), and Parsons’s pattern variables (1951), Trompenaars analyzed the questionnaire responses of approximately 15,000 employees representing 47 national cultures. Trompenaars describes national cultural differences using seven dimensions. Five dimensions are about how people relate to others, including universalism versus particularism, individualism
versus collectivism, neutral versus affective, specific versus diffuse, and achievement versus ascription. The sixth dimension is time orientation: past, present, or future and sequential or synchronous. The final dimension is relationship to nature: internal- or external-oriented. Just as with the Kluckhohn and Strodtbeck’s (1961) work, Trompenaars’s dimensions represent how societies develop approaches to handling problems and difficult situations.

Trompenaars’s dimensions are pertinent to this study as one requirement, and probably the most important requirement in building consensus for the development of international standards is to have a minimum of five countries support the development of the standard. There are over 33 countries participating in the development of the international STEP standards. Each country has a unique approach to consensus building. All approaches are considered and honored within the various standard formatting groups. Representatives from each country volunteer their time to create international standards that satisfy and incorporate their uniqueness.

**High and Low Context Societies**

Edward T. Hall (1976), an American anthropologist, uses the concept of context to explain differences in communication styles among cultures. “Context is the information that surrounds an event; it is inextricably bound up with the meaning of that event” (Hall & Hall, 1995, p. 232). Cultures can be categorized on a scale from high- to low-context:

A high-context (HC) communication or message is one in which most of the information is either in the physical context or internalized in the person, while very little is in the coded, explicit, transmitted part of the message. A low-context (LC) communication is just the opposite; i.e., the mass of the information is vested in the explicit code. (Hall, 1976, p. 101)
Trompenaars and Hampden-Turner (2001) clearly demonstrate what effective managers need to learn to lead their organizations into the digital age. Rather than offering universal applications, these authors examine the nature of effective leadership in some depth. In specific situations they review the dilemmas of management and provide hardcore examples of how to reconcile fundamental issues of leadership. Utilizing their base data from thousands of surveys of leaders and followers around the world and with their seven dimensions of cultural competence, they have interviewed global leaders as they cope with the dilemmas of leadership. Rather than presenting seven or more essential habits, they focus on how these leaders work with values and reconcile differences to attain more effective management.

The researchers suggest that business cultures are different, and that because business is run differently around the globe, we need different managerial and leadership competencies. What they call trans-cultural competence is their way of bridging those differences. It is a logic that tends to unify differences and that delineates the manager from the leader and the successful leader from the unsuccessful one. Trompenaars and Hampden-Turner call for a new way of thinking. Through-Through thinking is beyond either-or and even and-and thinking in that it synthesizes seemingly opposed values into coherence. Thus the main theme throughout this work is that effective leaders reconcile value dilemmas better than those who do not.

Resistance

Resistance is an important cultural component of institutional transformation that is often overlooked. It is especially relevant to colleges and universities in light of their longstanding tradition of criticism and a wide variety of sub- or counter-cultures. Sub-
cultures—based on organizational role, institutional position, or disciplinary affiliation—often flourish within the university environment, supporting their own set of customs, beliefs, and practices that are frequently incongruent with the larger university culture, not to mention the goals of most transformation efforts (Clark, 1984). Sub-cultures can also create symbolic "spheres of ownership" (i.e., feelings of ownership regarding symbolic territories or "turf" on campus that create serious stumbling blocks to change, especially when the proposed innovation appears to threaten these rights of possession) (Kashner, 1990).

It is the conflicting priorities and values among sub-cultures that most often contribute to resistance toward change efforts. Historically, the greatest clash has occurred between administrators—often the initiators and leaders of campus transformation efforts—and the faculty—the body frequently charged with implementing educational changes (Kashner, 1990; Swenk, 1999). Because faculty members' average tenure with a university far outlasts that of most presidents and administrators, faculty are often the gatekeepers of culture and traditions on the campus. When long-held cultural beliefs are challenged by change efforts, faculty naturally perceive the change initiative as threatening. Thus, unless these cultural elements are directly addressed, resistance will be the usual response to any transformation effort.

While conflict can be disruptive within any campus environment, resistance is not always negative. In many ways, resistance is an inevitable part of institutional transformation. Even planned change in an environment that has been properly prepared results in a certain amount of disequilibrium, such as initial cost increases or a short-term decrease in efficiency as individuals break old habits and become familiar with new...
processes and structures. According to the definition of institutional transformation adopted for this paper, change must be "both deep and pervasive" (Eckel, Hill, & Green, 1998). Therefore, resistance can be perceived as an indicator that the change effort has permeated the outer layers of the institution and is moving beyond a state of adjustment or isolated change to alter the cultural and structural elements of the institution on the collective level.

Resistance to change is such a pervasive occurrence in attempts at planned change that researchers have begun to include resistance, crisis, conflict, and/or politics as key elements in models of institutional transformation (Reynolds, 1994; Rowley et al., 1997; Simsek & Louis, 1994; Steeples, 1990). One example is Reynolds's model for change in the workplace, which includes four stages of change: denial, resistance, exploration, and commitment. During the first two stages, employees exhibit anger and tension and experience greater feelings of chaos at work. As a means of moving beyond resistance, Reynolds suggests readying the environment for change, including encouraging open communication, emphasizing the big-picture vision, and maintaining trust among the employees and management. It appears that institutional readiness for change is inversely related to the resistance experienced during the transformation effort. Reynolds also points out that once individuals move beyond the denial and resistance phases, there is usually a great burst of energy and activity among institutional members.

If resistance indicates that the innovation has reached the cultural level of the institution, a significant cultural shift truly verifies that transformation has occurred. The more an innovation is integrated into the culture of the organization, the more likely we
will be to see changes in the rewards structure and in decision-making strategies and the more likely the transformation effect will be sustained (Farmer, 1990).

Another area of resistance was found in new forms of work organization that have spread throughout much of the corporate world. Critics warn that team systems may encourage workers to internalize managerial definitions of their work situations, and, as a result, strengthen management's hegemony over them. Valas (2003) presents an ethnographic analysis of four manufacturing plants in which team initiatives have been introduced. The findings cast doubt on the hegemony thesis. Analyzing data bearing on the degree of managerial legitimacy, the feature of class boundaries, and instances of worker defiance in both traditional- and team-based production areas, Valas found that only occasional evidence of increased worker integration or incorporation within an up-and-coming managerial regime. Indeed, by drawing attention to the limited authority that workers were actually allowed, team systems tended to heighten worker suspicion and distrust and to foster patterns of solidarity that were difficult for managers to control. The most significant feature of the new production concepts may not be their siren-like appeal, but rather the tensions and contradictions they introduce into work organizations. In fact, Valas found such concepts provide workers with subtle yet strategic resources with which to renegotiate the boundaries of managerial authority.

I believe initially employees are suspicious of teams if they are coming from an environment where they are competing against their fellow employees. It is difficult to instill team enthusiasm when we have the bell curve merit systems that determine salary and career status. Sometimes employees are uncomfortable with consensus decisions, but overall, I feel the team approach to be positive reinforcement for the employee. In the
international standards community teams are the only avenue for consensus building. In the future post-industrial world teams will gain favorable recognition.

**Innovation**

In his work on the success and failure of innovations in higher education, Levine (1980) pinpoints incompatibility and lack of profitability as the two primary barriers to positive transformation results and, therefore, the main reasons that innovations (i.e., transformation efforts) fail. "Compatibility" refers to the degree of congruence between the innovation and the "norms, values, and goals of the institution"—all aspects of institutional culture, whereas "profitability" is defined as "the measure of the effectiveness of an innovation in satisfying the adopter's needs" (Levine, 1980, p. 19). Because needs are an outgrowth of cultural aspects of an institution, such as the purpose and mission, profitability can also be interpreted as a cultural element. Levine states that planned changes in colleges and universities may avoid failure by maximizing profitability and congruence. This is achieved by expanding the cultural boundaries of the institution to include the innovation or by completely absorbing the innovation so that the boundaries of the innovation are enveloped by the cultural boundaries of the institution. Therefore, the outcomes and results of innovation and change are embedded in the culture of organizations.

Simsek and Louis (1994) present a model of transformation that builds upon Levine's notion that the results of innovation and planned change efforts are related to organizational culture. In their "paradigm-shift" model, the outcome of successful transformation is an alteration of organizational culture in the direction of desired change. In order to utilize the idea of organizational change as a paradigm shift, Simsek and Louis...
present a dynamic model of transformation including five phases of change: normalcy, confronting anomalies, crisis, selection, and renewed normalcy. Similar to Levine (1980), Simsek and Louis acknowledge the importance of organizational culture and institutional values, myths, metaphors, and symbolic boundaries throughout the process of organizational change. Keup et al. (2001) conclude that this model of the change process is a good fit for institutions of higher education because it acknowledges aspects of the old paradigm (i.e., prevailing culture) while incorporating it into the newly adopted world view rather than undergoing a revolutionary cultural change.

An understanding of organizational culture is clearly important to the study of institutional transformation, given that transformation "alters the culture of the institution by changing select underlying assumptions and institutional behaviors, processes, and products" (Eckel et al., 1998, p. 3). At the same time, organizational culture and cultural change can be used as a means of preparing an environment for transformation, a yardstick for assessing whether or not a transformational change has actually taken place, and a means of achieving the desired results of an innovation. The success of any transformational effort may well depend on the extent to which practitioners are able to address issues of institutional culture in their strategic planning.

Measurements of Change

A study by Kuntz and Scholtes (2000) focused on measuring the minimal perturbation that is necessary to change the efficiency of a single process. They studied robustness measures in the context of Farrell’s (1957) model of empirical efficiency. One of the findings was that small changes are practicable, and large changes are obviously not always realistic because they imply a massive intrusion into the organization’s
business. This study was done in hospital environments. Some aspects of this work pertain to change in general, which was helpful to me in defining change generalities. Manufacturing parts in an automotive environment requires high impact change. Some of this work is helpful in looking at small institutional change and is also helpful in measuring the impact of change on a large production plant facility.

Brunnermeir and Martin (1999) document the exorbitant costs due to incorrect data, rework, and the resulting slowdown of the production process. Are these costs real? A “real life” production model is required to document these assumptions gathered from interviews from the automotive industry. My prototype STEP test bed addressed in this study will begin to measure the effects of digital delivery flow of information and the cost-saving effects to industry.

The Automotive Industry Action Group (AIAG) and the National Institute of Standards and Technology (NIST) (2002) conducted a study on product data management interoperability. The study found that collaborative product design between partners in a supply network is fraught with inefficiencies. The cost of maintaining and using disparate CAD and PDM systems, the delays due to the transfer of information on paper and its subsequent reentry into destination systems, and the quality problems introduced by the movement of data across media boundaries (e.g. electronic to paper to electronic) create exorbitant costs in system development.

The results of the study were to conclude that the business process specific transaction hypothesis was indeed viable and achievable with today’s technology. Specifically the study validated two strategic assertions. The first assertion was that standards-based collaboration can work in a global, distributed, and heterogeneous design.
environment. The second assertion is that Internet-based technology solutions are inexpensive, readily available, and easy to deploy in the supply chain.

The Strategic Automotive Product Data Standards Industry Group (SASIG) (2001) prepared a set of guidelines, developed through the collaboration of automotive organizations from around the world that presents requirements and methods necessary for improving and measuring the quality of the product data created and used within the global automotive industry. Before one can produce a quality product, one has to have quality guidelines. This document is the first of its kind to address the quality issue globally. It does not at this time address the manufacturing connection to quality. I expect this present study will contribute to the completion of this document.

A basic hypothesis in the literature on measurement of innovation is that innovation activity is stimulated by the spatial proximity of other economic actors working in the same or a related field, as well as by the easy availability of inputs needed for the innovation activity. Therefore, a certain degree of agglomeration or clustering of innovators within a particular area should be conducive to innovation activities (Baptista & Swann, 1998; Porter, 1998). Adopting a simple center-periphery scheme, the basic hypothesis suggests that the level as well as the success or efficiency of innovation activity is higher in the center than in more remote areas or in regions characterized by a relatively low degree of agglomeration.

There are two main reasons for such a spatial pattern given in the literature. First, spatial clustering of innovation activities of a certain type or in a certain technological field is usually associated with a well-developed supply of the needed inputs such as differentiated labor markets with specialized qualifications, a rich supply of innovation-
related services, and the easy availability of information relevant to innovation activities. Second, it is argued that knowledge spillovers that are generated by innovation activities are concentrated in areas close to their respective source. Spatial proximity to many such sources enables innovators to benefit from a higher level of knowledge spillover than that available in a more remote location far from other innovators active in the technological field relevant to them.

The general hypothesis concerning the impact of regional conditions on innovation activities as well as the relevant empirical work can be divided into three parts. The first part, which is related to the spatial pattern of process innovation, suggests that the diffusion of new technology proceeds 'down' the spatial hierarchy, i.e., that new processes are first implemented in the 'center', and are then put into practice by the periphery. The second part states that the propensity of a business to engage in Research and Development (R&D) and the intensity of R&D activities is highest in the center and lowest in the periphery. Part three maintains that the center is a favorable breeding ground for product innovation.

Thus far, empirical research has not been able to provide evidence supporting the first two parts of the hypothesis and has found only rather weak confirmation of part three. With regard to the spatial diffusion of new processes, the propensity to adopt a new technology is not significantly higher in the center as compared to the periphery if one accounts for the internal characteristics that influence the firm's propensity to adopt an innovation (mainly enterprise size and industry affiliation) (Alderman & Fischer, 1992; Davelaar, 1991; Davelaar & Nijkamp, 1989; Ewers & Fritsch, 1989; Muedespacher, 1987). After accounting for such internal characteristics, no significant spatial pattern
could be identified with regard either to a firm's propensity to engage in R&D or to its R&D intensity (measured, e.g., as the share of R&D employees).

However, investigating the structure of innovative activity in different regions, Kleinknecht and Poot (1992) found a significantly higher share of product R&D activity in total R&D for enterprises located in the Dutch core regions compared to those in the regions outside the center. Moreover, firms located in central regions of the Netherlands seem to be more likely to announce new products than firms in other regions (Brower, Budil-Nadvornikova, & Kleinknecht, 1999).

Leadership in the Change Process

Kotter (1996) discusses the pressure for organizations to change increases in intensity over the next decades. He discusses the methods managers have used in the attempt to transform their companies into stronger competitors—total quality management, reengineering, right sizing, restructuring, cultural change, and turnarounds—as routinely falling short because they fail to alter behavior. He discusses an eight-stage process for successful institution of change. One of the most important events for change is the commitment of the CEO in the company to promote change.

This is where I differ somewhat with Kotter. I have seen and experienced successful change transformations rising from a groundswell of people at lower (grass root) levels in an organization embracing change and promoting change to higher levels of management. I realize Kotter is relying on the CEO to take charge, but today we have a revolving door condition of CEOs moving from organization to organization. In the military, high level officers that manage vast department are there for only a few years and
then they move on. It is up to the groundswell of middle and lower managers to “steer the ship” and keep the organization on course.

Kotter (1999) is convinced that most organizations today lack the leadership they need. Kotter’s mission is to help reveal what leaders—real leaders—do. True leadership is an elusive quality, and too often people confuse management duties and personal style with leadership or even mistake unworthy leaders for the real thing. Kotter discusses the core issues that lie at the heart of leadership and encourages people to rethink their relationship to the work of leaders. I find this work helpful in how employees relate to leaders within the organization. I would also like to see how he defines relationships as people move in and out of leadership and follower roles. I believe this change in roles is a very effective way of working change into the business processes within an organization.

According to Deming (as cited in Mann, 1989):

1. The aim of leadership should be to help people and machines and gadgets to do a better job.

2. Leadership of management is in need of an overhaul, as well as leadership of production workers.

3. Remove barriers that rob the hourly worker of his right to pride of workmanship.

4. Leaders help the workers feel a sense of pride and pleasure in their work.

5. A leader does not need people who are merely good; a leader needs people who will grow in knowledge and get better.

May (2001) discusses how transformational leadership slips into paternalism unless it teaches rather than commands or manipulates. The professional today who insists
on transforming her clients, but who neglects to teach them, inevitably relies on managerial manipulative, and condescending modes of behavior modification. I find that I learn from the people I manage. It is a continuous circle of learning and teaching within the groups I manage.

Various studies have illustrated the inability of hierarchical models (i.e., chain of command, top-level decision making, control, etc.) of leadership for meeting the challenges facing higher education institutions (Bensimon & Neumann, 1993). Challenges, such as cost containment, accountability to the public, globalization, integrating technology, and measuring of student outcomes, require more participatory forms of leadership than have existed in the past (Rosener, 1990). As institutions have realized this and expanded leadership to include more individuals, there has been limited examination of how leadership might be interpreted differently by groups and individuals on college campuses, in particular, faculty, other levels of administration, and staff. Participatory leadership models, which rely on interdependence and collective efforts, necessitate that campus participants feel included in the leadership process and emphasize communication throughout the organization as critical for organizational success (Astin & Leland, 1991; Bensimon & Neumann, 1993; Rosener, 1990; Tierney, 1989). Similar to hierarchical leadership models, participatory models assume a common leadership reality for all individuals within the organization.

However, recent research illustrates that the assumption of a common understanding of leadership will result in significant challenges for organizations. For example, a growing body of scholarship provides evidence that women enact, think about, and interpret leadership differently from traditional images/models, which are
based on the experiences of White men in positions of authority (Astin & Leland, 1991; Bensimon & Neumann, 1993; Rosener, 1990). The research on women provides a foundation for examining other fundamental aspects of a person's identity that might be related to the way they interpret leadership. These studies focused on the question of whether who we are, based on our experiences, is related to what we know about leadership. An epistemological theory has emerged that shows promise for understanding these differences—positionality theory. This theory suggests that in addition to differences in background, power conditions shape perspectives. Because leadership has traditionally been closely associated with authority and power, focusing on the notion of power for explaining differences in leadership interpretations seems a logical connection.

Why should we be concerned about these multiple voices? Research focused on cultural diversity in organizations illustrates that stifling or not acknowledging difference leads to inefficiency, lack of productivity, reduced quality, and the inability to meet organizational goals (Cox, 1993). In contrast, knowledge of cultural differences enhances work relationships, effectiveness, and the ability to reach organizational goals (Cox, 1993). Many institutions find themselves struggling with resistance, losing disenfranchised faculty or administrators who think others do not respect their perspectives, and embattled with miscommunication and conflict.

Research by Astin and Leland (1991), Rosener (1990), and Helgesen (1990) that examined gender exclusively, focused on several conditions that might differentiate an individual's experience and resultant perspective. The reasons for different perspectives—power conditions, culture, and contextual influences—are also largely unexamined, making it difficult to address and change this condition. In this study Kezar and Eckel...
(2000) address the following research questions: How does positionality (i.e., role as faculty, location in the academic bureaucracy) relate to interpretations of leadership? How do conditions of power relate to interpretations of leadership? The purpose of the study was to examine differences in leadership perspectives in higher education, to create a framework for understanding these differences and why they exist, and to help individuals and institutions to recognize and negotiate these differences in order to meet the challenges ascribed to leadership.

Early leadership research (1950-1985) assumed a mostly shared or singular reality—leadership as hierarchical, authority-based, power- and influence-oriented, etc. Yet, the result of believing in a singular "reality" was that researchers tended not to explore differing viewpoints (Denzin & Lincoln, 1994). More recent studies within the contingency and cognitive traditions challenge this viewpoint. These researchers illustrate that there is no universal definition of leadership; its meaning or definition tends to be local and impacted by context (Bensimon et al., 1989; Birnbaum, 1992; Bolman & Deal, 1984; Martin, 1992; Tierney, 1988a, 1988b, 1988c). Furthermore, leadership research over the last decade has begun to demonstrate the influence of perspective and perception (Ayman, 1993; Bolman & Deal, 1984; Chemers & Ayman, 1993).

Cognitive and cultural research traditions have provided support for the view that leadership is socially constructed between people; thus, its meaning is negotiated among individuals or groups (Calas & Smirich, 1992). Although there is increasing support for local definitions of leadership and the importance of culture on the enactment of leadership, few researchers have explored the possibility that our experiences are related to understandings of leadership.
The literature on women leaders has brought the assumptions of earlier leadership work into question. Earlier models of leadership, derived almost exclusively from all-male samples, provide descriptions of traits, behaviors, and influence strategies associated with leaders. These models are exemplified by individuality, hierarchical power, depersonalization, persuasion, and control, among other characteristics (Fisher, 1984; Kerr & Gade, 1986). Recent literature that focused on women's leadership describes a very different image of leadership—a more participatory, relational, and interpersonal style.

In addition, these studies present different types of power and influence strategies, such as reciprocity and collectivity. Moreover, women leaders tend to conceptualize leadership as collective rather than individualistic. They emphasize responsibility toward others and empower others to act within the organization, and they de-emphasize hierarchical relationships (Astin & Leland, 1991; Cantor & Bernay, 1992; Ferguson, 1984; Helgesen, 1990; Rosener, 1990; Shakeshaft, 1987; Statham, 1987).

There is growing evidence that earlier models of leadership in higher education tend to be exclusive and represent an orientation to leadership derived from those traditionally in positions of power, i.e., a mostly White, male, upper-middle class, heterosexual orientation to leadership (Amey & Tombley, 1992; Bensimon et al., 1989; Bensimon & Neumann, 1993; Calas & Smirich, 1992; Cross & Ravekes, 1990; Lyons, 1990). Also, these studies did not examine multiple aspects of identity, such as race, social class, or role within an organization, in order to determine how these conditions appear to interact.
The assumption that an exclusive group's interpretation of leadership (i.e., college presidents and others in positions of authority) is inclusive of how different individuals understand leadership has been questioned (Martin, 1992; Tierney, 1988c, 1989). As noted in the problem statement, the most popular model—participatory leadership—requires all individuals to be involved in the leadership process. Yet, there is evidence that hierarchical models of leadership have excluded the understandings of people who do not hold formal leadership positions.

In higher education, this would include people such as faculty, students, or alumni. Past leadership research in higher education has focused mostly on people in authority, especially college presidents (but sometimes deans or department chairs), and assumed that leadership can be understood best from these official leaders' stories and descriptions (Bensimon et al., 1989; Cohen & March, 1986; Fisher, 1984; Kerr & Gade, 1986). Although perspectives were illustrated to differ depending on one's role within an organization, leadership researchers chose presidents exclusively to develop leadership models (Bensimon et al., 1989; Birnbaum, 1992; Chemers & Ayman, 1993; Martin, 1992; Peterson & White, 1992).

In a few studies, leadership has been explored from the perspectives of other institutional participants (e.g., faculty, trustees, or alumni); however, most studies continue to focus on positional leaders as an embodiment of leadership (Bensimon et al., 1989). Narrow studies such as these have a limited understanding about the views of leadership that other organizational members hold and these members' role within leadership. In summary, this literature suggests that women's views on leadership do
indeed differ from men. Research on faculty suggests that their views on leadership might also differ from administrators, but this needs to be empirically tested.

Yet the literature on different leadership perspectives (mostly utilizing standpoint theory, examining how gender impacts the way an individual views the world) offers incomplete explanations of why these differences exist. It also does not examine identity as complex, with multiple and overlapping aspects. Positionality theory provides a framework for understanding multiple perspectives. This theory has been applied to various issues, including different belief systems and developing knowledge, and it might also prove useful in understanding organizational and administrative issues.

My experiences while working with national and international organizations in the standards community are that the power structures are still predominately male-oriented. Of course in the manufacturing environment, there are very few participant females. With few females participating, the leadership roles are mostly male-dominated.

It is important to understand some of the assumptions of positionality theory (Kezar & Eckel, 2000), for this is the framework shaping the methodology and interpretations of many studies. This framework is helpful in interpreting organizational leadership and for future studies of leadership that intend to understand group and individual interpretations. Positionality theory examines whether who we are, based on our experience, influences what or how we know (Alcoff, 1988; Berger & Luckmann, 1967; Tierney, 1993). Essentially, the knower impacts what is known—in this case, interpretations of leadership. This theory advances standpoint theory, which tends to look at one aspect of a person's experience, e.g., gender, and associated power conditions.
Thus, the concept of positionality resists a fixed, static, essentialistic view of standpoints that is associated with many strands of standpoint theory—for example, that all women have a particular unchanging view (Alcoff, 1988; Collins, 1993; Haraway, 1991). Positionality theory acknowledges that people have multiple, overlapping identities and thus make meaning from various aspects of their identity, including social class, professional standing, and so forth.

Therefore it is more complex and dynamic than standpoint theory while retaining its epistemological concerns. Positionality theory assumes that power relations can change and that social categories are fluid and dynamic, affected by historical and social changes. Alcoff (1988) brings these various aspects together in the following:

When the concept of woman is defined not by a particular set of attributes but by a particular position, the internal characteristics of the person thus identified are not denoted so much as the external context within which that person is situated. The external situation determines the person's relative position, just as the position of a pawn on a chessboard is considered safe or dangerous, powerful or weak, according to its relation to the other chess pieces. (p. 433)

It is important to understand how power is defined, because this is a primary concept within positionality. Within positionality theory, power is a force pervading all contexts, historical situations, and interpersonal relationships (Alcoff & Potter, 1993; Haraway, 1991). It is not conceptualized as always repressive or oppressive (Kondo, 1990). Human agency is conceptualized as important to understanding power relations; power conditions do not simply shape people, people shape power conditions and the resultant relations (Kondo, 1990).

Thus, power conditions are negotiated and socially constructed; they can be transformed. They are not a static force. Power is defined, understood, and manifested locally (Kondo, 1990). Therefore, it is critical to examine a specific campus context and
determine how power conditions were manifested in that particular context. To assume that only broad social categories such as gender or social class impacted power relations within a specific context would limit analysis of it. Understandings of power are based on experience, in other words, on one's position.

Leadership Seers

Senge (2000) discusses the first quality of a 21st-century leader as cultivating a vision. Simply, he/she must be a seer. The concept of vision is rapidly losing its potency in organizational leadership. Because of its overuse, the concept is in real danger of being defined too narrowly (the "vision thing") or simply dismissed because of its familiarity. Vision is far too often defined as a leader waiting on Mount Sinai for the 10 Commandments. After receiving the newly written commandments, the leader is to encourage the organization through inspirational delivery. Though there is a sliver of truth in that description, the simple fact remains: "The Lone Ranger with a good idea is not the definition of vision, or a rounded description of a seer" (Senge, 2000, p. 28).

Leadership vision, therefore, is first the ability to notice "what is" as well as "what could be." It is concerned with attending to, before moving onto creating new, environments or processes. The present moment yields important clues about the future. Because leaders are forward thinking, they tend to miss "what is." They simply do not pay attention to the present "organizational moment." Yet, missing "what is" frequently leads to a misperception or a skewed perception of "what could be." Mark these words: Misreading the present enables a misleading of the future. Thus, leader-seers attend to the "now" as well as to the "possible."
Leader-seers, therefore, read the organizational layers that are unfolding in any given moment. These organizational layers include the leader’s own inner strengths and insecurities, as well as the larger drama unfolding within the community, its culture, and purposes. In fact, an authentic leader always reads his/her own life before he/she turns his/her discernment outward.

The postmodern leader recognizes that becoming a seer means inviting the organization to that role as well. Visional leadership flows from the ability to link both “what is” and “what could be” with the dreams and aspirations of people within the organization. Simply, leaders with vision invite others to see—to dream, to wonder. Further, they invite followers to weave their visions into the larger one. The author of *The Fifth Discipline Fieldbook* notes, “Unfortunately, too many people still think that ‘vision’ is the top leader’s job . . . . There is a deeper challenge: creating a sense of purpose that binds people together and propels them to fulfill their deepest aspirations” (Senge, 2000, p. 42).

Now a fuller picture of the leader-seer emerges. Leaders who see only the people will miss the purposes that act as threads weaving them together. They may also be distracted by the whims of followers or their insecurities. Conversely, leaders who see only the possibilities will miss the truth that the greatest fulfillment is always synergistic. Therefore, the leader must learn to cultivate what Warren Bennis (1989) calls the “management of attention” at every level of an organization’s relational web and purpose. It is out of this seeing that the second important quality of 21st-century leadership begs for attention and cultivation.
The Leader as Steward

Senge promotes the leader as steward who complements the leader as seer. The leader of today and tomorrow must be a steward of the emerging organizational dream and purpose. If, at the core of a leader, the quality of serving is wanting, then his/her seeing will rapidly degenerate into dysfunctional manipulation. Put another way, if one half of great leadership is seeing, then the other half is serving, or stewarding.

A new moral principle is emerging which holds that the only authority deserving one’s allegiance is that which is freely and knowingly granted by the led to the leader in response to, and in proportion to, the clearly evident servant stature of the leader. (Wren, 1995, p. 124)

Postmodern leaders understand that all human endeavors emerge. That is, all organizational endeavors are fundamentally people- and process-oriented. Leaders are stewards of both. This implies that postmodern leaders must cultivate their organizations much like a farmer cultivates the land. Farmers ensure that the conditions for growth exist. Then, as growth emerges, they tend to it, protect it, and harvest it. This stewarding or farming is not about control or domination. Rather, stewarding the organizational dream, story, vision, and its people requires far more creativity and ingenuity than does controlling things and manipulating people. It takes a willingness to be the servant of the organization. “It is true leadership; leadership by everyone; leadership in, up, around, and down this world so badly needs, and dominator management it so sadly gets” (Hock, 1999, p. 58).

The leader as steward cultivates two characteristics. The first characteristic is follower development. Leaders have a genuine desire to assist followers in developing their talents and strengths while unleashing them throughout the organization and in life. Hesselbein (1997) proposes, “Thus, our role as leaders involves more than just what
people do on the job. We also must be involved in what they are becoming as whole people and how the work environment is contributing to the process” (p. 8). The industrial view of people as mere “cogs in the machine” has no place in postmodern leadership. Neither does “pure profit-driven” human development resonate with a 21st-century leader. Leaders serve and develop people because they believe in people and want to see their passions and potential unleashed. Wise postmodern leaders know that everything else—profit and productivity—flows when something other than either of them is the focus. That something other is genuine service to, and development of, people.

Second, “leader stewards” are willing to persevere through the many resistances they will inevitably face. The process of cultivating and manifesting vision brings with it a variety of struggles, failures, and opportunities. Leaders are like midwives, sensing that life is emerging, they gently but firmly enable that life to come forth. Coaching those involved, the leaders are encouragers, mentors, and experts in the art of timing. They know when to push, and when to wait. They understand that resistance, both internal and external, is part of what ushers in the vision. They also know that resistance builds character and demands risk. Daft and Lengel (1998) echo this thought,

Leadership is difficult. Leadership is a struggle. Leaders who pursue a dream to improve the organization will find cooperation, but they will also meet resistance. That’s why warrior courage is so critical. If what you are doing comes easily, it is probably not leadership. (p. 48)

The leader as steward nurtures, directs, challenges, and perseveres. But most of all, he/she serves. This service unleashes the organization to meet its individual and cooperate potential, as well as create a climate of service.
The most common thread throughout the literature is that learning is complex, multidimensional, and appears to be inextricably connected to the learner's experiences (Brookfield, 1991; Dewey, 1997; Knowles, 1984, 1988). Twentieth-century gestalt psychologists like Kohler (1957) stated that "learning takes place through an act of insight" while the learner engages in and reflects on experiences. For students creating portfolios, insight may occur through reflecting on and writing about professional and personal experiences and result in greater self-knowledge. Humanistic learning theorists also see learning as grounded in experience, involving both affective and cognitive processes that lead to pervasive changes (Maslow, 1983; Rogers, 1970). Similarly, the portfolio engages affective and cognitive domains and can initiate a ubiquitous change in individuals' perspectives and attitudes.

Social learning theorists underscore the importance of the learner's social context (Bandura, 1970; Dewey, 1997; Vygotsky, 1978). Learning takes place not in isolation but through observation and modeling in social settings such as the family, the workplace, and schools. Bandura stresses the importance of social interaction, observation of social roles, and the critical role of mentors in the learning process. In student portfolios, the social settings of work and community as learning venues are acknowledged and analyzed.

According to Peter Senge (1990), learning organizations are organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together. The basic rationale
for such organizations is that in situations of rapid change only those that are flexible, adaptive, and productive will excel. For this to happen, it is argued, organizations need to discover how to tap people’s commitment and capacity to learn at all levels.

While all people have the capacity to learn, the structures in which they have to function are often not conducive to reflection and engagement. Furthermore, people may lack the tools and guiding ideas to make sense of the situations they face. Organizations that are continually expanding their capacity to create their future require a fundamental shift of mind among their members.

**Leading the Learning Organization**

Senge (1990) argues that learning organizations require a new view of leadership. He sees the traditional view of leaders (as special people who set the direction, make key decisions, and energize the troops) as deriving from a deeply individualistic and non-systemic worldview. At its center the traditional view of leadership is based on assumptions of people’s powerlessness and their lack of personal vision and inability to master the forces of change, deficits which can be remedied only by a few great leaders. Against this traditional view he sets a new view of leadership that centers on “subtler and more important tasks.”

In a learning organization, leaders are designers, stewards, and teachers. They are responsible for building organizations where people continually expand their capabilities to understand complexity, clarify vision, and improve shared mental models—that is, they are responsible for learning. Learning organizations will remain a good idea until people take a stand for building such organizations: “Taking this stand is the first leadership act,
the start of inspiring (literally ‘to breathe life into’) the vision of the learning organization” (Senge, 1990, p. 69).

**Organizational Imperatives**

Here the case against Senge is fairly simple. I can find very few organizations that come close to the combination of characteristics that he identifies with the learning organization. Within a capitalist system his vision of companies and organizations turning wholehearted to the cultivation of the learning of their members can only come into fruition in a limited number of instances. While those in charge of organizations will usually look in some way to the long-term growth and sustainability of their enterprise, they may not focus on developing the human resources that the organization houses.

The focus may well be on enhancing brand recognition and status (Klein, 2001), developing intellectual capital and knowledge (Leadbeater, 2000), delivering product innovation, and ensuring that production and distribution costs are kept down. As Hutton (1995) has argued, British companies’ priorities are overwhelmingly financial. What is more, “The targets for profit are too high and time horizons too short” (p. 148).

Such conditions are hardly conducive to building the sort of organization that Senge proposes. Here the case against Senge is that within capitalist organizations, where the bottom line is profit, a fundamental concern with the learning and development of employees and associates is simply too idealistic. Yet there are some currents running in Senge’s favor. The need to focus on knowledge generation within an increasingly globalized economy does bring us back in some important respects to the people who have to create intellectual capital.
Productivity and competitiveness are, by and large, a function of knowledge generation and information processing: Firms and territories are organized in networks of production, management, and distribution; the core economic activities are global—that is, they have the capacity to work as a unit in real time, or chosen time, on a planetary scale (Castells, 2001).

A failure to attend to the learning of groups and individuals in the organization spells disaster in this context. As Leadbeater (2000) has argued, companies need to invest not just in new machinery to make production more efficient, but in the flow of know-how that will sustain their business. Organizations need to be good at knowledge generation, appropriation, and exploitation. This process is not that easy.

Knowledge that is visible tends to be explicit, teachable, independent, and detachable. It is also easy for competitors to imitate. Knowledge that is intangible, tacit, less teachable, and less observable is more complex but more difficult to detach from the person who created it or the context in which it is embedded. Knowledge carried by an individual realizes its commercial potential only when it is replicated by an organization and becomes organizational knowledge. Here we have a very significant pressure for the fostering of learning organizations. The sort of know-how that Leadbeater (2000) is talking about here cannot be simply transmitted. It has to be engaged with, talked about, and embedded in organizational structures and strategies. It has to become the people's own.

One of the biggest problems with Senge's approach has nothing to do with the theory, its rightness, or the way it is presented. The issue here is that the people to whom it is addressed do not have the disposition or theoretical tools to follow it through. One
clue lies in his choice of disciplines to describe the core of his approach. A discipline is a series of principles and practices that we study, master, and integrate into our lives. In other words, the approach entails significant effort on the part of the practitioner. It also entails developing quite complicated mental models and being able to apply and adapt these to different situations—often spontaneously. Classically, the approach involves a shift from product to process (and back again). The question then becomes whether many people in organizations can handle this. All this has a direct parallel within formal education.

One of the reasons that product approaches to curriculum (as exemplified in the concern for SAT tests, examination performance, and school attendance) have assumed such a dominance is that alternative process approaches are much more difficult to do well. They may be superior, but many teachers lack the sophistication to carry them forward.

There are also psychological and social barriers. As Stenhouse (1975) put it some years ago, “The close examination of one’s professional performance is personally threatening; and the social climate in which teachers work generally offers little support to those who might be disposed to face that threat” (p. 67). We can make the same case for people in most organizations.

The process of exploring one’s performance, personality, and fundamental aims in life (and this is what Senge is proposing) is a daunting task for most people. To do it we need considerable support and the motivation to carry the task through some very uncomfortable periods. It calls for the integration of different aspects of our lives and experiences. There is, here, a straightforward question concerning the vision—Will people
want to sign up to it? To make sense of the sorts of experiences generated and explored in a fully functioning learning organization, there needs to be spiritual growth and the ability to locate these within some sort of framework of commitment. Thus, as employees, we are not simply asked to do our jobs and to get paid. We are also requested to join in something bigger. Many of us may just want to earn a living!

**Politics and Vision**

Here we need to note two key problem areas. First, there is a question of how Senge applies systems theory. While he introduces all sorts of broader appreciations and attends to values, his theory is not fully set in a political or moral framework. There is no consideration of questions of social justice, democracy, or exclusion. His approach largely operates at the level of organizational interests. This would not be such a significant problem if there were a more explicit vision of the sort of society that he would like to see attained, and attention to this with regard to management and leadership.

As a contrast we might turn to Drucker’s (1977) elegant discussion of the dimensions of management. He argued that there are three tasks equally important but essentially different that face the management of every organization. These are the following: (a) thinking through and defining the specific purpose and mission of the institution, whether business enterprise, hospital, or university; (b) making work productive and the worker achieving; and (c) managing social impacts and social responsibilities. He continues:

None of our institutions exists by itself and as an end in itself. Every one is an organ of society and exists for the sake of society. Business is not exception. “Free
enterprise” cannot be justified as being good for business. It can only be justified as being good for society. (p. 77)

If Senge had attempted greater connection between the notion of the learning organization and the learning society and paid attention to the political and social impact of organizational activity, then this area of criticism would be limited to the question of the particular vision of society and human flourishing involved. Second, there is some question with regard to political processes concerning his emphasis on dialogue and shared vision. While Senge clearly recognizes the political dimensions of organizational life, there is a sneaking suspicion that he may want to transcend it.

In some ways there is a link here with the concerns and interests of communitarian thinkers like Amitai Etzioni (1997). As Richard Sennett (1998) argues with regard to political communitarianism, it falsely emphasizes unity as the source of strength in a community and mistakenly fears that when conflicts arise in a community, social bonds are threatened. Within it (and arguably aspects of Senge’s vision of the learning organization) there seems, at times, to be a dislike of politics and a tendency to see danger in plurality and difference. Here there is a tension between the concern for dialogue and the interest in building a shared vision.

An alternative reading is that difference is good for democratic life (and organizational life) provided that we cultivate a sense of reciprocity and ways of working that encourage deliberation. The search is not for the sort of common good that many communitarians seek (Guttman & Thompson, 1996), but rather for ways in which people may share in a common life. Moral disagreement will persist; the key is whether we can learn to respect and engage with each other’s ideas, behaviors, and beliefs.
Interest in work and learning has been of interest to researchers, practitioners, and policy-makers within adult education for many years. The widespread and growing attention today, however, is of a different order and is seen to reflect wider changes in the organization of work and the place of work within a rejuvenated capitalism. Developing a smart workforce is seen as a key strategy for employers (Gerber & Lankshear, 2000) intent on surviving the rigors of restructured economic activity in the early decades of the new millennium.

Of greater significance than the quantitative indicators associated with these changes (decline in manufacturing and the growth of the service sector, changes within the labor market, growth of income inequality) has been the emphasis on qualitative changes that have focused on new cognitive and commitment attachments to work by employees (Levett, 2000). The nature and contribution of work-related learning is increasingly situated within such a context of change, both within the workplace and within the wider society (Boud & Garrick, 1999).

Forrester (2002) has a focus on work-related learning situated against a background of social and economic change. However, the issues raised and discussed are those arising from the author's education and research activities undertaken in collaboration with a number of British trade unions over the past decade. Work-related learning from this perspective is understood to encompass all the workplace employee training undertaken by the employer with or without the agreement of the trade unions, as well as those educational and training programs organized by the trade unions for their employee members with or without employer agreement. Although the issues raised and the argument developed in this study flow from the various research projects undertaken...
between a university adult education department and national trade unions, it has been the union members' (and other employees') education, training, and learning developments and programs, both in and outside of the workplace, that have driven the research activities.

Over the past decade, these activities have changed slightly in emphasis and have reflected the changing policy context in the UK (and especially, since 1997, the change in government), the changing union research and education agendas, and finally, our own research priorities as adult educators. Central to these research activities, however, has been the theme of work and learning.

The argument put forward in the study is that, in the increased competitive pressure on employers to improve the quality and quantity of the labor input, the notion of employee commitment has emerged as a key area of new management thinking and practices. Workplace or work-related learning is often seen as an essential part in capturing employee commitment in achieving corporate objectives. This interest in employee commitment arises from the wider socio-economic changes of recent decades and has resulted in many workplaces questioning aspects of the traditionalist Taylorist (9:00 to 5:00 work schedule) division between thinking and doing along with the rigidities characteristic of a Fordist (mass production) workplace regime.

However, instead of the alleged brave new world of employee empowerment, autonomy, satisfaction, and fulfillment within those new workplaces or workplaces of the future, there is just as likely to emerge new mechanisms of oppression and managerial control. If this is the case, or at least a possibility, then there is the danger that the equally
brave new world of adult learning in relation to work and learning will become a part of new forms of oppression and control in the workplace.

In the emergence of lifelong learning, Forrester (2002) explains that for those involved in education, training, learning, and the workplace in Britain, these are changed times. The recognition of the importance and contribution of employee learning to the competitiveness and economic well-being of the enterprise has been matched by a flurry of policy initiatives and funding opportunities at a national and regional level.

In contrast to a period of two or three decades ago, which was characterized by marginalization, endless rounds of cutbacks and cost-saving exercises, and by a hostile political environment, many of those in the area of adult continuing education today face the unfamiliar and often bewildering situation of being listened to, supported, and encouraged in the development of new, innovative work-related learning schemes and even in exploring the barriers and constraints that inhibit employees adopting a more proactive strategy and positive attitude towards their learning.

A variety of institutional initiatives (such as Individual Learning Accounts, and University of Industry and Learning Partnerships) is energetically promoted to oil and encourage the pathways back into learning through the workplace and elsewhere. These institutional developments are complemented by a rediscovered interest in the nature of learning and related epistemological issues, especially as they relate to the workplace (Garrick & Rhodes, 2000).

Lifelong learning, it seems, is everywhere, the perspective within which work-related learning in particular (and adult learning more generally) is to be situated. Despite the growing recognition that the term risks losing its purchase and analytical edge, it is
lifelong learning that is providing the strategic vision and legitimacy underpinning current developments in Britain, the European Union, and elsewhere.

The complex inter-relationship between work, or more accurately, economic competitiveness, and post-compulsory education and training in Britain is variously described as the new consensus or settlement (Avis, 1998, p. 251). A central feature of the modernizing consensus, actively promoted by New Labour, is not only the recognition of the importance of knowledge and skills within a successful and dynamic economy but also the contribution of this workplace learning and training towards addressing issues of social justice, equity, and social inclusion. Competing within the global economy by definition also necessitates the existence of a civilized society and the development of the talents of each and every one of us (Department of Education and Employment [DFEE], 1998, p. 3).

The creation of a knowledge-based economy is, it seems, an essential component in the creation of a just society. The post-Fordist assumptions underpinning such an analysis can add to its seductiveness and appeal to many of those interested in the issues of work and learning. This is especially the case when the policy concerns and rhetoric are matched by particular funding streams such as, in the case of trade unions only, the Trade Union Learning Fund (TULF) initiative. With their emphasis on the workplace, partnerships (mainly with employers), and with innovative developments (new, as opposed to existing or traditional provision), TULF projects have resulted in a variety of ambitious and fresh membership learning initiatives.

Trade unions in general, and the Trades Union Congress (TUC) in particular, have enthusiastically embraced the more welcoming and supportive policy and institutional
environment of lifelong learning initiated by the 1997 Labor Government. The 1998 Union Gateways to Learning (TUC, 1998a) report signaled the move towards this lifelong-learning perspective. The new framework for workplace learning is legitimated and related to the new lifelong-learning culture and to the emergence (at long last) of a real political will to create a learning society (TUC, 1998a, p. 3).

Exploration of these recent changes in trade union learning perspectives and practices elsewhere (Forrester & Payne, 1999, 2000) suggests that there is evidence of a rediscovered energy and enthusiasm by trade unions and the TUC for the development of learning opportunities for their membership. Arguably, workplace learning represents a strategic illustration of the new unionism, of trade unions repositioning and reformulating their role and contribution to the changed circumstances of the Labor Government. Within such a framework, the current promotion and training of union workplace learning representatives are seen as a central feature of the new educational framework, and much will depend on the nature and effectiveness of these key players (TUC, 1998a, p 5).

Interestingly, Forrester (2002) found the frequency with which employees recognized mutual benefits (from the learning) matched very closely to the benefits described by managers. He did record some tension and differences between the benefits to the employers and to the employees, but the emphasis tended to highlight a mutual benefits perspective. In an earlier discussion around the ED research work, he used a more critical and ambitious framework of change, modernity, and education (Forrester, Payne & Ward, 1995). However, the original themes of inclusion, entitlements to learning, and equity remained.
A third research project involved interviews with part-time employees and training personnel from a local supermarket. As part of a 2-year European Union-funded LEONARDO Project (1998) in the late 1990s, part-time employees from the supermarket participated in a workplace learning scheme designed to strengthen employees' knowledge and understanding about the wider societal "change processes" impacting on employees, the organization of work and on the local communities.

The interviews were undertaken on completion of the 3-month learning program and again sought to explore the benefits to the participants of their learning concerning the workplace and also their attitudes and practices in the wider community. In particular, researchers were interested in illustrations that demonstrated linkages in local understandings and, possibly, practices at the local workplace and community level with that at a societal or global level.

This theme of exploring the contribution and role of learning opportunities for trade unionists that extended beyond the vocational or work-related concerns was repeated in a parallel European Union-funded SOCRATES Project (1998), which attempted to incorporate a greater emphasis on the cultural, everyday experiences of the trade union learners from different countries in regard to a number of European themes such as social exclusion, unemployment, and racism.

A strong theme linking these research and development projects, then, has been the learning experiences and aspirations of employees within a context both of changing occupational identities and organizational restructuring on the one hand, with the values, anxieties, aspirations, and practices of employees as social and civic actors on the other hand. An important objective of these studies, of course, was to conform the content and
format of learning materials and initiatives for trade union education to a framework of lifelong learning.

An additional focus in the studies was a pedagogic one (learning support mechanisms, flexible learning, learning pathways, workplace learning centers). Linking such pedagogic concerns and examples of practice (such as employment development schemes) to emerging national or regional policy initiatives, similarly, was an important characteristic of the studies. The creation of a high value-added economy, it is suggested, not only confronts the problem of unemployment, but through state action, develops an appropriate infrastructure that curtails rogue employers, introduces minimum wage and rights at work legislation and introduces more inclusive forms of post-compulsory education and training.

Suddenly, almost overnight, adult educators interested in work and learning (and especially, with previously excluded learners) appear to be part of a powerful seductive movement that has nothing else in mind beyond the transformation of capitalism! Workplace learning or work-related learning has emerged as a central element in a strategy that interrelates learning, economic competitiveness, inclusiveness, the development of active trust, respect, and commitment both within the organization and throughout society. The drive to encourage each and every one of us to fulfill our potential, moreover, is seen as beginning to address perceived democratic shortcomings.

This is not the occasion to examine critically the claims of the emerging knowledge economy, paradigm shifts, or the portfolio society. Empirical studies, as opposed to proclamations, seem to suggest that there is as much continuity as there is change, or convergence as opposed to variability, in workplaces of today when contrasted
with those of yesteryear. The increased competitive pressures on management have resulted in many companies and workplaces questioning and experimenting with the traditional Taylorist division between thinking and doing as well as critically assessing the rigid divisions of a Fordist production regime.

The increased attention today on knowledge in the workplace is similarly not a new recognition; it formed part of capital-labor relations throughout the 20th century. The increasing emphasis on facilitating workplace creativity and learning, however, needs to be critically examined. As Ackroyd and Proctor (1996) observe,

There is little evidence that the emasculation of traditional skills is being countered by the emergence of new comprehensive systems of education and training to produce the “polyvalent employee.” What evidence there is of new forms of training points towards the use of cut-down "on-the-job" company-based skill approval and training schemes. (as cited in Thompson & Warhurst, 1998, p. 11)

Winning or capturing the hearts of employees, as opposed to the fatigued and exhausted physicality dimensions of employee performance, is at the center of the new managerial strategies. Reshaping the affective domain, however, is likely to remain the most precarious of all managerial responsibilities. The struggle to establish and sustain relationships of trust, loyalty, and commitment to corporate objectives represents a dramatic change to the old Taylorist concerns. In the new workplaces, employees' experience and knowledge are perceived to be the new capital resource.

Maximizing this human resource is seen as requiring a plethora of workplace organizational reforms (such as the flattening of hierarchies, informal and formal shifting divisions of labor, self-organizing teams) together with an array of sophisticated employee recruitment procedures. The focus on skills moves from an ability to perform,
with the emphasis on knowledge, flexibility, and experience, to a willingness to perform
with the emphasis on motivation, engagement, and identification with the company.
Learning organizations are not simply the most fashionable or current management trend, they
can provide work environments that are open to creative thought, and embrace the concept that
solutions to ongoing work-related problems are available inside each and every one of us. All we
must do is tap into the knowledge base, which gives us the ability to think critically and
creatively, the ability to communicate ideas and concepts, and the ability to cooperate with other
human beings in the process of inquiry and action.

This leads to just what a learning organization is and how it pertains to the
implementation of new technologies. A learning organization is one that seeks to create
its own future, that assumes learning is an ongoing and creative process for its members,
and one that develops, adapts, and transforms itself in response to the needs and
aspirations of people, both inside and outside itself. The implementation of new
technologies feeds those aspirations for challenge and creative opportunities. What
workplace learning organizations do is set us free because employees no longer have to
be passive players in the equation; they will learn to express ideas and challenge
themselves to contribute to an improved work environment by participating in a paradigm
shift from the traditional authoritarian workplace philosophy to one where the hierarchy
is broken down and human potential is heralded. Learning organizations foster an
environment wherein people can create the results they truly desire and where they can
learn to learn together for the betterment of the whole.

As Flecker and Hofbauer (1998) argue, molding the new model worker entails a
working environment and an industrial relations regime that encourages the employee to
reposition his and her behavior and to reshape his and her mental or emotional disposition. Employee subjectivity becomes less of a problem (as under Taylorism) and more of a resource. A new language emerges that centers on notions of problem-solvers, continuous improvers, and self-developers, and that stresses the importance of discretion and self-reliant judgment within a framework of flexibility.

Assuming, for the moment, that there is an empirical basis to the new politics of production perspective, it is clear from case-study experience that even the most dystopian studies often reveal the rather more muddied realities when managerial schemes are filtered through employee attitudes and self-organization (Thompson & Warhurst, 1998). Even the use of survey data suggests gloomy readings for managerial strategies designed around capitalizing on subjectivity (Summers, 1993) as various job satisfaction surveys reveal. Employees often do disengage and even perhaps, resist, within the new workplace, certainly at the shop-floor level, but also, although to a lesser extent, among managerial grades.

Stewart and Lucio (1998) argue, from their studies in the car industry, that their cases emphasize how unsettled the various social settlements are and indeed these are a product of internal struggles, contested and uncertain though these may be. For those adherents to the new knowledge worker or the key role of the symbolic analysts or the working smarter not harder perspective (Despres & Hiltrop, 1995; Frenkel, Korczynski, Donohue, & Shire, 1995), there is a failure to recognize the continuities of the Taylorist-Fordist system.

Workplace learning or work-related learning can be seen as part of the struggle over employee subjectivity. At stake is worker commitment towards corporate objectives.
Employee learning initiatives including those promoted by and involving outside agencies such as adult educators, universities and, even more importantly, trade unions, can and often are a central feature of management strategies designed to capture the whole employee and enhance the sense of belonging within the increasingly fragile context of work and self-identity.

Innovative curriculum design and development, new assessment methods, the promotion of experiential learning and recognition of prior learning, the re-discovered interest in tacit or practical knowledge, and other associated innovations can be seen and interpreted as sub-plots of the master discourse; namely, economic competition and employee performance and productivity within a neo-liberal framework. The reflective learner, in other words, could have little to do with pedagogic ambitions and objectives and much more to do with an old fashioned capital-labor scenario, albeit recast in more modernized framework. Linking the concerns and ambitious of the lifelong-learning community with the messy and contested domain of employee subjectivity raises a host of unfamiliar but dangerous issues. The greatest danger is the incorporation of learning initiatives as a part of workplace strategies that result in new forms of employee stress and strain and new forms of work intensification.

Lifelong-learning developments linked to the new workplaces provide the lubrication of flexible organizations. The emergence of citizenship as an issue in management debates indicates the extent and imagination within the new managerial thinking. As Parker (1997) puts it, “It is as if we are being asked to weaken or relinquish wider (and increasingly contested) affiliations of nation, gender, occupation, ethnicity,
profession, region and so on in favor of (putatively uncontested) organizational membership” (cited in Flecker & Hofbauer, 1998, p. 77).

The power and insidious nature of the new human resource perspective and the importance of alliances with pedagogues within the new management thinking and practices cannot be underestimated. At a societal level, as Wexler (1995) suggests and Garrick (1998) illustrates, the area of workplace or work-related learning is part of corporate reorganization of higher education and training. What counts as education and knowledge is the bottom-line of such reorganization strategies.

There are limits, constraints, and contradictions, however, to a scenario centered on the mobilization of subjectivity, and it is within such spaces that a critical pedagogic can intervene and, even possibly, survive. For example, where there is evidence of the emergence of the new working environment and patterns of work, there is a substantial case-study literature illustrating the persistence of conflicts and tensions between the alleged new measures of involvement and openness (quality circles, team working, continuous improvement initiatives) and rigid economic targets and performance schedules (Jones, 1997).

Other empirical studies question the simplistic consensus about links between education, training, and economic performance (Ashton & Green, 1996). In other instances, new forms of control (often through budgetary measures within a devolved profit-centered strategy) emerge within a supposedly decentralized framework of responsibility and autonomy. Other studies, however (see Ackers, Smith, & Smith, 1996), continue to demonstrate the tensions arising from the persistence of traditional social
relations of ownership and control leading to a continuing mistrust by employees of management-initiated workplace reorganizations.

As Flecker and Hofbauer (1998) observe, what is usually obscured by the rhetoric of (employee) empowerment is the fact that the space available for individual commitment and ingenuity is surrounded by guiding mechanisms that are more than an organization's safety net. Rather, they constitute a recycled iron cage. Winning employee commitment, however, does not end with the workplace. Aided by changes within the wider society, the attempt to capture employee subjectivity at the corporate level entails a confrontation with other aspects of employees' lives.

The struggle for commitment, time, involvement, and responsibility today extends to areas such as parenthood and leisure. Instead of an "end of history" in organizational control struggles, we can expect the perpetuation of "old" conflicts; that is, conflicts over the subordination of individual orientations and behavior to organizational goals. Indeed, it is likely that there will be the emergence of new tensions and conflicts as a consequence of the excessive demand for employee commitment within the workplace on the one hand, with employee strategies of coping and balance in their increasingly diverse social lives on the other hand.

There are few people left today who would argue that very little has changed and that it is still the same old capitalist process. However, I do not share the view of those who advocate a paradigm shift. The difficulty is in capturing the balance between continuity and change and, following Thompson and Warhurst (1998), in recognizing the increased importance of knowledgeability in work rather than the more optimistic and uncritical notion of knowledge workers or a learning workforce. To dismiss or
marginalize the continuing role of traditional Taylorist techniques, for example, seems to defy the available empirical evidence. As Waddington and Whitson (1996) conclude after a review of new management-initiated workplace reform in the 1980s, a more cautious assessment is required of workers' experience of commitment, participation, and involvement.

In particular, the effects of measures intended to enhance employee commitment are undermined by those arising from measures to increase competitiveness through work intensification. A failure to recognize and engage with such a crossfire by adult educationalists risks jeopardizing the objectives of workplace or work-related learning initiatives, irrespective of their innovative characteristics. Too great an emphasis on the learning as opposed to the work dimension risks rendering the employee learning activities becoming nothing more than an important and sophisticated part of persuading people to work harder. Work intensification forms an important theme in studies of the new workplace and has little empirical reality in the mantra of working smarter, not harder.

The new political spaces opening up for those interested in employee learning are real and provide, within the framework of lifelong learning, opportunities that can be both innovative and challenging. They also herald the need for a greater analytical and critical grasp of the wider socio-economic developments that today subsume our educational or learning activities. A failure to locate our efforts within such a context risks not only being encapsulated by hostile ideological strategies and agendas, but also ultimately risks the promise inherent within a radicalized version of lifelong learning.
Electronic Communication

The rise of e-commerce has introduced a new dynamic of competing on "Internet-time." We are beginning to see the advancement of new business models based on e-commerce including "judo strategy," "e-business," and "business-to-business (B2B)" (Yoffie & Cusamano, 1999; Leebaert, 1998). E-commerce presents opportunities to develop and deliver new products and services to customers and opportunities to establish direct links to customers and suppliers to make transactions. E-commerce will change everything about how a corporation operates: "[It] will change the relationship between consumers and producers in ways more profound than you can yet imagine" (Hamel & Sampler, 1998, p. 16). In many aspects, it is also propelling new models in supply chain management, forecasting and marketing, purchasing, and resource planning.

Marks (2000) evaluates the effectiveness of electronic communication. He discusses pre-electronic companies and web-enabled companies. He compares traditional versus e-business companies. His analysis suggests that traditional companies that adopt e-business are better off than the web "upstarts" because the traditional companies have a broader more entrenched business foundation. This reaffirms my belief that if my company can successfully produce parts electronically using international standards, it will be well situated for future business in a global economy. My company is a very traditional company. Moving it into the electronic design and manufacturing age is a slow process. Once it realizes the benefits, I expect the process will accelerate.

Today's technology renders the division of thinking and doing entirely obsolete, by giving those on the front lines access to the information and expertise they need to make strategic decisions. Helgesen (1995) discusses a clear example occurring during...
Operation Desert Storm. In that first post-modern war, technology became an instrument
for radically diffusing hierarchical power in the very prototype of the chain-of-command
hierarchical organization, the military unit. Sophisticated software programs capable of
both identifying and hitting targets pushed power down to men and women on the front
lines. Thus, pilots and tank commanders in the Kuwaiti desert were forced by expert
systems to make split-second decisions that their staff commanders would formerly have
made. Their doing so blurred the line between reconnaissance and attack. In the war in
Iraq, communication within the military and with the world was immediate.

This also pertains to electronic communication within organizations. Davis (1987)
states that when expertise is transferred into software, the software user becomes the
expert, which immeasurably enhances his or her authority and power. Helgesen (1995)
proposes webs of inclusion, where people puts themselves in the center of an
organization in which lines of communication are multiplicitous, open, and diffuse,
thereby providing an ideal structure for taking advantage of this aspect of technology and
emphasizing the value of information taken in by those at the front ranks and so restoring
to them decision-making power. Webs are also a particularly effective way of dealing
with a fast-changing situation, enabling those who gather information to elevate it in the
process and thus modify and adapt their plans as they go along.

From the mid-1950s until the mid-1960s, there was very little and limited
information technology available to support the business world. Zuboff (1988) refers to
"typewriters, printing presses, copying machines, telephones, files, calculators, and mail
sorting systems" as the available technology. More specifically, the technology which
supported commerce was physical: paper-based typewriters and photocopying machines,
handwritten telephone logs, and personally addressed and mailed letters. Each piece of
information was unshakably bound to a material item. Instead of beepers and voice mail,
exectives had secretaries. The Rolodex tracked customers, a daily planner tracked
appointments, and pneumatic tubes carried time-critical messages to and from different
offices. Long-distance telephone communication was relatively expensive, largely
because there was still a quarter century to go before the 1984 Justice Department
decision which broke AT&T’s monopoly, and electronic mail or other inexpensive means
to transmit large quantities of information did not exist. With such a lack of
infrastructure, electronic commerce could not exist.

In the next phase, office automation introduced electronic data interchange (EDI),
fax machines, value added networks (VANs), mainframes and microcomputers, and
rudimentary networks. This phase began in the late 1960s and 1970s for some businesses,
but in some others it continued well into the 1990s.

Darnay (1992) contains much information on the computer industry, and a small
part is summarized here. In 1969, the U.S. Justice Department forced IBM, which then
held over 60% of the market, to sell software for its mainframes separately from the
mainframe computers themselves. This opened up both the hardware and software
markets to more competition, and in the late 1970s, microcomputers from Apple,
Tandy, Commodore, and Atari were introduced. In 1979, VisiCorp introduced VisiCalc,
the first spreadsheet program; 2 years later, in 1981, IBM introduced the IBM PC, and in
1984, the user friendly Apple Macintosh appeared.

By the early-1980s, local area networks (LANs) were appearing in business, and
by the mid-1980s, networked microcomputers were not uncommon in businesses. The
networking market for microcomputers belonged mostly to Novell, which by 1990 had garnered 65% of the networking market, followed by Microsoft’s LAN Manager (Darnay, 1992; Hillstrom, 1994).

The mainframes tended to be more expensive and used in larger businesses for more computationally intensive tasks, and the personal computers tended to be less expensive and used either at work or in the home. As with all new technologies, in the beginning networking was relatively slow, clumsy, difficult, and expensive.

The early experience of General Motors, an electronic commerce pioneer, provides a good example of this stage. In 1984, General Motors made a commitment to using EDI, an early form of electronic commerce, to reduce costs and improve accuracy. General Motors had the bargaining power to demand that its suppliers convert to EDI by 1987 or be dropped, and even with such clout, implementation was difficult. The investment ran into the millions of dollars, and there was a long wait before any return on investment was seen (Suby, 1988). Furthermore, radical changes in company operations and intercompany relationships were required, and the communication issue appeared again, as the billing systems had trouble “talking” across industries (Engstrom, 1987). By July 1987, GM was paying approximately 10% of its total supplier payments electronically but had recognized no labor savings and very little postage cost savings (Gamble, 1987).

Although information technology was relatively new, applications were everywhere, and electronic commerce was beginning to happen. Stand-alone personal computers were used for word processing and quantitative analysis, and towards the end
of this era, were beginning to find use as comprehensively networked machines (Zubay, 1988).

According to Paul Strassmann, former CIO for Xerox and the Defense Department, “For 30 years America brought in computers to speed up the kind of work that just accentuates bureaucracy. They made these bloated structures more bloated” (Magnet, 1993, p. 103). Very little rethinking went into this process; rather, the automated process usually closely duplicated the manual one and at times exacerbated it. Little comprehensive electronic commerce was in place during this era due to technical difficulties, notably a lack of comprehensive networking between computers or businesses, and an attitude which tended to “pave the cowpaths” rather than leveraging new capabilities of electronic commerce.

We see that the development of information technology has been briefly traced from the paper-driven office through the “islands of technology” situation. When information technology moved forward again, it moved into an age of connectivity. This happened mainly in the 1980s and 1990s. The availability of the Internet, the World Wide Web, electronic mail, word processors, paging systems, laptop computers, integrated database systems, graphical user interfaces, and relatively inexpensive telecommunication services made sharing information a much easier task.

The hardware performance has increased by tremendous amounts. Zuboff (1988) writes that a computation that cost $1 in 1988 would have cost about $30,000 in 1950. Porter and Millar (1985) estimate that the cost of computer power relative to the cost of manual information processing is at least 8,000 times less than the cost in 1958, and
Zuboff points out that between 1958 and 1980, the time needed for one electronic computation fell by a factor of 80 million. Sales of semiconductors have grown from less than $5 billion in the early 1970s to $63 billion in 1994, and are estimated to reach $200 billion by the early 21st century (Deininger, 1994; Spencer & Grindley, 1993). Information technology has become more available along many dimensions: the price has fallen, the performance has increased, and sales have risen. Software performance has increased also. Local and wide area networks have become commonplace, and graphical user interfaces make connecting to the Internet relatively easy for even non-technical users.

A recent study by Nielsen Media Research for Commerce Net 2 found that 5.8 million Americans are directly connected to the Internet, and that another 3.9 million American adults use only online commercial services. The study additionally estimated that in the previous 3 months, 24 million people had used the Internet for something other than electronic mail (Green & Fugel, 1995). InterNIC, the registry which maintains Internet addresses, reported that as of December 8, 1995, there were 152,341 commercial domain names, and it was adding approximately 2,000 more each week (“How Big Is the Net?”, 1996).

Client/server technology and object-oriented engineering deliver performance beyond what any single computer can do. The combination of the Internet and object-oriented programming leads to the distributed objects paradigm, which Orfali, Harkey, and Edwards (1996) call “a second client/server revolution.” The result has been electronic commerce being used in many more places and ways than before.
According to Sokol (1989), advance shipment notices in the automotive industry tell the customer which parts have been shipped and when to expect them, and the financial industry uses Financial EDI, or FEDI, to process invoices, payment remittances, and credit and debit memos. Grocery stores use EDI as part of an efficient consumer response system to manage inventory better based on information gleaned from checkout counter registers, and Levi Strauss uses EDI as part of its vendor-managed inventory program.

A dozen corporate and university libraries have begun to use EDI to transmit book orders to a Web site managed by Bank One Services Corporation in Columbus, OH; by ordering over the Internet, the libraries receive a 5% discount (Messmer, 1996). The American Bankers Association projects electronic banking to grow from $1 billion today to $15 billion to $20 billion in 5 years, and banks such as Bank of America and Wells Fargo are using home banking and Web pages to take advantage of this trend. Companies from computer manufacturer Silicon Graphics to the components warehouse Marshall Industries are using electronic catalogs to communicate with customers, advertise, and sell products and services; there is a new paradigm of business value associated with electronic catalogs (Segev, Wan, & Beam, 1995). Electronic payment mechanisms will figure prominently as commerce moves on-line, and companies such as Harbinger, Premenos, and Sterling Software are already adapting their products for use over the Internet (Edwards, 1996).

In 1996, the $70 billion General Electric introduced the GE Trading Process Network (TPN), a secure Web-based system that should handle the documentation for $1 billion of corporate purchases and over 50% of GE's other purchasing activities,
including request for proposals (RFPs) and payments (Earls, 1996). Finally, the General Motors EDI project has also seen many benefits. By October 1988, GM's Truck and Bus plant was receiving its entire monthly supply of raw steel, approximately 35,000 tons, using bar-code EDI technology (Stevens, 1990). By 1993, the system was beginning to pay off; GM estimated cost savings due to EDI at $200-$300 per car; furthermore, the carmaker was paying over $3 billion in invoices annual electronically (Takac, 1993). By 1996, the benefits of EDI were well enough accepted in the industry that the Big Three automakers issued a united statement requiring EDI capability of all suppliers (Vasilash, 1996).

However, there are still some technological barriers to electronic commerce, most notably the perceived lack of secure transactions over the Internet. While theft online is estimated at over $10 billion annually ("How Big Is the Net?", 1996), fear of theft is to at least some degree oversensationalized. It has been estimated that a 1024-bit key from the RSA public/private key system would take $2.8 \times 10^{15}$ MIPS-years to crack using bruteforce methods; when the 429-bit key was finally factored in April 1994, the prediction was very close to the actual time required (Segev, Wan, Beam, Toma, & Weinrot, 1995).

Furthermore, it has been estimated that with proper security, Internet fraud losses could be limited to $1 per $1000 of business, a figure which compares favorably with MasterCard's typical losses of $2 on every $1000 of business, and mobile phone operator fraud figures which are much worse (Insurance Systems Bulletin, 1996). While the security issue appears more a matter of confidence than a well-founded fear, the public perception is the crucial element.
The change in information technology has been immense. From paper-driven offices and face-to-face meetings, the introduction of first the mainframe, then the personal computer, and the accompanying software advances of local and wide area networks, client/server technology, and object-oriented software engineering has changed the way business is conducted. They have made fundamental parts of electronic commerce technically possible.

Close on the heels of the change in information technology has been a change in the way value is added over the past 50 years. We have moved from an economy, which leaned more towards manufacturing and physical goods, to one which leans more towards services. The change continues; we are rapidly moving from a service-based economy to a knowledge- and intellectual-property-based economy. The shift to a knowledge-based economy made electronic commerce, which was already technically possible, now economically desirable, too.

In the same era as the paper-driven office and the carbon-paper copies, items for sale gained the most value in their manufacturing process. In the 1950s General Motors had become the size of many small nations. In this example, the value was the physical automobile. The customer was paying more for the steel and rubber, which went into the car, and less for service or knowledge encapsulated in the automobile. The infrastructure to support electronic commerce was not in place, but even if it were, this economy would not heavily value the advantages that transmitting information could give.

By the mid-1970s, the country had changed from a manufacturing-based economy to a service-based economy, partly because the production process had become so
efficient that fewer people were needed to make the same amount of goods. By 1987, an estimated 75% of the workforce was in some type of service industry (Nadler, 1987); and the service industry was growing faster than the manufacturing sector (Hughes, 1989).

An estimated 20 million service-sector jobs were created during the 1980s, including 2 million in the retail trade, 1.5 million in the restaurant industry, and 4 million in professional services (accounting, consulting, law) sector (Evans, 1992). The relative number of service employees outpaced the relative number of manufacturing employees over this period.

International Standards, The Standard for the Exchange for Product Model Data (STEP), Consensus, Development, and Implementation

The transition from sequential communications systems, such as railroads and telephony systems, to adaptive communications systems, such as the Internet, is a paradigm shift. This paradigm shift can also be identified by an emerging new class of technical standards. Technical standards throughout recorded history are a means to enable communications, inherent in all complex systems, and basic to communications engineering (Krechmer, 2000).

Standards appear fundamental for a life-like system to exist. Technical standards are necessary for any complex technology to exist. Technology, the fruit of invention, is basic to the long-term development of any human society, and standards bring these fruits to society in a broadly useful form. Prior to the creation of technical standards, technical information, for example tool making, was passed on only by instruction and example. As society becomes more complex, technical standards provide the means to communicate necessary common technical information broadly and uniformly. Standards
emerge in each and every human group; the level of standardization (language, writing, number system, monetary system, measurement system, navigational references, communications systems, etc.) in each tribe or society is an indicator of its sophistication and technological attainment. Viewed this way, technical standards appear to be inherent in all complex technical systems, fundamental to almost all forms of commerce and required for more complex communications (Krechmer, 2000).

The economic progress of society is closely linked to invention and innovation. Schumpeter (1939), an economist, developed the concept that all economic cycles are generated by invention and innovation. For the last several decades, every historic period has portrayed a paradigm shift unique to that period, due to the various shifts in technology-enhanced communications. Technical standards in all their forms are the means to codify technology for a society. Not surprisingly, technical standards also follow these paradigm shifts. Technical standards provide the information used to substantiate each new value system. The value system then develops into a new form of wealth.

Multiple standards are created and over time are winnowed down to the most desirable and culturally acceptable standards that codify the technical requirements previously developed. The same as invention, technology and all other forms of progress and standards follow an evolutionary path. Each stratum of standards codifies a level of technology for society and requires ways to balance two conflicting objectives: one, incentives for innovation (enabling private gain), and two, the diffusion of new products, services, and processes (enabling lower prices and greater usage—public good) (Shurmer & Lea, 1995).
As technology is applied in new ways, each stratum of standards continues to develop and expand. By identifying each stratum of standards, specific issues may be seen that impact society, and new approaches may be developed to better meet society's needs. The industrial revolution is replete with new systems for production (assembly line), transportation (railroads), as well as new systems for water, sewage, gas, electricity, telegraph, and telephony that are sequential (Tennenhouse & Wetherall, 1996). These sequential systems transport the desired product from service provider to consumer (or the reverse in the case of sewage) with considerable efficiency and little flexibility. These sequential systems were a new form of operation and organization that also required new concepts and procedures.

The particular type of sequential systems of interest here are those providing water, sewage, gas, electricity, and telephone services, often termed utility systems. Utility systems as they emerged in the 19th century brought forth a new concept: compatibility. Public utilities or state regulation of private utilities prevent commercial advantage where there is the potential for a "natural monopoly" (Ely, 1987). Natural monopolies have five characteristics:

1. Provides a necessary product or service
2. Has a dominant position over similar products or services
3. Controls the supply of the product or service
4. The natural monopoly's product or service may be increased with little relationship to cost
5. Unique and specific arrangements are necessary to use the product or service.
The unique and specific arrangements are compatibility specifications (private standards). Compatibility describes a relationship between two or more dissimilar entities. The systems for water, sewage, and gas require only the simplest compatibility standards for pipe coupling and content. The pipe and the coupling are not similar, but if sized and threaded properly, can mate. Outside-threaded pipe built to a similarity standard could mate with an inside-threaded coupling built to another mating similarity standard. But when the aspects of both the pipe and coupling necessary to allow mating are described in one document, it is an early version of a local compatibility standard. An electrical system requires only slightly more complex compatibility standards. Public interconnection to telephone systems requires yet more complex compatibility standards that define an interface.

The segment of the public communications market that is willing to acquire and use proprietary communications systems is in decline for basic reasons. Compatibility standards for public communications are becoming too important for the public to allow any private organization an overwhelming proprietary advantage. For this reason broad market acceptance of privately controlled specifications rarely occurs in public communications systems.

Public voice and early data communications (telegraph) were recognized to be a public good (e.g., universal service) very early in their development (Bell Telephone Laboratories, 1975). Early public voice and telegraph communications systems used similar equipment and systems to achieve compatibility. Achieving compatibility by requiring similar equipment is one of the characteristics identifying a natural monopoly. As public telephone and telegraph companies meet all the characteristics of a natural
monopoly, many states determined to control the industry via a public utility or regulated private utility. Data communications evolved through its development and use in large organizations and was not recognized as a public good until recently (i.e., the Internet).

IBM pioneered modern data communications systems and developed many proprietary compatibility specifications (under the proprietary system Synchronous Network Architecture), but these often technically superior, private specifications have been rendered obsolete by the market's desire for public data communications compatibility as exemplified by the Internet. The success of the Internet and the failure of IBM SNA may be partially explained by the perceived value of public compatibility standards rather than proprietary compatibility specifications.

There are three significant ways to create public standards:

1. State intervention (via regulation or public utility)
2. Formal consensus standardization
3. Market acceptance (culminating in standardization) of private specifications.

Due to the natural monopoly potential of telephone systems, these public voice communications systems, after an initial period, became public utilities or state-owned companies. Now these public voice communications systems are evolving away from state control and moving toward commercial control, i.e., systems that are publicly available for a fee and privately held (Rutkowski, 1994). The transition of the public voice communications companies to commercial control, without falling back to a natural monopoly, is partially made possible by the growing acceptance of formal consensus standardization. The privatization of many major Public Telephone and Telegraph (PT&T) organizations worldwide is one indication of this commercialization trend.
Too often, all standards are equated with state control. Reviewing the history of standards, unit and reference standards have required state involvement to achieve widespread utilization. Similarity standards, when they affect the public good, are often referenced in state regulation. However, products that use compatibility standards evidence greater self-reinforcing effects, the combination of effects that cause product demand to increase with increasing market penetration (Arthur, 1988) and therefore require less state enforcement. The need for state participation appears to decline with each later stratum of standards. As industry realizes the competitive advantage of establishing technical standards that enhance interoperability, the need to create standards consensus groups among corporations will grow.

The National Institute of Standards and Technology (1999) documents the results of a comprehensive effort by the National Institute of Standards and Technology (NIST) to review and analyze the development of STEP. More than two dozen individuals inside and outside NIST actively contributed to this document. This document is a good historical perspective of STEP's past history. It lacks the view beyond the design phase of product development, probably because there was so much effort to establish design processes at that time. Now we are moving into the manufacturing area of STEP. This is where the expertise is limited.

A Canadian document published by the Canadian CanSTEP, the Integrated Manufacturing Technologies Institute, and National Research Council Canada (1999) focuses on the global importance of international standards and gives a limited review of STEP. It delves into how organizations can use STEP, which is a valuable insight. It does not mention the shop-floor activities of a STEP-enabled plant.
Standards are the binding force for global economic progress. As the aforementioned chapters indicate, standards have enabled not only businesses to expand globally, but have enabled civilizations to begin to meld cultures. The implementation of international information standards will further enhance global economic prosperity.

Effecting Change in the Manufacturing Environment

The STEP Manufacturing Suite prepared by the South Carolina Research Authority (SCRA) (2001) defines the suite of STEP application protocols and the implementation architecture for STEP-enabled parts production within commercial and defense applications. This is a good study that directly addresses manufacturing issues in STEP. The work I have done on STEP NC has been added to this study at my request. Prior to my request there was no mention of AP 238 (STEP NC). My study has the potential to promote recognition of STEP NC and OMAC as a viable way to manufacture in the future.

The goal of the Technology Blue Ribbon Panel for the Air Force Research Laboratory Integrated Manufacturing Simulation for Affordability (2001) is to provide manufacturing capabilities that will assist the defense industry in reducing design changes, development cycle time, and cost. This document discusses interoperability between engineering and manufacturing. This study is limited by addressing only simulation. My work expands on these theories by implementing beyond simulation and moving these practices into production.

STEP numerical control (STEP NC) and the resulting efficiencies that will catapult manufacturing productivity into the next frontier is the primary focus of Hardwick (2001). Dr. Hardwick’s work in STEP NC in a laboratory environment has
influenced my work on STEP NC in the “real world” production environment. We have worked together to create the STEP NC data formats. We are both on the United States Technical Advisory Group for the Standard for Exchange for Product Model Data. Dr. Hardwick works in a lab environment. He has partnered with me in expanding STEP NC into a large production environment.

Kocakulah et al. (2000) provides an analysis of how a medium-sized company reacts to a changing market place in order to remain competitive. Reengineering efforts and Activity Based Costing were tools that Evansville Manufacturing used to form the new shape of the future organization. The implementation of international quality standards such as ISO 9000 and a progressive training initiative for employees are other examples of programs that will keep Evansville Manufacturing a global competitor. This study recommends taking this approach to other key markets that fit this high volume strategy. My study uses part of this strategy in another manufacturing and international standard environment. I firmly believe that company-wide process training is an effective way to institutionalize new technology.

Globalization does not always involve the wholesale movement of manufacturing capabilities to whatever country happens to have cheaper labor costs. Globalization requires the capacity to get close to one’s customers, regardless of where in the world they are. It means having the ability to allocate production capacity anywhere in the world where capacity is available. It means minimizing the communication loss when design work is done in a different part of the world from manufacturing and marketing (Bresticker, 1992). Globalization requires that the merged firm should "act globally, think locally."
The rise of e-commerce has introduced a new dynamic of competing on Internet-time. E-commerce will change everything about how a corporation operates: "[It] will change the relationship between consumers and producers in ways more profound than you can yet imagine" (Hamel & Sampier, 1998, p. 98). In conjunction with these dynamics, the manufacturing systems themselves will also have to change. We have already seen evidence of trends toward more process data acquisition and analysis, shorter production runs, and more stringent quality requirements. We often use the word *transition* because it connotes change as a process.

In order to better manage this process, we first recognize that more decision-making and operational action at different points in time are required during transitions than in steady-state periods. We also need to better understand the value of flexibility. While these ideas are conceptually comfortable, the modeling and application of these ideas are somewhat subtle.

Many recent aggregate studies find that computers play an important role in the strong economic performance of the United States economy, particularly the surge of productivity growth in the late 1990s (e.g., Jorgenson, 2001; Jorgenson & Stiroh, 2000; Nordhaus, 2001; Oliner & Sichel, 2000; Stiroh, 2001; Triplet & Bosworth, 2000). For example, Jorgenson and Stiroh (2000) find that total and average labor productivity growth between 1958 and 1996 is relatively low in industries outside of manufacturing. Within manufacturing, the annual growth rates of average labor productivity in Industrial Machinery and Equipment and Electronic and Electric Equipment are far higher than for other industries (4.1% and 3.1%, compared to 2.6% in the next highest industry, Instruments).
Similarly, Triplett and Bosworth (2000) examine total factor and labor productivity growth over three periods between 1960 and 1997. Productivity growth by any measure is far higher in manufacturing than in other industries during the two most recent periods (1973-1997 and 1987–1997) and is particularly pronounced for Electronic and Electric Equipment. That industry’s multifactor productivity growth of 7.3% between 1987 and 1997 far exceeds the rate of 2.4% for durable goods manufacturing, 2.4% (also) for all manufacturing industries, 0.5% for services, -0.5% for finance, insurance, and real estate, and 0.9% for the private sector as a whole.

Jorgenson (2001) finds that Information Technology (IT) contributes substantially to the growth in total factor productivity throughout the 1948-1999 period, and particularly for the 1990s. Both investments in IT and its use—consumption of IT services—contribute separately to the growth of gross domestic product. Jorgenson (2001) recommends research distinguishing between using and producing computers.

International comparisons of the pervasiveness of IT use among businesses and its effect on national economic performance have also been carried out. Some cross-country comparisons (e.g., Colecchia & Schreyer, 2001) find a clear role for IT in the U.S. and Japan.

Computers may affect productivity in at least two ways. They may be used directly as inputs to the production process, as a specific form of capital. This is the approach taken in most existing studies, including both the national and industry-level studies cited above, as well studies at the plant or business level (e.g., Brynjolfsson & Hitt, 2000; Dunne, Foster, Haltiwanger, & Troske, 2000; McGuckin, Stretiwieser, & Doms, 1998; Stolarick, 1999a, 1999b).
Consider a steel mill. Computers and automated processes are used to control production processes in modern steel mills. Many supporting business processes also can be computerized. For example, computers can be used to maintain a database of customers or shipments, or to do accounting or payroll. Computers may substitute for paper-based systems without changing the underlying business processes. But computers may also be used to organize or streamline the underlying business processes. When these computers are linked into networks, they facilitate standard business.

Gullickson and Harper (1999) discuss a number of possible sources of measurement bias in aggregate productivity growth processes such as order taking, inventory control, accounting services, and tracking product delivery that become electronic business processes (e-business processes; see Atrostic, Gates, & Jarmin, 2000). These e-business processes occur over internal or external computer networks that allow information from processes to be exchanged readily. Shipments may be tracked on-line, inventories may be automatically monitored, and suppliers notified when predetermined levels are reached. Adopting e-business processes automates and connects existing business processes. It can also change the way companies conduct not only these processes but also their businesses.

The surge of interest in supply chains exemplifies this potential for computers to affect productivity growth outside of the manufacturing industries that produce them. These effects are thought to occur through organizational change. Many core supply chain processes are widely cited as examples of successful e-business processes that, in turn, are expected to shift the location of the process among the participants in the supply chain. Brynjolfsson and Hitt (2000) argue that the effects of organizational changes may
rival the effects of changes in the production process. Viewed this way, computer networks are a productivity-enhancing technology.

Few previous micro data studies assess the effect of computer networks on productivity. Most assess the effect of computers alone, using either data on book values of computer capital or current investment in IT or computers, as a proxy for the computer capital stock. Only one previous study for the U.S. touches on the link between productivity and how computers were used. That study (McGuckin et al., 1998) uses Surveys of Manufacturing Technology (SMT) data from 1988 and 1993. Information was collected only from plants in the five manufacturing industries thought to be primary users of such technology: fabricated metal products, industrial machinery and equipment, electronic and other electric equipment, transportation equipment, and instruments and related products. Plants were asked about their use of 17 advanced technologies. McGuckin et al. (1998) examined the relationship among the use of all the advanced technologies and labor productivity and its growth rates in the five manufacturing industries. They found that diffusion differs across the surveyed technologies. Productivity is higher at plants using advanced technologies, even after controlling for multiple economic characteristics of the plant. The relationship between productivity and advanced technology use holds both in terms of the number of technologies used and in the intensity of that use. But the use of advanced technologies does not necessarily cause higher productivity. In particular, McGuckin et al. concluded that the positive relationship between average productivity and the use of advanced technologies arises because operations that are performing well are more likely to use advanced technologies than poorly performing operations. However, the study does not
separate the use of computer networks from other uses of computers and advanced technologies. It finds that using computer networks and other communication and control equipment increases labor productivity by about 12% in 1993.

Grennan, Mairesse, and Topiol-Bensaid (2001) analyze the effect of using computers in French manufacturing and services firms in 1987, 1991, and 1993. They conclude that an effect of about 20% might be conservative. Motohasi (2001) analyzed the effect of computer networks using firm-level data for manufacturing, wholesale, and retail sectors in Japan in 1991. For firms with networks, the estimated effects on productivity vary with the type of network and the e-business processes in which it is used. Motohashi (2001) and Brynjolfsson and Hitt (2000) find that IT affects total factor productivity only in firms with higher human capital and flatter workforce organization. However, causality is complex to model, the available micro data present challenges to economic measurement, and the studies are not designed to facilitate international comparisons, so this brief literature has not yet shed definitive light on how computer networks affect productivity.

The Computer Network Use Supplement (CNUS) to the 1999 Annual Survey of Manufactures (ASM) surveyed some 50,000 manufacturing plants about their use of online purchasing and ordering, the presence of computer networks, the kind of network (EDI, Internet, both), about 25 business processes (such as procurement, payroll, inventory, etc., conducted over computer networks—"e-business processes"), and whether those networked processes are used to interact internally or with the manufacturing plant's customers or suppliers (U.S. Census Bureau, 1999). The CNUS focuses on the use of computer networks rather than the presence of computers alone.
In June 2001, the U.S. Census Bureau released an analytical report on the use of e-business processes (E-statistics) (2000). The report is based on the 1999 CNUS and the 1999 ASM. Responses were obtained from more than 38,000 U.S. manufacturing plants, for a response rate of 82%. The E-statistics report highlights several e-business processes that appear closely related to the commercial activities of accepting and placing orders online. The data show that manufacturing plants use networks for much more than online sales and orders. Only half of manufacturing plants reporting that they have a network also report that they accept and/or place orders online.

Atrostic and Gates (2001) use the new 1999 CNUS data to model the use of computer networks. They find computer networks widely diffused within manufacturing, with networks at 52% of plants. Plants with networks are slightly more common in the North American Industry Classification System (NAICS) Nondurables subsectors (54% of plants) than in NAICS Durables subsectors (51%), but the percentage of employment at plants with networks is almost identical—76% in NAICS Nondurables and 75% in NAICS Durables. Within each subsector, diffusion rates range from lows of 27.1% in Apparel and 35.3% in Furniture to highs of 71.1% in Chemicals and 72.2% in Electrical Equipment. While the estimates in Atrostic and Gates are based on plant-level responses, they are calculated from data aggregated to a subsector level, and their analysis does not address productivity.

Atrostic and Nguyen (2002) were the first to use the new CNUS data to estimate plant-level economic activity. Because the data are only from respondents to the CNUS, and are unweighted, their results may apply only to responding plants and not
to the manufacturing sector as a whole. They note, however, the plants included in their sample account for a substantial share of U.S. manufacturing output.

**Summary of Literature Review**

**Dynamics of Corporate Change**

Re-engineering is about doing things differently (not a little bit different, but radically differently) (Volkurken, 1998). Burrus and Gittines (1998) discuss how sweeping technological innovations have changed the rules. In order to be successful, one must know how to deal with the new business rules, which will transform decision making and management processes worldwide. With the emergence of network economy and an information-rich environment, traditional hierarchies have been replaced by groups of interconnected organizations, with blurred boundaries and loose and often temporary alliances connecting customers, suppliers, and employees with stakeholders and competitors. These blurred boundaries are found within many organizations. This study correlates the dynamics of corporate change to the changes taking place in the creation of electronic delivery of product data information.

**Cultural Significance of Change**

Everyone brings cultural prejudices to the bargaining table. Rost (1993) argues the cultural changes that are imminent in the 21st century will impact the understanding of leadership, which he calls the industrial leadership paradigm. An organization's culture can be understood as the sum total of the assumptions, beliefs, and values that its members share and is expressed through "what is done, how it is done, and who is doing it" (Farmer, 1990, p. 76). Members of an organization often take its culture for granted.
and do not truly evaluate its impact on decisions, behaviors, and communication or consider the symbolic and structural boundaries of organizational culture until external forces test it. Therefore, when initiating transformation efforts, it becomes critical to understand and explicate the values and personal meanings that define organizational culture. Cultural issues are addressed within this study on the effects of processes in place for technological changes within the organization.

Measurements of Change

A study by Kuntz and Scholtes (2000) focused on measuring the minimal perturbation that is necessary to change the efficiency of a single process. They studied robustness measures in the context of Farrell’s (1957) model of empirical efficiency. One of the findings was that small changes are practicable, and large changes are obviously not always realistic because they imply a massive intrusion into the organization’s business. Business process specific transactions are indeed viable and achievable with today’s technology. Standards-based collaboration can work in a global, distributed, and heterogeneous design environment. Internet-based technology solutions are inexpensive, readily available, and easy to deploy in the supply chain. This study recommends the use of international standards to reduce product development cycles.

Leadership in the Change Process

Cognitive and cultural research traditions have provided support for the view that leadership is socially constructed between people; thus, its meaning is negotiated among individuals or groups (Calas & Smirich, 1992). Senge (1990) argues that learning organizations require a new view of leadership. He sees the traditional view of leaders (as
special people who set the direction, make key decisions, and energize the troops) as deriving from a deeply individualistic and non-systemic worldview. May (2001) discusses how transformational leadership slips into paternalism unless it teaches rather than commands or manipulates. The professional today who insists on transforming her clients, but who neglects to teach them, inevitably relies on managerial manipulative and condescending modes of behavior modification.

Pressure for organizations to change increases in intensity over the next decades. The methods that managers have used in the attempt to transform their companies into stronger competitors include total quality management, reengineering, right sizing, restructuring, cultural change, and turnarounds. The culture of the organization plays a significant role in the change process. This study addresses leadership issues for international standards adoption and implementation.

Learning Communities/Organizations

Learning takes place not in isolation but through observation and modeling in social settings such as the family, the workplace, and schools. Social interaction, observation of social roles, and the critical role of mentors are very important in the learning process.

The most common thread throughout the literature is that learning is complex, multidimensional, and appears to be inextricably connected to the learner's experiences (Brookfield, 1991; Dewey, 1997; Knowles, 1984, 1988). Twentieth-century gestalt psychologists like Kohler (1957) stated that "learning takes place through an act of insight" while the learner engages in and reflects on experiences.
Social learning theorists underscore the importance of the learner's social context (Bandura, 1970; Dewey, 1997; Vygotsky, 1978). Learning takes place not in isolation but through observation and modeling in social settings such as the family, the workplace, and schools.

Learning organizations are organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together (Senge, 1990). Learning organizations are important to this study as an environment where implementation of new technology can thrive.

Electronic Communication

Marks (2000) evaluates the effectiveness of electronic communication. He discusses pre-electronic companies and web-enabled companies. He compares traditional versus e-business companies. His analysis suggests that traditional companies that adopt e-business are better off that the web “upstarts” because the traditional companies have a broader, more entrenched, business foundation. Davis (1987) states that when expertise is transferred into software, the software user becomes the expert, which immeasurably enhances his or her authority and power. Helgesen (1995) proposes webs of inclusion, where people put themselves in the center of an organization in which lines of communication are multiplicitous, open, and diffuse, thereby providing an ideal structure for taking advantage of this aspect of technology and emphasizing the value of information taken in by those at the front ranks and so restoring to them decision-making power.
E-commerce presents opportunities to develop and deliver new products and services to customers and opportunities to establish direct links to customers and suppliers to make transactions. E-commerce will change everything about how a corporation operates. It will change the relationship between consumers and producers in ways more profound than can be imagined. In many aspects, it is also propelling new models in supply chain management, forecasting, and marketing, purchasing, and resource planning.

It is also propelling establishment of international standards to alleviate the barriers information encounters when it passes across dissimilar systems, infrastructures, and countries. Electronic communication is at the center of this study. International standards will allow information to flow unencumbered across disparate infrastructures.

International Standards, STEP

Technical standards throughout recorded history are a means to enable communications, inherent in all complex systems, and basic to communications engineering (Krechmer, 2000). Standards appear fundamental for a life-like system to exist. Technical standards are necessary for any complex technology to exist. As technology is applied in new ways, each stratum of standards continues to develop and expand. By identifying each stratum of standards, specific issues may be seen that impact society, and new approaches may be developed to better meet society's needs. The industrial revolution is replete with new systems for production (assembly line), transportation (railroads), as well as new systems for water, sewage, gas, electricity, telegraph, and telephony that are sequential (Tennenhouse & Wetherall, 1996).
Technology, the fruit of invention, is basic to the long-term development of any human society, and standards bring these fruits to society in a broadly useful form. Prior to the creation of technical standards, technical information (for example, tool making) was passed on only by instruction and example.

Today, some organizations shun international standards and rely on the proprietary standards that are unique to the computer hardware and software they purchase. This allows them to dictate to their suppliers which hardware and software should be purchased if the supplier desires a business relationship with the organization. This transfer of information does not require the additional “fix” to the computer that the use of international standards requires. Therefore they consider the exchange “pure.” The abundance of organizational acquisitions and mergers deems this approach to business costly and unrealistic. As society becomes more complex, technical standards provide the means to communicate necessary common technical information broadly and uniformly. Therein lies the importance of this study. Providing international information standards for the global community will enhance economic opportunity.

**Effecting Change in the Manufacturing Environment**

E-commerce will change everything about how industry operates (Kocakulah et al., 2000). Relationships between consumers and producers will change drastically. In conjunction with these dynamics, the manufacturing systems themselves will also have to change (Brynjolfsson & Hitt, 2000; Motohashi, 2001). We have already seen evidence of trends toward more process data acquisition and analysis, shorter production runs, and more stringent quality requirements. We often use the word transition because it connotes...
change as a process. This study specifically addresses the electronic exchange of manufacturing information and the transition from manual to electronic processes.
CHAPTER III

METHODOLOGY

This study examined the process for the implementation of a system for creating reciprocity between international design standards and new international manufacturing standards—in other words, how can designers and manufacturers share the same data on several diverse computer platforms for enhancing efficiency and effectiveness in production? The study also clarified areas of resistance to change and assist change agents in alleviating barriers to change. The goal of the studied program was to change the way business is done by adopting newly created international standards in the current business environment. The specific focus of the study was the international standard STEP NC. This chapter describes the design of the study, research questions, participants of the study, procedures used to conduct the study, the surveys, variables and measurement of data, and data analysis methods.

Design of the Study

This study employed survey methodology including both quantitative and qualitative approaches. The design of the study centered around analyzing the responses to survey items developed on the following issues:

1. Processes to implement change within organizations
2. The impact the development of non-proprietary international standards has on organizations

3. The change required to lead consensus for adoption and implementation of STEP NC

4. Who will provide the leadership necessary for change to adopt STEP NC within an organization.

A list was compiled of survey questions (Appendix A) concerning recommendations for the change that is required for the adoption and implementation of new technological standards.

Demonstration of STEP NC

Members of the focus group and members of the Industrial Review Board (IRB) had witnessed a proof of concept demonstrating the use of STEP NC. There was a demonstration of this technology at the General Dynamics Land Systems Scranton Pennsylvania plant.

There were three scenarios demonstrating three kinds of manufacturing/machining features (slot, pocket, hole) being cut on a milling machine:

1. Demonstrate an operator preparing STEP (AP 203) (design) for the CAM system to M/G codes and into the machine to cut a part. The significance of scenario one is that AP 203 will input a design (engineering) into a Gibbs CAM system (manufacturing) in a production environment. This can be done today in a traditional environment using STEP design standards. This means this new technology can be used in engineering and manufacturing environments today.
2. Demonstrate STEP NC (AP 238) (engineering) into the CAM system (manufacturing) to M/G codes and into the machine to cut the part. The significance of scenario two is that the CAM system creates and posts M and G codes from STEP NC automatically without operator intervention. This replaces the human interface eliminating opportunities for error.

3. Put STEP NC (engineering combined with manufacturing) into a controller and cut a part. The significance in scenario three is that the M & G codes are eliminated. This means that engineering, manufacturing, and the machines on the plant floor are interoperable. The information will flow smoothly across dissimilar platforms using non-proprietary international standards.

The proof of concept was a test of the software to determine connectivity of the various systems. The prototype test was the actual machining of a part. The comparison of the proof of concept to the prototype test and its variables was the determining factor for the operability of the system. The comparison was also the quality of the information encompassed in the technical file (completely automated) versus the traditional process (manual) using the various methods. The work preceding the demonstration and the demonstration was recognized as a revolutionary advance in the “Art to Part” process (Albert, 2000; Hardwick, 2000; Waurzyniak, 2001; Weyrich, 2001; Wichmann, 2000). STEP NC was recognized as one of the “Top Ten Technologies” of 2001 (ARC Advisory Group, 2001). The survey group, having witnessed the technology, was able to respond to the survey questions. The survey group responded to these questions via a web-site survey.
1. Do respondents have a process in place to implement change, which will benefit the adoption of new international standards within their organization?

There is a significant difference in the organization's processes in place to implement change, which will benefit the adoption of new international standards according to three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. This umbrella hypothesis was addressed by sub-hypotheses defined by individual items of the survey. See Table 1.

Table 1

Research Question 1 and Relevant Quantitative and Qualitative Items

<table>
<thead>
<tr>
<th>Research Question # 1</th>
<th>Items in the Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do respondents have a process in place to implement change that will benefit the adoption of new international standards within their organization?</td>
<td>Quantitative</td>
</tr>
<tr>
<td>8. Team</td>
<td>19. Change Process</td>
</tr>
<tr>
<td>17. Implement STEP</td>
<td>24. Not implement STEP NC</td>
</tr>
</tbody>
</table>

2. Do respondents believe their organization has a sense of urgency to create a vision focusing on the importance and value of adopting the non-proprietary international Standard for the Exchange of Product Model Data (STEP)?

There is a significant difference in the respondents’ belief that their organization has a sense of urgency to create a vision focusing on the importance and value of...
adopting non-proprietary international Standard for the Exchange of Product Model Data (STEP) according to three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. This umbrella hypothesis was addressed by sub-hypotheses defined by individual items of the survey. See Table 2.

Table 2

*Research Question 2 and Relevant Quantitative and Qualitative Items*

<table>
<thead>
<tr>
<th>Research Question # 2</th>
<th>Items in the Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do respondents believe their organization has a sense of urgency to create a vision focusing on the importance and value of adopting non-proprietary international Standard for the Exchange of Product model data (STEP)?</td>
<td>Quantitative</td>
</tr>
<tr>
<td></td>
<td>Qualitative</td>
</tr>
<tr>
<td>4. Importance</td>
<td>22. Early Adopter</td>
</tr>
<tr>
<td>5. Solutions</td>
<td>25. Add Value</td>
</tr>
<tr>
<td>7. Institutionalize</td>
<td></td>
</tr>
<tr>
<td>10. Communication</td>
<td></td>
</tr>
<tr>
<td>12. Win</td>
<td></td>
</tr>
<tr>
<td>13. Opportunity</td>
<td></td>
</tr>
</tbody>
</table>

3. Do respondents believe there are organizational change processes in place that familiarize and educate management about benefits of STEP Numerical Control preceding adoption and implementation of the standard?

There is a significant difference in the respondents’ beliefs that there are organizational change processes in place that familiarize and educate management about benefits of STEP Numerical Control preceding adoption and implementation of the standard according to three independent variables: (a) industry segment, (b) size of the
organization, and (c) length of employment. This umbrella hypothesis was addressed by sub-hypotheses defined by individual items of the survey. See Table 3.

Table 3

*Research Question 3 and Relevant Quantitative and Qualitative Items*

<table>
<thead>
<tr>
<th>Research Question # 3</th>
<th>Items in the Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do respondents believe there are organizational change processes in place that familiarize and educate management about benefits of STEP Numerical control preceding adoption and implementation of the organization?</td>
<td>Quantitative</td>
</tr>
<tr>
<td></td>
<td>15. Familiarity</td>
</tr>
<tr>
<td></td>
<td>16. Post Processors</td>
</tr>
<tr>
<td></td>
<td>Qualitative</td>
</tr>
<tr>
<td></td>
<td>20. Managing Change</td>
</tr>
<tr>
<td></td>
<td>27. Lead Consensus</td>
</tr>
</tbody>
</table>

4. Are respondents able to identify a leader in their organization who will promote the changes required for the use of STEP standards?

There is a significant difference in the respondents’ abilities to identify a leader in their organization who will promote the changes required for the use of STEP standards according to three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. This umbrella hypothesis was addressed by sub-hypotheses defined by individual items of the survey. Refer to Table 4.
Table 4

Research Question 4 and Relevant Quantitative and Qualitative Items

<table>
<thead>
<tr>
<th>Research Question #4</th>
<th>Items in the Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are respondents able to identify a leader in their organization who will promote the changes required for the use of STEP standards?</td>
<td>Quantitative</td>
</tr>
<tr>
<td>9. Leader</td>
<td></td>
</tr>
<tr>
<td>18. Promote</td>
<td>27. Implementation of STEP NC</td>
</tr>
</tbody>
</table>

Study Participants

A purposive sample was used in this study. The study participants were members of the Advanced Technology Program STEP NC Industrial Review Board. The Industrial Review Board (IRB) is made up of leading members of the Aerospace and Automotive industries, their software suppliers, and small to midsize machine shops that are their manufacturing suppliers. The IRB represents over 51 companies and over 100 people within those companies. The IRB was established to oversee the development of The Standard for the Exchange of Product Model Data/Numerical Control STEP NC under the auspices of a program funded by the National Institute of Standards and Technology (NIST). Many of the survey respondents in this study had witnessed a STEP NC prototype test. Others had read magazine and newspaper articles of the prototype test.

Procedures

An electronic group survey using a web site was conducted with a group of 110 people from the IRB who had a common interest in the development of STEP NC. The
discussions were via electronic mail and a web site. A letter of clearance was received from Andrews University's Institutional Review Board. The group had participated in the writing, editing, and voting of international standards. Many in the group have also witnessed the effectiveness of live demonstrations of the STEP NC standard.

The questionnaire was completed on a voluntary and confidential basis. The questionnaire was returned via the survey web site. The respondents had 2 weeks after receipt to respond. Included with the survey was a cover letter (Appendix B) explaining the purpose of the survey. Advanced permission from the chairperson of the IRB was obtained prior to distribution of the surveys. After 2 weeks, a count of returned surveys took place. At that time only 30 completed surveys had been returned. Since a significant number had not been returned, a second notice with a survey attached was redistributed with an urgent request to return the completed survey within a week of receipt of the second request. After 1 week’s time, a recount took place of the 51 completed surveys, and the analysis was done on the returned surveys.

Surveys

The survey study questions were validated by a small focus group before they were circulated for response. The focus group consisted of six people from the IRB who were considered experts in the field of STEP standards and experienced implementers of technological changes within their organizations. There were members from Automotive, Defense/Aerospace, United States Standards Organizations, Software, Manufacturing, and Machining organizations. This focus group represented the wide range of survey group participation. The focus group discussed the relevance of the sample survey questions and offered suggestions for survey questions via email. Those suggestions were
incorporated into the finalized list of survey questions. The surveys containing the study questions were used to document the group responses.

**Variables and Measurement of Data**

Fifteen quantitative survey questions were designed using a 5-point Likert Scale to collect the information from the questionnaire. The respondents answered the questions by grading the response on a scale of 1 to 5, depicting *Strongly Disagree* to *Strongly Agree*, respectively. The use of the Likert Scale was due to the fact that this was business research. The Likert Scale allows the researcher to obtain more quantitative information about the survey subject (Alinea Group, 2003). The Likert Scale is popular among business researchers for measuring attitude and is simple to administer (Zikmund, 1991). Responses can be gathered in a standardized way, so questionnaires are more objective—certainly more so than interviews (Milne & Owen, 1999).

According to Roberts, Laughlin, and Wedell (1999), "When the quantitative component to research is applied, the Likert Scale is commonly used, since it has the form with which everyone is familiar" (p. 76). Roberts et al. go on to say that there is some slight degraded validity of the Likert Scale at attitude extremes, i.e., (1) or (5), but they point out that it has nothing to do with frequency responses. Roberts et al. further concluded that unless identification of extremes is important to the study, the Likert Scale would provide results within an acceptably valid range. The words on the Likert Scale can be converted in a meaningful way to an interval scale (1 through 5), which gives the researcher the ability to use totals or to calculate numerical averages, which can then be used to respond to the research hypotheses (McCall, 2001). Also, the Likert Scale was selected for the quantitative portion of this study because of its “easy to use” aspects for
respondents with the provision of interval measures that give means and standard deviations.

Nine qualitative questions were measured by grouping the responses. According to Eisner (1998), when varying degrees of qualitative analysis features are used for analysis of the qualitative responses, "there is no reason why several forms of representation, including the quantitative, cannot be combined in the conduct of a study that is dominantly qualitative in character, or vice versa" (p. 41).

**Data Analysis Methods**

Both quantitative and qualitative analyses were used in this study. The quantitative responses were *Strongly Disagree, Disagree, Neutral, Agree*, and *Strongly Agree*. The qualitative portion of the survey used analysis procedures such as self as an instrument for interpretation. The qualitative responses were open-ended. The qualitative response themes are discussed. Each qualitative question was analyzed separately and then grouped with quantitative response themes.

The quantitative research questions were first analyzed by examining the means obtained for each item of the survey. A mean of 3.25 and above was chosen to indicate the affirmative on a particular item. The use of a conservative 3.25 representing a 65% approval rating was due to the international nature of the study and the newness of the studied technology.

The hypotheses associated with particular research questions sought to identify any differences among the various segments of the IRB on the issue. The null hypotheses were tested using one-way Analysis of Variance (ANOVA) at the .05 level of
significance. The qualitative items that generated open-ended comments were then analyzed and compared to the results of the quantitative aspect of the study.

Summary of Methodology

This chapter describes the design of the study, research questions, participants of the study, procedures used to conduct the study, the surveys, variables and measurement of data, and data analysis methods.
CHAPTER IV

PRESENTATION AND ANALYSIS OF THE DATA

Results

This study examined the process for the implementation of a system for creating reciprocity between international design standards and new international manufacturing standards; in other words, how can designers and manufacturers share the same data on several diverse computer platforms for enhancing efficiency and effectiveness in production? Can designers and manufacturers create an environment where computers and software can talk to each other? This purpose was addressed through an examination of one example of a model for the exchange of data—The Standard for the Exchange of Product Model Data—Numerical Control (STEP NC).

A secondary purpose was to examine the characteristics of the change process that accompanies the implementation of STEP NC and the impact those standards have on an organization. What are the changes in the manufacturing environment due to technological innovations? Burrus and Gittines (1998) discuss how sweeping technological innovations have changed the rules. A survey examined the changes required to lead consensus in the adoption and implementation of international standards.
Description of the Sample

A total of 51 survey responses were collected via a web site response form. The response rate was 51 out of 110 queried. (Refer to Appendix A for a copy of the questionnaire [survey] and Appendix C for detailed response frequencies and descriptive statistics for each question.)

Survey Analysis

The survey questions were divided into demographic questions, quantitative questions, and qualitative questions. Questions 1 through 3 were demographic. Questions 4 through 18 were quantitative using the Likert Scale for measurement. All of the quantitative questions asked respondents' opinions on a Likert-type scale ranging from Strongly Disagree (SD) with a value of 1 to Strongly Agree (SA) with a value of 5. Questions 19 through 27 were qualitative/open-ended with grouping used for measurement. Four respondents did not list the industry segment, size of organization, or length of employment they represented, therefore they are in the Other category.

Demographic Analysis

The demographic questions were Q1, Q2, and Q3. The first demographic question (Q1) asked respondents which industry segment they represented. The results were as follows: 8 responses, 15.7% were from Aerospace; 16 responses, 31.4% were from Automotive; 2 responses, 3.9% were from Factory Automation; 4 responses, 7.8% were from Manufacturing Equipment; 4 responses, 7.8% were from Research (University); 6 responses, 11.8% were from Defense; 11 responses, 21.6% were from Information Technology; Four respondents skipped demographic questions. This shows

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that the largest industry segment to respond was the automotive segment (31.9%) followed by the information technology segment (21.6%). See Table 5.

Table 5

*Composition of Sample by Different Industry Segments*

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>8</td>
<td>15.7</td>
</tr>
<tr>
<td>Automotive</td>
<td>16</td>
<td>31.4</td>
</tr>
<tr>
<td>Factory Automation</td>
<td>2</td>
<td>3.9</td>
</tr>
<tr>
<td>Mfg. Equipment.</td>
<td>4</td>
<td>7.8</td>
</tr>
<tr>
<td>Research (University)</td>
<td>4</td>
<td>7.8</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>11.8</td>
</tr>
<tr>
<td>Information Tech</td>
<td>11</td>
<td>21.6</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The second demographic question (Q2) was the size of the organization (number of employees) represented. The results were as follows: 1-49 = 9 responses, 17.6%; 50-99 = 7 responses, 13.7%; 100-499 = 4 responses, 7.8%; 500+ = 31 responses, 60.8%. Four respondents skipped demographic questions. This shows that the largest group to respond was from organizations the size of 500+ people. This was followed by organizations the size of 1 to 49 people followed closely by organizations of 50 to 99 people. See Table 6.

The third demographic question was length of employment. The results were as follows: 1-5 years = 4 responses, 7.8%; 6-10 years = 6 responses, 11.8%; 11 to 15 years = 9
responses, 17.6%; 15+ years = 32 responses, 62.7%. Four respondents skipped demographic questions. This shows that the largest group for length of employment to respond was the 15+ years of employment. Fewer responses were from people in the 11 to 15 years and the 6 to 10 years of employment. See Table 7.

Table 6

*Composition of Sample by Different Sizes*

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 49</td>
<td>9</td>
<td>17.6</td>
</tr>
<tr>
<td>50 - 99</td>
<td>7</td>
<td>13.7</td>
</tr>
<tr>
<td>100 - 499</td>
<td>4</td>
<td>7.8</td>
</tr>
<tr>
<td>500 +</td>
<td>31</td>
<td>60.8</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>99.9</td>
</tr>
</tbody>
</table>

Table 7

*Composite of Sample by Length of Employment*

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>4</td>
<td>7.8</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>11.8</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>9</td>
<td>17.6</td>
</tr>
<tr>
<td>15+ years</td>
<td>32</td>
<td>62.7</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>99.9</td>
</tr>
</tbody>
</table>
Category Analysis

In addition to the demographics the survey questions were divided into four categories for the purpose of investigating the null hypotheses. The research questions measured the respondents’ beliefs in the following:

1. Change processes for implementation of international standards
2. The creation of a vision focusing on the importance and value of adoption of international standards
3. Management’s familiarization and identification of benefits for organizational adoption of international standards
4. Leadership promoting the change required for adoption of international standards.

Refer to Tables 5 through 7 and 11 through 75 for the response frequencies and descriptive statistics for each category represented by research questions 1 through 4.

Research Questions and Related Null Hypotheses

1. Do respondents have a process in place to implement change which will benefit the adoption of new international standards within their organization?

There was no significant difference in the organizations’ processes in place to implement change that will benefit the adoption of new international standards according to three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. This umbrella hypothesis was addressed by sub-hypotheses defined by individual items of the survey. See Table 8.
Table 8

Research Question 1 and Related Null Hypotheses

<table>
<thead>
<tr>
<th>Research Question # 1</th>
<th>Items in the Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do respondents have a process in place to implement change that will benefit</td>
<td>Quantitative</td>
</tr>
<tr>
<td>benefit the adoption of new international standards within their organization?</td>
<td>8. Team</td>
</tr>
<tr>
<td></td>
<td>11. Vision</td>
</tr>
<tr>
<td></td>
<td>14. Institutionalize</td>
</tr>
<tr>
<td></td>
<td>17. Implement STEP</td>
</tr>
<tr>
<td></td>
<td>Qualitative</td>
</tr>
<tr>
<td></td>
<td>19. Change Process</td>
</tr>
<tr>
<td></td>
<td>20. Theory of Change</td>
</tr>
<tr>
<td></td>
<td>23. Implement STEP NC</td>
</tr>
<tr>
<td></td>
<td>24. Not implement STEP NC</td>
</tr>
<tr>
<td></td>
<td>26. Process Barriers</td>
</tr>
<tr>
<td></td>
<td>27. Change for Consensus</td>
</tr>
</tbody>
</table>

2. Do respondents believe their organization has a sense of urgency to create a vision focusing on the importance and value of adopting the non-proprietary international Standard for the Exchange of Product Model Data (STEP)?

There was no significant difference in the respondents' beliefs that their organization has a sense of urgency to create a vision focusing on the importance and value of adopting the non-proprietary international Standard for the Exchange of Product Model Data (STEP) according to three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. This umbrella hypothesis was addressed by sub-hypotheses defined by individual items of the survey. See Table 9.

3. Do respondents believe there are organizational change processes in place that familiarize and educate management about benefits of STEP Numerical Controlpreceding adoption and implementation of the standard?

There was no significant difference in the respondents' beliefs that there are organizational change processes in place that familiarize and educate management about

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Research Question 2 and Related Null Hypotheses

<table>
<thead>
<tr>
<th>Research Question # 2</th>
<th>Items in the Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do respondents believe their organization has a sense of urgency to create a vision focusing on the importance and value of adopting non-proprietary international Standard for the Exchange of Product model data (STEP)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quantitative</td>
</tr>
<tr>
<td></td>
<td>Qualitative</td>
</tr>
<tr>
<td>4. Importance</td>
<td>22. Early Adopter</td>
</tr>
<tr>
<td>5. Solutions</td>
<td>25. Add Value</td>
</tr>
<tr>
<td>7. Institutionalize</td>
<td></td>
</tr>
<tr>
<td>10. Communication</td>
<td></td>
</tr>
<tr>
<td>12. Win</td>
<td></td>
</tr>
<tr>
<td>13. Opportunity</td>
<td></td>
</tr>
</tbody>
</table>

benefits of STEP Numerical Control preceding adoption and implementation of the standard according to three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. This umbrella hypothesis was addressed by sub-hypotheses defined by individual items of the survey. See Table 10.

4. Are respondents able to identify a leader in their organization who will promote the changes required for the use of STEP standards?

There was no significant difference in the respondents’ ability to identify a leader in their organization who will promote the changes required for the use of STEP standards according to three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. This umbrella hypothesis was addressed by sub-hypotheses defined by individual items of the survey. See Table 11.
Research Question 3 and Related Null Hypotheses

<table>
<thead>
<tr>
<th>Research Question # 3</th>
<th>Items in the Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do respondents believe there are organizational change processes in place that familiarize and educate management about benefits of STEP Numerical control preceding adoption and implementation of the organization?</td>
<td>Qualitative</td>
</tr>
<tr>
<td></td>
<td>15. Familiarity</td>
</tr>
<tr>
<td></td>
<td>16. Post Processors</td>
</tr>
<tr>
<td></td>
<td>20. Managing Change</td>
</tr>
<tr>
<td></td>
<td>27. Lead Consensus</td>
</tr>
</tbody>
</table>

Table 11

Research Question 4 and Related Null Hypotheses

<table>
<thead>
<tr>
<th>Research Question #4</th>
<th>Items in the Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are respondents able to identify a leader in their organization who will promote the changes required for the use of STEP standards?</td>
<td>Qualitative</td>
</tr>
<tr>
<td></td>
<td>6. Process</td>
</tr>
<tr>
<td></td>
<td>9. Leader</td>
</tr>
<tr>
<td></td>
<td>18. Promote</td>
</tr>
<tr>
<td></td>
<td>21. Your Leadership</td>
</tr>
<tr>
<td></td>
<td>27. Implementation of STEP NC</td>
</tr>
</tbody>
</table>

Quantitative Data Analysis

The quantitative research questions are first answered by examining the means obtained for each item of the survey items. A mean of 3.25 and above was chosen to indicate the affirmative on a particular item. The hypotheses associated with a particular...
research question sought to identify any differences among the various segments of the IRB on the issue.

The null hypotheses were tested using one-way ANOVA at the .05 level of significance. The items that generated open-ended comments were then analyzed and compared to the results of the quantitative aspect of the study.

Research Question 1

Do respondents have a process in place to implement change that will benefit the adoption of new international standards within their organization?

This research question was addressed by item numbers 8, 11, 14, and 17 in the quantitative section of the survey. Table 12 displays the results for those items. Each item is stated accompanied by the sample size (N) the mean and the standard deviation (SD).

Table 12

**Research Question 1: Quantitative Survey Question Means and Standard Deviations**

<table>
<thead>
<tr>
<th>Item #</th>
<th>Question</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>A coalition/team has been assembled in your organization to lead the implementation of STEP standards.</td>
<td>51</td>
<td>3.67</td>
<td>1.28</td>
</tr>
<tr>
<td>11</td>
<td>Others in your organization are empowered to act on the vision for STEP implementation.</td>
<td>51</td>
<td>3.47</td>
<td>1.05</td>
</tr>
<tr>
<td>14</td>
<td>New STEP approaches are institutionalized in your organization.</td>
<td>51</td>
<td>2.84</td>
<td>1.10</td>
</tr>
<tr>
<td>17</td>
<td>Implementation of STEP is important for the manufacturing process in your organization.</td>
<td>51</td>
<td>3.20</td>
<td>1.13</td>
</tr>
</tbody>
</table>
An examination of the means shows that the IRB agreed with two of the four items (8 and 11). Items 14 and 17 were below the criterion of 3.25, which indicates non-agreement.

**Item #8**

A coalition/team has been assembled in your organization to lead the implementation of STEP standards.

**Null Hypothesis for Item #8.** There were no significant differences in the views held by the IRB that a coalition/team has been assembled in their organization to lead the implementation of STEP standards according to the following three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. The following composite ANOVA Table 13 for Item #8, "A coalition/team has been assembled in your organization to lead the implementation of STEP standards," indicates that the null hypothesis was retained for industry segment and length of employment groups, but rejected for size of the organization group.

**Industry segment.** The industry segments used for analysis were aerospace, automotive, defense, information technology, and others. The null hypothesis was retained ($F_{4, 46} = 1.21, p = .320$). There was no significant difference.

Table 14 indicates the means and standard deviations for various industry segments. All industry segments were above the criterion of 3.25 set except for the automotive group.

**Size of the organization.** The sizes of the organization were 1-49, 50-99, 100-499, and 500+. The null hypothesis was rejected ($F_{3,43} = 3.58, p = .021$). There was a
Table 13

*Composite ANOVA Table for Item #8 on the Three Independent Variables*

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>7.737</td>
<td>4</td>
<td>1.934</td>
<td>1.209</td>
<td>.320</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>73.596</td>
<td>46</td>
<td>1.600</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>81.333</td>
<td>50</td>
<td>1.600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>15.459</td>
<td>3</td>
<td>5.153</td>
<td>3.582</td>
<td>.021</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>61.860</td>
<td>43</td>
<td>1.439</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>77.319</td>
<td>46</td>
<td>1.439</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>7.977</td>
<td>3</td>
<td>2.659</td>
<td>1.649</td>
<td>.192</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>69.342</td>
<td>43</td>
<td>1.613</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>77.319</td>
<td>46</td>
<td>1.613</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* means significant at less than .05.

Table 14

*Means and Standard Deviations for Different Industry Segments on Item #8*

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace (AS)</td>
<td>9</td>
<td>3.78</td>
<td>.97</td>
</tr>
<tr>
<td>Automotive (AM)</td>
<td>14</td>
<td>3.21</td>
<td>1.25</td>
</tr>
<tr>
<td>Defense (D)</td>
<td>6</td>
<td>3.33</td>
<td>1.86</td>
</tr>
<tr>
<td>Information Tech. (IT)</td>
<td>10</td>
<td>4.30</td>
<td>1.34</td>
</tr>
<tr>
<td>Other (O)</td>
<td>12</td>
<td>3.75</td>
<td>1.06</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>3.67</td>
<td>1.28</td>
</tr>
</tbody>
</table>

significant difference. Schefee Post Hoc results show that the only groups that were different were the 1-49 and the 500+ groups. Table 15 indicates that the 500+ group tended not to agree that a coalition/team has been assembled in their organization to lead
the implementation of STEP standards as compared to the 1 - 49 group that is in most agreement.

Table 15

**Means and Standard Deviations for Different Sizes on Item #8**

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>1 - 49</th>
<th>50 - 99</th>
<th>100-499</th>
<th>500+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 49</td>
<td>9</td>
<td>4.56</td>
<td>.53</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 - 99</td>
<td>6</td>
<td>4.17</td>
<td>1.17</td>
<td>NS</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 - 499</td>
<td>3</td>
<td>3.67</td>
<td>1.53</td>
<td>NS</td>
<td>NS</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>3.17</td>
<td>1.31</td>
<td>*</td>
<td>NS</td>
<td>NS</td>
<td>X</td>
</tr>
</tbody>
</table>

**Length of employment.** The lengths of employment were 1 to 5 years, 6 to 10 years, 11 to 15 years, and 15+ years. The null hypothesis was retained ($F_{3,43} = 1.65$, $p = .192$). There is no significant difference. Table 16 indicates that the 11 to 15 years group tended not to agree that a coalition/team has been assembled in their organization to lead the implementation of STEP standards as compared to the other groups that were in agreement.

**Item #11**

Item #11 stated, Others in your organization are empowered to act on the vision for STEP implementation.

**Null Hypothesis for Item #11.** There were no significant differences in the views held by the IRB that others in their organization are empowered to act on the vision.
Table 16

Means and Standard Deviations for Length of Employment on Item #8

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>4.67</td>
<td>.58</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>3.50</td>
<td>.84</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>2.88</td>
<td>1.36</td>
</tr>
<tr>
<td>15+ years</td>
<td>30</td>
<td>3.70</td>
<td>1.34</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.60</td>
<td>1.30</td>
</tr>
</tbody>
</table>

for STEP implementation according to the following three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. The following Composite ANOVA Table 17 for Item #11, “Others in your organization are empowered to act on the vision for STEP implementation,” indicates that the null hypothesis was retained for the size of organization group and the length of employment group but was rejected for the industry segment group.

Industry segment. The null hypothesis was rejected \(F_{4,46} = 2.91, p = .032\).

There was a significant difference. Scheffe Post Hoc results show that all groups were different from the Information Technology group. The Aerospace group was slightly below the established mean. Table 18 indicates that the defense group and the Other group tended not to agree that others in their organization are empowered to act on the vision for STEP implementation as compared to the information technology group that is in most agreement.
Table 17

**Composite ANOVA Table for Item #11 on the Three Independent Variables**

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>11.036</td>
<td>4</td>
<td>2.759</td>
<td>2.906</td>
<td>.032*</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>43.670</td>
<td>46</td>
<td>.949</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>54.706</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>5.503</td>
<td>3</td>
<td>1.834</td>
<td>1.962</td>
<td>.134</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>40.199</td>
<td>43</td>
<td>.935</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>45.702</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>1.794</td>
<td>3</td>
<td>.598</td>
<td>.586</td>
<td>.628</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>43.908</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>45.702</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* means significant at less than .05

Table 18

**Means and Standard Deviations for Different Industry Segments on Item #11**

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>AS</th>
<th>AM</th>
<th>D</th>
<th>IT</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace (AS)</td>
<td>9</td>
<td>3.22</td>
<td>.44</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automotive (AM)</td>
<td>14</td>
<td>3.36</td>
<td>1.01</td>
<td>NS</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defense (D)</td>
<td>6</td>
<td>3.17</td>
<td>.98</td>
<td>NS</td>
<td>NS</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information Tech.(IT)</td>
<td>10</td>
<td>4.40</td>
<td>1.07</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Other (O)</td>
<td>12</td>
<td>3.17</td>
<td>1.11</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>*</td>
<td>x</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>3.47</td>
<td>1.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Size of the organization. The null hypothesis was retained \( F_{3,43} = 1.96, p = .134 \). There was no significant difference. Table 19 indicates the means and standard
deviations for various sizes of the organization. All sizes of the organization were above the criterion of 3.25 set except the 500+ group.

Table 19

Means and Standard Deviations for Different Sizes on Item #11

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 49</td>
<td>9</td>
<td>4.11</td>
<td>1.05</td>
</tr>
<tr>
<td>50 - 99</td>
<td>6</td>
<td>3.67</td>
<td>1.21</td>
</tr>
<tr>
<td>100 - 499</td>
<td>3</td>
<td>3.33</td>
<td>1.15</td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>3.24</td>
<td>.87</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.47</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Length of employment.** The null hypothesis was retained ($F_{3, 43} = .586, p = .628$). There was no significant difference. Table 20 indicates the means and standard deviations for various lengths of employment. All lengths of employment were above the criterion of 3.25 set, except the 1 to 5 years group and the 6 to 10 years group.

**Item #14**

New STEP approaches are institutionalized in your organization.

**Null Hypothesis for Item #14.** There were no significant differences in the views held by the IRB that new STEP approaches are institutionalized in their organization according to the following three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. The following Composite ANOVA
Table 20

*Means and Standard Deviations for Length of Employment on Item #11*

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>3.00</td>
<td>1.00</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>3.17</td>
<td>.75</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>3.38</td>
<td>.92</td>
</tr>
<tr>
<td>15+ years</td>
<td>30</td>
<td>3.60</td>
<td>1.06</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.47</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Table 21 for Item #14, "New STEP approaches are institutionalized in your organization," indicates that the null hypothesis was retained for industry segment and length of employment but rejected for size of the organization group.

**Industry segment.** The null hypothesis was retained ($F_{4,46} = 2.46, p = .06$). There was no significant difference. Table 22 indicates the means and standard deviations for various industry segments. All industry segments were below the criterion of 3.25, except for the Information Technology group, which was above the set criterion.

**Size of the organization.** The null hypothesis was rejected ($F_{3,43} = 3.61, p = .020$). There was a significant difference. Scheffe Post Hoc results show that groups 1 to 49 and 50 to 99 were above the criterion of 3.25 and the 100 to 499 and the 500+ groups were below the set criterion of 3.25.
Table 21

**Composite ANOVA Table for Item #14 on the Three Independent Variables**

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>10.709</td>
<td>4</td>
<td>2.677</td>
<td>2.461</td>
<td>.058</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>50.037</td>
<td>46</td>
<td>1.088</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>60.745</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>11.008</td>
<td>3</td>
<td>3.669</td>
<td>3.616</td>
<td>.020*</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>43.630</td>
<td>43</td>
<td>1.015</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>54.638</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>1.105</td>
<td>3</td>
<td>.368</td>
<td>.296</td>
<td>.828</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>53.533</td>
<td>43</td>
<td>1.245</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>54.638</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* means significant at less than .05.

Table 22

**Means and Standard Deviations for Different Industry Segments on Item #14**

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>9</td>
<td>2.44</td>
<td>.53</td>
</tr>
<tr>
<td>Automotive</td>
<td>14</td>
<td>2.86</td>
<td>.86</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>2.33</td>
<td>1.21</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>10</td>
<td>3.70</td>
<td>1.42</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>2.67</td>
<td>1.07</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>2.84</td>
<td>1.10</td>
</tr>
</tbody>
</table>
Table 23 indicates that the 1 to 49 and the 50 to 99 groups tended to agree that new STEP approaches are institutionalized in their organization as compared to the 100 to 499 and the 500+ who did not agree.

Table 23

*Means and Standard Deviations for Different Sizes on Item #14*

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>1-49</th>
<th>50-99</th>
<th>100-499</th>
<th>500+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 49</td>
<td>9</td>
<td>3.56</td>
<td>1.33</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 – 99</td>
<td>6</td>
<td>3.50</td>
<td>.84</td>
<td>NS</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 – 499</td>
<td>3</td>
<td>2.33</td>
<td>1.15</td>
<td>*</td>
<td>*</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>2.52</td>
<td>.91</td>
<td>*</td>
<td>*</td>
<td>NS</td>
<td>x</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>2.83</td>
<td>1.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Length of employment.** The null hypothesis was retained \(F_{3,43} = .296, p = .828\). There was no significant difference. Table 24 indicates that all groups tended not to agree that new STEP approaches were institutionalized in their organization.

**Item #17**

Implementation of STEP is important for the manufacturing process in your organization.

**Null Hypothesis for Item #17.** There were no significant differences in the views held by the IRB that implementation of STEP is important for the manufacturing process in their organization according to the following three independent variables: (a) industry
Table 24

Means and Standard Deviations for Length of Employment on Item #14

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>2.67</td>
<td>.58</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>2.50</td>
<td>1.05</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>2.75</td>
<td>1.16</td>
</tr>
<tr>
<td>15+ years</td>
<td>30</td>
<td>2.93</td>
<td>1.14</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>2.83</td>
<td>1.09</td>
</tr>
</tbody>
</table>

segment, (b) size of the organization, and (c) length of employment. The following
Composite ANOVA Table 25 for Item #17, “Implementation of STEP is important for
the manufacturing process in your organization,” indicates that the null hypothesis was
retained for industry segment and size of the organization groups but rejected for the
length of employment group.

**Industry segment.** The null hypothesis was retained ($F_{4,46} = .847, p = .503$).
There was no significant difference. Table 26 indicates the means and standard deviations
for industry segments. Aerospace and Automotive were above the criterion set at 3.25 and
Defense, Information Technology, and Other were below the criterion.

**Size of the organization.** The null hypothesis was retained ($F_{3,43} = 2.34, p = .09$).
There was no significant difference. Table 27 indicates the means and standard deviations
for various sizes of the organization. The 1-49 and the 50-99 groups were above the
criterion set at 3.25. The 100-499 and 500+ groups were below the set criterion.
Table 25

*Composite ANOVA Table for Item #17 on the Three Independent Variables*

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>4.392</td>
<td>4</td>
<td>1.098</td>
<td>.847</td>
<td>.503</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>59.648</td>
<td>46</td>
<td>1.297</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>64.039</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>8.254</td>
<td>3</td>
<td>2.751</td>
<td>2.334</td>
<td>.087</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>50.682</td>
<td>43</td>
<td>1.179</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>58.936</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>16.361</td>
<td>3</td>
<td>5.454</td>
<td>5.508</td>
<td>.003*</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>42.575</td>
<td>43</td>
<td>.990</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>58.936</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* means significant at less than .05.

Table 26

*Means and Standard Deviations for Different Industry Segments on Item #17*

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>9</td>
<td>3.67</td>
<td>1.00</td>
</tr>
<tr>
<td>Automotive</td>
<td>14</td>
<td>3.36</td>
<td>1.01</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>3.17</td>
<td>1.17</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>10</td>
<td>2.80</td>
<td>1.48</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>3.00</td>
<td>1.04</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>3.20</td>
<td>1.13</td>
</tr>
</tbody>
</table>
Table 27

Means and Standard Deviations for Different Sizes on Item #17

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 49</td>
<td>9</td>
<td>3.56</td>
<td>1.33</td>
</tr>
<tr>
<td>50 - 99</td>
<td>6</td>
<td>3.50</td>
<td>.84</td>
</tr>
<tr>
<td>100 - 499</td>
<td>3</td>
<td>2.33</td>
<td>1.15</td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>2.52</td>
<td>.91</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>2.83</td>
<td>1.09</td>
</tr>
</tbody>
</table>

Length of employment. The null hypothesis was rejected ($F_{3,43} = 5.551, p = .003$). There was a significant difference. Student Newman Keuls Post Hoc results showed all groups were different. Table 28 indicates that the 1 to 5 and the 11 to 15 years groups tended not to agree that implementation of STEP is important for the manufacturing process in their organization compared to the 6 to 10 and the 15+ years groups.

Table 28

Means and Standard Deviations for Length of Employment Item on #17

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>1 - 5</th>
<th>6 - 10</th>
<th>11-15</th>
<th>15 +</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>1.67</td>
<td>.58</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>4.17</td>
<td>.98</td>
<td>***</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>2.63</td>
<td>1.06</td>
<td>**</td>
<td>**</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>15 + years</td>
<td>30</td>
<td>3.40</td>
<td>1.00</td>
<td>**</td>
<td>*</td>
<td>*</td>
<td>x</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.26</td>
<td>1.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* significant at less than .05 level
** significant at less than .01 level
*** significant at less than .001 level

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Research Question 2

Do respondents believe their organization has a sense of urgency to create a vision focusing on the importance and value of adopting the non-proprietary international Standard for the Exchange of Product Model Data (STEP)?

This research question was addressed by items number 4, 5, 7, 10, 12, and 13 in the quantitative section of the survey. Table 29 displays the results for those items. Each item is stated accompanied by the sample size (N), the mean, and the standard deviation (SD). An examination of the means shows that the IRB agreed with all of the items (4, 5, 7, 10, 12, and 13).

Table 29

Research Question 2: Quantitative Survey Question Means and Standard Deviations

<table>
<thead>
<tr>
<th>Item #</th>
<th>Question</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>International non-proprietary standards are important to your organization.</td>
<td>51</td>
<td>4.49</td>
<td>.78</td>
</tr>
<tr>
<td>5</td>
<td>Identifying standards-based solutions are more important than corporate unification on proprietary products.</td>
<td>51</td>
<td>4.08</td>
<td>1.04</td>
</tr>
<tr>
<td>7</td>
<td>There is a sense of urgency in your organization to establish international standards (ISO) for Standard for the Exchange of Product model data (STEP).</td>
<td>51</td>
<td>3.45</td>
<td>1.24</td>
</tr>
<tr>
<td>10</td>
<td>There is communication of the vision of STEP throughout your organization.</td>
<td>51</td>
<td>3.41</td>
<td>1.24</td>
</tr>
<tr>
<td>12</td>
<td>Short-term wins are obtainable using STEP standards.</td>
<td>51</td>
<td>3.59</td>
<td>1.04</td>
</tr>
<tr>
<td>13</td>
<td>Improvements using STEP produce more opportunities for STEP usage.</td>
<td>51</td>
<td>4.08</td>
<td>.77</td>
</tr>
</tbody>
</table>
**Item #4**  International non-proprietary standards are important to your organization.

**Null Hypothesis for Item #4.** There were no significant differences in respondents' beliefs that international non-proprietary standards are important to their organization according to the following three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. The following Composite ANOVA Table 30 for Item #4, “International non-proprietary standards are important to your organization,” indicates that the null hypothesis was retained for industry segment and size of the organization groups but rejected for the length of employment group.

Table 30

*Composite ANOVA Table on Item #4 for the Three Independent Variables*

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>.845</td>
<td>4</td>
<td>.211</td>
<td>.325</td>
<td>.860</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>29.900</td>
<td>46</td>
<td>.650</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>30.745</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Between Groups</td>
<td>1.343</td>
<td>3</td>
<td>.448</td>
<td>.681</td>
<td>.569</td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Within Groups</td>
<td>28.274</td>
<td>43</td>
<td>.658</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>29.617</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Between Groups</td>
<td>5.150</td>
<td>3</td>
<td>1.717</td>
<td>3.017</td>
<td>.040*</td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Within Groups</td>
<td>24.467</td>
<td>43</td>
<td>.569</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>29.617</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* means significant at less than .05.

**Industry segment.** The null hypothesis was retained ($F_{4, 46} = .325, p = .860$).

There was no significant difference. Table 31 indicates that all industry segment
respondents believed that international non-proprietary standards were important to their organization.

Table 31

*Means and Standard Deviations for Different Industry Segments on Item #4*

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>9</td>
<td>4.67</td>
<td>.50</td>
</tr>
<tr>
<td>Automotive</td>
<td>14</td>
<td>4.50</td>
<td>.85</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>4.33</td>
<td>.82</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>10</td>
<td>4.60</td>
<td>.97</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>4.33</td>
<td>.78</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>4.49</td>
<td>.78</td>
</tr>
</tbody>
</table>

**Size of the organization.** The null hypothesis was retained ($F_{3,43} = .681, p = .569$). There was no significant difference. Table 32 indicates that all groups believed that international non-proprietary standards were important to their organization.

**Length of employment.** The null hypothesis was rejected ($F_{3,43} = 3.02, p = .04$). There was a significant difference. Scheffe Post Hoc results showed that the only group that was different but still in agreement was the 11 to 15 years group. Table 33 indicates that all groups believed that international non-proprietary standards were important to their organization.
Table 32

Means and Standard Deviations for Different Sizes on Item #4

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 49</td>
<td>9</td>
<td>4.78</td>
<td>.44</td>
</tr>
<tr>
<td>50 - 99</td>
<td>6</td>
<td>4.50</td>
<td>.84</td>
</tr>
<tr>
<td>100 - 499</td>
<td>3</td>
<td>4.33</td>
<td>.58</td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>4.34</td>
<td>.90</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>4.45</td>
<td>.80</td>
</tr>
</tbody>
</table>

Table 33

Means and Standard Deviations for Length of Employment on Item #4

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>1 - 5</th>
<th>6 - 10</th>
<th>11-15</th>
<th>15 +</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>4.67</td>
<td>.58</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>4.33</td>
<td>.52</td>
<td>NS</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>3.75</td>
<td>.89</td>
<td>*</td>
<td>*</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>15 + years</td>
<td>30</td>
<td>4.63</td>
<td>.76</td>
<td>NS</td>
<td>NS</td>
<td>*</td>
<td>x</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>4.45</td>
<td>.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* significant at less than .05 level.

Item #5

Identifying standards-based solutions are more important than corporate unification on proprietary products.
Null Hypothesis for Item #5. There were no significant differences in respondents’ beliefs that identifying standards-based solutions are more important than corporate unification on proprietary products according to the following three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. The following Composite ANOVA Table 34 for Item #5, “Identifying standards-based solutions are more important than corporate unification on proprietary products,” indicates that the null hypothesis was retained for industry segment, size of the organization group, and length of employment group.

Table 34

Composite ANOVA Table on Item #5 for the Three Independent Variables

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>2.54</td>
<td>4</td>
<td>.634</td>
<td>.570</td>
<td>.686</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>51.150</td>
<td>46</td>
<td>1.112</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>53.686</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>6.608</td>
<td>3</td>
<td>2.203</td>
<td>2.159</td>
<td>.107</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>43.860</td>
<td>43</td>
<td>1.020</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>50.468</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>5.226</td>
<td>3</td>
<td>1.742</td>
<td>1.656</td>
<td>.191</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>45.242</td>
<td>43</td>
<td>1.052</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>50.468</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Industry segment. The null hypothesis was retained ($F_{4,46} = .570, p = .686$). There was no significant difference. Table 35 indicates that all industry segment
respondents believed that identifying standards-based solutions were more important than
corporate unification on proprietary products.

Table 35

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>9</td>
<td>4.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Automotive</td>
<td>14</td>
<td>4.00</td>
<td>1.04</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>4.67</td>
<td>.82</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>10</td>
<td>3.90</td>
<td>1.45</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>4.08</td>
<td>.79</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>4.08</td>
<td>1.04</td>
</tr>
</tbody>
</table>

**Size of the organization.** The null hypothesis was retained ($F_{3,43} = 2.16, p = .107$). There was no significant difference. Table 36 indicates that all groups believed that identifying standards-based solutions were more important than corporate unification on proprietary products.

**Length of employment.** The null hypothesis was retained ($F_{3,43} = 1.66, p = .191$). There was no significant difference. Table 37 indicates that all groups believed that identifying standards-based solutions were more important than corporate unification on proprietary products.
Table 36

*Means and Standard Deviations for Different Sizes on Item #5*

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 49</td>
<td>9</td>
<td>4.44</td>
<td>.73</td>
</tr>
<tr>
<td>50 - 99</td>
<td>6</td>
<td>4.50</td>
<td>.84</td>
</tr>
<tr>
<td>100 - 499</td>
<td>3</td>
<td>5.00</td>
<td>.00</td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>3.82</td>
<td>1.14</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>4.11</td>
<td>1.05</td>
</tr>
</tbody>
</table>

Table 37

*Means and Standard Deviations for Length of Employment on Item #5*

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>4.33</td>
<td>1.15</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>4.33</td>
<td>.82</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>3.38</td>
<td>1.41</td>
</tr>
<tr>
<td>15+ years</td>
<td>30</td>
<td>4.23</td>
<td>.94</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>4.11</td>
<td>1.05</td>
</tr>
</tbody>
</table>

**Item #7**

There is a sense of urgency in your organization to establish international standards (ISO) for Standard for the Exchange of Product model data (STEP).
Null Hypothesis for Item #7. There were no significant differences in respondents' belief that there is a sense of urgency in their organization to establish international standards (ISO) for Standard for the Exchange of Product model data (STEP) according to the following three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. The following Composite ANOVA Table 38 for Item #7, "There is a sense of urgency in your organization to establish international standards (ISO) for Standard for the Exchange of Product model data (STEP)," indicates that the null hypothesis was retained for industry segment group, size of the organization group, and length of employment group.

**Industry segment.** The null hypothesis was retained \( (F_{4,46} = .990, p = .423) \). There was no significant difference. Table 39 indicates that all industry segment respondents believed that there was a sense of urgency in their organization to establish international standards (ISO) for Standard for the Exchange of Product model data (STEP).

**Size of the organization.** The null hypothesis was retained \( (F_{3,43} = 2.54, p = .069) \). There was no significant difference. Table 40 indicates the means and standard deviations for various sizes of organizations. All sizes of organizations were above the criterion set at 3.25 except for the 500+ group.
Table 38

**Composite ANOVA Table on Item #7 for the Three Independent Variables**

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>6.072</td>
<td>4</td>
<td>1.518</td>
<td>.990</td>
<td>.423</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>70.556</td>
<td>46</td>
<td>1.534</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>76.627</td>
<td>50</td>
<td>1.534</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>9.872</td>
<td>3</td>
<td>3.291</td>
<td>2.538</td>
<td>.069</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>55.745</td>
<td>43</td>
<td>1.296</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>65.617</td>
<td>46</td>
<td>1.296</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>5.317</td>
<td>3</td>
<td>1.772</td>
<td>1.264</td>
<td>.299</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>60.300</td>
<td>43</td>
<td>1.402</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>65.617</td>
<td>46</td>
<td>1.402</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 39

**Means and Standard Deviations for Different Industry Segments on Item #7**

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>9</td>
<td>3.56</td>
<td>.88</td>
</tr>
<tr>
<td>Automotive</td>
<td>14</td>
<td>3.00</td>
<td>1.11</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>3.33</td>
<td>1.86</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>10</td>
<td>4.00</td>
<td>1.33</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>3.50</td>
<td>1.38</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>3.45</td>
<td>1.24</td>
</tr>
</tbody>
</table>
Table 40

*Means and Standard Deviations for Different Sizes on Item #7*

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 49</td>
<td>9</td>
<td>4.22</td>
<td>.83</td>
</tr>
<tr>
<td>50 - 99</td>
<td>6</td>
<td>3.83</td>
<td>1.17</td>
</tr>
<tr>
<td>100 - 499</td>
<td>3</td>
<td>3.67</td>
<td>1.53</td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>3.10</td>
<td>1.18</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.45</td>
<td>1.19</td>
</tr>
</tbody>
</table>

*Length of employment.* The null hypothesis was retained \(F_{3,43} = 1.27, p = .30\). There was no significant difference. Table 41 indicates the means and standard deviations for length of employment. All lengths of employment were above the criterion set at 3.25 except for the 15+ group.

Table 41

*Means and Standard Deviations for Length of Employment on Item #7*

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>4.00</td>
<td>1.00</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>4.00</td>
<td>1.10</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>3.75</td>
<td>1.04</td>
</tr>
<tr>
<td>15+ years</td>
<td>30</td>
<td>3.20</td>
<td>1.24</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.45</td>
<td>1.19</td>
</tr>
</tbody>
</table>
Item #10

There is communication of the vision of STEP throughout your organization.

Null Hypothesis for Item #10. There were no significant differences in respondents' belief that there is communication of the vision of STEP throughout their organization according to the following three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. The following Composite ANOVA Table 42 for Item #10, “There is communication of the vision of STEP throughout your organization,” indicates that the null hypothesis was retained for industry segment group, size of the organization group, and length of employment group.

Table 42

Composite ANOVA Table on Item #10 for the Three Independent Variables

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>11.374</td>
<td>4</td>
<td>2.843</td>
<td>2.013</td>
<td>.108</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>64.979</td>
<td>46</td>
<td>1.413</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>76.353</td>
<td>50</td>
<td>2.013</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>7.489</td>
<td>3</td>
<td>2.496</td>
<td>1.749</td>
<td>.171</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>61.362</td>
<td>43</td>
<td>1.427</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>68.851</td>
<td>46</td>
<td>1.427</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>.384</td>
<td>3</td>
<td>.128</td>
<td>.080</td>
<td>.970</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>68.467</td>
<td>43</td>
<td>1.592</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>68.851</td>
<td>46</td>
<td>1.592</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Industry segment.** The industry segments used for analysis were Aerospace, Automotive, Defense, Information Technology, and Other. The null hypothesis was retained \( (F_{4,46} = 2.01, p = .108) \). There was no significant difference.

Table 43 indicates the means and standard deviations for the industry segment. Aerospace, Automotive, and Defense were below the criterion set at 3.25. Information Technology and Other were above the set criterion.

### Table 43

**Means and Standard Deviations for Different Industry Segments on Item #10**

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>9</td>
<td>3.22</td>
<td>1.09</td>
</tr>
<tr>
<td>Automotive</td>
<td>14</td>
<td>3.21</td>
<td>1.19</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>2.50</td>
<td>1.22</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>10</td>
<td>4.10</td>
<td>1.29</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>3.67</td>
<td>1.15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>51</td>
<td>3.41</td>
<td>1.24</td>
</tr>
</tbody>
</table>

**Size of the organization.** The null hypothesis was retained \( (F_{3,43} = 1.75, p = .171) \). There was no significant difference. Table 44 indicates the means and standard deviations for sizes of the organization. All groups were above the criterion set at 3.25 except for the 500+ group.
Length of employment. The null hypothesis was retained ($F_{3,43} = .080, p = .97$).

There was no significant difference. Table 45 indicates the means and standard deviations for the length of employment. All of the groups were above the criterion set at 3.25 except for the 6-10 years group.

Table 44

Means and Standard Deviations for Different Sizes on Item #10

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>$N$</th>
<th>Mean</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 49</td>
<td>9</td>
<td>4.00</td>
<td>1.32</td>
</tr>
<tr>
<td>50 - 99</td>
<td>6</td>
<td>3.83</td>
<td>1.17</td>
</tr>
<tr>
<td>100 - 499</td>
<td>3</td>
<td>3.33</td>
<td>1.15</td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>3.24</td>
<td>.87</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.36</td>
<td>1.22</td>
</tr>
</tbody>
</table>

Table 45

Means and Standard Deviations for Length of Employment on Item #10

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>$N$</th>
<th>Mean</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>3.33</td>
<td>.58</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>3.17</td>
<td>1.33</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>3.50</td>
<td>1.07</td>
</tr>
<tr>
<td>15 + years</td>
<td>30</td>
<td>3.37</td>
<td>1.33</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.36</td>
<td>1.22</td>
</tr>
</tbody>
</table>
Item #12

Short-term wins are obtainable using STEP standards.

Null Hypothesis for Item #12. There were no significant differences in respondents’ belief that short-term wins are obtainable using STEP standards according to the following three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. The following Composite ANOVA Table 46 for Item #12, “Short-term wins are obtainable using STEP standards,” indicates that the null hypothesis was retained for industry segment group, size of the organization group, and length of employment group.

Table 46

Composite ANOVA Table on Item #12 for the Three Independent Variables

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>5.214</td>
<td>4</td>
<td>1.304</td>
<td>1.220</td>
<td>.315</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>49.139</td>
<td>46</td>
<td>1.068</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>54.354</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>2.365</td>
<td>3</td>
<td>.788</td>
<td>.758</td>
<td>.524</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>44.741</td>
<td>43</td>
<td>1.040</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>47.106</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>6.698</td>
<td>3</td>
<td>2.233</td>
<td>2.376</td>
<td>.083</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>40.408</td>
<td>43</td>
<td>.940</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>47.106</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Industry segment. The null hypothesis was retained \((F_{4,46} = 1.220, p = .315)\).

There was no significant difference. Table 47 indicates that all industry segment respondents were at the mean or above the mean when believing that short-term wins are obtainable using STEP standards. One industry segment was far above the mean.

Table 47

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>9</td>
<td>3.78</td>
<td>.67</td>
</tr>
<tr>
<td>Automotive</td>
<td>14</td>
<td>3.50</td>
<td>.94</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>4.33</td>
<td>.82</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>10</td>
<td>3.50</td>
<td>1.43</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>3.25</td>
<td>1.06</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>51</td>
<td>3.59</td>
<td>1.04</td>
</tr>
</tbody>
</table>

Size of the organization. The null hypothesis was retained \((F_{3,43} = .758, p = .524)\). There was no significant difference. Table 48 indicates the mean and standard deviations for size of the organization. All groups were above the criterion set at 3.25.

Length of employment. The null hypothesis was retained \((F_{3,43} = .080, p = .97)\). There was no significant difference. Table 49 indicates the means and standard deviations for the length of employment. All groups were below the criterion set at 3.25 except for the 15+ years group.
Table 48

*Means and Standard Deviations for Different Sizes Item #12*

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 49</td>
<td>9</td>
<td>4.00</td>
<td>1.00</td>
</tr>
<tr>
<td>50 - 99</td>
<td>6</td>
<td>3.50</td>
<td>.84</td>
</tr>
<tr>
<td>100 - 499</td>
<td>3</td>
<td>4.00</td>
<td>.00</td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>3.49</td>
<td>1.09</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.62</td>
<td>1.01</td>
</tr>
</tbody>
</table>

Table 49

*Means and Standard Deviations for Length of Employment on Item #12*

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>3.00</td>
<td>1.00</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>3.17</td>
<td>.98</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>3.13</td>
<td>1.36</td>
</tr>
<tr>
<td>15+ years</td>
<td>30</td>
<td>3.90</td>
<td>.84</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.61</td>
<td>1.01</td>
</tr>
</tbody>
</table>

Item #13

Improvements using STEP produce more opportunities for STEP usage.
Null Hypothesis for Item #13. There were no significant differences in respondents' belief that Improvements using STEP produce more opportunities for STEP usage according to the following three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. The following Composite ANOVA Table 50 for Item #13, "Improvements using STEP produce more opportunities for STEP usage," indicates that the null hypothesis was retained for industry segment group, size of the organization group, and length of employment group.

Table 50

Composite ANOVA Table on Item #13 for the Three Independent Variables

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>4.090</td>
<td>4</td>
<td>1.023</td>
<td>1.838</td>
<td>.138</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>25.596</td>
<td>46</td>
<td>.556</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>29.686</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>1.831</td>
<td>3</td>
<td>.610</td>
<td>1.006</td>
<td>.399</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>26.084</td>
<td>43</td>
<td>.607</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>27.915</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>3.548</td>
<td>3</td>
<td>1.183</td>
<td>2.087</td>
<td>.116</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>24.367</td>
<td>43</td>
<td>.567</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>27.915</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Industry segment. The null hypothesis was retained ($F_{4,46} = 1.838, p = .138$). There was no significant difference. Table 51 indicates the means and standard deviations for industry segments. All groups were above the criterion set at 3.25.
**Size of the organization.** The null hypothesis was retained \( F_{3,43} = .758, p = .524 \). There was no significant difference. Table 52 indicates the means and standard deviations for size of the organization. All groups were above the criterion set at 3.25.

Table 51

*Means and Standard Deviations for Different Industry Segments on Item #13*

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>9</td>
<td>3.89</td>
<td>.67</td>
</tr>
<tr>
<td>Automotive</td>
<td>14</td>
<td>3.79</td>
<td>.43</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>4.67</td>
<td>.52</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>10</td>
<td>4.30</td>
<td>1.06</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>4.08</td>
<td>.79</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>4.08</td>
<td>.77</td>
</tr>
</tbody>
</table>

Table 52

*Means and Standard Deviations for Different Sizes on Item #13*

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 49</td>
<td>9</td>
<td>4.00</td>
<td>1.00</td>
</tr>
<tr>
<td>50 – 99</td>
<td>6</td>
<td>3.50</td>
<td>.84</td>
</tr>
<tr>
<td>100 – 499</td>
<td>3</td>
<td>4.00</td>
<td>.00</td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>3.49</td>
<td>1.09</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.62</td>
<td>1.01</td>
</tr>
</tbody>
</table>
Length of employment. The null hypothesis was retained \( F_{3,43} = .080, p = .97 \). There was no significant difference. Table 53 indicates the means and standard deviations for length of employment. All groups were above the criterion set at 3.25.

Table 53

Means and Standard Deviations for Length of Employment on Item #13

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>3.33</td>
<td>.58</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>3.83</td>
<td>.98</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>3.75</td>
<td>1.04</td>
</tr>
<tr>
<td>15+ years</td>
<td>30</td>
<td>4.23</td>
<td>.63</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>4.04</td>
<td>.78</td>
</tr>
</tbody>
</table>

Research Question 3

Do respondents believe there are organizational change processes in place that familiarize and educate management about benefits of STEP Numerical Control preceding adoption and implementation of the standard? This research question was addressed by item numbers 15 and 16 in the quantitative section of the survey. Table 54 displays the results of those items. Each item is stated accompanied by the sample size (N), the mean, and the standard deviation (SD). An examination of the means shows that the IRB agreed with all of the items (15, 16).
Table 54

Research Question 3: Quantitative Survey Question Means and Standard Deviations

<table>
<thead>
<tr>
<th>Item #</th>
<th>Question</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>You are familiar with the Standard for the Exchange of Product model data – Numerical Control (STEP NC).</td>
<td>51</td>
<td>3.97</td>
<td>.94</td>
</tr>
<tr>
<td>16</td>
<td>You are familiar with post processors and RS 274 (M&amp;G) codes.</td>
<td>51</td>
<td>3.63</td>
<td>1.18</td>
</tr>
</tbody>
</table>

**Item #15**

You are familiar with the Standard for the Exchange of Product model data—Numerical Control (STEP NC).

**Null Hypothesis for Item #15.** There were no significant differences in the respondents' belief that they are familiar with the Standard for the Exchange of Product model data—Numerical Control (STEP NC) according to the following three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. The following Composite ANOVA Table 55 for Item #15, "You are familiar with the Standard for the Exchange of Product model data—Numerical Control (STEP NC),” indicates that the null hypothesis was retained for industry segment group, size of the organization group, and length of employment group.

**Industry segment.** The null hypothesis was retained ($F_{4,46} = 2.209, p = .083$). There was no significant difference. Table 56 indicates means and standard deviations for industry segments. All industry segments were above the criterion set at 3.25.

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Table 55

Composite ANOVA Table on Item #15 for the Three Independent Variables

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>7.076</td>
<td>4</td>
<td>1.769</td>
<td>2.209</td>
<td>.083</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>36.845</td>
<td>46</td>
<td>.801</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>43.922</td>
<td>50</td>
<td>2.209</td>
<td>.083</td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>5.279</td>
<td>3</td>
<td>1.760</td>
<td>2.246</td>
<td>.097</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>33.699</td>
<td>43</td>
<td>.784</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>38.979</td>
<td>46</td>
<td>2.246</td>
<td>.097</td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>3.112</td>
<td>3</td>
<td>1.037</td>
<td>1.244</td>
<td>.306</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>35.867</td>
<td>43</td>
<td>.834</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>38.979</td>
<td>46</td>
<td>1.244</td>
<td>.306</td>
<td></td>
</tr>
</tbody>
</table>

Table 56

Means and Standard Deviations for Different Industry Segments on Item #15

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>9</td>
<td>4.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Automotive</td>
<td>14</td>
<td>3.43</td>
<td>.94</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>4.00</td>
<td>.89</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>10</td>
<td>4.50</td>
<td>.71</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>4.08</td>
<td>.90</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>3.96</td>
<td>.94</td>
</tr>
</tbody>
</table>
**Size of the organization.** The null hypothesis was retained \((F_{3,43} = 2.25, p = .10)\). There was no significant difference. Table 57 indicates means and standard deviations for size of the organization. All groups were above the criterion set at 3.25.

Table 57

*Means and Standard Deviations for Different Sizes on Item #15*

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 49</td>
<td>9</td>
<td>4.22</td>
<td>1.09</td>
</tr>
<tr>
<td>50 – 99</td>
<td>6</td>
<td>4.17</td>
<td>.41</td>
</tr>
<tr>
<td>100 – 499</td>
<td>3</td>
<td>5.00</td>
<td>.00</td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>3.76</td>
<td>.91</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.98</td>
<td>.92</td>
</tr>
</tbody>
</table>

**Length of employment.** The null hypothesis was retained \((F_{3,43} = 2.57, p = .07)\). There was no significant difference. Table 58 indicates means and standard deviations for length of employment. All groups were above the criterion set at 3.25 except for the 1 to 5 years group.

**Item #16**

You are familiar with post processors and RS 274 (M&G) codes.

**Null Hypothesis for Item #16.** There were no significant differences in the respondents’ belief that they are familiar with post processors and RS 274 (M&G) codes according to the following three independent variables: (a) industry segment, (b) size of
Table 58

Means and Standard Deviations for Length of Employment on Item #15

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>3.00</td>
<td>1.00</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>4.00</td>
<td>.63</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>4.00</td>
<td>1.07</td>
</tr>
<tr>
<td>15+ years</td>
<td>30</td>
<td>4.07</td>
<td>.91</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.98</td>
<td>.92</td>
</tr>
</tbody>
</table>

the organization, and (c) length of employment. The following Composite ANOVA Table 59 for Item #16, “You are familiar with post processors and RS 274 (M&G) codes,” indicates that the null hypothesis was retained for industry segment group, size of the organization group, and length of employment group.

Table 59

Composite ANOVA Table on Item #16 for the Three Independent Variables

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>12.89</td>
<td>4</td>
<td>3.22</td>
<td>2.60</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>57.03</td>
<td>46</td>
<td>1.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>69.92</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>8.30</td>
<td>3</td>
<td>2.77</td>
<td>2.10</td>
<td>.11</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>56.55</td>
<td>43</td>
<td>1.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>64.85</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>9.85</td>
<td>3</td>
<td>3.28</td>
<td>2.57</td>
<td>.07</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>55.00</td>
<td>43</td>
<td>1.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>64.85</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Industry segment. The null hypothesis was retained \((F_{4,46} = 2.60, p = .05)\).

There was no significant difference. Table 60 indicates the means and standard deviations for industry segments. All industry segments were above the criterion set at 3.25 except for the Automotive segment.

Table 60

Means and Standard Deviations for Different Industry Segments on Item #16

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>9</td>
<td>4.00</td>
<td>1.32</td>
</tr>
<tr>
<td>Automotive</td>
<td>14</td>
<td>2.86</td>
<td>1.17</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>3.50</td>
<td>1.38</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>10</td>
<td>4.10</td>
<td>.88</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>3.92</td>
<td>.90</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>3.20</td>
<td>1.13</td>
</tr>
</tbody>
</table>

Size of the organization. The null hypothesis was retained \((F_{3,43} = 2.10, p = .11)\). There was no significant difference. Table 61 indicates means and standard deviations for size of the organization. All groups were above the criterion set at 3.25 except for the 100-499 group.

Length of employment. The null hypothesis was retained \((F_{3,43} = 2.57, p = .07)\). There was no significant difference. Table 62 indicates means and standard deviations for length of employment. The 6 to 10 years and the 15+ years group were above the criterion set at 3.25. The 1 to 5 years and 11 to 15 years groups were below the criterion.
Table 61

*Means and Standard Deviations for Different Sizes on Item #16*

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 49</td>
<td>9</td>
<td>3.89</td>
<td>1.05</td>
</tr>
<tr>
<td>50 - 99</td>
<td>6</td>
<td>3.83</td>
<td>.98</td>
</tr>
<tr>
<td>100 - 499</td>
<td>3</td>
<td>2.33</td>
<td>1.15</td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>3.28</td>
<td>1.22</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.26</td>
<td>1.13</td>
</tr>
</tbody>
</table>

Table 62

*Means and Standard Deviations for Length of Employment on Item #16*

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>2.00</td>
<td>1.00</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>4.17</td>
<td>.75</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>2.62</td>
<td>1.06</td>
</tr>
<tr>
<td>15+ years</td>
<td>30</td>
<td>3.67</td>
<td>1.27</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.64</td>
<td>1.19</td>
</tr>
</tbody>
</table>

Research Question 4

Are respondents able to identify a leader in their organization who will promote the changes required for the use of STEP standards?

This research question was addressed by items number 6, 9, and 18 in the quantitative section of the survey. Table 63 displays the results of those items. Each item

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is stated accompanied by the sample size \((N)\), the mean, and the standard deviation \((SD)\). 
An examination of the means shows that the IRB agreed with Items 6 and 9. Item 18 had a mean of less than 3.25, which indicates non-agreement.

Table 63

Research Question 4 Quantitative Survey Question Means and Standard Deviations

<table>
<thead>
<tr>
<th>Item #</th>
<th>Question</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>The standards process takes too long and lags the state of the art.</td>
<td>51</td>
<td>3.76</td>
<td>.99</td>
</tr>
<tr>
<td>9</td>
<td>There is a leader within your organization promoting STEP.</td>
<td>51</td>
<td>3.76</td>
<td>1.21</td>
</tr>
<tr>
<td>18</td>
<td>There is a leader within your organization promoting STEP NC.</td>
<td>51</td>
<td>3.12</td>
<td>1.19</td>
</tr>
</tbody>
</table>

Item #6
The standards process takes too long and lags the state of the art.

Null Hypothesis for Item #6. There were no significant differences in the respondents' belief that the standards process takes too long and lags the state of the art according to three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. The following Composite ANOVA Table 64 for Item #6, "The standards process takes too long and lags the state of the art," indicates that the null hypothesis was retained for industry segment group, size of the organization group, and length of employment group.
Table 64

Composite ANOVA Table on Item #6 for the Three Independent Variables

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>3.32</td>
<td>4</td>
<td>.83</td>
<td>.831</td>
<td>.512</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>45.86</td>
<td>46</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>49.18</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>5.52</td>
<td>3</td>
<td>1.84</td>
<td>1.89</td>
<td>.146</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>41.88</td>
<td>43</td>
<td>.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>47.40</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>4.87</td>
<td>3</td>
<td>1.62</td>
<td>1.64</td>
<td>.194</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>42.53</td>
<td>43</td>
<td>.989</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>47.40</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Industry segment.** The null hypothesis was retained \( F_{4,46} = .831, p = .512 \).

There was no significant difference. Table 65 indicates means and standard deviations for industry segments. All industry segments were above the criterion set at 3.25.

Table 65

Means and Standard Deviations for Different Industry Segments on Item #6

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>9</td>
<td>3.67</td>
<td>.87</td>
</tr>
<tr>
<td>Automotive</td>
<td>14</td>
<td>3.43</td>
<td>.85</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>4.17</td>
<td>.75</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>10</td>
<td>3.80</td>
<td>1.32</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>4.00</td>
<td>1.04</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>3.76</td>
<td>.99</td>
</tr>
</tbody>
</table>
**Size of the organization.** The null hypothesis was retained ($F_{3,43} = 1.89, p = .146$). There was no significant difference. Table 66 indicates means and standard deviations for size of the organization. All groups were above the criterion set at 3.25 except for the 50-99 group.

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>$N$</th>
<th>Mean</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 49</td>
<td>9</td>
<td>4.22</td>
<td>.83</td>
</tr>
<tr>
<td>50 - 99</td>
<td>6</td>
<td>3.17</td>
<td>.98</td>
</tr>
<tr>
<td>100 - 499</td>
<td>3</td>
<td>4.33</td>
<td>1.15</td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>3.62</td>
<td>1.01</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.72</td>
<td>1.02</td>
</tr>
</tbody>
</table>

**Length of employment.** The null hypothesis was retained ($F_{3,43} = 1.64, p = .194$). There was no significant difference. Table 67 indicates means and standard deviations for length of employment. All groups were above the criterion set at 3.25 except for the 1 to 5 year group.

**Item #9**

There is a leader within your organization promoting STEP.

**Null Hypothesis for Item #9.** There were no significant differences in the respondents’ ability to identify a leader in their organization promoting STEP according to
Table 67

*Means and Standard Deviations for Length of Employment on Item #6*

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>3.00</td>
<td>1.00</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>4.33</td>
<td>.82</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>4.00</td>
<td>1.20</td>
</tr>
<tr>
<td>15+ years</td>
<td>30</td>
<td>3.60</td>
<td>.97</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.72</td>
<td>1.02</td>
</tr>
</tbody>
</table>

three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. The following Composite ANOVA Table 68 for Item #9, “There is a leader within your organization promoting STEP,” indicates that the null hypothesis was retained for industry segment group and for the length of employment group, but rejected for the size of organization group.

**Industry segment.** The null hypothesis was retained ($F_{4,46} = 1.83, \ p = .139$). There was no significant difference. Table 69 indicates means and standard deviations for industry segments. All industry segments were above the criteria set at 3.25 except for the Automotive group.

**Size of the organization.** The null hypothesis was rejected ($F_{3,43} = 4.31, \ p = .010$). There was a significant difference. Scheffe Post Hoc results showed that the only group that was different was the 500+ group that scored slightly below the criterion.
Table 68

**Composite ANOVA Table on Item #9 for the Three Independent Variables**

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>10.06</td>
<td>4</td>
<td>2.51</td>
<td>1.832</td>
<td>.139</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>63.12</td>
<td>46</td>
<td>1.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>73.18</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>16.13</td>
<td>3</td>
<td>5.38</td>
<td>4.306</td>
<td>.010*</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>53.70</td>
<td>43</td>
<td>1.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>69.83</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>5.36</td>
<td>3</td>
<td>1.79</td>
<td>1.192</td>
<td>.324</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>64.47</td>
<td>43</td>
<td>1.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>69.83</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* means significant at less than .05.

Table 69

**Means and Standard Deviations for Different Industry Segments on Item #9**

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>9</td>
<td>3.89</td>
<td>.93</td>
</tr>
<tr>
<td>Automotive</td>
<td>14</td>
<td>3.14</td>
<td>1.23</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>3.50</td>
<td>1.64</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>10</td>
<td>4.30</td>
<td>1.34</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>4.08</td>
<td>.79</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>3.76</td>
<td>1.21</td>
</tr>
</tbody>
</table>
Table 70 indicates means and standard deviations for size of organizations. All groups were above the criterion set at 3.25 except for the 500+ group.

Table 70

Means and Standard Deviations for Different Sizes on Item #9

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>1 - 49</th>
<th>50-99</th>
<th>100-499</th>
<th>500+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 49</td>
<td>9</td>
<td>4.44</td>
<td>.53</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 - 99</td>
<td>6</td>
<td>4.50</td>
<td>.55</td>
<td>NS</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 - 499</td>
<td>3</td>
<td>4.33</td>
<td>.58</td>
<td>NS</td>
<td>NS</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>3.24</td>
<td>1.33</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>x</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.70</td>
<td>1.23</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** significant at less than .01 level.

Length of employment. The null hypothesis was retained ($F_{3,43} = 1.19, p = .324$). There was no significant difference. Table 71 indicates means and standard deviations for length of employment. All groups were above the criterion set at 3.25 except for the 6 to 10 years group.

Item #18

There is a leader within your organization promoting STEP NC.

Null Hypothesis for Item #18. There were no significant differences in the respondents’ ability to identify a leader in their organization promoting STEP NC.

Table 71

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### Means and Standard Deviations for Length of Employment on Item #9

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>4.33</td>
<td>1.15</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>3.17</td>
<td>.98</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>3.25</td>
<td>1.28</td>
</tr>
<tr>
<td>15+ years</td>
<td>30</td>
<td>3.87</td>
<td>1.25</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.70</td>
<td>1.23</td>
</tr>
</tbody>
</table>

According to three independent variables: (a) industry segment, (b) size of the organization, and (c) length of employment. The following Composite ANOVA Table 72 for Item #18, “There is a leader within your organization promoting STEP NC,” indicates that the null hypothesis was retained for industry segment group and for the length of employment group but rejected for the size of organization group.

**Industry segment.** The null hypothesis was retained ($F_{4,46} = 1.03, p = .404$). There was no significant difference. Table 73 indicates the means and standard deviations for industry segments. Aerospace and Information Technology were above the criterion set at 3.25. Automotive, Defense, and Other were below the set criterion.

**Size of the organization.** The null hypothesis was rejected ($F_{3,43} = 3.14, p = .04$). There was a significant difference. Table 74 indicates means and standard deviations for size of the organization. All groups were above the criterion set at 3.25 except for the 500+ group. Scheffe Post Hoc results showed the 500+ group was different.
Table 72

Composite ANOVA Table on Item #18 for the Three Independent Variables

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Segment</td>
<td>Between Groups</td>
<td>5.84</td>
<td>4</td>
<td>1.46</td>
<td>1.03</td>
<td>.404</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>65.46</td>
<td>46</td>
<td>1.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>71.29</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Between Groups</td>
<td>11.61</td>
<td>3</td>
<td>3.87</td>
<td>3.14</td>
<td>.04*</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>53.03</td>
<td>43</td>
<td>1.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>64.64</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Employment</td>
<td>Between Groups</td>
<td>5.01</td>
<td>3</td>
<td>1.67</td>
<td>1.20</td>
<td>.320</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>59.63</td>
<td>43</td>
<td>1.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>64.64</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* means significant at less than .05.

Table 73

Means and Standard Deviations for Different Industry Segments on Item #18

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>9</td>
<td>3.67</td>
<td>.71</td>
</tr>
<tr>
<td>Automotive</td>
<td>14</td>
<td>2.71</td>
<td>1.20</td>
</tr>
<tr>
<td>Defense</td>
<td>6</td>
<td>2.83</td>
<td>.98</td>
</tr>
<tr>
<td>Information Tech.</td>
<td>10</td>
<td>3.30</td>
<td>1.57</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>3.17</td>
<td>1.19</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>3.12</td>
<td>1.19</td>
</tr>
</tbody>
</table>

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Table 74

Means and Standard Deviations for Different Sizes on Item #18

<table>
<thead>
<tr>
<th>Size of the Organization</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>1 - 49</th>
<th>50-99</th>
<th>100-499</th>
<th>500 +</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 49</td>
<td>9</td>
<td>4.11</td>
<td>1.05</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 - 99</td>
<td>6</td>
<td>3.33</td>
<td>1.37</td>
<td>NS</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 - 499</td>
<td>3</td>
<td>3.33</td>
<td>.58</td>
<td>NS</td>
<td>NS</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>500 +</td>
<td>29</td>
<td>2.83</td>
<td>1.10</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>x</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.17</td>
<td>1.19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Length of employment. The null hypothesis was retained ($F_{3, 43} = 1.20, p = .320$). There was no significant difference. Table 75 indicates means and standard deviations for length of employment. The 6 to 10 years and the 15+ years groups were above the criterion set at 3.25. The 1 to 5 years and the 11 to 15 years groups were below the set criterion.

Table 75

Means and Standard Deviations for Length of Employment on Item #18

<table>
<thead>
<tr>
<th>Length of Employment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 years</td>
<td>3</td>
<td>2.00</td>
<td>1.00</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>6</td>
<td>3.33</td>
<td>1.21</td>
</tr>
<tr>
<td>11 to 15 years</td>
<td>8</td>
<td>3.00</td>
<td>1.31</td>
</tr>
<tr>
<td>15 + years</td>
<td>30</td>
<td>3.30</td>
<td>1.15</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>3.17</td>
<td>1.19</td>
</tr>
</tbody>
</table>
Category Analysis for Qualitative Questions

In addition to the demographics, the survey questions were divided into four categories for the purpose of investigating the null hypotheses. The same categories were used to group both quantitative and qualitative responses. The categories measured the respondents' beliefs in the following:

1. Change processes for implementation of international standards
2. The creation of a vision focusing on the importance and value of adoption of international standards
3. Management’s familiarization and identification of benefits for organizational adoption of international standards
4. Leadership promoting the change required for adoption of international standards.

Data Analysis of Research Questions and Qualitative Survey Responses

Qualitative survey responses were grouped and analyzed. The specific answers to the qualitative survey questions are detailed in Appendix C.

Research Question 1

Do respondents have a process in place to implement change which will benefit the adoption of new international standards within their organization?

Change processes for implementation of international standards (Questions 19, 20, 23, 24, 26, 27) qualitative responses were grouped in this category under Research Question 1.

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Question 19 asked respondents, “What process do you use to implement change within your organization?” The respondents from Aerospace viewed change as a group process starting with a vision instead of an “as-is” and a “to-be” process followed by implementation. If the implementation proved successful, standard work procedures would be developed. Automotive respondents first examined new technology in pilot projects. Two interesting responses were that change happened from the top down and another response was that change happened from the bottom up. Defense used their advanced technology groups to evaluate and then propose change. Information Technology changed processes and products through customer feedback.

Question 20 asked respondents, “What is your theory for managing change?” The respondents from Aerospace regarded the empowerment and motivation of people as the best way to manage change. Automotive focused on explaining the reason for managing change and then testing and evaluating the process. Defense offered the development of a business case as a way to manage change. Information Technology suggested managing change by making change in increments, evaluating, and moving on.

Question 23 asked respondents, “Why will your organization implement STEP NC?” Aerospace would implement STEP NC to resolve interoperability issues. Automotive would implement to resolve interoperability issues and reduce lead times. Defense would implement STEP NC to resolve interoperability issues. Information Technology would implement STEP NC to resolve interoperability issues.

Question 24 asked respondents, “Why will your organization NOT implement STEP NC?” Aerospace would not implement STEP NC if there were not a sound business case. Automotive would not implement if the technology proves it did not save
money. Defense would not implement if inertia hindered the development of the technology. Information Technology would not implement until customers requested the technology.

Question 26 asked respondents, “What organizational process barriers have to be overcome for implementation of STEP NC?” Aerospace responded by stating there was natural resistance to change. Automotive responded by stating that there must be senior management “buy in.” Defense noted the lack of education as a barrier and the “if it isn’t broke, don’t fix it” mentality. Information Technology noted reluctance to change and the need for management consensus.

Question 27 asked respondents, “What change is required to lead the consensus for adoption and implementation of STEP NC within your organization?” Aerospace supported the development of a good business case. Automotive stated that STEP NC was accepted, and prototypes and business cases to prove value were expected in the near future. Defense stressed education of management would create acceptance. Information Technology stated no change was required; they were customer-driven.

Research Question 2

Do respondents believe their organization has a sense of urgency to create a vision focusing on the importance and value of adopting the non-proprietary international Standard for the Exchange of Product Model Data (STEP)?

The creation of a vision focusing on the importance and value of adoption of international standards (Questions 22 and 25) qualitative responses were grouped in this category under Research Question 2.
Question 22 asked respondents, “Do you consider your organization an early adopter of technology?” Aerospace took a “wait and see” approach before implementing high-end technologies and yet pushed the envelope in developing state-of-the-art high-end technologies. Automotive took a “wait and see” approach. Defense was an early adopter of technology. Information Technology was an early adopter.

Question 25 asked respondents, “In your opinion, how can STEP NC add value to your organization?” Aerospace responded by verifying STEP NC’s potential for resolving interoperability issues and therefore reducing costs. Automotive supported STEP NC for streamlining data collection and therefore reducing costs. Defense supported the resolution of computer interoperability issues by STEP NC. Information Technology believed development of STEP NC would give them the competitive advantage.

Research Question 3

Do respondents believe there are organizational change processes in place that familiarize and educate management about benefits of STEP Numerical Control preceding adoption and implementation of the standard?

Management’s familiarization and identification of benefits for organizational adoption of international standards (Questions 20 and 27) qualitative responses were grouped in this category under Research Question 3.

Question 20 asked respondents, “What is your theory for managing change?” Aerospace respondents regarded the empowerment and motivation of people as the best way to create an environment for managing change. Automotive promoted explanation of the purpose for managing change and then testing and evaluating the process. Defense
offered the development of a business case as a way to manage change. Information Technology suggested managing change by making change in increments, evaluating, and moving on.

Question 27 asked, “What change is required to lead the consensus for adoption and implementation of STEP NC within your organization?” Aerospace supported the development of a good business case. Automotive stated that STEP NC was accepted, and prototypes and business cases to prove value were expected in the near future. Defense stressed that education of management would create acceptance. Information Technology stated no change was required; they were customer-driven.

Research Question 4

Are respondents able to identify a leader in their organization who will promote the changes required for the use of STEP standards?

Leadership promoting the change required for adoption of international standards (Questions 21 and 27) qualitative responses were grouped in this category under Research Question 4.

Question 21 asked respondents, “What do you do to lead the change process in your organization?” Aerospace educated, taught, and then “got out of the way.” Automotive led with education and introduction of new ideas. Defense proposed and executed cooperative Research and Development projects. Information Technology communicated ideas with vision and enthusiasm.

Question 27 asked respondents, “What change is required to lead the consensus for adoption and implementation of STEP NC within your organization?” Aerospace supported the development of a good business case. Automotive stated that
STEP NC was accepted, and prototypes and business cases to prove value were expected in the near future. Defense stressed that education of management would create acceptance. Information Technology stated no change was required; they were customer-driven.

Organizations generally have processes in place for change, but they have not institutionalized the processes for adoption of international standards. Varying degrees of sizes of an organization determine the expediency of institutionalizing STEP NC. The large organizations of 500+ will take longer to adopt and implement STEP NC. More success with testing of the standard will mean faster implementation.

The use of the broader suite of various official ISO Standard for the Exchange of Product Model Data (STEP) standards are currently in use but not institutionalized. Organizations agree that the use of international non-proprietary standards will greatly enhance organizational productivity. There was a leader identified within the organization who promoted the use of STEP standards, but fewer responses for identifying a leader for promoting STEP NC. The lesser support by a leader for STEP NC was explained by the newness of this standard. This analysis of the detailed qualitative responses supports the quantitative aspect of the study, as presented in Table 76.
### Table 76

**Summary of Results on the Quantitative Analysis**

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Item #</th>
<th>Question</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
<td>A coalition/team has been assembled in your organization to lead the implementation of STEP standards.</td>
<td>51</td>
<td>3.67</td>
<td>1.28</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Others in your organization are empowered to act on the vision for STEP implementation.</td>
<td>51</td>
<td>3.47</td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>New STEP approaches are institutionalized in your organization.</td>
<td>51</td>
<td>2.84</td>
<td>1.10</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>Implementation of STEP is important for the manufacturing process in your organization.</td>
<td>51</td>
<td>3.20</td>
<td>1.13</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>International non-proprietary standards are important to your organization.</td>
<td>51</td>
<td>4.49</td>
<td>.78</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Identifying standards-based solutions are more important than corporate unification on proprietary products.</td>
<td>51</td>
<td>4.08</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>There is a sense of urgency in your organization to establish international standards (ISO) for Standard for the Exchange of Product model data (STEP).</td>
<td>51</td>
<td>3.45</td>
<td>1.24</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>There is communication of the vision of STEP throughout your organization.</td>
<td>51</td>
<td>3.41</td>
<td>1.24</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Short-term wins are obtainable using STEP standards.</td>
<td>51</td>
<td>3.59</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Improvements using STEP produce more opportunities for STEP usage.</td>
<td>51</td>
<td>4.08</td>
<td>.77</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>You are familiar with the Standard for the Exchange of Product model data – Numerical Control (STEP NC).</td>
<td>51</td>
<td>3.97</td>
<td>.94</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>You are familiar with post processors and RS 274 (M&amp;G) codes.</td>
<td>51</td>
<td>3.63</td>
<td>1.18</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>The standards process takes too long and lags the state of the art.</td>
<td>51</td>
<td>3.76</td>
<td>.99</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>There is a leader within your organization promoting STEP.</td>
<td>51</td>
<td>3.76</td>
<td>1.21</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>There is a leader within your organization promoting STEP NC.</td>
<td>51</td>
<td>3.12</td>
<td>1.19</td>
</tr>
</tbody>
</table>
CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

The majority of large organizations have moved from the traditional way of doing business to the electronic commerce way of doing business. Outdated paper processes, lack of international standards, and the lack of computer interoperability have created costly industry productivity problems. Organizations want to move from traditional isolated islands of information into large interconnected networks. According to Solomon (2001), in an era of globalization, rapid technological changes, and intense competition, new forms of organizational designs and networks have replaced traditional forms of organizations.

Traditional organizations are realizing that they also have the opportunity of entering the national and international marketplace by leveraging their strengths in the development of an electronic approach to conducting business. Organizations are responding to a new set of global challenges in a rapidly changing business environment. Marks (2000) suggests traditional companies that adopt E-business are better off than the web “upstarts” because the traditional companies have a broader more entrenched business foundation.
The research conducted by Nembard et al. (2000) corroborates the need to examine the dynamics of change using electronic commerce. The manufacturing environment is becoming increasingly dynamic with upsurges in electronic commerce, supply chain management, forecasting, and procurement and resource planning. These drivers led to an opportunity for companies to collect and use information to identify changes that will affect their manufacturing system.

**Statement of the Problem**

Today there is an environment within organizations represented by islands of information. Information cannot be exchanged easily. The information is stored in computers that cannot talk to each other. Cumbersome paper processes, lack of non-proprietary international standards, and computer interoperability deficiencies have created industry productivity problems. Millions of dollars are lost each day due to inefficiencies caused by paper processes and the inability of computers to talk to each other.

Increasingly, firms in the aerospace and defense sectors are turning to electronic commerce alternatives such as electronic data interchange and technical data interchange to make these partnerships more efficient. Many companies want to share the complex technical data output of CAD, CAM, and PDM.

Much of the promise of technical data interchange remains unrealized. Technical data, a crucial resource of any enterprise, is captive to the software system in which it was first created. The different platforms, electronic languages, and formats used hinder economic expansion. In other words, computers cannot talk to each other—computers cannot share information.
There is work in the global international standards community to resolve the product data life cycle interoperability problems with the creation and implementation of a series of standards under the broad auspices of STEP. One of the STEP standards under the umbrella of STEP is STEP NC. STEP NC links engineering and manufacturing data flows. This study focused on STEP NC.

**Purpose of the Study**

The purpose of this study was to explore the creation and implementation of International non-proprietary STEP and STEP NC standards as a way to create the opportunity for interoperability among disparate computer software and hardware systems for engineering and manufacturing data.

This study examined the process for the implementation of a system for creating reciprocity between international design standards and new international manufacturing standards—in other words, how can designers and manufacturers share the same data on several diverse computer platforms for enhancing efficiency and effectiveness in production?

The study also clarified areas of resistance to change and assisted change agents in alleviating barriers to change. The goal of the studied program is to change the way business is done by adopting newly created international standards in the current business environment.

The specific focus of the study was the international standard STEP NC. The results of the study could be used by the STEP NC international standards community as a means to expedite the industry’s acceptance and implementation process of STEP NC.
Many of the survey respondents in this study had witnessed a STEP NC prototype test. Others had read magazine and newspaper articles of the prototype test.

**Importance of the Study**

This was the first timeSTEP NC Application Protocol 238 had been used in a production environment in the United States. It was also the first time that this particular STEP NC Application Protocol 238 was used in a production environment globally.

This was also the first time a study had been conducted on the impact of change and leadership in the implementation of STEP NC. Once STEP NC is implemented on a broad basis, it will revolutionize the industrial community by linking engineering and manufacturing electronically (Waurzyniak, 2001). This electronic link will allow for a smooth flow of information to the shop floor for creation of quality parts. The cost to produce parts will be greatly reduced.

The changes and consensus required to implement a global economic information exchange will become a template for future global consensus activities. For the first time, there is work currently in process that addresses engineering and manufacturing interoperability in an electronic/digital environment. This work is the development of global standards that require the consensus of over 32 countries to reach decisions on how and what it will take to accomplish these difficult tasks.

The majority of product costs today result from the lack of government, prime contractor, and supplier data interoperability (Brunnermeier & Martin, 1999). Computer platforms are based on proprietary source codes that will not allow transfer of information from one commercial brand of computer to another. This lack of data interoperability results in delayed production. Each time data files encounter a different
computer, the data requires human and software interfaces to fix the data file so it can input to another system.

Rework costs industry an estimated $1 million per day, and data-related problems cost industry millions. The goal is to provide an interoperable digital data environment to allow data flow across dissimilar platforms. This would be accomplished by building a 3D data file for each design that will flow uninterrupted from CAD through CAM and into the machine on the shop floor to cut parts. The 3D data file would contain all the information that would otherwise have to be entered by the user. The file would flow from design to manufacturing without stops on the way to re-enter data for each different brand of computer the file encounters.

In the automotive industry suppliers spend at least $200 million annually reworking data files; tooling suppliers spend more than $450 million. Automotive suppliers believe they could reduce their delivery by 4 months if they received perfectly interoperable data from the OEMs for each new design. Automotive OEMs believe they could reduce the design to production time by 2 months by using perfectly interoperable data (Brunnermeier & Martin, 1999).

Suppliers would save significant costs annually by not reworking files; tooling suppliers would also attain significant savings. OEMs would reduce design to production by months using interoperable data. Suppliers could reduce delivery time by 4 months if they received interoperable data from OEMs for each new design. Many of these savings would occur by using ISO STEP NC to link design, manufacturing, and the machines on the shop floor (Hardwick, 2001).
Summary of Literature Review

A review of the literature indicated that there have been a number of studies on change, the effect of change and leadership. There are a few studies on implementing international standards. This study surveyed respondents’ views on change regarding process and international standards implementation.

The literature review addresses the emergence of network economy and an information-rich environment, where traditional hierarchies have been replaced by groups of interconnected organizations with blurred boundaries and loose and often temporary alliances connecting customers, suppliers, and employees with stakeholders and competitors (Burrus & Gittines, 1998; Volkurken, 1998). These blurred boundaries are found within many organizations. This study correlates the dynamics of corporate change to the changes taking place in the creation of electronic delivery of product data information.

The cultural significance of change is important as members of an organization often take its culture for granted and do not truly evaluate its impact on decisions, behaviors, and communication or consider the symbolic and structural boundaries of organizational culture until external forces test it. Therefore, when initiating transformation efforts, it becomes critical to understand and explicate the values and personal meanings that define organizational culture (Farmer, 1990). Cultural issues are addressed within this study on the effects of processes in place for technological changes within the organization.

The measurements of change are created by business process-specific transactions and indeed are viable and achievable with today’s technology. Standards-based
collaboration can work in a global, distributed, and heterogeneous design environment. Internet-based technology solutions are inexpensive, readily available, and easy to deploy in the supply chain. This study recommends the use of international standards to reduce product development cycles.

Leadership in the change process is discussed as pressure for organizations to change increases in intensity over the next decades. The methods that managers have used in the attempt to transform their companies into stronger competitors include total quality management, reengineering, right sizing, restructuring, cultural change, and turnarounds. The culture of the organization plays a significant role in the change process (Rost, 1993). This study addresses leadership issues for international standards adoption and implementation.

Learning in communities and organizations takes place not in isolation but through observation and modeling in social settings such as the family, the workplace, and schools. Social interaction, observation of social roles, and the critical role of mentors are very important in the learning process.

Learning organizations are organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together (Senge, 1990). Learning organizations are important to this study as an environment where implementation of new technology can thrive.

Electronic communication presents opportunities to develop and deliver new products and services to customers and opportunities to establish direct links to customers
and suppliers to make transactions. E-commerce will change everything about how a
corporation operates (Marks, 2000). It will change the relationship between consumers
and producers in ways more profound than can be imagined. In many aspects, it is also
propelling new models in supply chain management, forecasting and marketing,
purchasing, and resource planning. It is also propelling establishment of international
standards to alleviate the barriers information encounters when it passes across dissimilar
systems, infrastructures, and countries. Electronic communication is at the center of this
study. International standards will allow information to flow unencumbered across
disparate infrastructures.

Standards appear fundamental for a life-like system to exist. Technical standards
are necessary for any complex technology to exist (Krechmer, 2000). Technology, the
fruit of invention, is basic to the long-term development of any human society, and
standards bring these fruits to society in a broadly useful form. Prior to the creation of
technical standards, technical information (for example, tool making) was passed on only
by instruction and example. As society becomes more complex, technical standards
provide the means to communicate necessary common technical information broadly and
uniformly. Therein lies the importance of this study. Providing international information
standards for the global community will enhance economic opportunity.

Electronic-commerce will change how industry operates today. Relationships
between consumers and producers will change drastically. It will also effect change in the
manufacturing environment. In conjunction with these dynamics, the manufacturing
systems themselves will also have to change. We have already seen evidence of trends
toward more process data acquisition and analysis, shorter production runs, and more
stringent quality requirements. We often use the word transition because it connotes change as a process. This study specifically addresses the electronic exchange of manufacturing information and the transition from manual to electronic processes.

**Methodology**

Both quantitative and qualitative methods were used in this study. The quantitative aspects utilized a researcher-developed instrument to assess the perceptions of a select group of respondents. The qualitative portion of the survey used varying degrees of the qualitative analysis procedures on issues related to international standards adoption and implementation and were categorized to support the quantitative responses. The qualitative responses were open-ended. The qualitative response themes were discussed. Each qualitative question was analyzed separately and then grouped with quantitative response themes.

The design of the study centered around analyzing the responses to survey items developed on the following issues:

1. Processes to implement change within organizations
2. The impact development of non-proprietary international standards has on organizations
3. The change required to lead consensus for adoption and implementation of STEP NC
4. Who will lead the change necessary to adopt STEP NC within an organization.

A list was compiled of survey questions (Appendix A) concerning recommendations for the change that is required for the adoption and implementation of new technological standards.
Overview of Findings

Quantitative Findings

Questions 4 through 18 were quantitative. All of the quantitative questions asked respondents' opinions on a Likert scale ranging from *Strongly Disagree* (SD) with a value of 1, to *Strongly Agree* (SA) with a value of 5.

Qualitative Findings

Questions 19 through 27 were qualitative open-ended questions. The qualitative responses were grouped under the four research questions. In addition to the demographics, the survey questions were divided into four categories matching the four research questions for the purpose of investigating the null hypotheses. The same categories were used to group both quantitative and qualitative responses. The categories measured the respondents' beliefs in the following:

1. Change processes for implementation of international standards
2. The creation of a vision focusing on the importance and value of adoption of international standards
3. Management's familiarization and identification of benefits for organizational adoption of international standards
4. Leadership promoting the change required for adoption of international standards.

Each qualitative question was analyzed separately and then grouped with the same quantitative response category themes.
Data Analysis for Research Questions and Quantitative/Qualitative Findings

Research Question 1

Do respondents have a process in place to implement change which will benefit the changes required for implementation of new international standards within their organization?

Quantitative Responses and Analysis

Research Question 1 was answered through Items 8, 11, 14, and 17 of the survey instrument as follows:

Item #8. A coalition/team has been assembled in your organization to lead the implementation of STEP standards.

Item #11. Others in your organization are empowered to act on the vision for STEP implementation.

Item #14. New STEP approaches are institutionalized in your organization.

Item #17. Implementation of STEP is important for the manufacturing process in your organization.

Overall, the respondents agreed with the statements for item 8 ($M = 3.67$), Item 11 ($M = 3.47$), and Item 17 ($M = 2.84$), but disagreed with Item 14 ($M = 2.84$), since Item 14 did not meet the threshold mean of 3.25 set for agreement.

Each item was then analyzed using one-way ANOVA to determine whether differences existed in the perceptions of the respondents by (a) industry segment, (b) size of the organization, and (c) length of employment. Industry segment had five categories: Aerospace, Automotive, Defense, Information Technology, and Other. Size of
organization had four categories: 1–49, 50–99, 100–499, and 500+. Length of employment had four categories: 1–5 years, 6–10 years, 11–15 years, and 15+ years. Null hypotheses were tested in these respective areas.

The results of the hypothesis testing for Item #8 indicated that the null hypothesis was retained for industry segment and length of employment but was rejected for size of organization. No significant differences existed in the views held by the respondents that a coalition team has been assembled in their organization to lead the implementation of STEP standards by industry segment and length of employment.

This response indicated that the automotive segment was somewhat less enthusiastic about forming a team to lead STEP implementation than the rest of the industry segments. This is perceived to be because, at this time, the automotive industry can dictate the data format. This condition is perceived to be temporary due to the fact of future mergers and acquisitions.

However, there was a significant difference in the views held by the respondents that a coalition team has been assembled in their organization to lead the implementation of STEP standards by size of organization. The 500+ group tended not to agree ($M = 3.17$) compared to the 1–49 group that happened to be in most agreement ($M = 4.56$). Within large organizations it is more difficult to adopt new ways of transferring data. Once there are more production programs initiating the use of STEP standards, more people will form teams to advocate the values found in STEP implementation.

The results of the hypothesis testing for Item #11 indicated that the null hypothesis was retained for size of organization and length of employment but was rejected for industry segment. No significant differences existed in the views held by the
respondents that others in their organization are empowered to act on the vision for STEP implementation by size of organization and length of employment.

However, there was a significant difference in the views held by the respondents in the industry segment. The Defense group tended not to agree ($M = 3.17$) and the Aerospace group tended not to agree ($M = 3.22$) compared to the Automotive group ($M = 3.36$) and the Information Technology group who were in most agreement ($M = 4.40$).

It is perceived that even though three industry segments were slightly below the mean, there are some people who are empowered. People with fewer years in the organization feel less empowered. Once the value of STEP has been established due to the additional implementation programs, people will have concrete "lessons learned" to present to management.

The results of the hypothesis testing for Item #14 indicated that the null hypothesis was retained for industry segment and length of employment but was rejected for size of organization. No significant differences existed in the views held by the respondents that new STEP approaches are institutionalized in their organization by industry segment and length of employment.

However, there was a significant difference in the views held by the respondents that new STEP approaches are institutionalized in their organization by size of organization. The 500+ group tended not to agree ($M = 2.52$) compared to the 1–49 group that happened to be in most agreement ($M = 3.56$). There were pockets of STEP implementations. Information Technology readily viewed STEP as the technology to create interoperability.
The rest of industry was fearful of having to change their current processes. There was also the fear of the machine taking jobs away from people. When employees are educated in the facts of the use of this technology, they will be able to see where they fit into the new process. They will also see where the process they manage will become much more cost effective and efficient.

The results of the hypothesis testing for Item #17 indicated that the null hypothesis was retained for industry segment and length of employment but was rejected for size of organization. No significant differences existed in the views held by the respondents that implementation of STEP is important for the manufacturing process in their organization by industry segment and size of the organization.

However, there was a significant difference in the views held by the respondents that implementation of STEP was important for the manufacturing process in their organization by length of employment. The 11 to 15 years group \((M = 2.63)\) and the 1 to 5 years group \((M = 1.67)\) tended not to agree compared to the 15+ years group \((M = 3.40)\) and the group that happened to be in most agreement was the 6 to 10 years group \((M = 4.17)\). The perception is that due to draft status of the STEP NC standard, organizations still need proof of its value. This means we need more STEP NC demonstration programs and more production programs.

**Qualitative Responses and Analysis**

Change processes for implementation of international standards (Questions 19, 20, 23, 24, 26, and 27) qualitative responses were grouped in this category under Research Question 1.
Question 19 asked respondents, “What process do you use to implement change within your organization?” The respondents from Aerospace viewed change as a group process starting with a vision instead of an “as-is” and a “to-be” process followed by implementation. If the implementation proved successful, standard work procedures would be developed. Automotive respondents first examined new technology in pilot projects. Two interesting responses were that change happened from the top down and another response was that change happened from the bottom up.

Defense used their advanced technology groups to evaluate and then propose change. Information Technology changed processes and products through customer feedback. The perception was that the smaller the size of the organization, the more informal the change process. The larger-sized organizations (more than 100 people) had a formal process in place for change.

The Aerospace industry tended to implement standard work procedures, whereas the Automotive industry implemented pilot projects and lessons learned to create process change. Defense created policies for change with the intention that the new processes would flow down throughout the organization. The Information Technology industry segment used the process of consensus-building from customer feedback. Industry needs to contribute more funding for implementation of new technologies. Once this is accomplished, industry will institutionalize change processes.

Question 20 asked respondents, “What is your theory for managing change?” The respondents from Aerospace regarded the empowerment and motivation of people as the best way to manage change. Automotive focused on explaining the reason for managing change and then testing and evaluating the process. Defense offered the development of a
business case as a way to manage change. Information Technology suggested managing change by making change in increments, evaluating them, and moving on. If there are more rewards for changes that improve the processes we use for development of our programs, there will be more structured approaches to managing change.

Question 23 asked respondents, “Why will your organization implement STEP NC?” Aerospace would implement STEP NC to resolve interoperability issues. Automotive would implement to resolve interoperability issues and reduce lead times. Defense would implement STEP NC to resolve interoperability issues. Information Technology would implement STEP NC to resolve interoperability issues.

The perception is that the Aerospace industry believed the empowerment of people created the environment of accepting and promoting change within the organization. The Automotive industry segment believed a top management approach to educating employees in “big picture” effects of the change would provoke improvement throughout the organization. The Defense industry promoted preparation of a business case to create an environment conducive to change. Information Technology believed in a combination of understanding the relevance and utility of an idea and then evaluating it.

The smaller-sized organizations were mostly customer-driven. Larger organizations had more resources to educate, evaluate, and implement. As STEP NC permeates the processes in new programs and the government creates international standard program requirements, STEP NC will be implemented.

Question 24 asked respondents, “Why will your organization NOT implement STEP NC?” Aerospace would not implement STEP NC if there were not a sound business case. Automotive would not implement if the technology proves it did not save
money. Defense would not implement if inertia hindered the development of the technology. Information Technology would not implement until customers requested the technology.

The perception is that the Aerospace industry would implement STEP Numerical Control only if a business case warranted a good return on investment. The Automotive industry segment would not implement STEP NC unless top management endorsed the technology. The Defense industry would not implement STEP NC if their focus were on other activities they deemed more important. Information Technology would not implement STEP NC unless there were customer demand.

Small organizations will wait for other companies to perfect the standard. They will also wait for customer demand. Larger organizations will wait for the standard to mature. Defense will follow government recommendations. STEP NC is at the beginning stages of government recognition as one of the answers to resolve interoperability issues. European and Asian automotive companies are beginning to experiment with STEP NC. When the standard is endorsed as the replacement for manual operations, everyone will be eager to implement. The international STEP NC standard does not have a competing American standard that is already in use. Therefore, the advantages for adoption are imminent.

Question 26 asked respondents, "What organizational process barriers have to be overcome for implementation of STEP NC?" Aerospace responded by stating there was natural resistance to change. Automotive responded by stating that there must be senior management "buy in." Defense noted the lack of education as a barrier and held a "if it
isn’t broke, don’t fix it” mentality. Information Technology noted reluctance to change and the need for management consensus.

The perception is that the Aerospace industry would need a solid business case to justify the battles required to overcome well-established processes. The Automotive industry would have “not invented here” barriers to overcome along with the “buy in” barrier of senior management. Defense also required long-range benefits of new processes promoted repeatedly because they claimed to have systems in place that work.

The larger-sized organizations usually had a research department where there were opportunities to pilot new technologies. Larger organizations still had difficulty convincing the production side of the organization to implement due to the resistance to change. The smaller-sized organizations usually had a “wait and see” approach to implementing new technology. Organizations sized 1-49 were sometimes more adventurous due to the fact that their very existence was determined by their new approaches to problem solving using new processes. Once STEP NC is proven ready for production as a value-added process, the barriers will evaporate.

Question 27 asked respondents, “What change is required to lead the consensus for adoption and implementation of STEP NC within your organization?” Aerospace supported the development of a good business case. Automotive stated that STEP NC was accepted, and prototypes and business cases to prove value were expected in the near future. Defense stressed that education of management would create acceptance. Information Technology stated no change was required; they were customer-driven.

The perception is that the Aerospace segment is slow to change. New technology must be ingrained in new procedures with proper traceability of the benefits. The
Automotive segment requires more “buy in” from upper management. This requires education of management. Automotive pointed out that current machines would have to wear out before they could afford new machines that could accommodate the new technology. The Defense industry segment has issued a policy to use STEP standards. The change now has to be among personnel who guide the processes. All industry segments promote more education as the way to make the change happen.

The smaller-sized organizations generally agreed that the customer drives the change process. Larger-sized organizations generally agreed that education drives the change process. There need to be more organizations willing to expand their reach for the development of new processes by initiating a funding mechanism for process improvement programs.

Research Question 2

Do respondents believe their organization has a sense of urgency to create a vision focusing on the importance and value of adopting the non-proprietary international Standard for the Exchange of Product Model Data (STEP)?

Quantitative Responses and Analysis

Research Question 2 was answered through Items 4, 5, 7, 10, 12, and 13 of the survey instrument as follows:

Item #4. International non-proprietary standards are important to your organization.

Item #5. Identifying standards-based solutions are more important than corporate unification on proprietary products.
Item #7. There is a sense of urgency in your organization to establish international standards (ISO) for Standard for the Exchange of Product model data (STEP).

Item #10. There is communication of the vision of STEP throughout your organization.

Item #12. Short-term wins are obtainable using STEP standards.

Item #13. Improvements using STEP produce more opportunities for STEP usage.

Overall, the respondents agreed with the statements for Item 4 ($M = 4.49$), Item 5 ($M = 4.08$), Item 7 ($M = 3.45$), Item 10 ($M = 3.41$), Item 12 ($M = 3.59$), and Item 13 ($M = 4.08$). Each item was then analyzed using one-way ANOVA to determine whether differences existed in the perceptions of the respondents by (a) industry segment, (b) size of the organization, and (c) length of employment. Industry segment had five categories: Aerospace, Automotive, Defense, Information Technology, and Other. Size of organization had four categories: 1–49, 50–99, 100–499, and 500+. Length of employment had four categories: 1–5 years, 6–10 years, 11–15 years, and 15+ years. Null hypotheses were tested in these respective areas.

The results of the hypothesis testing for Item #4 indicated that the null hypothesis was retained for industry segment and length of employment but was rejected for size of organization. No significant differences existed in the views held by the respondents that international non-proprietary standards are important to their organization by industry segment and size of the organization groups.

However, there was a difference in views held by respondents that international non-proprietary standards are important to their organization by the length of
employment group. The 11 to 15 years group \((M = 3.75)\), the 6 to 10 years group \((M = 4.33)\), and the 15+ years group \((M = 4.63)\) were in agreement compared to the group that happened to be in most agreement, the 1 to 5 years group \((M = 4.67)\).

The responses from all industry segments and size of organizations were well above the mean with a majority of responses falling into \textit{Agree} and \textit{Strongly Agree}. The length of employment group was slightly above the mean but, compared to the other groups, showed a significant difference in agreement. The opportunity to have international agreement on the family of STEP standards for transactions was deemed important for international commerce. Every organization recognized the benefits of non-proprietary standards but seemed to be unwilling to wait while these international standards were developed. There needs to be a process to accelerate the creation of international product data standards.

The results of the hypothesis testing for Item #5 indicated that the null hypothesis was retained for industry segment and length of employment but was rejected for size of organization. No significant differences existed in the views held by the respondents that identifying standards-based solutions are more important than corporate unification on proprietary products by industry segment, size of organization, and length of employment groups. Proprietary standards limit access to interchangeable data, therefore increasing the cost of business transactions. Organizations need to volunteer their expertise and manpower in creating international standards.

The results of the hypothesis testing for Item #7 indicated that the null hypothesis was retained for industry segment, length of employment, and size of the organization. No significant differences existed in the views held by the respondents that there is a
sense of urgency in their organization to establish ISO for STEP by industry segment, size of organization, and length of employment groups.

Further analysis indicated the Automotive segment was below the established ($M = 3.25$). The mean for the automotive industry was ($M = 3.00$). A significant difference was not realized because the rest of the industry segments surveyed well above the mean. Therefore the industry segment group as a whole did not indicate a significant difference. The perception is that several North American automotive companies dictated using the same hardware and software for data exchange. This eliminated the need for standards for disparate hardware and software systems.

Most organizations, due to mergers and acquisitions, are not able to control which hardware and software are used. These organizations benefit from the use of international product data standards. North American automotive companies that have international automotive partnerships will eventually use international STEP standards because the European and Asia automotive companies are moving in that direction.

The results of the hypothesis testing for Item #10 indicated that the null hypothesis was retained for industry segment, length of employment, and size of the organization. No significant differences existed in the views held by the respondents that there is communication of the vision of STEP throughout their organization by industry segment, size of organization, and length of employment groups.

The null hypothesis was retained because of the high means of the comparable groups. The perception is that there was communication of a STEP vision. This is where education of the value of international standards will be added to the understanding of the
standards. More demonstration and production programs will convince organizations to establish a vision.

The results of the hypothesis testing for Item #12 indicated that the null hypothesis was retained for industry segment, length of employment, and size of the organization. No significant differences existed in the views held by the respondents that short-term wins were obtainable using STEP standards by industry segment, size of organization, and length of employment groups.

The null hypothesis was retained because of the high means of the comparable groups. Pilot programs testing standards are excellent vehicles for adoption of standards. More demonstration programs will convince industry of the value of STEP standards and garner organizational commitment.

The results of the hypothesis testing for Item #13 indicated that the null hypothesis was retained for industry segment, length of employment, and size of the organization. No significant differences existed in the views held by the respondents that improvements using STEP produce more opportunities for STEP usage by industry segment, size of organization, and length of employment groups.

All of the industry segment respondents were above the established mean of 3.25. Defense, Aerospace, and Information Technology were in the Strongly Agree area. Further analysis indicated all sizes of organizations and length of employment groups were above the established mean. The perception is that once STEP is implemented and results in cost savings, there will be more implementation of STEP standards. This is where more STEP implementation programs will demonstrate the value of STEP.
Qualitative Responses and Analysis

The creation of a vision focused on the importance and value of adoption of international standards (Questions 22 and 25) qualitative responses were grouped in this category under Research Question 2.

Question 22 asked respondents, “Do you consider your organization an early adopter of technology?” Aerospace took a wait-and-see approach before implementing high-end technologies and yet pushed the envelope in developing state-of-the-art high-end technologies. Automotive took a wait-and-see approach. Defense was an early adopter of technology. Information Technology was an early adopter. The perception is that the Aerospace industry is divided into two areas of technology adoption. Technology “pushers” want early adoption. Those responsible for product delivery under tight budget and time constraints want to wait and see if the technology is cost effective.

The Automotive industry segment tended to take a wait-and-see approach to the early adoption of new technology. They were very cautious of adoption unless they saw their competitors using it and taking the competitive advantage. They then jump in and at least partially adopt. The Defense industry segment was an early adopter of technology. Defense has a budget to support many laboratories to incubate technologies. The technologies flow into defense production. The Information Technology segment was usually an early adopter of technology as it enhanced their competitive position.

The smaller-sized organizations tended to be early adopters of technology to gain the competitive edge. The larger-sized organizations were split. They had departments where early adoption was possible and production departments where there was skepticism of new ways of doing business.
Question 25 asked respondents, “In your opinion, how can STEP NC add value to your organization?” Aerospace responded by verifying STEP NC’s potential of resolving interoperability issues and therefore reducing costs. Automotive supported STEP NC for streamlining data collection and therefore reducing costs. Defense supported the resolution of computer interoperability issues by STEP NC. Information Technology believed development of STEP NC would give them the competitive advantage.

The perception is that the Aerospace industry segment believed the values added were standardization and interoperability benefits. The Automotive industry segment believed the added value is less cost for more accurate data transfers. They also predicted less cost and complexity of software and controller products. The Defense industry predicted added value in the ability to switch vendors and the ability to archive data for lengthy time periods. The Information Technology segment predicted added value by offering customers a coherent mechanism in which to incorporate a complete manufacturing process.

The smaller-sized organizations saw the added value as opening up more markets for them. The larger-sized organizations saw the value as a resolution to interoperability problems. More STEP NC implementation programs will convince industry of the added value.

Research Question 3

Do respondents believe there are organizational change processes in place that familiarize and educate management about benefits of STEP Numerical Control preceding adoption and implementation of the standard?
Quantitative Responses and Analysis

Research Question 3 was answered through Items 15 and 16 of the survey instrument as follows:

Item #15. You are familiar with the Standard for the Exchange of Product model data—Numerical Control (STEP NC).

Item #16. You are familiar with post processors and RS 274 (M&G) codes.

Overall, the respondents agreed with the statements for Item 15 ($M = 3.67$) and Item 16 ($M = 3.47$). Each item was then analyzed using one-way ANOVA to determine whether differences existed in the perceptions of the respondents by (a) industry segment, (b) size of the organization, and (c) length of employment. Industry segment had five categories: Aerospace, Automotive, Defense, Information Technology, and Other. Size of organization had four categories: 1—49, 50—99, 100—499, and 500+. Length of employment had four categories: 1—5 years, 6—10 years, 11—15 years, and 15+ years. Null hypotheses were tested in these respective areas.

The results of the hypothesis testing for Item #15 indicated that the null hypothesis was retained for industry segment, length of employment, and size of the organization. No significant differences existed in the views held by the respondents that they are familiar with STEP NC by industry segment, length of employment, and size of the organization.

Further analysis indicates that all industry segments, organizational sizes, and length of employment groups were above the established mean of 3.25. The perception is that the respondents are familiar with the specific STEP NC standard within the STEP family of standards. All survey respondents were familiar with the standards.
important because STEP NC is a new standard. There needs to be a continuation of information spread throughout industry as to the value of the standards.

The results of the hypothesis testing for Item #16 indicated that the null hypothesis was retained for industry segment, length of employment, and size of the organization. No significant differences existed in the views held by the respondents that they are familiar with post processors and RS 274 (M&G) codes by industry segment, length of employment, and size of the organization.

Further analysis indicated all industry segments were familiar with M&G codes and above the established mean of 3.25. The perception is that more Automotive segment survey respondents were in the field of engineering and also knowledgeable of M&G codes, which is a manufacturing process. The perception is that the larger the size of the organization, the more opportunity people have of cross-training experiences between engineering and manufacturing.

**Qualitative Responses and Analysis**

Management’s familiarization and identification of benefits for organizational adoption of international standards (Questions 20 and 27) qualitative responses were grouped in this category under Research Question 3.

Question 20 asked respondents, “What is your theory for managing change?” The respondents from Aerospace regarded the empowerment and motivation of people as the best way to manage change for STEP NC. Automotive focused on explaining the reason for managing change and then testing and evaluating the process for manufacturing. Defense offered the development of a business case as a way to manage change for STEP.
NC. Information Technology suggested managing change by making change in increments, evaluating them, and moving on.

The perception is that the Aerospace industry believed the process of familiarizing and educating created the vision and empowered the employees with the capabilities to carry it forward. The Automotive industry segment leaned toward having a process in place to familiarize and educate top management to convince them of the importance of engineering and manufacturing interoperability. Defense believed in their established training process to lead the way for implementation of STEP NC. Information Technology had processes in place to leverage from academia and industry. All segments had a process for familiarizing and educating.

The smaller-sized organizations used employee empowerment. The larger-sized organizations used education by management for STEP NC adoption. Change can be proposed through evaluations of current processes. Once new processes are in place, the tracking of benefits must be documented.

Question 27 asked respondents, “What change is required to lead the consensus for adoption and implementation of STEP NC within your organization?” Aerospace supported the development of a good business case to create the familiarization and educational basis for changing processes to allow the adoption of STEP NC. Automotive stated that STEP NC was accepted, and prototypes and business cases to prove value were expected in the near future. Defense stressed that education of management would create acceptance. Defense also noted that government was in the process of identifying use of international standards as a requirement for future program implementation.
Information Technology stated no change was required for consensus leadership in STEP NC implementation; they were customer-driven.

The perception for all industry segments is that when the STEP NC reaches maturity and is proven effective, the processes are there to implement. Small and large-sized organizations agreed with this perception. Therefore, industry must implement pilot programs to work out the inherent problems that are part of new technology implementations.

**Research Question 4**

Are respondents able to identify a leader in their organization who will promote the changes required for the use of STEP standards?

**Quantitative Responses and Analysis**

Research Question 4 was answered through Items 6, 9, and 18 of the survey instrument as follows:

- Item #6. The standards process takes too long and lags the state of the art.
- Item #9. There is a leader within your organization promoting STEP.
- Item #18. There is a leader within your organization promoting STEP NC.

Overall, the respondents agreed with the statements for Item 6 ($M = 3.76$), Item 9 ($M = 3.76$), and Item 18 ($M = 3.12$). Each item was then analyzed using one-way ANOVA to determine whether differences existed in the perceptions of the respondents by (a) industry segment, (b) size of the organization, and (c) length of employment. Industry segment had five categories: Aerospace, Automotive, Defense, Information Technology, and Other. Size of organization had four categories: 1–49, 50–99, 100–499,
and 500+. Length of employment had four categories: 1–5 years, 6–10 years, 11–15 years, and 15+ years. Null hypotheses were tested in these respective areas.

The results of the hypothesis testing for Item #6 indicated that the null hypothesis was retained for industry segment, length of employment, and size of the organization. No significant differences existed in the views held by the respondents that the standards process takes too long and lags the state of the art by industry segment, length of employment, and size of the organization. Respondents indicated their frustration with the painstaking process of international standards development when organizations are ready to implement the new technology now. This is where industry can dedicate and support their experts in assisting the international standards community in developing standards that will benefit everyone.

The results of the hypothesis testing for Item #9 indicated that the null hypothesis was retained for industry segment and length of employment but was rejected for size of organization. No significant differences existed in the views held by the respondents that there is a leader within their organization promoting STEP by industry segment and length of employment. The 50–99 group happened to be in most agreement ($M = 4.50$). Organizations were likely to have a leader promoting the family of STEP standards. North American industry needs to cooperate with their European and Asian partners and counterparts to move the international standards technology into their organizations.

The results of the hypothesis testing for Item #18 indicated that the null hypothesis was retained for industry segment and length of employment but was rejected for size of organization. No significant differences existed in the views held by the respondents that there is a leader within their organization promoting STEP NC by
industry segment and length of employment. However, there was a significant difference in the views held by the respondents that there is a leader within their organization promoting STEP NC by size of organization. The 500+ group tended not to agree \((M = 2.83)\) compared to the 1 – 49 group that happened to be in most agreement \((M = 4.11)\).

Further analysis indicated all industry segments were above the established mean of 3.25 in agreeing there was a leader in their organization promoting STEP NC. Three out of four “size of organization” groups were above the established mean. Organizations of 50-99 \((M = 3.17)\) were below the established mean. Three out of four of the “length of employment” groups were above the established mean. The 1 to 5 years group \((M = 3.00)\) was below the established mean. The perception is that there is leadership in promoting STEP NC. This leadership is on a small scale and needs to be moved to top management once the value of STEP NC is proven.

**Qualitative Responses and Analysis**

Leadership promoting the change required for adoption of international standards (Questions 21 and 27) qualitative responses were grouped in this category under Research Question 4.

Question 21 asked respondents, “What do you do to lead the change process in your organization?” Aerospace educated, taught, and then “got out of the way.” Automotive led with education and introduction of new ideas. Defense proposed and executed cooperative Research and Development projects. Information Technology communicated ideas with vision and enthusiasm.

The perception is that Aerospace had leaders who presented plans to communicate the effectiveness of the STEP standards by invigorating personnel with a
vision of future dynamic accomplishments. The Automotive industry created "champions" to promote the promise of STEP standards implementation. The Defense industry leaders participated in high level technology and management groups that could elevate requirements to the appropriate levels to initiate mandated policy. The Information Technology segment leaders brought outside STEP information to their management.

Smaller- and larger-sized organizations had identifiable leaders that brought the vision to the rest of the organization. Publicizing new technology approaches throughout the organization will open the door for acceptance. People need to share this information across departments by inviting everyone to the demonstrations or briefings of the potential benefits.

Question 27 asked respondents, "What change is required to lead the consensus for adoption and implementation of STEP NC within your organization?" Aerospace supported leadership in promoting the development of a good business case and the possibility of global use agreements. Automotive stated that management and the technical expert leaders should be communicating on an ongoing basis. This way STEP would be accepted, and prototypes and business cases would prove value. Defense stressed that education of management would create acceptance. Defense also stated that the participants in the STEP program should be the leaders for consensus of STEP adoption and implementation. Information Technology stated that the user base carried the leadership flag. They were also customer-driven.

The perception is that all industry segments had leaders/champions who were continuously eager to enlighten their organizations. They were usually leading the way
for process change. Some of the past experiences with international standards were negative. Leaders within industry must convince their organizations that these old problems have been fixed and the newer standards are now deployable.

Discussion

The survey sample findings from every industry segment queried were in favor of adoption and development of non-proprietary international standards to enhance computer hardware/software interoperability issues. This was usually a popular belief, but obstacles in establishing non-proprietary international standards were many. One of the obstacles is the resistance to change. According to Hammer and Champy (1993), “America’s business problem is that it has entered the 21st century with companies designed during the 19th century” (p. 122). Reengineering the corporation requires challenging assumptions and embracing change. This requires leaders who are brave enough to “start over.” The reengineering leader makes reengineering happen.

Organizations have invested funding, training, and organizational structuring into retaining systems that were developed only for each department. Therefore, those systems have proprietary software that is not interoperable (Brunnermeir & Martin, 1999). It will take time to replace those proprietary systems. Burrus and Gittines (1998) discuss how sweeping technological innovations have changed the rules. In order to be successful, one must know how to deal with the new business rules, which will transform decision making and management processes worldwide.
Although there are pockets of international standards use within departments, the North American automotive industry continues to ignore institutionalized implementation of international standards. This non-commitment is at the expense of program efficiency.

The North American automotive industry places the burden of interoperability on its strained supplier base. This will soon become an issue, as the cost to produce automobiles in the United States is greater than in the European and Asian automotive industries.

The Aerospace and Defense industries were in the forefront of international standards use. The Air Force, Army, and Navy realize the interoperability benefits. There are still issues of funding program implementation. The military has issued a memorandum in support of using STEP for an interoperability strategy for product data throughout the life cycle (Joint Aeronautical Commanders Group, 2002).

The respondents from every industry segment queried viewed communication, education, and pilot programs as the methods to initiate process change. Demonstration and pilot programs initiated by government interest will push international standards technology into organizations as a method for reducing development cycle times. Most respondents in every industry segment queried were knowledgeable of the international standard STEP NC. The respondents were knowledgeable because they were part of the standards process. Media interest (newspapers, magazine articles) in the promotion of the technology and reaching the entire industrial community (Albert, 2000; Hardwick, 2000; Waurzyniak, 2001; Weyrich, 2001; Wichmann, 2000) will promote understanding of the standard and its capabilities.
The survey respondents were anxiously waiting for further testing and development of STEP NC. The respondents felt that once STEP NC was in place in their organization, there would be significant cost-saving benefits. There is a lack of funding both in government and industry to develop technologies for process improvements. In the past, government led the way for new technology development. Meanwhile, military-related research and development spending has been falling as a share of the total United States' R&D, from half in 1960 to one-third by 1970. Today, it is down to 15% of the total (Coy, 2003). The government was instrumental in creating technologies such as the Internet and global positioning systems. We need to regain government support to create a competitive environment for industry in America.

The respondents from every industry segment queried felt further development and implementation of STEP NC would revolutionize the exchange of data between engineering and manufacturing. There was a wide range in the response to leadership for change. Some felt that leadership was from the top down within the organization and others felt it was a bottom-up process. Invariably all industry segments had champions/leaders who promoted change within their organizations. Therefore, the leader must learn to cultivate what Warren Bennis (1989) calls the “management of attention” at every level of an organization’s relational web and purpose.

This study has supported and validated the research and testing efforts the STEP NC community has undertaken in developing this new standard. This study has also supported the thesis that changing the way business is done is a difficult process. Only when the cost benefits of this standard are tested, refined, and proven will industry adopt the new procedures.
Conclusion

There are several significant questions that this study answers. The following research questions and their responses are discussed.

1. Do respondents have a process in place to implement change that will benefit the adoption of new international standards within their organization?

Yes, there were processes in place to implement change. There was a slight disagreement within the size of the organization group. It is perceived that the larger-sized organizations did not have a specific team in place to implement a change process that would benefit the adoption of international standards, but did have processes for change, whereas the industry segment group and the length of employment group agreed that there was a change team in place that would benefit international standards implementation.

When asked if others were empowered to act on the vision of STEP, the industry segment disagreed while the other two groups, size of organization and length of employment, agreed. This is due to the fact that the Automotive industry segment was not actively pursuing the use of international standards. Institutionalizing international standards was determined by industry segment, with the lack of international standardization within the Automotive industry skewing the responses very close to a Disagree. Larger organizations had not institutionalized international standards. This was determined by the bulk of the respondents who were from the larger organizations within the Automotive industry.

2. Do respondents believe their organization has a sense of urgency to create a
vision focusing on the importance and value of adopting non-proprietary international Standards for the Exchange of Product Model Data (STEP)?

Almost all groups agreed in the sense that they felt there was importance, urgency, and value in adopting STEP standards. The only group that felt their organization lagged in this effort were people who had been employed for over 15 years. The perception is that they had become a little disappointed in their organization's ability to recognize the importance of international standards and to move forward in a timely manner.

3. Do respondents believe there are organizational change processes in place that familiarize and educate management about benefits of STEP Numerical Control preceding adoption and implementation of the standard?

Everyone was familiar with STEP NC and M&G codes. The perception is that because this group has been active within the international standards community, they were well aware of the current standards and the new technology that will replace them. They were the champions for educating and familiarizing their organization.

4. Are respondents able to identify a leader in their organization who will promote the changes required for the use of STEP standards?

All groups could identify a leader within their organization who promoted international STEP standards. They also agreed that the creation of international standards took too long. One of the reasons for the length of time it takes to create and approve an international standard is the number of countries that have to concur on content and format, and the volunteer aspect of the various committees. One of the
interesting factors is that there was a leader promoting not only STEP standards but also specifically the STEP NC standard.

Overall, there was an agreement of survey respondents that the future of engineering and manufacturing data interoperability was in developing non-proprietary international standards to promote global business.

**Recommendations**

1. Further studies should be conducted on a larger scale as the STEP standard matures including teamwork and leadership issues associated with resistance to change within organizational cultures. The advantages of further studies would be to assist organizations in expediting the adoption of STEP standards.

2. Industry should set aside funding to pilot international STEP NC standards in production environments promoting the urgency and early adoption of the standard.

3. Studies should be conducted on pilot results with the objective of establishing limited production programs for STEP NC. Publication of the studies will encourage industry to move the STEP technology into production.

4. U. S. Government should increase R&D funding to encourage development of international standards technologies to improve industry processes.

5. Government and industry should work together to create a business case for the emerging STEP standard using pilot program results for educating the organization.

6. Industry in North America should become aware of their competitors’ efforts in Europe and Asia in the use of international standards. They should initiate processes within their organizations for adoption of international standards by creating teams within
their organization to explore joint STEP projects with their suppliers and off-shore divisions.
APPENDIX A

DISSENGTATION SURVEY: LEADERSHIP IN REACHING GLOBAL
CONSENSUS ON TECHNOLOGICAL STANDARDIZATION

Part 1: About Your Organization

1. Check (X) appropriate response.

<table>
<thead>
<tr>
<th>Aerospace</th>
<th>Materials</th>
<th>Defense</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>Factory Automation</td>
<td>Information Tech.</td>
</tr>
<tr>
<td>Electronics</td>
<td>Mfg. Equip./Process</td>
<td>Test and Inspection</td>
</tr>
<tr>
<td>Energy</td>
<td>Research (University)</td>
<td>Other</td>
</tr>
<tr>
<td>Health Care</td>
<td>Telecommunications</td>
<td></td>
</tr>
</tbody>
</table>

2. Size of your organization (by number of employees)

<table>
<thead>
<tr>
<th>1-49</th>
<th>50-99</th>
<th>100-499</th>
<th>500+</th>
</tr>
</thead>
</table>

3. How long have you been employed in your field?

<table>
<thead>
<tr>
<th>1 to 5 years</th>
<th>6 to 10 years</th>
<th>11 to 15 years</th>
<th>15+ years</th>
</tr>
</thead>
</table>

Part 3: SURVEY QUESTIONS–LEADERSHIP IN REACHING CONSENSUS IN TECHNOLOGICAL STANDARDIZATION
(Please X or Circle Answer)

Strongly Disagree Disagree Neutral Agree Strongly Agree

4. International non-proprietary Standards are important in your organization.

SD D N A SA

5. Identifying standard-based solutions is more important than corporate unification on proprietary products.

SD D N A SA

6. The standards process takes too long and lags the state of the art.

SD D N A SA

233
7. There is a sense of urgency in your organization to establish international standards (ISO) for STandard for the Exchange of Product model data (STEP).

8. A coalition/team has been assembled in your organization to lead the implementation of STEP standards.

9. There is a leader within your organization promoting STEP.

10. There is communication of the vision for STEP throughout your organization.

11. Others in your organization are empowered to act on the vision for STEP implementation.

12. Short-term wins are obtainable using STEP standards.

13. Improvements using STEP produce more opportunities for step usage.

14. New step approaches are institutionalized in your organization.

15. You are familiar with the Standard for Exchange of Product model data – Numerical Control (STEP NC).

16. You are familiar with post Processors & RS 274(M&G) codes.

17. Implementation of STEP NC is important for the manufacturing process in your organization.

18. There is a leader within your organization promoting STEP NC.
19. What process do you use to implement change within your organization?

20. What is your theory for managing change?

21. What do you do to lead the change process in your organization?

22. Do you consider your organization an early adopter of technology, or does your organization have a wait-and-see approach?

23. Why will your organization implement STEP NC?

24. Why will your organization NOT implement STEP NC?

25. In your opinion how can STEP NC add value in your organization?

26. What organizational process barriers have to be overcome for implementation of STEP NC?

27. What change is required to lead the consensus for adoption and implementation of STEP NC within your organization?
APPENDIX B

PARTICIPANT LETTER

Dear Participant:

My name is Carol Tierney and I am a doctoral student at Andrews University. As part of my research, I am examining the attitudes, perceptions, and beliefs that participants hold regarding international product data exchange standards and specifically the Standard for the Exchange of Product Model Data – Numerical Control (STEP NC), and to determine the acceptance and implementation of the standard.

The following survey will require approximately fifteen minutes or less to complete. There is no compensation for responding, nor is there any known risk. In order to insure that all information will remain confidential, any potential identifying links such as e-mail addresses will be eliminated upon completion of the survey. Copies of the project will be provided to my Andrews University advisor as well as the Advanced Technology Program Industrial Review Board (IRB). If you choose to participate in this project, please answer all questions as honestly as possible and return the completed questionnaire promptly through email to my address (tierneyc@gdls.com). Participation is strictly voluntary and you may refuse to participate at any time.

Thank you for taking the time to assist me in my educational endeavors. The data collected will provide useful information regarding international standards and hopefully assist in the acceptance and implementation of those standards. Completion and return of the questionnaire will indicate your willingness to participate in this study. If you require additional information or have questions, please contact me at the telephone number below.

Sincerely,

Carol Tierney (586) 825-5230
### Table 77

**Question 19: Qualitative Responses Based on Size of the Organization and Industry Segment**

<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>What process do you use to implement change within your organization?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>Envision what the desired state is understand where you are develop a plan to change from current state to future desired state and implement</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Process neither well-defined nor consistent</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Townhall meetings; management team consensus at the high level</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>As a small company our change process is informal. Change is initiated both top-down and bottom-up with wide communication and opportunity for feedback. In some cases change is introduced and pioneered within a business unit for subsequent adoption co</td>
<td></td>
</tr>
<tr>
<td>Aerospace 100-499</td>
<td>Architecture Standards Board</td>
<td></td>
</tr>
<tr>
<td>Aerospace 500+</td>
<td>We are currently implementing standard work for manufacturing engineering. This includes NC Standard Work. Process changes will be implemented through standard work procedure changes and guidelines</td>
<td></td>
</tr>
<tr>
<td>Aerospace 1-49</td>
<td>Doing the performance matrix from AS-IS to TO-BE and quantify the gains of STEP-NC</td>
<td></td>
</tr>
<tr>
<td>Aerospace 500+</td>
<td>One-on-one contacts. Plant ideas in such a manner that the plantees thinks its their idea</td>
<td></td>
</tr>
<tr>
<td>Aerospace 500+</td>
<td>No response</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>Validation and testing in a non-production environment first. Implement changes in a pilot project. Full deployment after successful pilot project.</td>
<td></td>
</tr>
<tr>
<td>Automotive 1-49</td>
<td>Since we are a standardization type of body: consensus awareness</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>Investigate prove value get support get approval get buy in implement.</td>
<td></td>
</tr>
<tr>
<td>Check appropriate response</td>
<td>Size of your organization (by number of employees)</td>
<td>What process do you use to implement change within your organization?</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>In technology a pilot project approach is taken. After success there are competence networks where the results can be shown and discussed (within manufacturing). Company standard routines can then be elaborated and establish if decided.</td>
<td></td>
</tr>
<tr>
<td>Automotive 50-99</td>
<td>Lead from the top and assigned to the department most effected.</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>CDS development system</td>
<td></td>
</tr>
<tr>
<td>Automotive 1-49</td>
<td>The process to implement has a number of steps. The idea for change is evaluated followed by testing on pilot basis. This is followed by limited production using production data. The final step is inclusion into the overall process.</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>Education examples of success and marketing</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>Change comes from either top down corporate initiatives or through bottom-up projects that are solving specific problems</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>Bottom-up approach which should be just the opposite. Also I am in a prototype area and try to procure and test new and different metrology equipment.</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>Try to commonize Use lessons learned Standard solutions to make applications plug and play [not pray]</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+ Defense 500+</td>
<td>Controlled ECR's through web or PLM system</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>When faced with an urgent problem groups look into Changing methods to resolve the issue. When problems are not pressing it is difficult to motivate people to make drastic Changes.</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>By publishing changes to policy which then cascades down through the organisational structure down to desk level</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>The advanced technology group typically prototypes new technology solutions via cooperative R&amp;D activities and then works to transition to production.</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>Raising technologies issues advantages and disadvantages with management with frequent follow-up for technology insertion.</td>
<td></td>
</tr>
<tr>
<td>Factory Automation 1-49</td>
<td>Successful implementations that deliver problem solutions are the most effective evangelist in our organization.</td>
<td></td>
</tr>
<tr>
<td>Check appropriate response</td>
<td>Size of your organization (by number of employees)</td>
<td>What process do you use to implement change within your organization?</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>Skip</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>Change occurs when a technology champion who has support of key industry stakeholders in government industry and the science and technology community pushes forward new or innovative ideas. These ideas generally have to match long-term planning that</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>We are a software developer that responds directly to the needs of our customers (Alibre Inc.)</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>I work with the management team and delegate based on my sense of what is required</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>Top down approach.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>-</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>Consensus building based on customer feedback.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>50-99</td>
<td>xx</td>
</tr>
<tr>
<td>Information Technology</td>
<td>100-499</td>
<td>Mainly project related change used to fund new processes for adoption.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>6 Sigma</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>50-99</td>
<td>Depends on the change. As we're a vendor the majority of our product direction is determined by market conditions and customer demand.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>I am not sure what you are asking but at the moment we are quite heavily involved in process orientation of the organisation. I think it is not One process. It depends on the type of change and the area where the change is implemented.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>1-49</td>
<td>Information dissemination on the new possibilities offered by the concept of product data and STEP-NC</td>
</tr>
<tr>
<td>Research (University)</td>
<td>50-99</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Research (University)</td>
<td>500+</td>
<td>By consensus</td>
</tr>
</tbody>
</table>
### Question 20, Qualitative Responses Based on Size of the Organization and Industry Segment

<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>What is your theory for managing change?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>Same</td>
<td>Try to get everyone to understand and buy-in on change at the outset</td>
</tr>
<tr>
<td>Other</td>
<td>Involve all affected</td>
<td>I believe that changing the behavior of people is essential to achieving long-lasting change and that people tend to respond more to feelings rather than logic when considering change.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>100–499</td>
<td>Technology roadmaps for communication and visualization of a given time frame.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>I don't have a theory</td>
</tr>
<tr>
<td>Aerospace</td>
<td>1–49</td>
<td>Through Empowerment of the employees and motivation</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>Ask questions that tend to keep folks moving in a productive direction and out of the dead end side roads. Create win-win collaborations with folks and groups attempting to do make the same type of changes in their respective organizations.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>no response</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Fully tested and validated the changes before implementation</td>
</tr>
<tr>
<td>Automotive</td>
<td>1–49</td>
<td>Don't understand the question</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Change must add Value!</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>I have personally no idea of theories in the management area however test and evaluation in a structured way seems to be fruitful.</td>
</tr>
<tr>
<td>Automotive</td>
<td>50-99</td>
<td>Education and buy in by all effected departments.</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Small successful steps</td>
</tr>
</tbody>
</table>
| Automotive                | 1–49                                          | My theory of managing change is to look at the process for deficiencies or bottlenecks. Try to find or invent a new way of handling a process. Propose a
<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>What is your theory for managing change?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive 500+</td>
<td>change based on information gathered through evaluations. Then implement the change when all indicate</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>There is a need for well informed open minded and capable top management team.</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>a) get management sponsorship b) identify the key issues to deployment of the new process/change c) manage expectations</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>Offer an explanation of the theory behind the change. It satisfies the curiosity and can often provoke improvements through innovative enhancements to the change that is to be implemented.</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>Make presentations Try an get management buy in Try and make the various levels think alike electronically tracked documents</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>I believe that one must be willing to try new techniques and evaluate the results of change. It is important to track change carefully and re-evaluate rather than to resist trying the change.</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>Just do it!</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>Technology changes are difficult to attain unless matched with a suitable and pressing business case.</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>Persistence and Patience.</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>We must assume that creation of goals is a closed loop process. We must continually re-evaluate our current situation to make sure we are leveraging from industry and academia. Identified technology or methodology gaps must then enter the planning stag</td>
<td></td>
</tr>
<tr>
<td>Factory Automation 1-49</td>
<td>Information Technology 1-49 skip</td>
<td></td>
</tr>
<tr>
<td>Information Technology 500+</td>
<td>Unclear. I suppose it is a combination of understanding the relevance and utility of new technology and then evaluating whether it will actual be beneficial/effective.</td>
<td></td>
</tr>
<tr>
<td>Information Technology 1-49</td>
<td>Market demand.</td>
<td></td>
</tr>
<tr>
<td>Information Technology 1-49</td>
<td>Make incremental changes constantly as a learning process. Evaluate and move on.</td>
<td></td>
</tr>
<tr>
<td>Check appropriate response</td>
<td>Size of your organization (by number of employees)</td>
<td>What is your theory for managing change?</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>None.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>Change is validated by proper user even changed again if necessary.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>Common sense; Come to a timely decision after appropriate due diligence.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>50-99</td>
<td>xx</td>
</tr>
<tr>
<td>Information Technology</td>
<td>100-499</td>
<td>Again project team approach total team buy-in even if others in organisation do not follow.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>Top Down</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>50-99</td>
<td>Again depends on the type of change. Some things can be effected through edict while others need to be effected through consensus. Certainly supporting information makes the justification of the change easier.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>Also here I am uncertain of your question. Generally as far as I know we do not have a very specific theory for methods to implement changes. Often a project or organisation is built around a person or group that has ideas or solutions that has potential</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>1-49</td>
<td>It will take 3 to 5 years to convince more managers to use STEP and STEP-NC standards due to missing available products in the CAM and CNC area.</td>
</tr>
<tr>
<td>Research (University)</td>
<td>50-99</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Research (University)</td>
<td>500+</td>
<td>By consensus</td>
</tr>
</tbody>
</table>
Table 79

*Question 21, Qualitative Responses Based on Size of the Organization and Industry*

**Segment**

<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>Question 21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td></td>
<td>Must be driven supported by top management.</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>I don't</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>Make it very visible that I have embraced the change</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>I articulate the benefit/cost to the organization and gain insight from key players impacted by the process. It is essential that the key players buy-in to the change and take ownership. Acceptance requires a trust/belief that the organization and the</td>
</tr>
<tr>
<td>Aerospace</td>
<td>100-499</td>
<td>Develop contextual views presentations plans architecture infrastructure to communicate the as-is and to-be views that fit our business model.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>I lead the NC standard work team. Consensus of the team with representatives from across manufacturing provides the authority for changes to standard work. Procedural changes must be balloted.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>1-49</td>
<td>Education teaching and Accelerated Integrated workshop (AIWs)</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>Give very smart people very good ideas and then get out of the way.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>no response</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Work with all parties who will be impacted by the change.</td>
</tr>
<tr>
<td>Automotive</td>
<td>1-49</td>
<td>I stress the importance of communicating correct information I support exchange of experience I support any activity that could raise awareness</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>I am basically a technical resource/manager and serve as in house champion/sales to demonstrate value of new technology</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Discuss new things and try to see if there is a real need and if so make a case study in a project group including operators and maintenance staff.</td>
</tr>
<tr>
<td>Automotive</td>
<td>50-99</td>
<td>Lead by example Assure that I am using the latest technology to advance the company and insist departmental Vice-Presidents do the same.</td>
</tr>
<tr>
<td>Check appropriate response</td>
<td>Size of your organization (by number of employees)</td>
<td>What do you do to lead the change process in your organization?</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------------------------------------------</td>
<td>--------------------------------------------------------------</td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>Direct involvement with standards committees develop vision projects to test new ideas develop pilot projects to assess cost improvements</td>
<td></td>
</tr>
<tr>
<td>Automotive 1-49</td>
<td>I investigate new and emerging software to see where it will fit into our process and if there will be return on investment (ROI) if we were to implement that software. I also identify computer hardware changes that may need to occur based on the software</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>I try to make sure that people on all levels in the organisation are educated properly regarding standardization. There is a need for creative marketing.</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>a) communication b) incorporation</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>Offer process and product improvements to Management.</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>Send messages</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>enable the tracking technology assist with performing the change as needed</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>I try to publicize within the organization the results and benefits of projects I am involved with. It is hoped that knowledge of the benefits of the change will lead to a willingness to attempt change.</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>I don't.</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>Propose and execute cooperative R&amp;D projects. Manage technology transfer activities.</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>Participate on high level technology and management groups that can elevate requirements to the appropriate levels.</td>
<td></td>
</tr>
<tr>
<td>Factory Automation 1-49</td>
<td>Design and deliver systems that solve our organizations problems.</td>
<td></td>
</tr>
<tr>
<td>Information Technology 1-49</td>
<td>skip</td>
<td></td>
</tr>
<tr>
<td>Information Technology 500+</td>
<td>I provide input in the change process that is relevant to my technical area. Input can come from people from every part of the organization to help make plans as strong and effective as possible.</td>
<td></td>
</tr>
<tr>
<td>Information Technology 1-49</td>
<td>Bring Market demand and Industry needs to the attention of our management team.</td>
<td></td>
</tr>
<tr>
<td>Information Technology 1-49</td>
<td>Regular management meetings. Regular one-on-one</td>
<td></td>
</tr>
<tr>
<td>Check appropriate response</td>
<td>Size of your organization (by number of employees)</td>
<td>What do you do to lead the change process in your organization?</td>
</tr>
<tr>
<td>----------------------------</td>
<td>---------------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Technology</td>
<td></td>
<td>meetings with the management teams.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>More communications.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>Processes copy and where used controls.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>Convince others with facts vision and enthusiasm.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>50-99</td>
<td>xx</td>
</tr>
<tr>
<td>Information Technology</td>
<td>100-499</td>
<td>Business case led.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>Seed idea followed by strong business case and demonstratable benefits</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>50-99</td>
<td>Disseminate Educate Motivate and Congratulate</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>Create understanding through presentations seminars training and prototyping/testing. Get support from management get the right people/resources Work out solutions</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>1-49</td>
<td>our organisation is convinced so I try to convince SME managers in the area we are active.</td>
</tr>
<tr>
<td>Research (University)</td>
<td>50-99</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Research (University)</td>
<td>500+</td>
<td>By consensus</td>
</tr>
</tbody>
</table>
Table 80

**Question 22: Qualitative Responses Based on Size of the Organization and Industry**

**Segment**

<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>Do you consider your organization an early adopter of technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>depend on ROI within a year or so. Also depends on state of current technology.</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Early adopter</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Middle of road</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Early adopter</td>
<td></td>
</tr>
<tr>
<td>Aerospace</td>
<td>1-49 YEs</td>
<td></td>
</tr>
<tr>
<td>Aerospace</td>
<td>100-499 Mostly wait and see however I am working on the ANC project to promote the development of STEP-NC. I have been working on STEP-NC for 7 years now.</td>
<td></td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+ Depends on the technology. We are continually involved in process improvement and research on new processes.</td>
<td></td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+ Technology pushers want early adoption. Those responsible for product delivery under tight budget &amp; time constraints want to wait and see.</td>
<td></td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+ wait-and-see before implementing high-end mature technologies yet pushing the envelope in developing state-of-the-art high-end technologies</td>
<td></td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+ no response</td>
<td></td>
</tr>
<tr>
<td>Automotive</td>
<td>500+ In the particular area involving the development and use of STEP my organization is definitely using the wait-and-see approach.</td>
<td></td>
</tr>
<tr>
<td>Automotive</td>
<td>500+ Used to be early adopter of technology now the organization is taking the wait-and-see approach.</td>
<td></td>
</tr>
<tr>
<td>Automotive</td>
<td>500+ wait and see 75% early adopter 25% (when competitive advantage is through change)</td>
<td></td>
</tr>
<tr>
<td>Automotive</td>
<td>500+ early adopter</td>
<td></td>
</tr>
<tr>
<td>Automotive</td>
<td>500+ Wait and see</td>
<td></td>
</tr>
<tr>
<td>Automotive</td>
<td>500+ The company takes part in development of new technologies but implementation might never risk the quality of the products being produced. Therefore good investigation procedures are important.</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>Do you consider your organization an early adopter of technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive 500+</td>
<td>Wait-and-see</td>
<td></td>
</tr>
<tr>
<td>Automotive 50-99</td>
<td>We push to understand technology and implement as soon as we can to get an advantage in the marketplace.</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>early adopter</td>
<td></td>
</tr>
<tr>
<td>Automotive 1-49</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>Both where technology can potentially impact us internal to our organization we investigate and sometimes participate in early adopter programs. However our OEM customers often dictate what we must do. Example NO translation from CAD tool A to CAD too.</td>
<td></td>
</tr>
<tr>
<td>Automotive 1-49</td>
<td>I think we take both approaches. Technology that we see an immediate ROI we will aggressively approach especially if we see a competitive advantage. The wait and see approach on technology comes in play when we are not completely sold on an idea or th</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>Mixture of the above.</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>It varies depending upon the current situation. When faced with serious problems the organization has been willing to adopt drastic and innovative solutions. In normal times the organization proceeds much more cautiously.</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>We are usually an early adopter. Deployed an EJB system in 1999 led the development of several STEP standards (for shipbuilding). Have deployed production STEP XML support (AP227).</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>In many areas associated with ammunition organization is generally leading technology. For ISO including STEP NC generally involved in pockets of interest in adapting technologies developed by others.</td>
<td></td>
</tr>
<tr>
<td>Factory Automation 1-49</td>
<td>The majority of the organization is wait-and-see; my group integrates the latest technology.</td>
<td></td>
</tr>
<tr>
<td>Information Technology 1-49</td>
<td>By definition software developers are defined by developing technology for the early adopter.</td>
<td></td>
</tr>
<tr>
<td>Information Technology 500+</td>
<td>Wait-and-see; has developed parallel technology on a specific point.</td>
<td></td>
</tr>
<tr>
<td>Check appropriate response</td>
<td>Size of your organization (by number of employees)</td>
<td>Do you consider your organization an early adopter of technology</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>Sometimes an early adopter and sometimes wait-and-see. Strangely we are early adopters on the hard visionary stuff and wait and see on the easy obvious stuff.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>100-499</td>
<td>Front edge early adopter if good business match.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>50-99</td>
<td>xx</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>Yes</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>The organization is an early adopter in order to evaluate and measure technology to promote better standards efforts that relevant to industry.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>We are about the first implementers of various aspects of the STEP standard</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>Wait-and-see.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>It depends on what area it is. We are quite early ahead of others in some areas but more wait and see in other areas.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>1-49</td>
<td>We are an early adopter</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>50-99</td>
<td>We tend to stay very aware of leading edge technologies but are not bleeding edge implementers due to our customers' expectations.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>Wait &amp; See</td>
</tr>
<tr>
<td>Research (University)</td>
<td>50-99</td>
<td>Yes</td>
</tr>
<tr>
<td>Research (University)</td>
<td>500+</td>
<td>Depending on areas of research.</td>
</tr>
</tbody>
</table>
Table 81

**Question 23: Qualitative Responses Based on Size of the Organization and Industry**

**Segment**

<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>Why will your organization implement STEP NC?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td></td>
<td>We will only implement if ROI is favorable (this could also be a result of increased sales industry perception as a leader versus productivity gains).</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>NA---We are a technology developer</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>Won't</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Aerospace 1-49</td>
<td></td>
<td>If business justifies we will adapt.</td>
</tr>
<tr>
<td>Aerospace 100-499</td>
<td></td>
<td>Hopefully for supporting our build anywhere initiative. It will most likely be used out of house at or vendor sites first.</td>
</tr>
<tr>
<td>Aerospace 500+</td>
<td></td>
<td>We don't know yet if we will. If there is a good business case for it we will. As a company that has to manage 200+ post processors it could greatly simplify the programming process especially if the type II data is standardized (probing data upload et</td>
</tr>
<tr>
<td>Aerospace 500+</td>
<td></td>
<td>Will not want to be seen as being a technology utilization laggard</td>
</tr>
<tr>
<td>Aerospace 500+</td>
<td></td>
<td>- interoperability between CAM systems and CNC's</td>
</tr>
<tr>
<td>Automotive 500+</td>
<td></td>
<td>no response</td>
</tr>
<tr>
<td>Automotive 500+</td>
<td></td>
<td>The day top management of my organization understands the importance of STEP and is convinced that the software is robust and reliable STEP NC and other STEP applications will be implemented.</td>
</tr>
<tr>
<td>Automotive 500+</td>
<td></td>
<td>To streamline CAE-CAD-CAM-Control process.</td>
</tr>
<tr>
<td>Automotive 500+</td>
<td></td>
<td>ROI and vendor support of standard</td>
</tr>
<tr>
<td>Automotive 500+</td>
<td></td>
<td>try to standardize input to NC machines and output from groups prior to manufacturing</td>
</tr>
<tr>
<td>Automotive 500+</td>
<td></td>
<td>If it proves to live up to advertisement If controls can be obtained If UG cooperates</td>
</tr>
<tr>
<td>Automotive 500+</td>
<td></td>
<td>The biggest need is probably in the method workshops and prototype workshops where the programming time exceeds the machining time. STEP-NC seems to be the next generation of direct</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>Why will your organization implement STEP NC?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive 500+</td>
<td>500+</td>
<td>We will probably implement STEP NC when it has been proven and can be demonstrated to offer an advantage over our present system.</td>
</tr>
<tr>
<td>Automotive 50-99</td>
<td>500+</td>
<td>Cut cost and speed product delivery to our customers.</td>
</tr>
<tr>
<td>Automotive 1-49</td>
<td>1-49</td>
<td>It will implement STEP when STEP is a proven technology and cost improvements are realized.</td>
</tr>
<tr>
<td>Automotive 1-49</td>
<td>500+</td>
<td>We do not implement directly we work on behalf of those who are implementing. So I could express their view: Our principals implement STEP NC since it is a mean to reduce cost shorten lead-times and adapt to a growing complexity.</td>
</tr>
<tr>
<td>Automotive 1-49</td>
<td>500+</td>
<td>N/A</td>
</tr>
<tr>
<td>Automotive 1-49</td>
<td>500+</td>
<td>- To replace older technologies. - Elimination of unique post processors for each NC machine. - Represents a 30% increase in throughput. - Industry recognized standard for processing NC cutter information. - Supported by the CAD industry.</td>
</tr>
<tr>
<td>Defense 500+</td>
<td>500+</td>
<td>It won't.</td>
</tr>
<tr>
<td>Defense 500+</td>
<td>500+</td>
<td>To provide more flexibility and the ability to deal with various vendors.</td>
</tr>
<tr>
<td>Defense 500+</td>
<td>500+</td>
<td>Yes although not for the current APs that address milling and turning. We don't do much of that but we are working on the Integrated Steep Processing Environment project (NSRP funded) which is going to use STEP-NC for steel processing. Working with STEP</td>
</tr>
<tr>
<td>Defense 500+</td>
<td>500+</td>
<td>Reaching level of comfort with this technology and its logical fit into 21st century enterprise applications that we are moving towards.</td>
</tr>
<tr>
<td>Factory Automation 1-49</td>
<td>1-49</td>
<td>We need to distance our selves from particular controller details in RS274 and move to a more logical description of the machining process. Manufacturing systems must become more flexible and we must not be tied to a single controller for a single part.</td>
</tr>
<tr>
<td>Information Technology 1-49</td>
<td>1-49</td>
<td>Yes. Our software's file format is STEP</td>
</tr>
<tr>
<td>Information Technology 500+</td>
<td>500+</td>
<td>To comply with standards; that's all.</td>
</tr>
<tr>
<td>Check appropriate response</td>
<td>Size of your organization (by number of employees)</td>
<td>Why will your organization implement STEP NC?</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>We are committed to STEP overall and believe that this represents a key component necessary to drive design and manufacturing closer together.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>100-499</td>
<td>Natural fit with RAMP technology.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>50-99</td>
<td>xx</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>To create value for users and provide leadership to the industry.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>STEP and related standards is part of the mission to help manufacturing industries.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>Maybe to extend our implementations towards STEP-NC but this is not intended at this time</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>To address interoperability request from the customers.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>That is not sure at all at the moment. I think STEP-NC needs to prove that it is a competitive solution before it is usable. Competitive is not just about the time to create a NC program. It has to produce competitive NC code in terms of workpiece quality</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>1-49</td>
<td>To be ready for the challenges of the near future</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>50-99</td>
<td>Because of customer (or partner) demand.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>Not at this time.</td>
</tr>
<tr>
<td>Research (University)</td>
<td>50-99</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Research (University)</td>
<td>500+</td>
<td>Need NURBS curve in one of our proprietary process.</td>
</tr>
</tbody>
</table>
Table 82

**Question 24: Qualitative Responses Based on Size of the Organization and Industry**

**Segment**

<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>Why will your organization NOT implement STEP NC?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>None of our customers use STEP standard currently so we don’t see STEP NC in our organization in the near future.</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Not interested in NC machining. Not part of what we do.</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Our organization is not involved in direct manufacturing of products or the development of NC programs.</td>
<td></td>
</tr>
<tr>
<td>Aerospace 1-49</td>
<td>If the business case Doesn’t justify the investment and ROI</td>
<td></td>
</tr>
<tr>
<td>Aerospace 100-499</td>
<td>Boeing is very slow to change. Too many stove pipes. The aerospace paradigm is not as compelling as the auto industry.</td>
<td></td>
</tr>
<tr>
<td>Aerospace 500+</td>
<td>If there is not a sound business case if it is not widely used by controller/machine makers or if the standard greatly lags technology.</td>
<td></td>
</tr>
<tr>
<td>Aerospace 500+</td>
<td>Will not want to take on the resistance to change battles. Management will wrongfully listen to very smart very young computer science guru’s without an ounce of vision and common sense.</td>
<td></td>
</tr>
<tr>
<td>Aerospace 500+</td>
<td>- if STEP-NC is not mature yet (requires CAM and CNC vendors to figure out how to interpret STEP-NC)</td>
<td></td>
</tr>
<tr>
<td>Aerospace 500+</td>
<td>no response</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>No buy-in by upper management.</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>Uncertainty of the technology lack of off-the-shelf solutions from commercial vendors hard to make people change</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>ROI and vendor not supporting the standard</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>capabilities of manufacturing dept's or machines</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>So far nothing demonstrated in the area of production machining</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>There are still two approaches not harmonized as far</td>
<td></td>
</tr>
<tr>
<td>Check appropriate response</td>
<td>Size of your organization (by number of employees)</td>
<td>Why will your organization NOT implement STEP NC?</td>
</tr>
<tr>
<td>----------------------------</td>
<td>---------------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>The cost of Change and the voices promoting STEP NC not being heard by the appropriate persons.</td>
<td></td>
</tr>
<tr>
<td>Automotive 50-99</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>If improvements and efficiencies are not realized</td>
<td></td>
</tr>
<tr>
<td>Automotive 1-49</td>
<td>Not relevant</td>
<td></td>
</tr>
<tr>
<td>Automotive 500+</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Automotive 1-49</td>
<td>- Lack of support by the CAD industry. - Cost to implement is too high. - Not recognized as an industry standard. - Inability to convince upper management that this is the right thing to do.</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>The UK MoD now has only a very small manufacturing base - all new projects are contracted out to industry.</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>NC operations are not a major bottleneck or problem at the moment. The focus of the organization is in other areas.</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Defense 500+</td>
<td>Inertia associated with not being directly involved in the development of this technology or the associated ISO standards. Eventually believe that it will be implemented.</td>
<td></td>
</tr>
<tr>
<td>Factory Automation 1-49</td>
<td>We must.</td>
<td></td>
</tr>
<tr>
<td>Information Technology 1-49</td>
<td>Not an option to not support STEP NC</td>
<td></td>
</tr>
<tr>
<td>Information Technology 500+</td>
<td>not until we receives requests form the field.</td>
<td></td>
</tr>
<tr>
<td>Information Technology 1-49</td>
<td>It will take too long and there are many many more companies that need to implement it before our effort will add value. For instance machine tool controller manufacturers.</td>
<td></td>
</tr>
<tr>
<td>Information Technology 100-499</td>
<td>STEP-NC is currently limited by operation and machine sequence and lack of transferable in-process geometry. For most manufacture NC cutting is limited proportion of work content. Organisation will not 'only' implement STEP-NC.</td>
<td></td>
</tr>
<tr>
<td>Information Technology 50-99</td>
<td>xx</td>
<td></td>
</tr>
<tr>
<td>Information Technology 1-49</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>
### Question 24

<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>Why will your organization NOT implement STEP NC?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>500+</td>
<td>n/a</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>Missing customers request</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>1-49</td>
<td>As far as I can see about STEP NC the approach is good but the quality of the standard is questionable. It seems to have been created from a bottom up approach that almost certainly will lead into many problems of scale as the standard grows. The area that</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>50-99</td>
<td>It may need a big investment in Software and Controller hardware.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>Because of lack of customer (or partner) demand.</td>
</tr>
<tr>
<td>Research (University)</td>
<td>50-99</td>
<td>No research efforts are currently focused on developing and implementing STEP-NC.</td>
</tr>
<tr>
<td>Research (University)</td>
<td>500+</td>
<td>Not enough background understanding about this new technology. Lack of vendor support.</td>
</tr>
</tbody>
</table>
Table 83

**Question 25, Qualitative Responses Based on Size of the Organization and Industry Segment**

<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>In your opinion how can STEP NC add value in your organization?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td></td>
<td>Increase productivity through efficiencies and knowledge capture AND increased sales.</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>Can't</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Aerospace</td>
<td>1-49</td>
<td>Catalyst for CAD/CAM/CNC integration</td>
</tr>
<tr>
<td>Aerospace</td>
<td>100-499</td>
<td>By forcing us to standardize our product and process data and build the supporting knowledge bases to enable deployment.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>By getting the machine/controller makers to standardize.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>Information archival and reusability. Reduce costs to go from design to manufacturing. Bring manufacturing constraints into design at an earlier stage.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>Interoperability between CAM systems and CNC's</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>No response</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Much flexibility is added by not using proprietary methods.</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>To streamline CAE-CAD-CAM-Control process make part programs more portable</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Lower interoperability costs</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Standardized NC files</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>I need to see that it does first</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>In a mass customization production I think that the part similarity makes the approach unnecessary except for the quick handling of design changes. The old machine tools will probably not have interfaces and if they exist it is difficult to motivate in</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Enhanced interoperability of my metrology equipment. This can save many $ throughout the whole data collection process.</td>
</tr>
<tr>
<td>Automotive</td>
<td>50-99</td>
<td>Same as 23</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Accurate data transfers efficient asset utilization less</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>In your opinion how can STEP NC add value in your organization?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>1-49</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>cost and complexity of software and controller products</td>
</tr>
<tr>
<td></td>
<td>500+</td>
<td>See 23</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Automotive</td>
<td>1-49</td>
<td>Eliminate numerous post-processors for one standard. Also the ability to rapidly adjust a cutter path from one NC to another in the case of a machine breakdown.</td>
</tr>
<tr>
<td>Defense</td>
<td>500+</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It provides more flexibility lets us switch vendors when desirable and lets us archive NC data in a neutral format rather than a proprietary one.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Make it possible to perform work here using our automated system and using design data imported from other systems.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Completes the link between CAD and factoring floor which in turn enables full range of options for data exchange across the enterprise.</td>
</tr>
<tr>
<td>Factory Automation</td>
<td>1-49</td>
<td>Provide though leadership and demonstrations of the ability to realize a STEP NC system.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>We believe providing functionality in support of STEP NC will give Alibre a competitive advantage in the market place.</td>
</tr>
<tr>
<td></td>
<td>500+</td>
<td>not sure.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>We can differentiate our products by supporting it.</td>
</tr>
<tr>
<td></td>
<td>100-499</td>
<td>Use of STEP input eventual replacement of post processors.</td>
</tr>
<tr>
<td></td>
<td>50-99</td>
<td>xx</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>Make our product a more complete solution for manufacturing companies.</td>
</tr>
<tr>
<td></td>
<td>500+</td>
<td>STEP NC can add value to our organization by offering a coherent mechanism in which to incorporate many of the CNC process improvements discovered in our research work into actual production.</td>
</tr>
<tr>
<td></td>
<td>1-49</td>
<td>Customers buying solutions on this</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>In your opinion how can STEP NC add value in your organization?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>Adopt XML (instead of EXPRESS) as the standard language.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>A more high level interface to the machine tool. The feature approach to manufacturing operations. NC-programs that more easily can be moved between machine tools.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>1-49</td>
<td>Interchangeability of data and direct connection and data exchange via the Internet. Build up a better database in the CAM area. Save experience of experts on the shop floor.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>50-99</td>
<td>By opening up markets that would not have normally been available to us.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>Elimination of the human decision making process. Replacement of some of the legacy tools used. Less number of errors on the shop floor. Capture of knowledge into a central repository.</td>
</tr>
<tr>
<td>Research (University)</td>
<td>50-99</td>
<td>By providing a piece of the puzzle in digital manufacturing.</td>
</tr>
<tr>
<td>Research (University)</td>
<td>500+</td>
<td>Need NURBS curve in one of our proprietary process.</td>
</tr>
</tbody>
</table>
Table 84

*Question 26, Qualitative Responses Based on Size of the Organization and Industry*

**Segment**

<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>Question 26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td></td>
<td>Currently ISO 9001:2000 so we need to revise some our working procedures. This shouldn't be a big barrier.</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>Most any deployment of STEP will require overcoming organizational process barriers. Industry has in general invested heavily in defining their processes and there is a resistance to change. The process barriers often exist in multiple divisions/dept</td>
</tr>
<tr>
<td>Aerospace</td>
<td>1-49</td>
<td>Cost and Manpower</td>
</tr>
<tr>
<td>Aerospace</td>
<td>100-499</td>
<td>Find new jobs for our NC programmers.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>Cost training acceptance. There are also problems with the claims put forward by some of STEP NC’s most ardent advocates. These claims are so obviously inflated that other benefits are questioned.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>STEP literacy. Provide the solid business case that justifies the battles needed to overcome well seated organization process barriers.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>STEP-NC being viewed immature</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>No response</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Top management has to trust its technical staff and its recommendations. Management and staff have to be willing to change the way they do business.</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>The way we have always done it mentality</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Consistent Vendor compliance with standard</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Lack of promotion by std’s organizations</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Not invented here for 20 years we've done it like this</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Machine tool suppliers willingness to apply the approach.</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Buy-in by Senior Management that there is a distinct advantage. Also the people that work for that Senior Management must be aware of the advantages and pushing for implementation.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>What organizational process barriers have to be overcome for implementation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>50-99</td>
<td>None</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>CAD companies must support STEP output formats</td>
</tr>
<tr>
<td>Automotive</td>
<td>1-49</td>
<td>The barriers are mainly in early stages: decision makers support lack of qualified resources for planning lack of investment</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>With any implementation cost is key as well as acceptance from OEM and other downstream customers or suppliers. Not particular to STEP NC</td>
</tr>
<tr>
<td>Automotive</td>
<td>1-49</td>
<td>Recognition by our CAD vendors.</td>
</tr>
<tr>
<td>Defense</td>
<td>500+</td>
<td>n/a</td>
</tr>
<tr>
<td>Defense</td>
<td>500+</td>
<td>People have to look for long range benefits not the quickest way to transfer data today.</td>
</tr>
<tr>
<td>Defense</td>
<td>500+</td>
<td>The fact that there are already systems in place that work.</td>
</tr>
<tr>
<td>Defense</td>
<td>500+</td>
<td>Education of key personnel on what this technology offers and its advantages to the overall organization.</td>
</tr>
<tr>
<td>Factory Automation</td>
<td>1-49</td>
<td>Integration into commercial controllers. Education.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>There are not internal barriers. Our big problem in implementation of new technologies is inertia in the user base.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>None of your business.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>None to speak of. Other than building a consensus to do it. Beyond pure demoware this of course is dependent on practical adoption by others in the industry.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>100-499</td>
<td>Ease of geometry transfer for multi machine manufacture of components. Realistic approach to material and surface treatments.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>50-99</td>
<td>xx</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>Achieving management consensus.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>Within the research side there would be little organization barriers to overcome. However within the production facilities it would have to be proven to be better technology. Actual metal workers may be reluctant to change from established technologies.</td>
</tr>
<tr>
<td>Information</td>
<td>1-49</td>
<td>No</td>
</tr>
<tr>
<td>Check appropriate response</td>
<td>Size of your organization (by number of employees)</td>
<td>What organizational process barriers have to be overcome for implementation?</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Technology</td>
<td>500+</td>
<td>Make STEP-NC easily extensible.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>I think that the barrier is more about if the knowledge built in and handled by the STEP-NC controller reflects the knowledge by which you/we want to control the manufacturing process.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>Convincing responsible managers Replacing the older but well working systems Big initial costs</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>1-49</td>
<td>Need to have significant customer demand before we will invest the necessary resources to implement.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>50-99</td>
<td>Business case needs to be presented &amp; proved!</td>
</tr>
<tr>
<td>Research (University)</td>
<td>50-99</td>
<td>Financial support for and interest in research focused on STEP-NC. Monetary and human resources.</td>
</tr>
<tr>
<td>Research (University)</td>
<td>500+</td>
<td>Need to find out later.</td>
</tr>
</tbody>
</table>
### Question 27, Qualitative Responses Based on Size of the Organization and Industry Segment

<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>What change is required to lead the consensus for adoption and implementation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>1-49</td>
<td>New tooling/controls training software etc.</td>
</tr>
<tr>
<td>Other</td>
<td>100-499</td>
<td>Develop value proposition of the STEP-NC process and show the gains in reducing Design process and machining.</td>
</tr>
<tr>
<td>Other</td>
<td>500+</td>
<td>To develop a good business case for implementation. Boeing is very conservative traditional and slow to change.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>STEP NC is still a long way from proving itself. Even if the technology was available today there would need to be major changes to our procedures with regard to traceability etc.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>Manufacturing is not a big part of our operation. Once the group feels that they are being left behind the energy for change will build and it will happen. To get this feel the young folks need more opportunity to travel and see what others are doing.</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>Demonstrated maturity of STEP-NC offering capability</td>
</tr>
<tr>
<td>Aerospace</td>
<td>500+</td>
<td>Management and the technical experts should be communicating on an ongoing basis. Now let’s assume that it is recommended to top management that STEP NC should be implemented. Then for STEP NC to be properly implemented top management has to have bou</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Education successful implementation examples product availability</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Management belief that STEP can provide an acceptable solution. Past experience with STEP 203/214 has been very negative. It’s not that the standard was bad; it’s that the standard was not fully implemented by the application vendors. One vendors product</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Some kind of global use agreement between std organizations and companies that provide NC machines</td>
</tr>
<tr>
<td>Check appropriate response</td>
<td>Size of your organization (by number of employees)</td>
<td>What change is required to lead the consensus for adoption and implementation?</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Proof that it works Proof that vendors will adopt a standard not their own flavor CAM vendors adopt a standard and not their own flavor</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>In prototype work shops I think it is enough if the NC-controller can be easily adopted. In series production I doubt that anything can bring consensus about implementation until hundreds of NC-machines have been worn out and changed.</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>Senior Management in a high-level meeting to display the advantages/disadvantages (costs...). Someone must first put together a business case and then sell it like a good used car.</td>
</tr>
<tr>
<td>Automotive</td>
<td>50-99</td>
<td>None</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>STEP is accepted within our corp.</td>
</tr>
<tr>
<td>Automotive</td>
<td>1-49</td>
<td>I think we are still the early stages mentioned in 26 later there will be other challenges in the implementation process</td>
</tr>
<tr>
<td>Automotive</td>
<td>500+</td>
<td>N/A</td>
</tr>
<tr>
<td>Automotive</td>
<td>1-49</td>
<td>Implementation by our CAD vendors.</td>
</tr>
<tr>
<td>Defense</td>
<td>500+</td>
<td>n/a</td>
</tr>
<tr>
<td>Defense</td>
<td>500+</td>
<td>Those participating must continue to stress the benefits to as many in company management as possible.</td>
</tr>
<tr>
<td>Defense</td>
<td>500+</td>
<td>None</td>
</tr>
<tr>
<td>Defense</td>
<td>500+</td>
<td>Broader participation of personnel on leading development efforts relating to STEP and to broader STEP initiatives within DoD.</td>
</tr>
<tr>
<td>Factory</td>
<td>1-49</td>
<td>Education.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>We are there. The user base carries the flag.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>Have 1 person attached to the project.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>It's support by a complete chain through production. If we vendors from CAD through CAM and machine tool controls supporting it would really help drive us even if only a few players in each area.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>100-499</td>
<td>Fit and assist within Process Planning.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>50-99</td>
<td>Xx</td>
</tr>
</tbody>
</table>
### Question 27

<table>
<thead>
<tr>
<th>Check appropriate response</th>
<th>Size of your organization (by number of employees)</th>
<th>What change is required to lead the consensus for adoption and implementation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>None</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>None.</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1-49</td>
<td>This is purely customers driven</td>
</tr>
<tr>
<td>Information Technology</td>
<td>500+</td>
<td>Emphasis on the interoperability.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>That STEP-NC is established by machine tool vendors and/or used by our customers.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>1-49</td>
<td>Readiness for first try out installations to prove concept advantages and cost savings.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>50-99</td>
<td>Industry acceptance and customer demand for STEP-NC.</td>
</tr>
<tr>
<td>Mfg. Equip./Process</td>
<td>500+</td>
<td>You need to make it work and make it more robust and demonstrate the savings. We don't have time to tinker around with technology that has a lot of problems.</td>
</tr>
<tr>
<td>Research (University)</td>
<td>50-99</td>
<td>An overall different approach to manufacturing within SC4. STEP-NC must be regarded as a piece of a bigger puzzle, which is manufacturing.</td>
</tr>
<tr>
<td>Research (University)</td>
<td>500+</td>
<td>Need to convince others about the benefit of STEP-NC over the existing method.</td>
</tr>
</tbody>
</table>


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Summers, D. (1993, June 14). Management—the right attitude—staff surveys are popular, but can be fraught with pitfalls. Financial Times, 8.


CURRICULUM VITAE

Carol Oak Tierney

EDUCATION:

2003   Ph.D. Candidate – Andrews University Leadership Program
1983   Master’s Degree in Business Administration, Central Michigan University
1982   Master’s Degree in Logistics Management, Central Michigan University
1975   Bachelor’s Degree in Math, Science Education, University of Michigan

PROFESSIONAL EXPERIENCE:

1985 - Present   Program Manager, Engineering, Advanced Programs
                General Dynamics Land Systems


1979 – 1980   Engineering Analyst, Ford Motor Company