Reducing Instability In A Transforming Organization

By

Thelton Raymond Salter

B.S. Mechanical Engineering (1982)

Louisiana Tech University

Submitted to the System Design and Management Program
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Signature of Author _____

Thelton Salter
System Design and Management Program
May 2007

Certified by _____

Deborah Nightingale
Thesis Supervisor
Professor of Aeronautics & Astronautics and Engineering Systems

Certified by _____

Patrick Hale
Director
System Design & Management Program

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ABSTRACT

It is obvious from many studies that an alignment and understanding around vision, strategy and goals must occur within a corporation across all organizations before the corporation can operate at its highest efficiency. This becomes even more important in a "flat" organization with distributed leaders. Having this type organization allows transformation to a lean enterprise because decisions can be made at a much lower level and therefore accomplished faster. However, the leaders must know and understand the corporate vision, strategy and organizational goals, which create the context and framework for many of the decisions that will need to be made. Absent this understanding, decisions can appear disjointed, uneven and without purpose towards meeting larger corporate goals and once made, the decision may not in fact support the corporate strategy. The results of this may manifest itself in internal instability caused by leadership vision changes.

The Labor Aerospace Research Agenda (LARA) at MIT, starting in the late 1990's, has documented leadership vision changes as a major source of internal instability. This instability could be real or perceived but in either case if not properly managed could lead to a less efficient transformation. Thus, a structured approach around a common framework to create a shared vision from top to bottom throughout the corporation could prevent this instability from occurring.

One corporation being studied has instituted a "roadmap" process, which was developed, in part, to address this issue. While the roadmap process does not address all stakeholders or potential sources of instability, it does address leadership vision and how that vision is turned into a strategy with shared goals. The purpose of this thesis is to:

1) Present an outline of the process used to align the corporation
2) Present the results of whether there is a measurable difference in instability driven by changes in leadership vision between departments that use the "roadmap" process and those that don't
3) Compare the results from this company and others previously studied to determine if there is more or less internal instability naturally within the company
4) Conclude whether the roadmap process evaluated is beneficial or not and propose potential modifications to the process.

Thesis Supervisor: Deborah J. Nightingale
Title: Professor of Aeronautics & Astronautics and Engineering Systems

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This is the completion of an educational journey that started several years ago and appeared, at times, to be never ending. There have been many ups and downs along with several sideways movements of progress. There have been numerous people involved and there are many I could recognize but through all of this there has been only one area of constant support; my family. It is for them that I owe the largest debt and therefore they are the ones most deserving of acknowledgement.

To my children, thanks for understanding me missing various events as I studied and did research. I hope the roller coaster rides make up for the missed time. To my mother and father, thanks for always supporting me and being interested in what I was doing no matter what "hair-brained" idea I had pursued. Finally, to my wife there is no way to express in words how much you have meant to me. While this endeavor has lasted only a few years, I think being together 27 years is a better testament of how much you mean to me.

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1.0 INTRODUCTION

Since the beginning of manned flight, the aviation industry has continually advanced the "state of the art" by bringing technology to the product. The early aviation pioneers started with fairly simple design architectures that were created by small teams of innovators for a relatively small aviation marketplace predominantly from western countries. Technology advancements during these times tended to be focused on areas of higher efficiency, lighter weight and faster speed. There seemed to be a product premium for the most technologically advanced products as they searched for a dominant design. Even though one might claim the dominant design for commercial and military airplanes has been defined based on principles from Utterbach (1994), the ever-increasing technology development approach continues today. The Super-Jumbo A380, the advent of stealth (a whole new metric for airplane design), unmanned flight, burgeoning space tourism businesses and increased emphasis on surveillance, intelligence and reconnaissance since September 11 are examples of ever increasing complexity of the aviation industry. However, it is no longer sufficient to bring the most advanced technology product to market. It also must be at the right price, at the right time, using highly complex architectures, with increasing worldwide competition, utilizing substantial workforces spread across many time zones in a highly uncertain marketplace that has been made even more uncertain since the events of September 11, 2001.

No longer dominated by western powers, Japan and other countries such as Russia and China have also started the beginning of home grown aviation industries. This raises the specter of the western aviation industry going the way of the western auto industry. This risk is driving changes to take place in the aviation

industry not only through the introduction of different types of technologies and more efficient products (both from a cost and usage perspective – higher reliability, longer life, better fuel efficiency, more easily maintained) but also through more efficient organizational structures created by transforming themselves to "Lean" enterprises.

A "Lean" enterprise requires changes throughout the company and many of its stakeholders. Collapsed organizational hierarchy, more efficient processes, better connection to both internal and external customers, etc. are the types of changes that must be made to transform the enterprise to operate at higher efficiency and effectiveness. This "Lean Transformation" process is part of the strategy that many aerospace companies are using to meet all stakeholder needs more efficiently and increase corporate value.

Many organizational and process concepts from various industries are being adopted by the aviation industry. Systems engineering approaches are frequently being used to increase workforce efficiency through evaluation of the whole system thus bringing a more balanced product to market. Standard processes that create repeatable products are also being implemented. "Platform" concepts are being created by which products can be scaled up and down in size from earlier successful models to deliver a new product faster at lower development costs. Concurrent engineering, integrated management and product teams and distributed leadership models have also been introduced in order to create complex products faster with higher quality, at cheaper prices in an uncertain marketplace.

Using an integrated management structure requires leadership and decision-making capabilities distributed at all levels so that product delivery speed can be

increased. Leadership is not solely the purview of the CEO but can and should permeate all levels of the firm (Senge, 1996). Leaders across different constituencies of the enterprise have different responsibilities, different perspectives and a different array of goals and objectives, they must, to be successful as a group, collectively develop at least one subset of common goals and objectives around which they can work together and which can simultaneously support the pursuit of their individual unshared goals (Bozdogan et. al., 2000). Organizations that are successful in utilizing a distributed leadership approach and having that leadership connected from top to bottom on the vision, strategy, goals and objectives should result in improved product development team performance, reduced team instability and thus increased team effectiveness leading to higher product quality, decreased development cost, decreased time to market and a more competitive product. However, it is imperative that the distributed leadership be aligned and connected with the strategy and vision both laterally and vertically throughout the organization or progress could be slowed, incorrect decisions could be made and employee morale negatively impacted, as workers experience instability within the organization and lack of understanding of how their efforts support the company at large.

While it makes sense that the leadership strategy and vision should be aligned and connected across the corporation, it is not necessarily clear how that should occur. This research will take a closer look at the impacts to organizational instability when alignment and connection of the corporate strategy and vision with departmental goals occurs. This will be accomplished by evaluating one company's approach and comparing its instability levels with other corporations that do not use

a similar approach. This research will also consider the impact on employees' understanding of how their efforts support the corporate strategy and vision.

This research submits that creating an alignment between corporate vision and strategy with organizational goals across all individuals within a "matrixed" organization will have positive impacts by increasing performance, increasing morale and creating less instability within product teams thus allowing a smoother "Lean Transformation". Summaries of the various sections of this paper that go towards proving this supposition are presented below.

Section 2.0 "Background", provides the details behind how one particular company found itself loosing market share and the transformational process steps it started taking to become more competitive. The new product development processes, organizational structure, employee impact and the process adopted to create the corporate alignment mentioned above are discussed and analyzed in this section.

Section 3.0 "Research Approach" discusses the process that was undertaken to conduct this research and the strategy used for comparison of past data and collection of new data. Previous data from other corporations is presented as well as the survey used to collect that data. A hypothesis of the impact that the alignment process has is presented as well as a proposed process for evaluating and benchmarking departmental alignment techniques. The organizations selected to participate in the survey as well as modifications to the original survey are also discussed.

Section 4.0 "Results" presents the findings of this research and compares the previous results from "Un-aligned" organizations to the same survey results of

an "Aligned" organization. The various increases and decreases in levels of the instability are analyzed for statistical significance. Rationale, through interviewing participants, for increases and decreases in levels of instability results is also discussed. There is also an evaluation of the changes along various lines of different demographics.

Sections 5, 6 and 7 respectively present results of benchmarking various alignment processes, recommendations for changes to the alignment process and conclusions that can be made as a result of this research.

2.0 BACKGROUND

AERO Corp.* is a world leader in the design, manufacture and service of commercial and military aircraft engines, industrial gas turbines and space propulsion systems. The company employees approximately 40,000 people that support more than 9,000 customers in 180 countries around the world. The company is the pioneer behind many major advances in both military and commercial aviation. Over the years, they have patented numerous innovations and technologies that have made aviation more cost effective, comfortable and dependable. (AERO Corp. website)

AERO Corp. has a rich history dating back to the golden ages of manned flight and has survived the process of competitor reduction consistent with the establishment of a dominant design to provide significant advances in technologies that have helped propel the industry to where it is today. It has a rich portfolio of technologies that it continues to use and expand today to maintain its presence and leadership in various parts of the aerospace market. Currently its products are integrated into numerous aerospace platforms. However, its market level of participation has been under challenge recently due to factors such as changing market place (requiring shorter development times and lower development costs), strategic mis-steps, competitive pressures and many traditional customers under extraordinary financial pressures.

AERO Corp. found itself as a mature business with mature processes that were not necessarily consistent with a rapidly changing aerospace environment.

* AERO Corp. is a fictitious name used to protect the corporate identity of company investigated for this research

This phenomenon is common in industries with mature product platforms and long established dominant designs. Ultimately these mature companies must turn their efforts towards process innovation and organizational re-structuring to enable product development characteristics (increased speed and reduced costs) consistent with meeting new market demands. These drivers have forced AERO Corp. to improve their product development processes. They had to have processes and organizational structure that allowed 1) the business to be aligned around the corporate vision and strategy, 2) company objectives to be met and 3) rapid decisions to be made. Therefore, AERO Corp. started a Lean Transformation to create an organization and processes consistent with meeting the new demands of the aerospace marketplace.

AERO Corp. created the following in order to meet these new demands.

1. Integrated product teams to allow decision making at the lowest design level (This resulted in defining leadership for each of these teams and the need to connect these leaders)
2. A "Lean" type culture to recognize waste
3. The tools and training necessary to eliminate the waste (such as Value Stream Mapping)
4. Standardized engineering processes to ensure consistent products

2.1 RE-ORGANIZATION DETAILS

The design, manufacture and validation of AERO Corp. products required a very complex product development structure that draws on significant technical expertise from a multitude of engineering disciplines. From the company's early

days to the late 1980's, AERO Corp. engaged a vertical integration "silo" style structure (Reference Figure 2.1-1) across the whole organization driven by a mass production mentality. In engineering, the vertical structure divided technical personnel according to discipline (Ex: Structures, Materials, Design). The vertical organizational structure provided AERO Corp. with the development of deep technical knowledge and critical expertise, essential to the early development of complex products. However, it also set up a decision-making and leadership process around these few critical experts. As aerospace technology matured and quality increased, the long cycle times, high product and development costs and long decision making processes associated with vertically integrated organizations were no longer competitive in the market environment. In the late 1980's Lean manufacturing led the way for intensified aerospace industry competition on cost, quality and time to market. This caused AERO Corp. to recognize the need to implement organizational change in order to remain competitive (Wozniak, 2002).

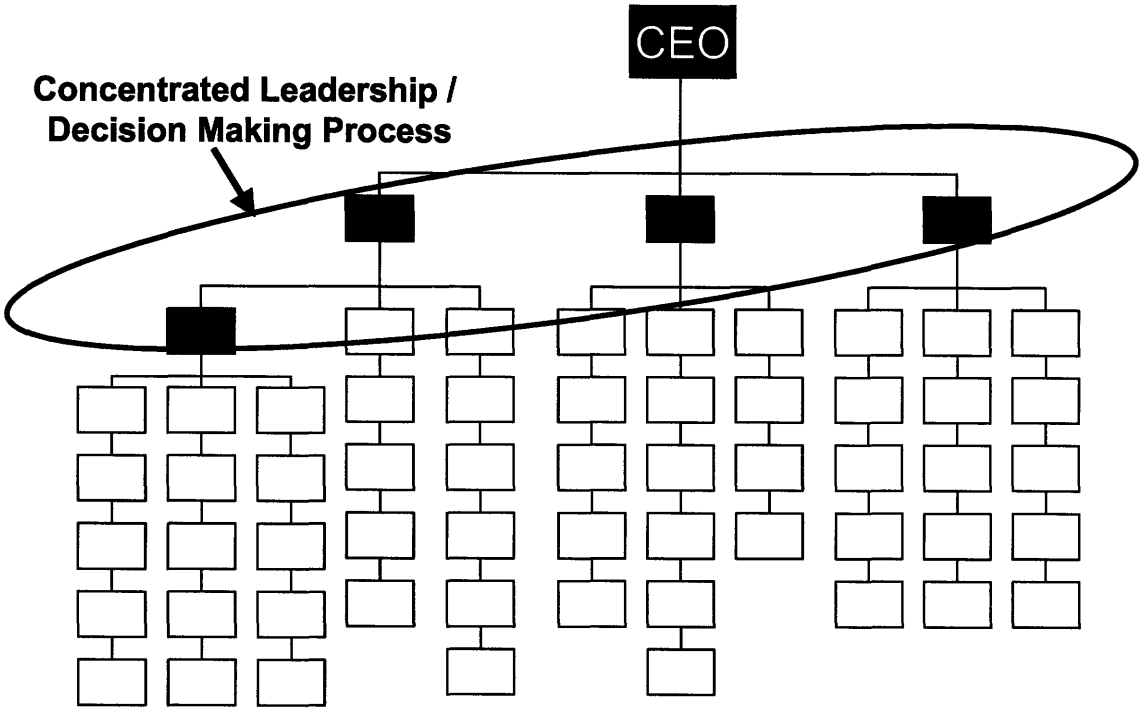


Figure 2.1-1. "Silo" Organization

The first major engineering organizational change implemented at AERO Corp. was a concurrent engineering structure where many engineering and manufacturing tasks could be conducted in parallel. The concurrent engineering structure helped shorten development cycles but didn't provide all the benefits AERO Corp. needed to remain competitive in the industry.

Thus, a few years later, in the early 1990's AERO Corp. implemented integrated product development team (IPT) structure. The IPT process helped AERO Corp. move the organizational focus from a discipline focus to a more product centric focus. Then in 1993, AERO Corp realized that their teams could be more effective if they were grouped around the major components of the product. This re-grouping of IPT teams created "Centers of Excellence" aligned with the

decomposition of the product architecture in which the engineering teams focused on ten major component assemblies. In addition to the component-centered groupings, this structure provided a representative from manufacturing to each of the IPT's (Wozniak, 2002)

In 1997 three major changes were made to the organization structure and how it operated. First, AERO Corp. recognized a need for system level integration between organizational structures and thus deployed three systems engineering organizations. These systems engineering groups were focused primarily on the system level attributes of design, performance and test. These three functions were combined into a system level IPT that was focused on a system view that was necessary to optimize the product by trading attributes and requirements among the centers of excellence. Second, product centers were established to provide major part families with centralized manufacturing facilities focused on delivering parts within the "agreed to" cost and schedule objectives. Third, a group of leaders within all of the IPT's (system and component level) were identified and linked to specific programs. This leadership function was to connect the program requirements with the components centers that would perform the work. However, this function did not connect corporate vision and strategy with work being performed for individual programs. An element that was later found to be deficient (Wozniak, 2002).

As part of this organizational evolution a program management team structure was defined that consisted of each major business discipline as well as technical representation from IPT leadership. Its function was to guide the integration of each discipline (technical and non-technical) and establish guidelines

for how each discipline was to support AERO Corp. products through the development, delivery and customer usage of the product.

In late 1998, to further reduce product development and manufacturing cost, AERO Corp. deployed a module center organizational structure consisting of four different module centers. The module center organization combined the ten component centers of excellence around similar product types and co-located the engineering and manufacturing organization. The organizational construct after this change is depicted in Figure 2.1-2.

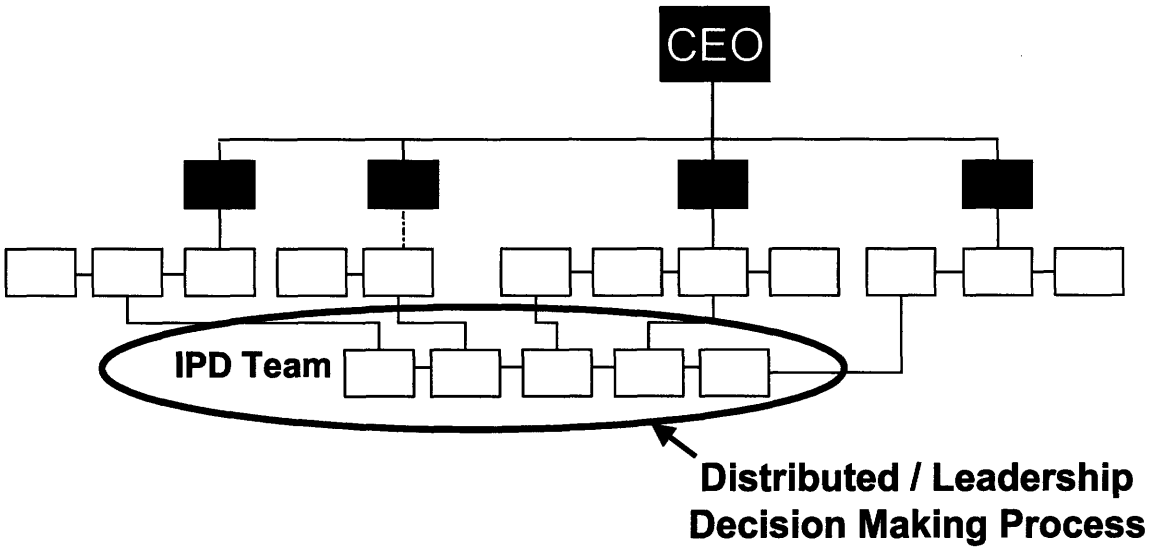


Figure 2.1-2. Distributed Leadership, Decision Making Architecture

In order to manage the organizational evolution and transition to a Lean structure, AERO Corp. developed an operational guidebook and IPT specific workflow maps to help their development teams define their new product development processes and achieve competitive quality, cost and schedule

objectives. The guidebook outlines concepts that enable the Integrated Program Development and covers all areas of program and product life cycle from strategy development through service. The workflow maps define which processes each IPT should use relative to the development phase of the program from conceptual design through end of life. The workflow maps also link the processes between all the IPT's so that each part of the matrix organization knows the inputs and outputs to its individual processes (Wozniak, 2002).

As described above, a tremendous amount of effort is put into linking what each individual does from a work perspective to support a specific program. However, little effort was initially placed on linking programs across the company and aligning them with corporate strategy and vision. Eventually, AERO Corp. recognized that this element of transformation was missing and started what they called the "Roadmap" process. This process is described in further detail later in this document.

2.2 EMPLOYEE IMPACT

Following this substantial organizational re-engineering process in the early 2000's, AERO Corp. recognized that there were significant morale issues among employees and they embarked on a thorough employee survey program designed to determine which specific areas needed to be improved. This was accomplished by allowing every employee to provide input both in free form commentary and ranking levels of satisfaction relative to standardized questions. Initial surveys had approximately a 60% participation rate. A very low rate of participation showing apathy towards the company and any process that was being used to try and

measure morale. The results from the initial surveys were less than positive for the company and thus AERO Corp. defined specific issues that needed to be addressed. AERO Corp. started working on improvements to increase employee satisfaction while it was going through the Lean Transformation. The process of incorporating employee morale improvements while continuing to go through Lean Transformation tended to work against each other. Improvements in morale tended to be offset by Lean Transformation changes, which resulted in increased instability in the workplace and thus lower morale.

As can be seen from the organization structure defined above, AERO Corp. is a highly "matrixed" organization, with numerous lower lever leadership roles defined to enable rapid decision-making. As a result of the survey, it was recognized that while many new leadership positions were being created and were distributed throughout the organization, there was no clear connection and alignment of that leadership to corporate strategies and vision. The "who", "what", "where" and "how" were addressed through the guidebook and workflow maps mentioned earlier but the when and the why were still missing (Bozdogan et. al., 2000).

It was also noted that team leaders at the lowest level might not be properly linking team objectives with corporate strategy. This showed up in the results of employee surveys when asked the following questions.

1. Does your leadership communicate organizational goals?
2. Do you think AERO Corp. strategies are competitive?
3. Does your work group support corporate strategies?

The initial survey results showed a significant need to align corporate strategy with departmental goals. This could be a monumental task in a large "matrixed" organizational structure with numerous products and customers but was necessary in order to:

1. Ensure leadership communicates a consistent message from top to bottom (thus reducing perceived uncertainty and change around the vision and strategy)
2. Provide the context in which decisions can be made at leadership levels thus allowing quicker, more efficient and more competitive decisions to be made.
3. Provide connectivity between employee work scope and corporate strategy so each individual understands how his work supports the corporation.

Several new processes were incorporated throughout AERO Corp. to increase the employee morale and over time, several of the measures showed significant improvement (Many measures were used with all showing some level of improvement anywhere from minimal to significant. The details of this data are considered proprietary by AERO Corp. and therefore not published in this document) along with significant employee participation increase (about 85% participation) in the survey. However, the main process used to increase the ratings on the three questions above was creation of yearly "Roadmaps" for all departments and the communication of the attributes and status of these "Roadmaps" to all employees within the department. The "Roadmaps" became a framework by which corporate vision, strategy, objectives, and status towards

meeting the objectives can be aligned and flowed down throughout the whole corporation from the President to individual employees.

2.3 ROADMAP PROCESS

At the end of each year, the president of AERO Corp. creates his "Roadmap" for the next year. It includes a "Vision Statement" representing the President's vision for the next year. It also includes a common set of key attributes (such as customer, employees, quality, financial, etc.) that are used on each subsequent "Roadmap" created below the presidential map. These key attributes are designed to support the vision statement. Each key attribute also has a strategy linked to it that defines the approach for improving the key attributes. There is also a list of objectives that are to be accomplished over the next year that, if accomplished, allow the vision and strategy to come to fruition. The "Roadmap" is assembled with the understanding that If the objectives are successfully completed during the year, the strategies would be met and the vision realized. Following creation of the presidential "Roadmap", successively lower level leaders (Vice presidents, through department leaders down to managers, team leaders; including major suppliers; and ultimately individual employees) create their "Roadmaps" that are linked to various parts of the higher preceding "Roadmap" level. This is done in a feedback fashion with the higher-level leader reviewing his "Roadmap" with lower level leaders prior to publishing it. This is done to ensure their buy in prior to them creating their own "Roadmaps" and thus creating a linkage between the succeeding and subsequent "Roadmaps". The intent of this whole process is to provide a

complete linkage between vision, strategy, goals and status to those goals from top to bottom within the corporation.

Typically, as the year progresses each leader periodically rates the accomplishments of his group's goals and objectives, albeit somewhat subjectively, as a red, yellow or green and presents this to employees of that organization. Status relative to objectives also flows up and down the organizational structure so that positive or negative performance at lower levels can be linked to performance impacts at higher levels. Figures 2.3-1, -2 and -3 are generic examples of "Roadmaps" and show how the corporate strategy and vision is turned into department goals and objectives.

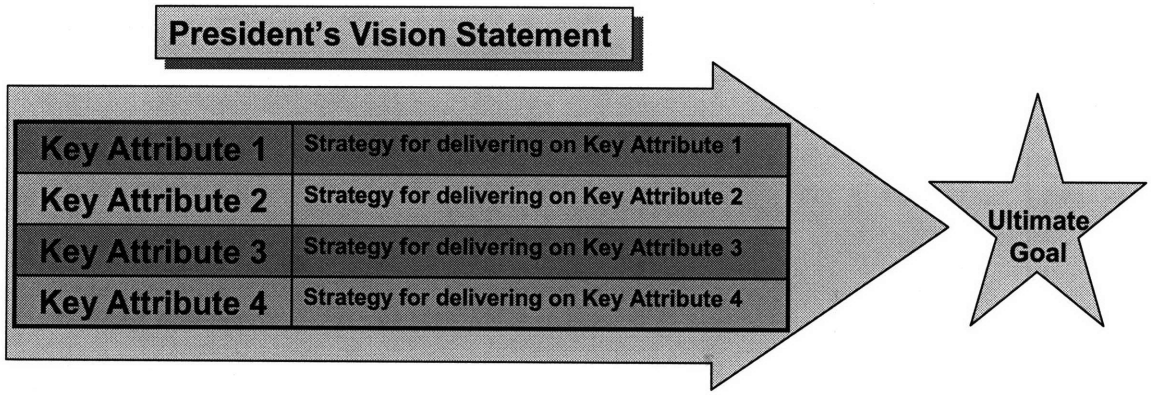
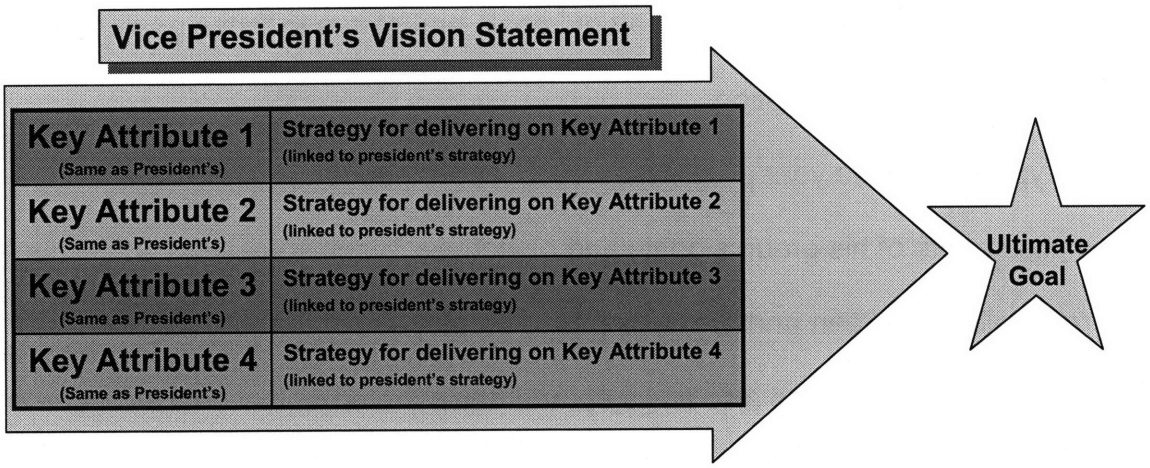


Figure 2.3-1. AERO Corp. Presidential "Roadmap"



- List of Vice President's objectives for delivering on Key Attribute strategies

Figure 2.3-2. AERO Corp. Vice Presidents "Roadmap"

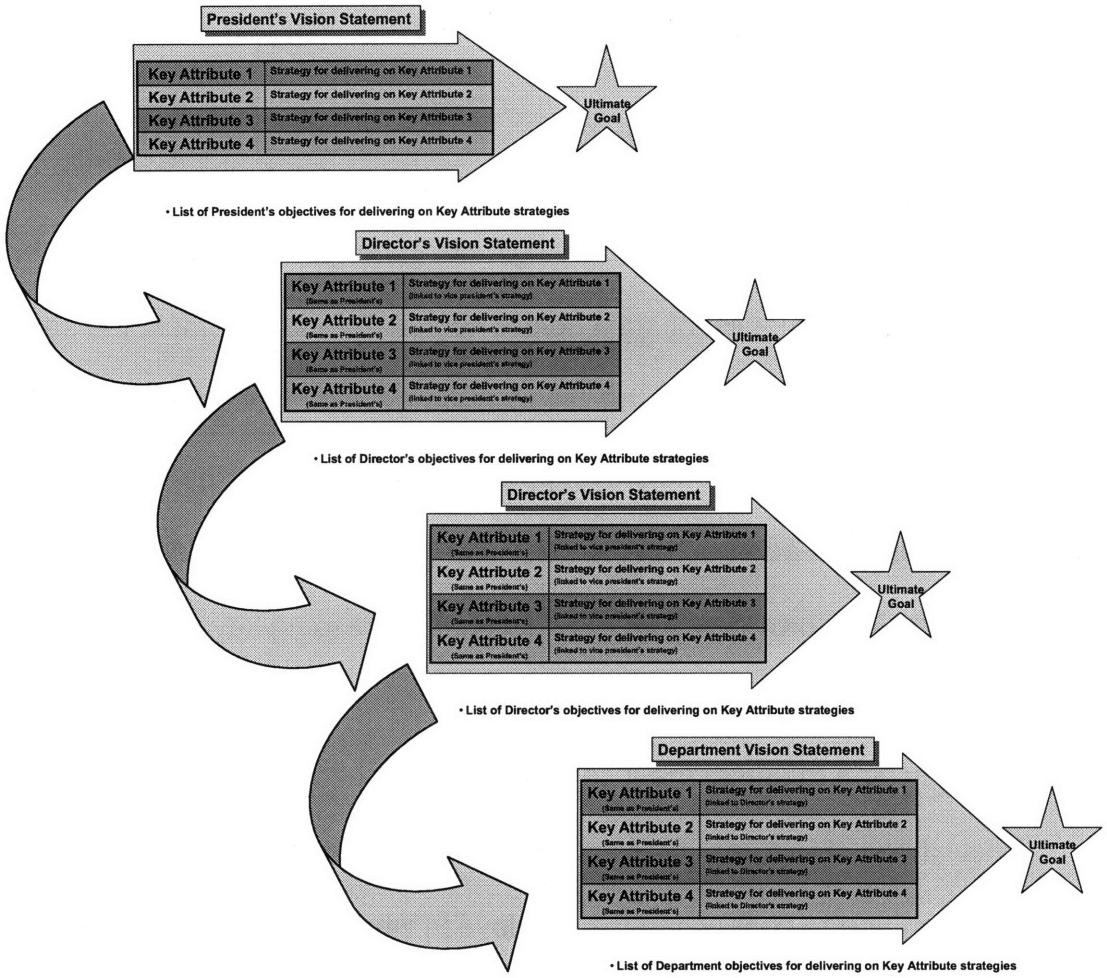


Figure 2.3-3. Linkage of Vision, Strategy and Objectives

In parallel with this one year "Roadmap", the president creates a 5-year Vision "Roadmap". The 5-year "Roadmap" contains a higher-level company direction than the one-year "Roadmap" but gives a detailed vision of where the president envisions the company 5 years out. The 5-year "Roadmap" also includes the objectives necessary to meet the 5-year vision. This "Roadmap" is propagated down the organization only a couple of levels and is not flowed down to the individual employee. However, it is reviewed with individual employees and it does provide a detailed vision down to the department level of where the company is

headed 5 years out. This "Roadmap" is updated every year just like the one year "Roadmap".

While there is a significant set of criteria used to create these "Roadmaps" for consistency, they are not completely rigid but in fact are somewhat flexible. The key attributes (similar to a list of stakeholder needs) appear to remain the same across the whole corporation but the vision, strategy and objectives are tailored to reflect individual group functions that support the higher level "Roadmap". This has lead to many different approaches for lower level "Roadmaps" which will be discussed later. This provides both the rigidity of addressing key stakeholders as defined by the president but the flexibility of each department to define the objectives they plan to use to meet key stakeholder needs.

This whole "Roadmap" process became so central to the company's Lean Transformation and to connecting the employees with leadership vision that the president of the corporation recently issued the following statement to all employees "... we have made tremendous progress diversifying our portfolio, improving employee fulfillment and positioning AERO Corp. for future growth. By continuing to focus on our "Roadmap" goals we will carry on the leadership legacy that will secure our future. While our fundamental strategy won't change, we will accelerate our progress towards "Lean", so we can be an even stronger, more balanced company in the years ahead."

3.0 RESEARCH APPROACH

In a "silo" style organizational structure there was never any need to ensure there was a vision and strategic alignment between the executive and working level employees. Most major decision-making occurred at the top. (Reference Figure 2.1-1) The top understood the vision and strategy and made decisions accordingly. However, to undergo a Lean Transformation a distributed leadership structure must be created where decision-making is made at much lower levels across multiple linkages of people (Reference Figure 2.1-2).

Without the knowledge and understanding of the vision and strategy, the decision-making process in a Lean environment would not be properly aligned with company vision and strategic objectives. The inability of an individual employee, whether they consider themselves a leader or not, to understand how their work efforts and decisions relate to corporate vision and strategy has to result in "instability" (this term will be defined in following sections) from their perspective.

Several studies have indicated the need to align the organization and acknowledge that it is necessary as part of Lean implementation.

One study suggested a candidate framework for the "Value Proposition" was to 1) create stakeholder alignment, 2) balance stakeholder expectations and 3) establish clear communication of balanced expectations with all stakeholders (Stanke, 2000). This in essence is what the "Roadmap" process at AERO Corp. was intended to do for internal and some external stakeholders. However, it does not address all stakeholders.

The "Roadmap" process aligns key attributes (e.g. stakeholder needs) with internal company objectives to meet those needs. The "Roadmap" process itself

ensures a balanced approach given that many stakeholders have input to the objectives. These balanced expectations are communicated on a regular basis (typically monthly) throughout the corporation. Actually, AERO Corp. took this framework approach one step further by providing a status relative to meeting the expectations.

A second study resulted in the following assessment. Among key leadership challenges, the group highlighted integration from IPT to the shop floor, alignment across levels and consistent metrics (Klein, 1997) This study also resulted in the following observation. Linkage - alignment of goals and measure doesn't just happen - it requires a process where goals set at any level are communicated to the other levels as part of goal formulation and where disconnects surfaces at other levels are fed back to adjust original goals (Klein, 1997) Again, the "Roadmap" process tends to address these findings through aligning the organization and setting goals from top to bottom with a review cycle conducted before the goals are finalized.

Also, there were three separate case studies (Cutcher-Gershenfeld, 1998, Inaba and Barrett, 1999 and Kochan, 2000) that evaluated major drivers for instability (defined as a particular kind of uncertainty involving both unpredictability and increased lack of control) (Cutcher-Gershenfeld and Rebentisch, 2002) within an organization. The case studies were conducted on major suppliers of aerospace products that were all going through Lean Transformation. While they were completely different companies in different parts of the aviation industry (none of them were direct competitors), it was shown, through the use of a questionnaire

process, that one of the highest sources of internal instability among all of them was "Changes in Leadership Vision" (Reference Figure 3.0-1).

Each of these major corporations was undergoing transformation and each was experiencing a relatively high level of internal instability within those organizations driven by changes to the leadership vision. This instability may have been real (leadership vision changes frequently) or perceived (vision hasn't changed but could be incorrectly interpreted by lower level leaders and thus the perception of change) but in either case if not properly managed it will lead to a less efficient organization and most probably lower morale.

*Internal Instability**	*Boeing Wichita*	*Textron Systems*	*Rocketdyne*
Internal budgets	**0.98**	**1.12**	**1.06**
Voluntary Turnover	**0.95**	**0.92**	**0.67**
Re-engineering	**0.96**	**1.05**	**0.92**
Leadership Vision	**1.01**	**1.16**	**1.09**
Tension / stress around change	**1.11**	**1.17**	**1.14**
Subcontract out work	**0.59**	**0.79**	**0.82**
In sourcing of work	**0.49**	**0.55**	**0.47**

*** 0 = never, 1 = sometimes, 2 = frequently**

Figure 3.0-1. Data from Previous Instability Study

Given the nature of these studies and the broad organizations they represent, this area of instability should be one of focus for any major corporation. A structured approach to create a shared vision could prevent this instability from

occurring. The "Roadmap" process could fulfill this need by aligning and connecting the organization with the leadership vision and strategy thus lowering the amount of instability associated with changes in leadership vision.

Since these studies created a process by which to measure instability drivers, it provides a framework and process by which to evaluate the impact of the "Roadmap" on internal organizational instability.

3.1 QUESTIONNAIRE

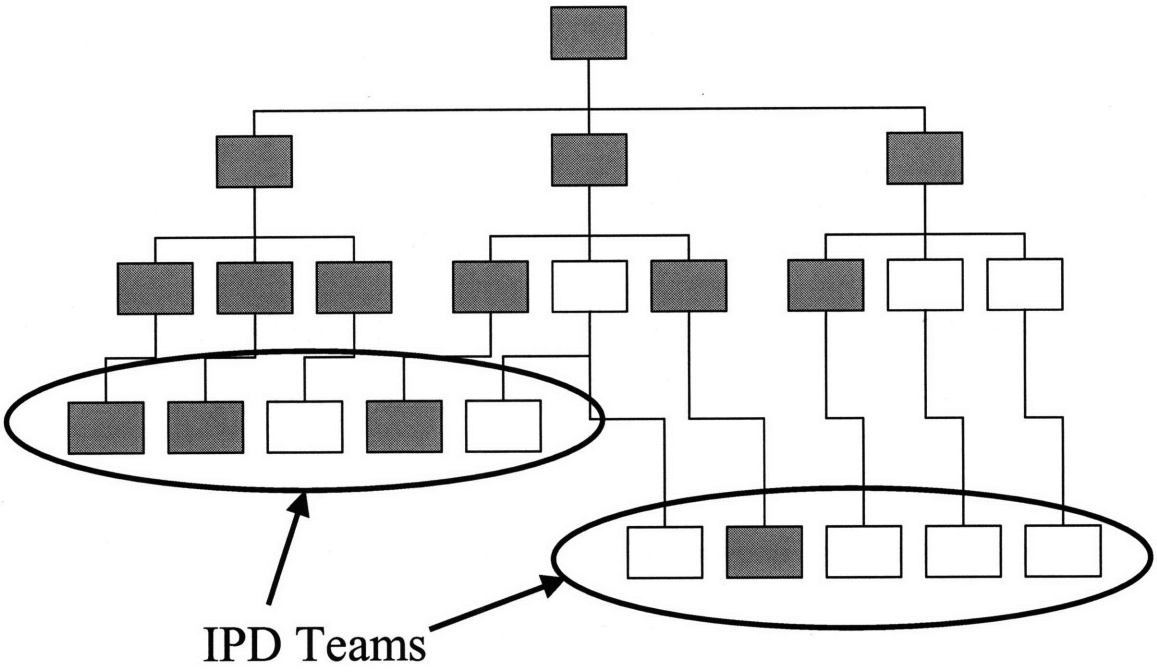
The three separate case studies mentioned above provide a unique opportunity to test the impacts of the "Roadmap" process. Each of three different companies was given the same set of questions to evaluate the main drivers of instability. "Changes in leadership vision" was the second highest reason given for internal instability in all 3 companies (Reference Figure 3.0-1). Giving the same questionnaire to AERO Corp. employees would provide a comparison basis between AERO Corp. and other companies, each going through a Lean Transformation, as well as a comparison internal to AERO Corp. between employees that participate in the "Roadmap" process and those that don't. The details of the questionnaire and the process used to gather the data will be discussed in more detail later in this document.

3.2 HYPOTHESIS

It is obvious from several studies that an organizational alignment and connection around corporate vision, strategy and goals must occur within the company for it to operate at its highest level of efficiency. This becomes even more

important in a flat, "matrixed" organization with distributed leaders where the connectivity and alignment are not always obvious. Having this type organization allows transformation to a Lean Enterprise because decisions can be made at a much lower level and therefore accomplished faster and thus higher throughput. However, the distributed leaders and employees must know the corporate strategy, vision and goals, which creates the context and framework for many of the decisions that will need to be made. Absent this understanding, decisions can appear disjointed, uneven and without purpose to meeting larger corporate goals. This may manifest itself in internal instability associated with changes to leadership vision as documented in previously mentioned case studies.

AERO Corp. has instituted a process to provide the linkage across the organization. As envisioned by the management team, this process is disciplined and thorough, for the stakeholders that it attempts to get aligned, and should thus provide significant impacts toward reducing internal instability due to changes in leadership vision. It is anticipated the survey results will show that the "Roadmap" process is a good process for linking and aligning the organization so that strategy and vision can flow throughout the work group functions and thus reduce instability. However, it is also anticipated that the "Roadmap" process has not been implemented universally within the corporation. It appears that some organizations flowed it down all the way to the employee level and some stopped at a higher level (Reference Figure 3.2-1).



Green fill indicates "Roadmap" alignment created
No fill indicates "Roadmap" alignment not created

Figure 3.2-1. Anticipated "Roadmap" Alignment within AERO Corp.

The same questionnaire will be given to both types of organizations. It will include questions that will allow the data to be sorted relative to those that use the "Roadmap" and those that don't. Comparing employee survey responses to instability, for those that are aware of the "Roadmap" with those that are not, should provide a good basis for understanding the impact of the "Roadmap" within AERO Corp. If the "Roadmap" is an effective tool, there should be quantifiable differences between these two groups.

Also, comparing AERO Corp. sources of instability results with other corporations that have taken the same survey should give a good indication of whether the "Roadmap" process could have similar results outside AERO Corp. (It

is not unexpected that this would occur because the "Roadmap" process is not something that would be unique to AERO Corp. However, there may be differences driven by company culture that will not be captured as part of this study.)

3.3 REVIEW ROADMAP PROCESS

The framework of the "Roadmap" process will also be evaluated for potential modifications to make it more effective as a Lean Transformation tool. Its composition was allowed to be flexible as long as it met the intent. This has resulted in several different embodiments of the "Roadmap". These different approaches will be evaluated for usefulness relative to Lean Transformation guidelines. Recommendations will be made on ways to change the process if any are noted as part of this study. This process will be compared to the characteristics of a Lean Enterprise as defined by "Transitioning to a Lean Enterprise" (Bozdogan, et. al, 2000) to decide if this "Roadmap" process is a good framework for building the alignment described. It is anticipated that this process will have significant benefit but could be modified and improved based on getting input from multiple users and comparing to established characteristics of Lean.

3.4 CONDUCTING SURVEY

The original complete survey (Appendix B) conducted by LARA representatives from MIT was given to three aerospace companies (Rocketdyne, Boeing – Wichita and Textron Systems) as part of a project to define instabilities within transforming organizations. The results of this original work defined internal and external sources of instability. The research also evaluated various methods

used to mitigate instability, the impact of instability on workplace innovations and operations, the frequency of initiatives and their relationship to various forms of instability, etc. (Cutcher-Gershenfeld, et. al., 2005) The original survey to conduct this research included sections titled

- Part A: Individual Profile
- Part B: Instability
- Part C: Work Practices
- Part D: Context
- Part E Learning Environment
- Part F: Outcomes
- Part G Demographics and Other Factors

As part of the research for this paper, a subset of the complete survey, using parts of Part A: Individual Profile and Part B: Instability (Shown in Appendix A), was given to 100 employees of AERO Corp. Since this research is focused on one particular process and its impact on instability level within the corporation, the subset survey consisted of questions specific to defining levels of instability within the corporations. The other sections of the original survey and pieces of Parts A: Individual Profile and Part B: Instability were removed and were not used as part of this study.

Since this survey was given to one company at their main facility, many of the original questions in Part A were removed. Only questions concerning time in aerospace industry, job classification within the organization and work area were used to determine if these might have had an impact on results. Sections of Part B not directly associated with determining the level of instability were also removed.

Questions from the original Part B of the survey that involved external instabilities were included even though the research for this paper is specific to internal instabilities. This was done to ensure that new participants were not influenced differently by the questions in this section relative to past participants. Therefore only data for questions b, f, i, j, l, m and n were used, correlated and compared with published data for internal instability from the LARA research. The complete original survey is included in Appendix B for comparison purposes.

3.4.1 SELECTING ORGANIZATIONS

The original LARA survey was given to a wide range of individuals across many disciplines. However, the percentages taking the survey from each organization varied considerably from company to company. It would be virtually impossible to ensure the survey participation at AERO Corp. was consistent with any of the previous surveys given that organizational structure and naming is widely different. Therefore, selection of the participants came from members of various integrated product teams, which were almost exclusively from the technical side of the organization. The participants were randomly selected and included various development and product team leaders as well as team participants from various functions. Limitations placed on the scope of the study by AERO Corp. prevented involving all functions on the integrated teams but, given the quantity of survey responses, the trends from the data still should be able to identify particular areas of more or less instability. Because follow up interviews will be used to put clarification on the responses, the trend of the data should give a valid indication of instability levels.

3.4.2 PROCESS USED

Copies of the survey were handed out to participants at multiple group meetings at various locations across AERO Corp. To preclude biasing the results, the participants were given no background information prior to taking the survey other than it was voluntary, anonymous, should take about 10 minutes and was part of a master's thesis. Following the completion of the survey, individual participants placed their survey sheet in a folder, which was picked up after all responses were received. Following completion of all the surveys, the data was analyzed and follow up interviews were conducted with individuals to try and understand why particular levels of instability might be high or low relative to previous surveys. This gave the author the opportunity to put some of the instability measured as a result of the survey into context relative to events going on at AERO Corp. The results of this are described in further detail below.

3.4.3 SURVEY QUESTIONS

Part A and B of this survey (Reference Appendix A) differ to the original survey conducted by LARA as described above in Section 3.4. However, for this exercise, three additional responses were requested in Part A. The 3 additional questions were:

1) I have seen my department's or the program office "Roadmap"
2) I know where to find a copy of the "Roadmap"
3) I have attended meetings where the "Roadmap" was discussed

They were all created as an attempt to quantify each participant's knowledge of the AERO Corp. "Roadmap" process. Each "Roadmap" question was intended to show increased knowledge of particular "Roadmaps" so the level of "Roadmap" knowledge could be correlated with instability in leadership vision. It was anticipated that less knowledge of the "Roadmaps" would correlate with higher instability due to changes in leadership vision.

The complete list of questions concerning instability from the original survey was included to evaluate if other processes might also be influenced by the "Roadmap". For instance, if instability was markedly different, follow up interviews might reveal additional impacts of the "Roadmap" process or it might reveal other forces at work.

4.0 RESULTS

Of 100 surveys handed out, 98 were submitted back with responses. Two were removed because they did not contain sufficient input and one was removed because information was provided that would have revealed the identity of the submitter. Of the 95 remaining responses only 5 had never been involved in the "Roadmap" process. There were 6 that had seen their department's "Roadmap" but could not locate a copy and 18 that knew about their department's map and could find a copy but had never been involved in meetings to discuss them. This means that of 95 usable responses only 29 were not completely involved with the "Roadmap" process and of the 29 only 5 had never heard of the "Roadmap". (Reference Appendix C for Survey Results Raw Data). Because of the high involvement with the "Roadmap" process, the anticipated measurable differences

due to incomplete flow down (Reference Figure 3.2-1) within AERO Corp. will not be possible to evaluate. This has led to the need to revise the original approach of comparing instability data between those that use the "Roadmap" process and those that don't. This comparison will not be possible. However, comparing the data between AERO Corp. and the previous survey results of Boeing-Wichita, Rocketdyne and Textron Systems will be possible and is shown in Figure 4.0-1. Because there was a wide response from different job classifications and years in the aerospace industry, a comparison can be made to determine if instability seemed to be more associated with one particular group or another. This is discussed later in more detail.

*Internal Instability**	*Boeing Wichita*	*Textron Systems*	*Rocketdyne*	***Road Map***
Internal budgets	**0.98**	**1.12**	**1.06**	1.16
Voluntary Turnover	**0.95**	**0.92**	**0.67**	1.04
Re-engineering	**0.96**	**1.05**	**0.92**	**0.74**
Leadership Vision	1.01	1.16	1.09	**0.96**
Tension / stress around change	1.11	1.17	1.14	**1.03**
Subcontract out work	**0.59**	**0.79**	**0.82**	**1.00**
In sourcing of work	**0.49**	**0.55**	**0.47**	**0.38**

*** 0 = never, 1 = sometimes, 2 = frequently**

Figure 4.0-1. Comparison of Instability Data

4.1 INSTABILITY DUE TO CHANGES IN LEADERSHIP VISION

The data indicates a significant drop in instability due to changes in leadership vision and a shift, relative to the three comparison companies, in the drivers of instability. Follow up discussion with participants indicates this is due almost solely to the "Roadmap" process and the periodic communication of "Roadmap" objective status. Several survey participants deemed this communication process equal to or more important than the process of creating the "Roadmap". This shows that it is not just the creation but the continued monitoring and reporting on "Roadmap" status that is important in maintaining alignment and connection across the organization. One could understand that if the "Roadmap" was simply created and never reviewed within the organization it would lose its meaning. AERO Corp. chose to review the "Roadmaps" at various levels within the organization on a periodic basis (typically monthly or quarterly).

There is one additional item of note. The instability due to changes in leadership vision is lower than comparison companies even though the company President recently changed. This near term event did not appear to have a significantly negative impact to the levels of instability unlike recent event impacts on other instability drivers (Reference Section 4.3 below). This could have resulted in a spike of instability as the new president started putting his vision and strategy into place. This did not occur and could possibly be a result of the new president maintaining the "Roadmap" process established by his predecessor. This continued the process of linking and aligning the corporation from top to bottom even under a new president with a different vision and strategy.

4.2 RESULTS BY DEMOGRAPHIC

The intent was to compare responses from survey participants that use the "Roadmap" process with those that did not. As mentioned earlier, there were very few that were not part of the "Roadmap" process and thus this comparison was not possible. However, there was a wide and significant range of responses from survey participants relative to years working in the aviation industry and job level within the company. The comparisons between these groups are below.

4.2.1 RESULTS RELATIVE TO YEARS OF EXPERIENCE

The data was sorted between respondents that had more than 20 years experience and those that had less to try and understand if the changes in instability were experience related. The 20-year mark was chosen because it gave close to equal number of responses on each side and there was not a cluster of responses at the 20-year level. This resulted in a database of 49 responses with 20 years or more of experience and 46 responses with less than 20 years experience.

As can been seen in Figure 4.2.1-1 below, the following observations can be made.

- The instability driven by Internal Budgets, Re-engineering and Sub-contracted Out Work is substantially higher for those with greater than 20 years experience.
- The instability driven by Changes in Leadership Vision is substantially less for those greater than 20 years experience.

- The instability driven by Tension and Stress Around Change, Voluntary Turnover and In Sourcing of Work is about the same between the two populations.

While the number of respondents is small relative to the size of AERO Corp. this data suggests that the "Roadmap" process is either not reaching younger employee or is not understood by them.

However, an ordinal logistic regression approach to evaluate whether there is a correlation between years of service and instability due to changes in leadership vision was conducted. This evaluation showed that for an alpha of 0.05 (defined as high confidence that there was a correlation between years of service and changes in leadership vision) there was not enough evidence in the data to conclude that there was a correlation.

*Internal Instability**	*20 years or More*	*Less than 20 Years*	*AERO Corp. Avg.*
Internal budgets	**1.27**	**1.04**	**1.16**
Voluntary Turnover	**1.02**	**1.07**	**1.04**
Re-engineering	**0.82**	**0.65**	**0.74**
Leadership Vision	**0.88**	**1.04**	**0.96**
Tension / stress around change	**1.02**	**1.04**	**1.03**
Subcontract out work	**1.08**	**0.91**	**1.00**
In sourcing of work	**0.35**	**0.41**	**0.38**

*** 0 = never, 1 = sometimes, 2 = frequently**

Figure 4.2.1-1 Instability Comparisons for Different Experience Levels

4.2.2 RESULTS RELATIVE TO JOB LEVEL

To try and understand if the changes in instability were related to rank within the corporation, the data was sorted between respondents that had attained a Grade Level 4 ranking and those that had not. The Grade 4 mark was chosen because it gave, as close to an equal number of responses on each side as possible and it is the level that AERO Corp. typically categorizes as "Leadership". This resulted in a database of 39 responses with Grade 4 and above and 56 responses less than Grade 4.

As can been seen in Figure 4.2.2-1 below, the following observations can be made.

- The instability driven by all causes except In Sourcing of Work is substantially higher for Grade Level 4's than other grade levels combined.
- The instability driven by Changes in Leadership Vision is higher among leaders within AERO Corp. than lower grade levels.

As above, the number of respondents is small relative to the size of AERO Corp. but this data suggests that the "Roadmap" process is having less of an impact on the leadership team than on the employees.

It was also noted from the data, that there is a fair degree of overlap between individuals with higher number of years of experience and higher Grade Level. Of the 49 participants had have greater than or equal to 20 years experience there were 31 that were also a Grade 4 or above.

Therefore, these two populations may not be separate measures of the impact of the "Roadmap" process on populations within AERO Corp.

However, an ordinal logistic regression approach was also conducted on the Grade Level population to evaluate whether there was a correlation between grade level and instability due to changes in leadership vision. This evaluation showed that for an alpha of 0.05 (defined as high confidence that there was a correlation between years of service and changes in leadership vision) there was not enough evidence to support that grade level is a strong predictor for instability due to changes in leadership vision.

*Internal Instability**	*Grade 4 & Above*	*Below Grade 4*	*AERO Corp. Avg.*
Internal budgets	**1.36**	**1.02**	**1.16**
Voluntary Turnover	**1.18**	**0.95**	**1.04**
Re-engineering	**0.92**	**0.61**	**0.74**
Leadership Vision	**1.00**	**0.93**	**0.96**
Tension / stress around change	**1.15**	**0.95**	**1.03**
Subcontract out work	**1.18**	**0.88**	**1.00**
In sourcing of work	**0.31**	**0.43**	**0.38**

*** 0 = never, 1 = sometimes, 2 = frequently**

Figure 4.2.2-1. Instability Comparison for Different Grade Levels

4.3 RESULTS OF FOLLOW UP INTERVIEWS

Once the data was obtained and processed, it could be seen that when comparing the results from the previous survey there were some significant differences on the drivers of instability on an average basis. Follow up interviews

were set up to try and obtain some background into why various areas of instability were higher or lower than previous data. While the responses from the survey were anonymous, who participated was not. A random group of individuals were contacted and given the overall results. These people were then asked to comment on why they thought instability levels were higher or lower than other companies. While this process is not truly scientific it did provide possible explanation for the data trends. A summary of the possible rationale behind the values of instability is listed below.

- Internal Budgets (higher than comparison companies). The survey was conducted in February. This corporation financial process closes accounts on December 31 and reopens them under new numbers on January 1. Many participants had recently gone through the process of having to find out what the new charge numbers were. On several occasions this was described as a highly inefficient process. This in fact points to another area AERO Corp. should consider the implementation of Lean to reduce instability. Several respondents indicated they had spent significant amounts of time (hours) to find out what the new charge numbers were. Obviously this would drive instability within the organization.
- Voluntary Turnover (higher than comparison companies). On January 1, the retirement benefits changed for anyone retiring after that date. This appears to have caused many to retire before December 31. This had obviously impacted several

areas as they attempted to bring in new resources to replace those that retired. As with the item above, the timing of the survey drove responses because of recent events.

- Re-Engineering (lower than comparison companies). AERO Corp. had gone through a significant re-engineering process (See Re-Organization Details Section 2.1) that had ended in 2000. There had been no significant changes of this type since then thus there was relatively small instability associated with this driver because it was either unknown to employees of less than 6 years or was significantly in the past to cause concern for employees over a 6-year tenure.
- Leadership Vision (lower than comparison companies). This is described in detail in previous paragraphs.
- Tension / Stress Around Change (lower than comparison companies). It appears there may be a couple of reasons behind this reduction in instability. Reasons sighted were 1) corporate stability over the last several years (no significant changes) and 2) significant increase in downward communication explaining any change that was occurring. One interesting aspect of the "Roadmap" process is that status relative to objectives is periodically presented. This in itself is part of the increased downward communication sighted as one reason for reduced instability in this area. Thus it could be

concluded that the "Roadmap" process has had an influence on two major areas of instability.

- Sub contract out work (more than comparison companies). There has been a substantial push by management to outsource more labor. Many processes were put in place to expedite this. Issues sighted were 1) several of the processes did not work as advertised, 2) significant "hand holding" of the outsourced labor and 3) high turnover among employees of the outsourcing company.
- In source of work (less than comparison companies). This driver of instability appears to almost be the antithesis of the one above. If the amount of outsourcing is high then the amount of in sourcing should be low. Thus, there should be higher instability associated with outsourcing and less instability for in sourcing. For AERO Corp. in sourcing was minimal.

4.4 IMPACT OF ROADMAP PROCESS

Based on the data collect and using average comparison, it does appear that as a whole the "Roadmap" process is reducing the amount of instability associated with changes in Leadership Vision. However, in order to do a statistical comparison to past data, significant assumption would have to be made about the previous data (only average data about the whole population was available). It was felt that the level of significance associated with these assumptions would impact the results

making the observations of limited use (this could be an area of further study). Because there was not sufficient participation from respondents that were not involved in the "Roadmap" process, it is unclear whether these groups had higher instability levels before the introduction of the "Roadmap" process or not. Therefore, this should be something that AERO Corp. investigates further on its road to transformation.

5.0 RESULTS OF BENCHMARKING ROADMAP ARCHITECTURES

As a part of trying to understand the impacts of the "Roadmap" process to various organizations, a review of how several groups handled the "Roadmap" was conducted. While AERO Corp. has instituted the "Roadmap" process throughout the company, there have been few guidelines or criteria issued for ensuring consistency, standardization or the use of best practices. This has resulted in several variations of how the "Roadmap" is instituted as it flows from top to bottom throughout the company. While a comparison could be made among the various "Roadmap" types to determine which was more effective, it would be of considerable scope if a tool like the instability questionnaire were used. Instead, the numerous "Roadmaps" were reviewed, categorized into different types and then compared for linkage and alignment from President to department level.

There were three main types of "Roadmap" architecture noted. For the most part they all maintained the Key Attributes and Strategies for Delivering on Key Attributes (Reference Figure 2.3-1) but differed considerably on how Objectives for delivering on Key Attribute strategies were constructed. The three types of objective architectures are described below,

- Objectives listed in no particular order or fashion
- Objectives divided into two types "Company Wide" and "Department Specific".
- Objectives divided into the two types mentioned above but the Department Specific objectives are further divided and linked to Key Attributes.

It is this last type of "Roadmap" that appears to have the highest probability of properly linking the organization. It lets the employees know which objectives people outside the group will also have (Company Wide) and which specific objectives are unique to their organization (Department Specific). It further defines which unique objectives are targeted towards Key Attributes that are measured at the highest strategic level (Reference Figure 2.3-3) and thus completes the strategy and vision alignment from top to bottom. By listing Department Specific objectives aligned with Presidential level Key Attributes, as shown in Figure 5.0-1, it brings the whole process full circle and aligns the whole company vision and strategy.

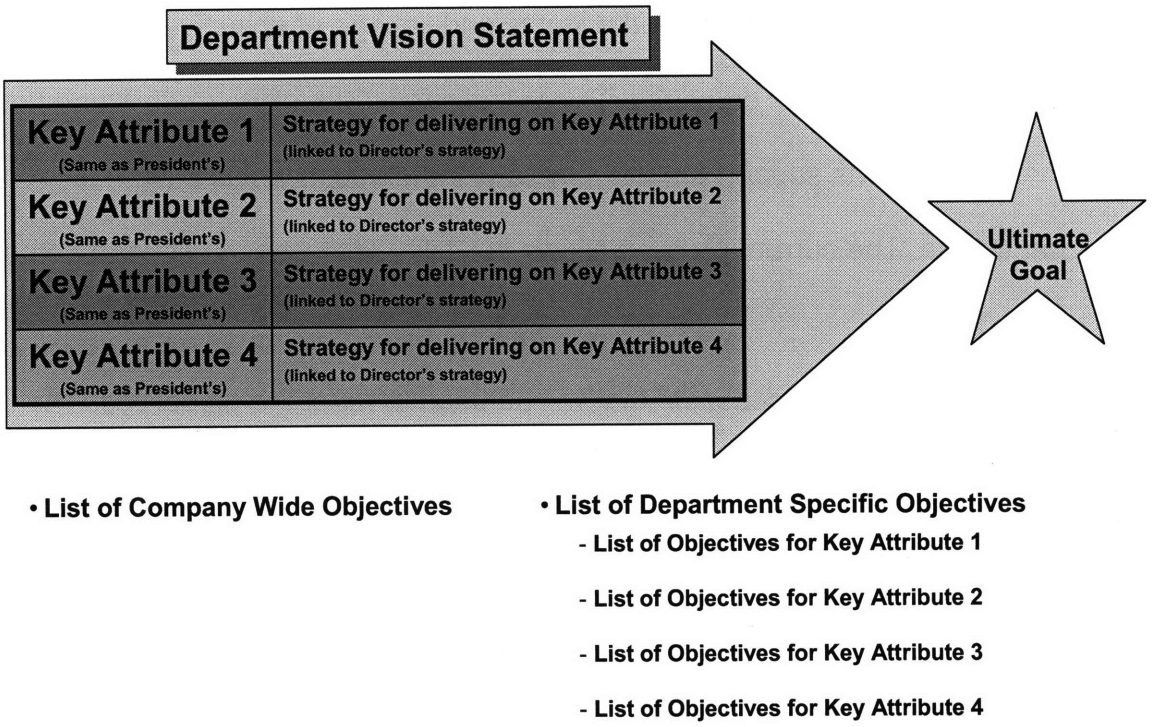


Figure 5.0-1 Recommended Roadmap Architecture

One additional process that was noted but was not widely used was to periodically status progress relative to each objective. In other words the objectives were turned into high-level metrics that were given "stop light" status (red, yellow, green) periodically throughout the year. When done properly this gives further linkage across the corporation showing how the company as well as the individual department is performing relative to meeting its objectives for the year.

6.0 RECOMMENDATIONS

While the data supports the "Roadmap" process as a useful tool to reduce instability caused by changes in leadership vision, some changes to the process could make this a better tool for managing a company in transformation. Recommended changes are listed below

1) Consistent format, criteria, metric status and linkage of objectives should be mandated across the company. This will allow individuals to understand how their work efforts support the distributed work teams in which they participate. The current process allows flexibility but loses the linkage across departments.
2) Add a list of "Key Processes" that will be used to meet the objectives. The "Roadmap" process almost has all the ingredients necessary for the "X-Matrix" analysis (Nightingale and Stanke, 2005). The "X-Matrix" has 4 specific parts (Strategic Objectives, Stakeholder Values, Key Processes and Metrics) that allow an evaluation of how well the company is aligned towards delivering stakeholder value. The "Key Attributes" of the "Roadmap" process are equivalent to "Strategic Objectives" in the "X-Matrix". Strategies for delivering on objectives as defined in the "Roadmap" process, in most cases, were very similar to "Stakeholder Values" in the "X-Matrix". Adding a list of "Key Processes" (X-Matrix) that link to the "Roadmap" Department Objectives would also link to AERO Corp. Strategic Objectives. Doing a periodic "stop light" status of these objectives treats them much like metrics. Therefore by adding the "Key Processes" and doing periodic status (already a part of the "Roadmap" process) would link all the pieces of the "X-Matrix" but in a "Roadmap" format.

In essence without understanding the "X-Matrix" process AERO Corp. understood the usefulness of such a process as it transformed itself and almost created its own "X-Matrix" that also linked the corporation from top to bottom.

7.0 CONCLUSIONS

AERO Corp. chose an approach that deploys a system wide linkage and alignment of vision, strategy and objectives from top to bottom. Their approach also provides a framework that helps decisions be put into proper context. As products and organizational structures become more complex, the leadership will require better understanding of the context of ones decision and how it relates to a much higher strategy and vision so that the proper decisions can be made and that the vision does not appear to constantly change. Additionally, the "Roadmap" process results in a documentation of vision and strategy which allows following leaders to understand previous vision and employees to understand how and why changes or the evolution of changes to the vision and strategy occur.

When coupled with a "stop light" status, the "Roadmaps" become a visual performance measurement system for the office much like an andon light on the shop floor. Although not immediate feedback, it does give the office worker a sense of what is working well and what needs attention to ensure weaknesses are corrected.

While the "Roadmap" process is proving to be a useful tool it requires complete "grass roots" buy in to reach its full potential. There is still considerable cynicism around the benefits of this process, particularly noted during follow up interviews. However, the data points out that progress towards reducing the highest causes of instability is being made. Additional areas of research that could further enhance the understanding of the impacts of the process on organizational instability are:

1) Compare instability within one company among employees that use a similar alignment process and those that don't. While the comparison is made between AERO Corp. and other companies, there are cultural and business differences between companies that could impact levels of instability that were not taken into account by this research.

2) Additional investigation into different employee characteristics (such as job function, years of service, etc.) to better understand if and why differences in instability exist in various groups and therefore potentially tailor to process to better meet all employees needs.

3) Evaluate different alignment processes to better understand the impacts to instability and thus propose an alignment process that would better balance the levels of instability among all groups. To have one group show a significant difference in levels of instability from another presents the prospect that the alignment process benefits may only be temporary.

4) Follow up surveys with the corporations involved in the last surveys to understand if instability is being reduced and whether anything other than a "Roadmap" process can also affect this type of change.

It was also noted that the relatively simple survey was a very useful tool when coupled with follow up interviews to identify potential areas of instability and

the more detailed causes of the instability. In a couple of cases it pointed out additional areas where AERO Corp. could evaluate potential improvements.

1) Budget instability associated with first part of the year,
2) Transition of people to jobs of retiring employees,
3) Understanding and correcting any differences in instability drivers between different experience levels and ranking within the corporation.

APPENDIX A

Questionnaire Used for Survey

INSTABILITY SURVEY

Part A: Individual profile

A1. How long have you worked in the aerospace industry? _____ Years

A2. What is your job classification (Example L4, L5, etc.) ?_____

A3. What is the primary area in which you work? _____
(for example, assembly, machining, material handling, engineering, quality control, accounting, etc.)

Check as many of the following boxes that apply (Reference 2006 or 2007 "Roadmap"):

☐ I have seen my department's or the program office "Roadmap"

☐ I know where to find a copy of the "Roadmap"

☐ I have attended meetings where the "Roadmap" was discussed

Part B. Instability: Over the past three years, how often has your work been impacted by each of the following: Circle one number in each row

	Never	Sometimes	Frequently
a. My work has been affected by changes in budget allocations for government contracts	0	1	2
b. My work has been affected by changes in internal company budgets	0	1	2
c. My work has been affected by changes in product demand	0	1	2
d. My work has been affected by changes in customer requirements, technical design or materials	0	1	2
e. My work has been affected by changes in equipment or other technology	0	1	2
f. My work has been affected by voluntary staffing turnover within my facility (voluntary quits or retirements)	0	1	2
g. My work has been affected by involuntary staffing turnover within my facility (involuntary layoffs)	0	1	2
h. My work has been affected by changes in supplier performance	0	1	2
i. My work has been affected by subcontracting of work previously done "in house"	0	1	2

j. My work has been affected by the "in-sourcing" of work (bringing it back to the facility) that had previously been out sourced	0	1	2
k. My work has been affected by mergers or acquisitions involving the parent company	0	1	2
l. My work has been affected by "re-engineering" or restructuring of operations	0	1	2
m. My work has been affected by changes in leadership vision	0	1	2
n. My work has been affected by tensions and stress around change	0	1	2

APPENDIX B

Original Questionnaire

Part A: Individual profile

A1. a. How long have you worked in the aerospace industry? _____ Years

b. How long have you worked for this company? _____ Years

c. How long have you worked in this facility? _____ Years

d. How long have you worked in your present work area? _____ Months

A2. What is your title or job classification? _____

A3. What is the primary product or program that you work on? _____

A4. What is the primary area in which you work? _____
(for example, assembly, machining, material handling, engineering, quality control, accounting, etc.)

A5. Do you primarily work on products or projects that are: ☐ a) military ☐ b) commercial ☐ c) both

A6. If you work on a team what is the name of your team? _____

A7. Have you been laid off in the last 3 years? ☐ Yes ☐ No

A8. Have you switched from one work area to another? ☐ Yes ☐ No

If you answer was yes in question A8, was the switch ☐ a) voluntary ☐ b) involuntary

Part B: Instability

B1. Over the past three years, how often has your work been impacted by each of the following:

	Never	Sometimes	Frequently
a. My work has been affected by changes in budget allocations for government contracts	0	1	2
b. My work has been affected by changes in internal company budgets	0	1	2
c. My work has been affected by changes in product demand	0	1	2
d. My work has been affected by changes in customer requirements, technical design or materials	0	1	2
f. My work has been affected by changes in equipment or other technology	0	1	2

g. My work has been affected by voluntary staffing turnover within my facility (voluntary quits or retirements)	0	1	2
g. My work has been affected by involuntary staffing turnover within my facility (involuntary layoffs)	0	1	2
h. My work has been affected by changes in supplier performance	0	1	2
i. My work has been affected by subcontracting of work previously done "in house"	0	1	2
j. My work has been affected by the "in-sourcing" of work (bringing it back to the facility) that had previously been out sourced	0	1	2
k. My work has been affected by mergers or acquisitions involving the parent company	0	1	2
l. My work has been affected by "re-engineering" or restructuring of operations	0	1	2
m. My work has been affected by changes in leadership vision	0	1	2
n. My work has been affected by tensions and stress around change	0	1	2
o. Other*(Please specify)*: _____	0	1	2

B2. Over the past three years, how often have you experienced any of the following in your work area:

	Never	***Sometimes***	***Frequently***
a. Cross-training/multi-skilling so you can switch among jobs in this facility	0	1	2
b. Work-sharing (e.g., putting workers on reduced hours)	0	1	2
c. Reducing overtime to avoid layoffs	0	1	2
d. Working with an informal assurance of employment security	0	1	2
e. Working with a formal no layoff pledge	0	1	2
f. Employer using temporary or contract workers	0	1	2
g. Employer bringing people from other facilities to work here	0	1	2
h. Increased personal control over daily responsibilities	0	1	2
i. Your direct involvement in work redesign	0	1	2
j. Employer assigning you to work in other programs/facilities	0	1	2

k. Participating in integrated product teams	0	1	2
l. Use of computer-aided manufacturing	0	1	2
m. Use of flexible or tool-less assembly techniques	0	1	2
n. Out-sourcing work to suppliers to meet fluctuation in demand	0	1	2
o. Technical training	0	1	2
p. Apprenticeship or professional development training	0	1	2
q. Interpersonal/team skills training	0	1	2
p. The imposition of a hiring freeze	0	1	2
q. Significant reduction of the management staff in this facility	0	1	2
r. Layoff of a substantial number of workers	0	1	2
s. Other *(Please specify)* _____	0	1	2

Part C: Work Practices

C1. The following questions focus on your workplace. In each case there are a pair of ideas or practices. Read each pair carefully and then circle the number that represents how you see current realities in your work area. Select "1" if your work area is closest to the practice on the left, "6" if it is closest to the practice on the right, or pick the appropriate number in-between. If the idea or practice does not apply to your work area, circle "NA."

Elements of the Work System in Your Work Area

Circle the number that most reflects current realities in your facility (or NA, if Not Applicable).

a. Simultaneous/concurrent engineering	1	2	3	4	5	6	Sequential engineering	NA
b. Substantial "in-process" inventory in manufacturing	1	2	3	4	5	6	Minimal "in-process" inventory	NA
c. No changes in cycle time	1	2	3	4	5	6	Reducing cycle times	NA
d. Flexible/programmable machines	1	2	3	4	5	6	Dedicated machines	NA
e. Crisis management	1	2	3	4	5	6	Anticipate/avoid crises	NA
f. Preventive maintenance	1	2	3	4	5	6	Repair equipment when it breaks down	NA

g. Arm's length supplier relations	1	2	3	4	5	6	Tightly integrated suppliers	NA
h. Departments or functions maximize their own gains	1	2	3	4	5	6	Everyone works to optimize the entire system	NA
i. Extensive access to business/performance information	1	2	3	4	5	6	Limited access to business/ performance information	NA
j. Low trust between management and employees	1	2	3	4	5	6	High trust between management and employees	NA
k. Separate quality inspection	1	2	3	4	5	6	In-process inspection	NA
l. Focus is on individual responsibility	1	2	3	4	5	6	Overall mission is everyone's responsibility	NA
m. Centralized decision making	1	2	3	4	5	6	Decentralized decision making	NA
n. Job rotation	1	2	3	4	5	6	No job rotation	NA
o. If it's not broke don't fix it	1	2	3	4	5	6	Continuous improvement	NA
p. All training provided by external experts	1	2	3	4	5	6	Extensive use of in-house trainers	NA
q. No formal technical skills training	1	2	3	4	5	6	Extensive formal technical skills training	NA
r. Labor/overhead cost accounting	1	2	3	4	5	6	Activity-Based Cost (ABC) accounting	NA
s. Gainsharing/pay for performance/ pay for skill	1	2	3	4	5	6	No incentive or performance based pay	NA
t. No formal group process training	1	2	3	4	5	6	Extensive formal group process training	NA
u. High level of worker responsibility on the job	1	2	3	4	5	6	Low level of worker responsibility on the job	NA
v. "Flow" of material or design ideas-- no wasted steps	1	2	3	4	5	6	Many extra steps and waste in flow of material or design ideas	NA
w. Engineering organized by functional specialty	1	2	3	4	5	6	Engineering organized by integrated product or process teams (IPT)	NA

C2. When has there been the most change in the way you do your job– in the form of the various work practices listed above? (Please check one)

☐ From 1997 to present ☐ From 1993 to 1996 ☐ From 1990 to 1993 ☐ Prior to 1990

C3. Overall, where has the majority of the drive to implement these new work practices come from? (please check one)

☐ Driven top down by corporate leaders ☐ Driven top down by facility leaders ☐ Negotiated by all parties ☐ Driven bottom up by facility employees

Part D: Context

D.1 Please indicate the degree to which you agree or disagree with the following statements with respect to your primary work area.

		Strongly Disagree		*Neither Agree nor Disagree*		*Strongly Agree*	*Don't Know*
a.	In the current labor market my skills make it easy to find a job	1	2	3	4	5	?
b.	In my work area, there are high levels of turnover among production employees	1	2	3	4	5	?
c.	In my work area, there are high levels of turnover among supervisory and management employees	1	2	3	4	5	?
d.	Where I work there are high levels of turnover among engineers	1	2	3	4	5	?
e.	In my work area, task assignments are unclear	1	2	3	4	5	?
f.	In my work area, there are poor relationships among people	1	2	3	4	5	?
g.	There is high demand for the product I make	1	2	3	4	5	?
h.	I feel more and more uncertain about my future in this industry	1	2	3	4	5	?
i.	I would highly recommend that my children work in this industry	1	2	3	4	5	?

Part E: Learning Environment

E.1 Please indicate the degree to which you agree or disagree with the following statements:

		Strongly Disagree		*Neither Agree nor Disagree*		*Strongly Agree*
a.	My employer provides opportunities to learn new skills	1	2	3	4	5

b.	My employer encourages me to try different approaches to solve problems	1	2	3	4	5
c.	My employer assigns tasks I can perform without error	1	2	3	4	5
d.	I am rewarded for using on my job, what I have learned in training	1	2	3	4	5
e.	My supervisors and coworkers help reschedule work so that I can attend training	1	2	3	4	5
f.	In my work area, supervisors are open to new ideas and suggestions	1	2	3	4	5
g.	In my work area, employees are open to new ideas and suggestions	1	2	3	4	5
h.	I can openly express my views (e.g., agreement or disagreement) to management	1	2	3	4	5
i.	I understand how my job relates to others in the organization	1	2	3	4	5
j.	I have the skills I need to perform my job quite effectively	1	2	3	4	5
k.	I am encouraged to develop the skills needed for advancement	1	2	3	4	5
l.	My employer always asks me about my training needs	1	2	3	4	5
m.	I am quite proficient at my job	1	2	3	4	5
n.	I am confident in my ability to adapt to change on my job	1	2	3	4	5
o.	Employees here are responsible for demonstrating on the job what they learned in training	1	2	3	4	5
p.	I have learned more tasks and increased my flexibility	1	2	3	4	5
q.	The information necessary for my work is always available	1	2	3	4	5
r.	I have been assigned a mentor to help my learning in the organization	1	2	3	4	5
s.	I have served in a formal apprenticeship program to learn my craft	1	2	3	4	5
t.	I am paid on a "pay for knowledge" basis where I get additional increments of pay for learning new skills	1	2	3	4	5
u.	Practically everything I know about how to do my job I have learned through "on-the-job" training (OJT)	1	2	3	4	5

v.	My skill level has increased as a result of new work practices	1	2	3	4	5
w.	Increasing my skill level will help me maintain employment	1	2	3	4	5
x.	Learning new work practices will increase my employability	1	2	3	4	5

Part F: Outcomes

F1. In the areas you have worked over the past three years, what has been the overall trend for the following employment outcomes:

	Significant Decrease		*No Change*		*Significant Increase*	*Don't Know*
a. Use of contract (non-payroll) personnel	1	2	3	4	5	?
b. Use of temporary workers	1	2	3	4	5	?
c. Total number of regular/permanent employees	1	2	3	4	5	?
d. Use of overtime	1	2	3	4	5	?
e. Outsourcing certain operations	1	2	3	4	5	?
f. Loss of people with critical skills	1	2	3	4	5	?
g. Apprentice training	1	2	3	4	5	?
h. Number of tasks included in my job	1	2	3	4	5	?
i. Hiring college recruits	1	2	3	4	5	?
j. Other (please specify) _____	1	2	3	4	5	?

F2. Please give your overall impression of the changes in these performance indicators over the past three years in your work area? (Circle one number for each row.)

Performance Indicators	*Significant Decrease*		*No Change*		*Significant Increase*	*Don't Know*
a. Productivity	1	2	3	4	5	?
b. Quality of product or service	1	2	3	4	5	?
c. Customer service	1	2	3	4	5	?
d. Overall worker satisfaction	1	2	3	4	5	?
e. Turnover	1	2	3	4	5	?

f. Absenteeism	1	2	3	4	5	?
g. Schedule/delivery performance	1	2	3	4	5	?
h. Profitability	1	2	3	4	5	?
i. Moving decision-making authority to lower organizational levels	1	2	3	4	5	?
j. Information flow throughout the corporation	1	2	3	4	5	?
k. Employee trust in management	1	2	3	4	5	?
l. Employee trust in co-workers	1	2	3	4	5	?
m. Worker responsibility for outcomes	1	2	3	4	5	?
n. Employment security	1	2	3	4	5	?
o. Overall understanding of company goals	1	2	3	4	5	?
p. Communication with co-workers and people on other teams (if relevant)	1	2	3	4	5	?

Part G: Demographics and Other Factors:

G1. How many hours of formal training have you received in the last year? (Please *check one)*

☐ Less than 8 hours ☐ 8-20 hours ☐21-40 hours ☐41-80 hours ☐More than 80 hours

G2. What percentage of your training was voluntary?

☐ None ☐ Under 25% ☐ 26-50% ☐ 51-75% ☐ 76-100%

G3. What percentage of your training was on your own time?

☐ None ☐ Under 25% ☐ 26-50% ☐ 51-75% ☐ 76-100%

G4. What percentage of your training was on company time?

☐ None ☐ Under 25% ☐ 26-50% ☐ 51-75% ☐ 76-100%

G5. In the hours of formal training above, how many of the hours were related to technical skills?

☐ Less than 4 hours ☐5-10 hours ☐ more than 10 hours

G6. In the hours of formal training above, how many of the hours were related to people or process skills?

☐ Less than 4 hours ☐5-10 hours ☐ more than 10 hours

G7. How many weeks in the last year have you worked over 40 hours? _____ Weeks

G8. Your gender: ☐ Male ☐ Female

G9. Your age range: ☐ Under 25 ☐26-35 ☐36-45 ☐46-55 ☐56-65 ☐Over 65

G10. Your education level: *(select one)* ☐ High school ☐Some college ☐Two-year degree ☐Bachelor's degree ☐Master's degree ☐Doctorate

Other _____

Additional Comments:

_____

_____

APPENDIX C

Raw Data Collected on Survey

Raw Data

Years	Job class	Road map 1	Road map 2	Road map 3	A	B=1	C	D	E	F=2	G	H	I=6	J=7	K	L=3	M=4	N=5
7	6	X	X	X	0	0	1	2	1	1	1	1	2	1	0	0	2	2
8	5	X	X	X	1	1	0	1	1	1	0	1	2	0	0	1	1	1
2	7	X	X	X	1	1	0	1	0	1	0	0	1	1	0	0	1	0
15	4	X	X	X	1	0	1	2	1	2	0	1	1	0	0	1	1	1
16	9	X	X	X	0	1	1	1	1	0	1	0	1	0	0	1	1	1
19	6	X	X	X	1	1	1	1	0	1	0	0	1	0	0	0	1	0
25	4	X	X	X	2	2	0	2	1	1	0	2	1	0	0	1	1	2
5	40	X	X	X	0	1	0	0	0	1	0	0	0	0	0	0	1	1
30	4	X	X	X	0	1	1	1	1	0	0	1	1	0	0	0	1	1
28	4	X	X	X	1	2	1	1	1	2	0	0	1	0	0	0	1	2
20	6	X	X	X	1	2	0	1	0	0	0	2	2	1	0	0	1	1
17	4	X	X	X	2	2	1	2	2	2	2	2	2	0	2	2	2	2
18	5	X	X	X	1	1	2	2	1	1	0	1	1	1	0	1	1	2
11	5	X	X	X	2	2	2	2	1	0	1	1	1	1	1	1	2	2
22	5	X	X	X	1	1	1	2	1	0	0	1	1	1	0	1	1	0
25	5	X	X	X	1	1	1	1	1	1	0	1	0	0	0	0	0	1
26	5	X	X	X	1	1	0	1	1	0	1	1	1	0	1	1	1	0
28	5	X	X	X	1	1	1	2	1	1	1	0	1	0	0	1	1	1
28	5	X	X	X	2	2	2	2	1	1	1	1	1	1	1	1	2	2
29	4	X	X	X	2	1	2	2	1	2	1	1	1	0	0	0	1	0
20	5	X	X	X	1	2	0	2	0	1	1	1	1	0	0	0	1	1
21	5	X	X	X	2	2	2	2	1	1	0	2	2	0	1	2	2	1
34	5	X	X	X	2	2	1	2	1	2	1	1	2	0	0	2	1	2
27	4	X	X	X	1	1	1	1	1	2	0	1	1	1	0	0	1	1
25	4	X	X	X	0	1	0	1	1	0	0	1	0	0	0	0	0	1
17	4	X	X	X	1	2	1	2	1	1	1	1	1	1	0	1	1	2
9	4	X	X	X	2	2	2	1	1	2	1	2	2	1	1	2	2	1
8	37	X	X	X	0	1	0	0	1	1	0	0	0	1	0	0	1	2
3	7	X	X	X	0	1	2	2	1	1	0	1	1	0	0	0	1	1
5	5	X	X	X	2	2	2	2	2	2	0	1	1	0	0	1	1	1
6	7	X	X	X	1	1	2	0	1	1	1	0	1	0	0	0	1	0
32	4	X	X	X	1	2	1	2	2	1	0	1	2	0	1	2	2	2
24	4	X	X	X	0	2	1	1	2	1	0	0	0	0	0	1	1	1
24	4	X	X	X	2	2	1	2	1	2	1	0	1	0	0	1	1	2
26	5	X	X	X	2	2	0	2	1	2	0	1	1	0	0	1	2	1
28	4	X	X	X	2	2	1	1	1	1	0	1	1	0	0	1	1	1
22	4	X	X	X	2	2	1	2	0	1	0	1	1	0	0	1	1	1
30	4	X	X	X	2	2	1	1	2	1	0	2	2	0	1	2	0	1
30	4	X	X	X	2	2	1	2	1	2	1	2	2	0	0	1	1	1
35	4	X	X	X	1	2	1	1	2	1	1	1	2	0	1	1	2	1
29	4	X	X	X	0	1	0	2	1	1	0	1	0	0	0	0	0	0
18	4	X	X	X	1	1	0	2	0	2	0	1	2	1	0	0	1	0
20	4	X	X	X	0	1	2	2	1	1	0	1	1	1	0	0	1	1
4	5	X	X	X	1	0	0	1	1	2	1	1	1	0	0	1	2	1
20	5	X	X	X	0	0	0	2	2	1	0	2	1	0	0	1	0	0
7	7	X	X	X	1	1	1	1	1	1	1	1	1	1	1	1	2	1
33	4	X	X	X	0	1	1	1	1	1	0	2	1	0	0	1	0	1
29	4	X	X	X	1	2	2	2	1	1	0	2	2	1	0	1	1	1
29	4	X	X	X	1	1	1	2	1	1	0	2	1	1	0	0	1	1
39	40	X	X	X	0	1	0	1	1	1	0	0	1	0	0	1	1	1
25	4	X	X	X	0	0	0	0	1	1	0	2	2	0	0	1	1	1
29	4	X	X	X	0	2	2	2	0	0	0	0	1	0	0	0	1	0
24	4	X	X	X	1	1	1	1	1	1	0	1	0	0	0	1	1	1

Raw Data (Cont.)

Years	Job class	Road map 1	Road map 2	Road map 3	A	B=1	C	D	E	F=2	G	H	I=6	J=7	K	L=3	M=4	N=5
9	5	X	X	X	0	0	2	2	0	0	0	2	2	1	0	1	1	0
10	4	X	X	X	1	1	2	2	1	2	0	2	1	0	0	2	2	2
24	4	X	X	X	2	1	2	2	2	1	1	2	2	1	1	2	1	1
25	4	X	X	X	0	1	0	1	2	1	0	0	0	0	0	1	2	2
27	4	X	X	X	1	1	1	1	0	1	0	1	2	0	0	1	0	1
18	4	X	X	X	1	1	1	1	0	1	0	1	1	0	0	1	1	1
9	5	X	X	X	2	2	2	2	1	2	1	1	2	2	0	0	1	1
11	5	X	X	X	1	1	1	2	1	1	1	2	1	1	0	1	1	1
20	4	X	X	X	1	1	1	1	1	1	0	0	2	0	0	1	1	1
29	4	X	X	X	1	1	1	1	1	0	1	1	1	1	1	1	1	1
9	6	X	X	X	1	1	0	1	1	2	0	0	0	0	0	0	0	1
3	7	X	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7	6	X	X	X	2	2	1	2	0	0	0	0	0	0	0	0	0	1
5	6	X	X		1	1	0	1	1	0	0	1	1	0	0	0	1	1
35	4	X	X		1	1	0	1	1	1	1	1	0	0	1	1	1	1
12	40	X	X		0	1	1	1	1	1	1	1	0	0	1	1	0	1
25	5	X	X		1	1	1	1	1	1	1	1	1	1	1	1	1	1
25	5	X	X		1	0	0	1	1	1	0	1	1	0	0	0	0	0
7	6	X	X		0	0	1	2	1	1	1	1	2	1	0	0	2	2
29	4	X	X		2	1	1	1	0	2	1	1	1	0	0	0	0	1
15	5	X	X		2	2	0	1	0	1	0	0	0	0	0	0	1	1
8	4	X	X		0	2	0	2	2	1	0	2	2	1	0	1	2	2
19	5	X	X		1	2	1	1	1	2	1	0	1	1	1	2	2	2
9	5	X	X		0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	8	X	X		0	0	0	0	0	0	0	1	0	0	0	0	0	1
1	7	X	X		1	1	0	1	2	2	0	0	1	1	0	0	1	1
18	40	X	X		0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	5	X	X		0	0	0	1	1	1	0	1	1	0	0	0	0	0
15	5	X	X		1	1	1	1	0	0	0	0	0	0	0	0	1	0
0	8	X	X		0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	7	X	X		1	2	1	1	0	0	0	0	1	0	0	2	1	1
21	5	X			1	1	2	2	1	1	1	1	1	1	1	1	2	2
29	38	X			1	1	1	0	0	1	0	0	1	2	1	1	0	2
3	7	X			0	2	2	2	2	2	1	2	0	0	0	2	2	2
3	7	X			2	2	1	1	1	2	0	0	0	0	0	0	0	0
35	4	X			1	1	2	2	2	1	1	2	2	2	1	2	1	2
30	4	X			0	1	0	1	1	1	1	0	0	0	1	2	0	1
4	8				1	1	1	2	1	2	1	0	2	1	0	2	1	2
1	8				0	0	1	2	1	1	0	0	1	0	0	0	1	1
25	7				1	0	0	0	1	1	0	0	0	2	0	0	0	0
0	8				0	1	0	0	0	1	1	1	1	1	0	1	1	1
5	5				1	1	1	1	1	2	0	0	1	0	0	1	1	1
			Total		86	110	81	124	86	99	35	82	95	36	21	70	91	98
			Average		0.91	1.16	0.85	1.31	0.91	1.04	0.37	0.86	1.00	0.38	0.22	0.74	0.96	1.03

Data Sorted by Grade Level

Years	Job class	Road map 1	Road map 2	Road map 3	A	B=1	C	D	E	F=2	G	H	I=6	J=7	K	L=3	M=4	N=5
15	4	X	X	X	1	0	1	2	1	2	0	1	1	0	0	1	1	1
25	4	X	X	X	2	2	0	2	1	1	0	2	1	0	0	1	1	2
30	4	X	X	X	0	1	1	1	1	0	0	1	1	0	0	0	1	1
28	4	X	X	X	1	2	1	1	1	2	0	0	1	0	0	0	1	2
17	4	X	X	X	2	2	1	2	2	2	2	2	2	0	2	2	2	2
29	4	X	X	X	2	1	2	2	1	2	1	1	1	0	0	0	1	0
27	4	X	X	X	1	1	1	1	1	2	0	1	1	1	0	0	1	1
25	4	X	X	X	0	1	0	1	1	0	0	1	0	0	0	0	0	1
17	4	X	X	X	1	2	1	2	1	1	1	1	1	1	0	1	1	2
9	4	X	X	X	2	2	2	1	1	2	1	2	2	1	1	2	2	1
32	4	X	X	X	1	2	1	2	2	1	0	1	2	0	1	2	2	2
24	4	X	X	X	0	2	1	1	2	1	0	0	0	0	0	1	1	1
24	4	X	X	X	2	2	1	2	1	2	1	0	1	0	0	1	1	2
28	4	X	X	X	2	2	1	1	1	1	0	1	1	0	0	1	1	1
22	4	X	X	X	2	2	1	2	0	1	0	1	1	0	0	1	1	1
30	4	X	X	X	2	2	1	1	2	1	0	2	2	0	1	2	0	1
30	4	X	X	X	2	2	1	2	1	2	1	2	2	0	0	1	1	1
35	4	X	X	X	1	2	1	1	2	1	1	1	2	0	1	1	2	1
29	4	X	X	X	0	1	0	2	1	1	0	1	0	0	0	0	0	0
18	4	X	X	X	1	1	0	2	0	2	0	1	2	1	0	0	1	0
20	4	X	X	X	0	1	2	2	1	1	0	1	1	1	0	0	1	1
33	4	X	X	X	0	1	1	1	1	1	0	2	1	0	0	1	0	1
29	4	X	X	X	1	2	2	2	1	1	0	2	2	1	0	1	1	1
29	4	X	X	X	1	1	1	2	1	1	0	2	1	1	0	0	1	1
25	4	X	X	X	0	0	0	0	1	1	0	2	2	0	0	1	1	1
29	4	X	X	X	0	2	2	2	0	0	0	0	1	0	0	0	1	0
24	4	X	X	X	1	1	1	1	1	1	0	1	0	0	0	1	1	1
10	4	X	X	X	1	1	2	2	1	2	0	2	1	0	0	2	2	2
24	4	X	X	X	2	1	2	2	2	1	1	2	2	1	1	2	1	1
25	4	X	X	X	0	1	0	1	2	1	0	0	0	0	0	1	2	2
27	4	X	X	X	1	1	1	1	0	1	0	1	2	0	0	1	0	1
18	4	X	X	X	1	1	1	1	0	1	0	1	1	0	0	1	1	1
20	4	X	X	X	1	1	1	1	1	1	0	0	2	0	0	1	1	1
29	4	X	X	X	1	1	1	1	1	0	1	1	1	1	1	1	1	1
35	4	X	X		1	1	0	1	1	1	1	1	0	0	1	1	1	1
29	4	X	X		2	1	1	1	0	2	1	1	1	0	0	0	0	1
8	4	X	X		0	2	0	2	2	1	0	2	2	1	0	1	2	2
35	4	X			1	1	2	2	2	1	1	2	2	2	1	2	1	2
30	4	X			0	1	0	1	1	1	1	0	0	0	1	2	0	1
Total L4 ("Leadership" Level)					**39**	**53**	**38**	**57**	**42**	**46**	**14**	**45**	**46**	**12**	**11**	**36**	**39**	**45**
Average L4 ("Leadership" Level)					**1.00**	**1.36**	**0.97**	**1.46**	**1.08**	**1.18**	**0.36**	**1.15**	**1.18**	**0.31**	**0.28**	**0.92**	**1.00**	**1.15**

Data Sorted by Grade Level (Conti.)

Years	Job class	Road map 1	Road map 2	Road map 3	A	B=1	C	D	E	F=2	G	H	I=6	J=7	K	L=3	M=4	N=5
8	5	X	X	X	1	1	0	1	1	1	0	1	2	0	0	1	1	1
18	5	X	X	X	1	1	2	2	1	1	0	1	1	1	0	1	1	2
11	5	X	X	X	2	2	2	2	1	0	1	1	1	1	1	1	2	2
22	5	X	X	X	1	1	1	2	1	0	0	1	1	1	0	1	1	0
25	5	X	X	X	1	1	1	1	1	1	0	1	0	0	0	0	0	1
26	5	X	X	X	1	1	0	1	1	0	1	1	1	0	1	1	1	0
28	5	X	X	X	1	1	1	2	1	1	1	0	1	0	0	1	1	1
28	5	X	X	X	2	2	2	2	1	1	1	1	1	1	1	1	2	2
20	5	X	X	X	1	2	0	2	0	1	1	1	1	0	0	0	1	1
21	5	X	X	X	2	2	2	2	1	1	0	2	2	0	1	2	2	1
34	5	X	X	X	2	2	1	2	1	2	1	1	2	0	0	2	1	2
5	5	X	X	X	2	2	2	2	2	2	0	1	1	0	0	1	1	1
26	5	X	X	X	2	2	0	2	1	2	0	1	1	0	0	1	2	1
4	5	X	X	X	1	0	0	1	1	2	1	1	1	0	0	1	2	1
20	5	X	X	X	0	0	0	2	2	1	0	2	1	0	0	1	0	0
9	5	X	X	X	0	0	2	2	0	0	0	2	2	1	0	1	1	0
9	5	X	X	X	2	2	2	2	1	2	1	1	2	2	0	0	1	1
11	5	X	X	X	1	1	1	2	1	1	1	2	1	1	0	1	1	1
25	5	X	X		1	1	1	1	1	1	1	1	1	1	1	1	1	1
25	5	X	X		1	0	0	1	1	1	0	1	1	0	0	0	0	0
15	5	X	X		2	2	0	1	0	1	0	0	0	0	0	0	1	1
19	5	X	X		1	2	1	1	1	2	1	0	1	1	1	2	2	2
9	5	X	X		0	0	0	0	1	0	0	0	0	0	0	0	0	0
35	5	X	X		0	0	0	1	1	1	0	1	1	0	0	0	0	0
15	5	X	X		1	1	1	1	0	0	0	0	0	0	0	0	1	0
21	5	X			1	1	2	2	1	1	1	1	1	1	1	1	2	2
5	5				1	1	1	1	1	2	0	0	1	0	0	1	1	1
7	6	X	X	X	0	0	1	2	1	1	1	1	2	1	0	0	2	2
19	6	X	X	X	1	1	1	1	0	1	0	0	1	0	0	0	1	0
20	6	X	X	X	1	2	0	1	0	0	0	2	2	1	0	0	1	1
9	6	X	X	X	1	1	0	1	1	2	0	0	0	0	0	0	0	1
7	6	X	X	X	2	2	1	2	0	0	0	0	0	0	0	0	0	1
5	6	X	X		1	1	0	1	1	0	0	1	1	0	0	0	1	1
7	6	X	X		0	0	1	2	1	1	1	1	2	1	0	0	2	2
2	7	X	X	X	1	1	0	1	0	1	0	0	1	1	0	0	1	0
3	7	X	X	X	0	1	2	2	1	1	0	1	1	0	0	0	1	1
6	7	X	X	X	1	1	2	0	1	1	1	0	1	0	0	0	1	0
7	7	X	X	X	1	1	1	1	1	1	1	1	1	1	1	1	2	1
3	7	X	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1	7	X	X		1	1	0	1	2	2	0	0	1	1	0	0	1	1
4	7	X	X		1	2	1	1	0	0	0	0	1	0	0	2	1	1
3	7	X			0	2	2	2	2	2	1	2	0	0	0	2	2	2
3	7	X			2	2	1	1	1	2	0	0	0	0	0	0	0	0
25	7				1	0	0	0	1	1	0	0	0	2	0	0	0	0
0	8	X	X		0	0	0	0	0	0	0	1	0	0	0	0	0	1
0	8	X	X		0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	8				1	1	1	2	1	2	1	0	2	1	0	2	1	2
1	8				0	0	1	2	1	1	0	0	1	0	0	0	1	1
0	8				0	1	0	0	0	1	1	1	1	1	0	1	1	1
16	9	X	X	X	0	1	1	1	1	0	1	0	1	0	0	1	1	1
8	37	X	X	X	0	1	0	0	1	1	0	0	0	1	0	0	1	2
29	38	X			1	1	1	0	0	1	0	0	1	2	1	1	0	2
5	40	X	X	X	0	1	0	0	0	1	0	0	0	0	0	0	1	1
39	40	X	X	X	0	1	0	1	1	1	0	0	1	0	0	1	1	1
12	40	X	X		0	1	1	1	1	1	1	1	0	0	1	1	0	1
18	40	X	X		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (Below "Leadership" Level)					**47**	**57**	**43**	**67**	**44**	**53**	**21**	**37**	**49**	**24**	**10**	**34**	**52**	**53**
Average (Below "Leadership" Level)					**0.84**	**1.02**	**0.77**	**1.20**	**0.79**	**0.95**	**0.38**	**0.66**	**0.88**	**0.43**	**0.18**	**0.61**	**0.93**	**0.95**

Data Sorted by Years Experience

Years	Job class	Road map 1	Road map 2	Road map 3	A	B=1	C	D	E	F=2	G	H	I=6	J=7	K	L=3	M=4	N=5
39	40	X	X	X	0	1	0	1	1	1	0	0	1	0	0	1	1	1
35	4	X	X	X	1	2	1	1	2	1	1	1	2	0	1	1	2	1
35	4	X	X		1	1	0	1	1	1	1	1	0	0	1	1	1	1
35	4	X			1	1	2	2	2	1	1	2	2	2	1	2	1	2
35	5	X	X		0	0	0	1	1	1	0	1	1	0	0	0	0	0
34	5	X	X	X	2	2	1	2	1	2	1	1	2	0	0	2	1	2
33	4	X	X	X	0	1	1	1	1	1	0	2	1	0	0	1	0	1
32	4	X	X	X	1	2	1	2	2	1	0	1	2	0	1	2	2	2
30	4	X	X	X	0	1	1	1	1	0	0	1	1	0	0	0	1	1
30	4	X	X	X	2	2	1	1	2	1	0	2	2	0	1	2	0	1
30	4	X	X	X	2	2	1	2	1	2	1	2	2	0	0	1	1	1
30	4	X			0	1	0	1	1	1	1	0	0	0	1	2	0	1
29	4	X	X	X	2	1	2	2	1	2	1	1	1	0	0	0	1	0
29	4	X	X	X	0	1	0	2	1	1	0	1	0	0	0	0	0	0
29	4	X	X	X	1	2	2	2	1	1	0	2	2	1	0	1	1	1
29	4	X	X	X	1	1	1	2	1	1	0	2	1	1	0	0	1	1
29	4	X	X	X	0	2	2	2	0	0	0	0	1	0	0	0	1	0
29	4	X	X	X	1	1	1	1	1	0	1	1	1	1	1	1	1	1
29	4	X	X		2	1	1	1	0	2	1	1	1	0	0	0	0	1
29	38	X			1	1	1	0	0	1	0	0	1	2	1	1	0	2
28	4	X	X	X	1	2	1	1	1	2	0	0	1	0	0	0	1	2
28	4	X	X	X	2	2	1	1	1	1	0	1	1	0	0	1	1	1
28	5	X	X	X	1	1	1	2	1	1	1	0	1	0	0	1	1	1
28	5	X	X	X	2	2	2	2	1	1	1	1	1	1	1	1	2	2
27	4	X	X	X	1	1	1	1	1	2	0	1	1	1	0	0	1	1
27	4	X	X	X	1	1	1	1	0	1	0	1	2	0	0	1	0	1
26	5	X	X	X	1	1	0	1	1	0	1	1	1	0	1	1	1	0
26	5	X	X	X	2	2	0	2	1	2	0	1	1	0	0	1	2	1
25	4	X	X	X	2	2	0	2	1	1	0	2	1	0	0	1	1	2
25	4	X	X	X	0	1	0	1	1	0	0	1	0	0	0	0	0	1
25	4	X	X	X	0	0	0	0	1	1	0	2	2	0	0	1	1	1
25	4	X	X	X	0	1	0	1	2	1	0	0	0	0	0	1	2	2
25	5	X	X	X	1	1	1	1	1	1	0	1	0	0	0	0	0	1
25	5	X	X		1	1	1	1	1	1	1	1	1	1	1	1	1	1
25	5	X	X		1	0	0	1	1	1	0	1	1	0	0	0	0	0
25	7				1	0	0	0	1	1	0	0	0	2	0	0	0	0
24	4	X	X	X	0	2	1	1	2	1	0	0	0	0	0	1	1	1
24	4	X	X	X	2	2	1	2	1	2	1	0	1	0	0	1	1	2
24	4	X	X	X	2	1	2	2	2	1	1	2	2	1	1	2	1	1
24	4	X	X	X	1	1	1	1	1	1	0	1	0	0	0	1	1	1
22	4	X	X	X	2	2	1	2	0	1	0	1	1	0	0	1	1	1
22	5	X	X	X	1	1	1	2	1	0	0	1	1	1	0	1	1	0
21	5	X	X	X	2	2	2	2	1	1	0	2	2	0	1	2	2	1
21	5	X			1	1	2	2	1	1	1	1	1	1	1	1	2	2
20	4	X	X	X	0	1	2	2	1	1	0	1	1	1	0	0	1	1
20	4	X	X	X	1	1	1	1	1	1	0	0	2	0	0	1	1	1
20	5	X	X	X	1	2	0	2	0	1	1	1	1	0	0	0	1	1
20	5	X	X	X	0	0	0	2	2	1	0	2	1	0	0	1	0	0
20	6	X	X	X	1	2	0	1	0	0	0	2	2	1	0	0	1	1
Total (20 years or greater)					**49**	**62**	**42**	**68**	**50**	**50**	**17**	**50**	**53**	**17**	**14**	**40**	**43**	**50**
Average (20 years or greater)					**1.00**	**1.27**	**0.86**	**1.39**	**1.02**	**1.02**	**0.35**	**1.02**	**1.08**	**0.35**	**0.29**	**0.82**	**0.88**	**1.02**

Data Sorted by Years Experience (Cont.)

Years	Job class	Road map 1	Road map 2	Road map 3	A	B=1	C	D	E	F=2	G	H	I=6	J=7	K	L=3	M=4	N=5
19	5	X	X		1	2	1	1	1	2	1	0	1	1	1	2	2	2
19	6	X	X	X	1	1	1	1	0	1	0	0	1	0	0	0	1	0
18	4	X	X	X	1	1	0	2	0	2	0	1	2	1	0	0	1	0
18	4	X	X	X	1	1	1	1	0	1	0	1	1	0	0	1	1	1
18	5	X	X	X	1	1	2	2	1	1	0	1	1	1	0	1	1	2
18	40	X	X		0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	4	X	X	X	2	2	1	2	2	2	2	2	2	0	2	2	2	2
17	4	X	X	X	1	2	1	2	1	1	1	1	1	1	0	1	1	2
16	9	X	X	X	0	1	1	1	1	0	1	0	1	0	0	1	1	1
15	4	X	X	X	1	0	1	2	1	2	0	1	1	0	0	1	1	1
15	5	X	X		2	2	0	1	0	1	0	0	0	0	0	0	1	1
15	5	X	X		1	1	1	1	0	0	0	0	0	0	0	0	1	0
12	40	X	X		0	1	1	1	1	1	1	1	0	0	1	1	0	1
11	5	X	X	X	2	2	2	2	1	0	1	1	1	1	1	1	2	2
11	5	X	X	X	1	1	1	2	1	1	1	2	1	1	0	1	1	1
10	4	X	X	X	1	1	2	2	1	2	0	2	1	0	0	2	2	2
9	4	X	X	X	2	2	2	1	1	2	1	2	2	1	1	2	2	1
9	5	X	X	X	0	0	2	2	0	0	0	2	2	1	0	1	1	0
9	5	X	X	X	2	2	2	2	1	2	1	1	2	2	0	0	1	1
9	5	X	X		0	0	0	0	1	0	0	0	0	0	0	0	0	0
9	6	X	X	X	1	1	0	1	1	2	0	0	0	0	0	0	0	1
8	4	X	X		0	2	0	2	2	1	0	2	2	1	0	1	2	2
8	37	X	X	X	0	1	0	0	1	1	0	0	0	1	0	0	1	2
8	5	X	X	X	1	1	0	1	1	1	0	1	2	0	0	1	1	1
7	6	X	X	X	0	0	1	2	1	1	1	1	2	1	0	0	2	2
7	6	X	X	X	2	2	1	2	0	0	0	0	0	0	0	0	0	1
7	6	X	X		0	0	1	2	1	1	1	1	2	1	0	0	2	2
7	7	X	X	X	1	1	1	1	1	1	1	1	1	1	1	1	2	1
6	7	X	X	X	1	1	2	0	1	1	1	0	1	0	0	0	1	0
5	5	X	X	X	2	2	2	2	2	2	0	1	1	0	0	1	1	1
5	5				1	1	1	1	1	2	0	0	1	0	0	1	1	1
5	6	X	X		1	1	0	1	1	0	0	1	1	0	0	0	1	1
5	40	X	X	X	0	1	0	0	0	1	0	0	0	0	0	0	1	1
4	5	X	X	X	1	0	0	1	1	2	1	1	1	0	0	1	2	1
4	7	X	X		1	2	1	1	0	0	0	0	1	0	0	2	1	1
4	8				1	1	1	2	1	2	1	0	2	1	0	2	1	2
3	7	X	X	X	0	1	2	2	1	1	0	1	1	0	0	0	1	1
3	7	X	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3	7	X			2	2	1	1	1	2	0	0	0	0	0	0	0	0
3	7	X			0	2	2	2	2	2	1	2	0	0	0	2	2	2
2	7	X	X	X	1	1	0	1	0	1	0	0	1	1	0	0	1	0
1	7	X	X		1	1	0	1	2	2	0	0	1	1	0	0	1	1
1	8				0	0	1	2	1	1	0	0	1	0	0	0	1	1
0	8	X	X		0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	8				0	1	0	0	0	1	1	1	1	1	0	1	1	1
0	8	X	X		0	0	0	0	0	0	0	1	0	0	0	0	0	1
Total (Less than 20 years)					**37**	**48**	**39**	**56**	**36**	**49**	**18**	**32**	**42**	**19**	**7**	**30**	**48**	**48**
Average (Less than 20 years)					**0.80**	**1.04**	**0.85**	**1.22**	**0.78**	**1.07**	**0.39**	**0.70**	**0.91**	**0.41**	**0.15**	**0.65**	**1.04**	**1.04**

References

Cutcher-Gershenfeld, J., "Fostering Continuous Improvement in a Changing Business Context", Textron Systems, Wilmington, Massachusetts, 1998, 1999, 2000.

Cutcher-Gershenfeld, Joel and Rebentisch, Eric, "The Impact of Instability on Complex Social and Technical Systems", MIT ESD Internal Symposium, 2002.

Cutcher-Gershenfeld, et. al., "Final Report: Labor Aerospace Research Agenda (LARA)", MIT, 2005.

The Enterprise TTL Team: Dr. Kirk Bozdogan et. al., "Transitioning to a Lean Enterprise: A Guide to Leaders. Volume 1: Executive Overview", MIT 2000.

The Enterprise TTL Team: Dr. Kirk Bozdogan et. al., "Transitioning to a Lean Enterprise: A Guide to Leaders. Volume 3: Roadmap Explorations", MIT, 2000.

Inaba and Barrett, "Transformation Through Employee Involvement and Workplace Training: The Challenges of a Changing Business Context", Rocketdyne Propulsion and Power, Canoga Park, California, 1999.

Klein, Jan et. al., "Implementation Workshop: High Performance Work Organization", MIT, 1997.

Kochan, "From Three to One: Integrating a High Performance Work Organization Process, Lean Production and Activity Based Costing Change Initiatives", Boeing Corporation, Wichita, Kansas, IAM, 2000.

Nightingale, D. and Stanke, A., "Enterprise Value Stream Mapping and Analysis: EVSMA", MIT, 2005.

Senge, P. 1996, "Leading Learning Organizations: The Bold, the Powerful, and the Invisible" In D. Ancona, *Leadership in an Age of Uncertainty*. MIT Leadership Center Research Brief.

Stanke, Alexis, "Best Life Cycle Value, the F/A-18E/F, and the Lean Enterprise Model". Presented at LAI Implementing Lean PD Workshop. September 22, 2000.

Utterback, James, "Mastering the Dynamics of Innovation", Harvard Business School Press, Massachusetts, 1994

Wozniak, Chandra Kay Stich, "Transforming a New Product Development Organization: A System Engineering Development Case Study", MIT, 2002