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RED IS GOOD:

TRANSFORMATIONAL CHANGES FOR US AIR FORCE AIRCRAFT MAINTENANCE

by

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Contents

Biography

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Red is Good - What to Fix?

If it ain't broke, don't fix it. True but...If you don't know it's broke, it don't get fixed.

– General W. Creech, *The Five Pillars of TQM*[1]

Over the last 20 years, the U.S. Air Force has seen its fleet of aircraft reduced by 40 percent while the average age of that inventory has gone from 8 years in 1973 to 24 years in 2008. The negative trend is expected to continue to a projected average of 26.5 years by 2012.[2] A compounding factor is that on any given day 14% of the fleet (about 800 aircraft) is either grounded or operating with flight restrictions primarily due to age.[3] Since the end of Operation Desert Storm, the Air Force has maintained an average rate of 2.3 million flight hours per year with a fleet that is much smaller and older than the one fielded during that first Gulf War.[4] Since 2003, Operations Iraqi Freedom (OIF) and Enduring Freedom OEF) have put further stress on the fleet with the result aircraft will reach their projected service life much sooner than planned or budgeted for.

Within this challenging environment of flat, or decreasing, budgets, limited manpower, and a rapidly aging fleet of aircraft, the Air Force sought a way to transform its culture in order not only to survive but to remain the world's premier force in the domains of air, space and cyberspace. The Air Force transformation initiative called Air Force Smart Operations for the 21st Century, or AFSO21, was begun without considering the organizational-level changes required to implement, only effects desired. The desired effects of AFSO21 have been stated as:

1. increasing Airmen productivity,
2. improving readiness and availability of critical equipment,
3. increasing responsiveness and agility,

4. sustaining and improving operational safety and reliability, and
5. increasing energy efficiency.[5]

This paper focuses on the service cultural changes required to achieve the desired effects of AFSO21 based on the relentless pursuit of continuous process improvement. However, successful, valid, reliable, and continuous process improvement is only possible in an environment that tolerates, encourages, and promotes the public airing of dirty laundry. Others have labeled this as a "Red is Good" mentality, from the well known construct of PowerPoint briefings for metrics using red, yellow, and green stoplight charts depicting established target status.[6] In a "Red is Good" culture problems are viewed as great opportunities to improve versus a failure or threat. Toyota Corporation is recognized globally as a benchmark for fostering and using a "Red is Good" culture, demonstrated by Toyota President Katsuaki Watanabe's visit to one of his U.S. manufacturing plants. When shown the plant met all metric targets (all green) for its most recent reporting period, Watanabe observed, to the dismay of his U.S. managers, "Ah, no problems, must need no managers."[7] Watanabe, as a change agent champion, curtly and elegantly conveyed that metrics and goals were useless if leaders weren't using them as tools to find process problems and waste that could be eliminated. Unfortunately, many current USAF leaders look at metrics from the exact opposite point of view - as an opportunity to show others that they are on top of their game and meeting/exceeding all expectations.[8] In other words, a "Green is Good" mentality.

This investigation will be framed by three research questions (RQ):

RQ1. Can focused metrics precede cultural change?
RQ2. Does the Air Force, specifically the aircraft maintenance community, currently support a "Red is Good" culture?
RQ3. If so, then is the aircraft maintenance community a bonafide learning organization that can achieve the greatest impact possible from continuous process improvement initiatives?

This analysis will examine metrics in addition to their impact on organizational culture change and transformation followed by an evaluation of USAF aircraft maintenance community initiatives to look at what to fix. Answers to these questions will generate several changes at the Air Force enterprise-level if the service hopes to achieve simultaneous efficiency and effectiveness targets for aircraft readiness and reliability.

Culture Change and Transformation

Most transformation programs start on the wrong foot. And because they often follow in the wake of failed restructuring efforts that have left indelible scars on the workforce, they are seen as just another attempt at cost reduction.

- T. Hope and H. Jeremy, *Transforming the Bottom Line*[9]

What is organizational culture? How should the Air Force, as an organization, be categorized? What are the common characteristics of successful cultural change agents in large organizations? Where does the current Air Force AFSO21 (Lean) transformation fit into all this? Edgar Schein defines culture as "a pattern of shared basic assumptions learned by a group as it solved its problems…taught to new members as the correct way to think and feel in relation to those problems."[10] In general terms, organizational culture comes from three sources:

1. the beliefs, values, and assumptions of the founders of the organization,
2. the learning experiences of group members as their organization evolves, and
3. new beliefs, values, and assumptions brought in by new members and leaders.[11]

By Schein's characterizations today's Air Force is a mature organization where culture defines leadership rather than leadership defining culture. Mature organizations can function successfully for many years so long as their cultural assumptions remain relevant to the external

environment. However, if the environment changes and the organization can't adapt, that inflexibility leads to a rapid period of decline.[12] Furthermore, if mature organizations have a long history of success grounded in certain core assumptions about themselves and the environment, they are unlikely to challenge or reexamine those assumptions because they remain a significant source of pride and self-esteem. This reluctance can act as filters (or blinders) and prevent key leaders from recognizing alternative, but necessary, means of survival.[13]

Successful cultural transformation starts with a well constructed vision instilling a forward-looking mind-set that positions the organization to move confidently and aggressively toward bold objectives.[14] Further, the vision of transformational leaders must consistently and clearly communicate organization priorities, goals and assumptions throughout the workforce. If ignored, workers become preoccupied with their individual task stovepipes and procedural details.[15] This is known as organizational alignment. When a company has synergistic and mutually supportive metrics, goals, and objectives at all organizational levels a complete organizational alignment - true change and transformation - is possible. Aligned organizations have clear objectives, a common language, and a trust-based, open information system.[16] Once these conditions for success have been set, a culture of excellence where great ideas flourish from the bottom-up is truly possible. The trick is successfully converting these ideas from concepts to actions. Transformational leaders can break through corporate cultural inertia by seeking, promoting, and celebrating progressive thinking.[17] Jim Collins, author of "Good to Great," states that it is just as important to avoid demotivating people by failing to deliver results on their ideas - their progressive thinking. Instead, change agent champions "point to tangible accomplishments - however incremental at first - and show how these steps fit into an overall

concept that will work. When leaders do this in such a way that people see and feel the buildup of momentum, they will line up with enthusiasm."[18]

Organizational culture analysis demonstrates it takes anywhere from three to ten years to successfully change the fundamental culture of a large organization.[19] Unfortunately, as exemplified by Mr. Hope and Mr. Jeremy's comments in their book "Transforming the Bottom Line", the Air Force Lean transformation efforts were incomplete from the start. The Air Force's backwards approach to transformation turned continuous process improvement on its head. The service programmed major budget cuts, primarily personnel, between 2007 and 2011 in order to save 21 billion dollars *while assuming risk until transformational capabilities were identified*. Instead, successfully transforming organizations must first reduce the workload, not the work force.[20] The Air Force did the exact opposite. It cut manpower budgets while assuming that workload reductions and speed and quality improvements would follow. Air Force leaders must reevaluate their basic assumptions about service transformation to attain the effects desired with AFSO21. Once apparent, only then will the Air Force be capable of the bold policy and organizational changes necessary to facilitate transformation.

Metrics, Goal Setting, and Cultural Connections

Goals without metrics are more of a hallucination than a vision.
- University of Tennessee Leading For Results[21]

What gets planned, gets measured. What gets measured, gets done.
- W. Turk, *Is Your Project on Track?*[22]

Metrics can and do influence corporate culture, whether intentional or not. To be effective, metrics must flow from a clearly defined strategy. An organization that fails to measure itself correctly will not know how or where it falls short.[23] Metrics, when properly developed and utilized, provide leaders with valuable tools to measure progress and lead change at all organizational levels. The most effective metrics are customer focused and capture the entire value stream. However, unwise use or misapplied focus of metrics can be counterproductive and actually hinder organizational progress. Wrong metrics can be a powerfully counterproductive corporate culture force.

First and foremost, metrics should always reflect the value of the organization's product to the customer ensuring delivery at the right place, time, quantity, quality, and price.[24] In developing metrics, the core questions should be, "Where are we going?" and "How do we get there?"[25] Value stream visible metrics have the following attributes:

- accuracy (reliably expresses the phenomenon being measured),
- objectivity (not subject to dispute),
- comprehensible,
- timely, and
- robust (resistant to being gamed and hard to manipulate).[26]

Another important point for leaders to consider in metrics development is unity of focus for the best return on investment. Leaders should personally champion no more than five of the highest

level critical end product metrics and cascade responsibility for supporting metrics downward through the organization. Goal setting is also a critically important leadership task. Stretch goals encourage team members to achieve higher levels of performance than they may have thought possible. Incremental and realistic increases in goal difficulty raise the level of effort required to achieve goals while simultaneously expanding the performance envelope of the entire enterprise stream.[27] Metrics are worthless unless the results are critically reviewed on a regular basis, with the target being complete process improvement. Good metrics should allow target setting, identify issues and problems, and provide feedback on process efficiency and effectiveness.[28] Metrics should be developed with the involvement of the worker being measured. Good metrics are displayed in simple and visible scoreboards that let all personnel know how they are doing - as the simple stoplight chart does - using Red (significant problems that could impact success), Yellow (correctable problems), and Green (everything is on time, on budget, etc.) indicators.[29]

Good customer focused metrics focus on the entire value stream. Rather than using traditional metrics just because they are "what's always been tracked," if metrics don't create value as perceived by the customer they should be considered for elimination. Once set and focused on key high-return processes, ownership of the entire value stream should be assigned to a specific individual or small group. That person or persons is empowered with total responsibility and authority to improve performance within the value stream.[30] This is much more effective than isolated attempts to maximize "stovepipe" performance, because ultimately final output is constrained by whatever the lowest level of support is in any component of the value stream.[31]

Assigning team empowerment to value streams is the most powerful tool at any leader's disposal. While leaders are solely responsible for setting strategy - owning the process - teams should be the primary unit of execution and do all the real value-creating work.[32] There are four guiding principles of metrics for value-stream teams:

1. Targets should be aligned with strategy.
2. Teams play a role in choosing targets.
3. Focus on the customer including possible development of new metrics.
4. Measures should influence behavior.[33]

Teams at Toyota Corporation take ownership of the entire value stream and use the Plan-Do-Check-Analyze (PDCA) cycle to achieve process improvement where it can be most effective.[34] The PDCA cycle is a systematic method that codifies the "continuous" in continuous process improvement. Planning involves analyzing the value stream, finding the areas with the most waste, and deciding what adjustments to make in order to remove that waste from the process. The Do step involves carrying out the corresponding plans of action. Checking means judging results of actions taken against predetermined targets in the Do phase. In other words, comparing what should have happened with what actually happened in order to make further refinements. Good checking requires an atmosphere friendly to peer- and self-criticism. Otherwise, if personnel sense that failed attempts at process improvement are perceived negatively by leadership, honest feedback will be lost. Progress is impossible without an atmosphere where mistakes can be reported freely. Finally, the Adjust step is as simple as it sounds. Reflect on the results of the Check phase. If the results from the Check phase meet the target, then standardize. If not, find the root cause and restart the PDCA cycle.[35] Two key things here are:

1. Does the organization have a culture that supports and encourages systematic problem solving?
2. What really happens when people report problems?[36]

The PDCA cycle system embodies the many pitfalls to beware of when using metrics. The two most common are overreaction to bad news and overemphasis on measures that actually undermine desired output product quality (called "suboptimization"). Creating a culture where the bearer of bad news is lionized rather than ostracized is one of the most difficult things for any leader to achieve. The Air Force saw this at the highest level with the recent resignations of the Chief of Staff and Secretary of the Air Force. While the official statement from the Secretary of Defense was that these resignations were related to recent Air Force missteps involving custody of nuclear weapons and components, many in and outside the Air Force believe otherwise. Michael Dunn, Air Force Association President, recently summed it up stating, "Secretary Wynne and General Moseley have been outspoken in pointing out the Air Force needs to recapitalize and modernize the fleet…it is apparent to us that the Department of Defense did not appreciate the military advice nor the warnings they were getting."[37] This effectively signaled to the entire Air Force that our organization maintains a "Red is Bad" culture. In a "Red is Good" culture, problems are viewed as opportunities for systematic problem solving. A "Red is Bad" culture is not unique to the Air Force. There are numerous instances of many working in service and maintenance type industries where the only experience with metrics and data is negative. In some production environments, metrics are used to punish low performers, justify cutbacks, and support dubious arguments that foster an environment of distrust and wariness.[38] This leads, for example, to inaccurate, inflated job completion estimates to create a buffer in order to minimize reprimands for not meeting the schedule. On the other hand, reporting realistic estimates, and system problems, would allow leaders to have full and accurate process visibility and better manage uncertainty and risk in the daily schedule.[39] The second pitfall arises in cases where metrics not only have limited value and fail to provide information on possible process faults, but

are also costly (in terms of both data capture systems and man-hours) to record or worse, suboptimize (undermine) the actual enterprise goal being sought. The Air Force Logistics Management Agency (AFLMA) recently demonstrated how metrics emphasized at C-5 flying wings actually undermined the desired strategic readiness goals sought by Air Mobility Command.[40]

Rather than a pass/fail indicator, metrics should instead be used to judge process efficiency and effectiveness as well as identification of trends.[41] Furthermore, metrics should be constantly refined to ensure that leaders and process owners can get to the heart of the issue.[42] No leader wants to be in a situation where process owners are reluctant to provide data that reflects negatively on the process. This human tendency must be overcome or else it creates a false reading of current project status.[43] It is important to remember what should be the true purpose of all good metric rating systems: to help tell a story and gain a shared understanding of what's important. Effective rating systems should lead to discovery of problems and result in solutions.[44]

This discussion of metrics leads to the cultural connection question, "Can metrics influence culture?" W. Bruce Chew, a Harvard expert on factory productivity in America, believes metrics do influence behavior if they are properly created. Chew states,

> When the primary goal is to influence behavior, the simpler the better must be the rule. If the people who use an index can't understand it at a gut-level, it probably will not affect their decisions and priorities.[45]

In fact, measurement systems drive behavior at all levels and the choice of measures is critical to the behavior to be influenced.[46] Therefore it is critical that managers consider who and what shall be influenced by the metrics they chose to track.[47] Enterprise metrics, those specifically designed with the intention of aligning incentives and behavior across the entire organizational

value stream, ensure that both individual and corporate goals are synchronized.[48] Truly translational metrics discourage personnel from focusing only on their individual production stovepipes and instead begin thinking about the value, quality, quantity, and timeliness of the final output product.[49] Simultaneously, keeping internal process metrics in perspective is important to prevent an overemphasis from suboptimizing real customer value.[50] Ultimately, behavior guided by consistent application of metrics and goals over time leads to a real and permanent culture change that successfully considers the entire value stream process. When a leader has accomplished that, the corporate culture has taken a major step forward towards successful long-term continuous process improvement.

Current Air Force Aircraft Maintenance Metrics

Choosing metrics for metrics' sake is a bad thing and really proves nothing. A good maintenance manager will not strive to improve a metric but will use them to improve the performance of the organization.

- Terry L. Gabreski, Brigadier General, USAF
Director of Logistics, Air Force Materiel Command[51]

The U.S. Air Force flies 430 sorties per day in support of Operations Iraqi Freedom and Enduring Freedom. In fact, the Air Force airlift fleet averages a takeoff every 90 seconds, every day, 365 days a year.[52] Reams of data on operational tempo, flight hours, etc. are collected by Air Force maintenance data analysts. These measurements enable predictive estimates of structural fatigue, system performance, and airframe service life. Research shows cost per flying hour increases significantly during the first 12 years of aircraft service life so it is important to collect and track these metrics for predictive analysis.[53] The most recent version of the Air Force Maintenance Metrics Handbook lists 34 primary maintenance metrics to track.[54] These

are used not only for predictive analysis, but also for trend analysis and progress checks. Recent independent research studies by AFLMA and the office of Aerospace Studies (OAS) highlighted problems with aircraft maintenance data validity as well as the absence of a systematic method for goal setting at higher headquarters. Likewise, other studies have shown how non-aligned metrics suboptimize the desired enterprise-level performance for some weapon systems. Finally, a "Green is Good/Red is Bad" culture still permeates the aircraft maintenance community.

The metrics used to reflect fleet health at both wing- and enterprise-level for the aircraft maintenance community are Mission Capable (MC) Rate, Aircraft (sometimes called Fleet) Availability, Home Station Logistics Departure Reliability Rate (HSLDR) for Mobility Air Forces, and Utilization Rate (UTE) for Combat Air Forces.

MC Rates are simply determined by the number of aircraft that can fly at least one assigned mission divided by the number of aircraft possessed by the entire wing. Aircraft availability is the metric for determining "health of the inventory" and is dependent on the MC rate as well as the number of aircraft across the entire enterprise (possessed, back-up, depot, etc.).[55] This measure is useful for determining if the total logistics enterprise is capable of providing sufficient aircraft to accomplish mission requirements. A certain percentage of the fleet must always be available on any given day in order to execute the enterprise flying program.[56] HSLDR metrics judge operational effectiveness based on customer needs in the Mobility Air Forces and is determined by comparing on-time takeoffs to deviations from the flying schedule.[57] For the Combat Air Forces, UTE rates are the local measure of effectiveness, counting the number of flying hours an aircraft is utilized during a given month, quarter, or year.[58]

Traditionally, MC rates have been a common benchmark. A typical unit would compare its MC rate against established MAJCOM standards or against the rates of similar units. Units that were lower in comparison to these benchmarks would then try to identify what (process, policy, or resource) was the influencing factor and seek remedies.[59] More recently, enterprise leaders have preferred to focus on aircraft availability because it best articulates systemic fleet stress levels and overall combat capability. Aircraft availability provides a direct answer to the question, "How many aircraft are ready right now?"[60] Aircraft availability drivers include MC, Not Mission Capable for Maintenance (NMCM), and Not Mission Capable for Supply (NMCS) rates as well as factors such as aircraft in depot or undergoing modifications.

The Air Force has been collecting maintenance data for decades but suffers from three data collection problems common to service environments:

1. There is so much data that it is difficult to separate the wheat from the chaff.
2. For various reasons some collected data is no longer available.
3. The data often does not measure what it purports to measure.[61]

Recently, the AFLMA and OAS collaborated on a study of C-5 maintenance data. They discovered much of the data on past C-5 modifications was lost when C-5 depot responsibilities transferred from Kelly to Robins AFB.[62] The AFLMA also found that Air Force metrics were inaccurate and vulnerable to both intentional and unintentional manipulation. Researchers uncovered wing-level delays in recording aircraft status changes to "not mission capable," when in fact aircraft status had already changed.[63] AFLMA also recorded systemic issues involving Air Force enterprise-level maintenance metrics. Procedural methods for reporting broken aircraft systems obfuscated the actual cause. Ultimately, lack of input control and discipline at the wing in following electronic data reporting procedures injected doubt into the entire maintenance data collection process.[64] On top of doubts about the actual data, AFLMA also

found no formal methodology or analysis involved in determining the metric goals for C-5 MC, NMCM, or NMCS rates.[65] Likewise, a separate GAO study found that Air Combat Command has no historical record of any process establishing most of the goals for its primary aircraft maintenance metrics.[66] GAO investigators suggest "the lack of documentation in setting the goals ultimately obscures basic perceptions of readiness and operational effectiveness" while wasting the time of wing aircraft maintainers who attempt to meet standards having no basis in actual organizational performance - institutionalized suboptimization.[67]

Air Force maintenance metrics also have alignment issues. Proper organizational alignment is the case where all other variables being held constant, improvement in lower-level metrics leads to improvement in the higher-level metrics.[68] While it is common to see different metrics at different organizational levels, this split focus can be problematic when local goals are not aligned with the overall enterprise strategy.[69] This results in suboptimization or an overemphasis on a particular metric that ignores the actual root cause of the core problem and may in fact exacerbate the problem.[70] An AFLMA study revealed misalignment between the primary wing-level leadership C-5 metric, HSLDR, and the Air Mobility Command's primary metric of Aircraft Availability. The AFLMA study demonstrated that these metrics were not aligned. As a result, wing-level maintainers were focused on maximizing operational effectiveness while the MAJCOM was concentrating on strategic readiness improvements.[71]

Furthermore, the Air Force still lacks the ability for constructive self-criticism, an essential ingredient of continuous process improvement. Metrics must be looked at as tools for fixing problems affecting the process, otherwise their value is questionable. In fact, metrics that "show the pain" best have the greatest value.[72] The Air Force has an "only Green is Good" mentality whereby leadership, often due to its own self-preservation instinct, has no tolerance for

items marked "Red" for non-compliance.[73] An environment where constant deficiency identification is the norm must be the goal. While the USAF aircraft maintenance community has the obsessive desire to measure just about everything, the wrong things are often measured and a negative stigma exists to take the time to study a process closely enough in order to actually improve it.[74] Only when this paradigm is changed can the Air Force expect sustained operational improvements.[75]

When Air Force maintenance organizations combine effective metrics with a "Red is Good" mentality true long-term improvements will be realized. This is the essence of root cause analysis. Leaders can begin asking such questions as:

- "What are the specific causes for flying schedule deviations?"
- "Are there enough people to meet mission needs?"
- "Are specific aircraft or equipment causing trend distortions?"
- "Is supply support sufficient and responsive?"[76]

Wing-level Maintenance Data Analysis Sections must do more than just provide specific information or data. Instead, all the tools at their disposal should be used to present pertinent root cause analyses. A dynamic relationship between analysts and maintenance leaders must exist where the analysts are fully integrated partners with the leader's agenda of long-term process improvement.[77] Good analysis remedies the tendency to focus on final results rather than the critical factors that drive those results. Lean organizations find ways to measure the independent variables, such as resources, funding, manpower, or programming data, having the greatest effect on fleet readiness.[78] Many units are discovering there are better measures than MC Rates to assess how a wing meets sortie production and long-term fleet health requirements. A more effective approach may be increased emphasis on the scheduling process to maintain a balance between daily sortie production for the near-term and future fleet health for the long-term.[79] Significant transformational process improvement will only begin when wing-level

maintenance organizations focus on using metrics for true root cause analysis to achieve aligned, requirement driven, enterprise-level goals.

Toyota Builds Cars and the Air Force Flies Planes

You can't tell the winners without a scorecard, or tell the losers either. And without a scorecard, neither winners nor losers will know which they are. No one will know how to get better, either.

— General W. Creech, The Five Pillars of TQM [80]

The success of the Toyota production system and its foundational culture is well known. Facing restricted budgets, limited personnel, and dwindling financial resources - the reality of the Lean Air Force - the aircraft maintenance community needs to fundamentally change its culture to improve mission effectiveness. Real cultural change can only be achieved if the Air Force learns and applies the right lessons from observing the Toyota production system and other successful Lean organizations.

The Toyota cultural model of a learning organization is the construct many organizations strive to emulate. The core of the Toyota production system is an attitude of self-reflection and self-criticism together with a burning desire to improve. Toyota leaders at all levels are encouraged to openly address things that don't go right, then take responsibility and propose countermeasures to prevent these things from recurring.[81] The difference between Toyota and many other companies is Toyota's fanatical process orientation. Less successful companies have results oriented leaders or what is called a "Green is Good" mentality. Process oriented leaders are more patient, believing that investments in the people and the process lead to the desired results while, on the other hand, "Green is Good" managers want to immediately measure bottom line performance of any attempted continuous improvement programs.[82] Many companies and

leaders are unable to overcome the paradox that by continually surfacing problems and stopping to fix them as they occur, waste is eliminated and productivity soars. Instead assembly lines are run continuously and problems accumulate, eventually causing lower quality and increased delays.[83] Toyota also ensures that all leaders clearly understand the company's core value stream. All internal service operations view their role as supporting the core value stream. The leaner the core value stream, the leaner the supporting operations can be.[84] Toyota leaders are commonly described as focused on the long-term and dedicated to the company's core values with detailed hands on value stream knowledge. At Toyota problems are seen as opportunities to train and coach other employees.[85] Unfortunately, for many companies the essence of building in quality has been lost in bureaucratic and technical details. This is why Toyota keeps it simple:

1. Go and see.
2. Analyze the situation.
3. Use one-piece flow and visual signals to surface problems.
4. Ask "Why?" five times.[86]

The most important metrics to Toyota managers are those driving problem solving and supporting process orientation. These value stream measures test everything from lead time to first-pass quality to cost. Aggressive goals begin at the executive-level and each lower level develops measurable annual objectives designed to support the executive level goals. These metrics are updated daily and become more specific the lower down in the process hierarchy.[87] Of note, metrics that have no influence on improving operational excellence of the core value stream or enable suboptimization are eliminated.[88]

How can the Air Force maintenance community transform its "flies planes" culture to one of effective continuous improvement like that at Toyota? Achieving the Toyota-level of transformation requires both patience and perseverance where corporate culture is both the creation of and the product of a learning organization. It has taken Toyota well over a decade to

build a North American organization that resembles the learning enterprise it built over the course of several decades in Japan.[89] The challenge is in creating an aligned organization of employees who share the organization's core beliefs and continually learn together.[90] To "learn" means to have the capacity to build on the past and incrementally move forward, rather than starting over and reinventing the wheel with each new leadership change. This is the fulcrum point of the Air Force's challenge. To build a learning organization it is necessary to have stability of personnel, slow promotion, and carefully planned succession systems to protect organizational knowledge bases.[91] Successfully transforming culture takes years of applying consistent approaches and principles. To its credit, the Air Force has made attempts to become a learning organization but has fallen far short of the Toyota model. As Commander, Tactical Air Command, General Creech instituted senior officer immersion programs. In General Creech's program, wing senior officers (normally colonels and above) were required to spend two weeks working side by side with Airmen as they went about their daily routine. The purpose was for wing senior leaders to gain a deeper understanding of the environment, challenges, and demands faced by Airmen on a daily basis. At the end of the two weeks, these leaders were required to provide a written report to General Creech with insights and recommendations. General Creech rightly believed that "it's when leaders do not understand the challenges - and the real problems and issues - that they give direction that adds to the problem rather than to the solution."[92] Since General Creech's retirement over 20 years ago, less ambitious incarnations of this program have sporadically continued. While the benefits of the Creech immersion program are intuitively obvious, it pales in comparison to the learning organization model at Toyota where value stream managers understand virtually every facet of the process they lead. This problem is particularly

acute in aircraft maintenance where officers and senior NCOs are rotated frequently and often have little or no experience with the weapon system they are charged with supporting.

A transformed learning organization would enable the Air Force to empower a new breed of wing-level leaders. A "Chief Process Officer" who takes ownership of understanding, tracking, measuring, and optimizing crucial end-to-end aircraft maintenance business practices. These leaders must establish the right maintenance process metrics, measure performance, devise improvements, or, if a process is clearly broken, reengineer it, and establish a continuous program of process optimization as Toyota's keep it simple questions force managers to do.[93] Additionally, the synergistic engagement of Airmen in transformation efforts is dependent on the cues they take from the top leadership in the wing.[94] The most successful Chief Process Officer leaders will lead by example. If they are enthused, the employees will know and the enthusiasm will become contagious. The tried and true practices of management by walking around and engaging in meaningful, business-oriented dialogue with people are still the most effective.[95]

The Chief Process Officer leader must have a firm grasp on enterprise thinking. This is defined as a discipline for seeing the whole, recognizing patterns and interrelationships, and learning how to structure these interrelationships in more effective, efficient ways.[96] Toyota has achieved a culture of stopping or slowing down to fix problems to get quality right the first time. While this may sound simplistic, countless organizations have tried to emulate Toyota and failed. The company philosophy of getting quality right first enhances long-term productivity. Toyota developed visual systems to alert teams or project leaders when a machine or process needed assistance.[97] Metric data are used to learn and monitor process performance, not as a method for punishing or rewarding people. Dr. W. Edwards Deming, the famous American engineer who led the quality movement in Japan and later in America, stated that 96 percent of quality

problems were built into the work system while only 4 percent were due to individual employee performance.[98] The great majority of experts agree that process rather than people offer the greatest opportunities for continuous improvement.[99] For a variety of reasons, service processes such as aircraft maintenance are full of waste. Service processes:

1. are by their nature slow processes which drive up expense,
2. tend to have far too much work in progress, often as the result of extreme complexity in the service itself, and
3. are flush with non-value added (to the customer) work typically comprising 50 percent of the total service cost.[100]

This represents a huge potential for enterprise thinkers to achieve significant improvements in speed, quality, and cost improvement. According to Lou Giuliano, CEO of ITT Industries, in an organization full of leaders who are enterprise thinkers, "everybody's number one task becomes improving the processes for which they have the responsibility."[101]

The Toyota production system also teaches valuable lessons about the potential pitfalls from the introduction of new technology. Jim Collins theorized in "Good to Great" that fantastically successful companies use technology as an accelerator of momentum, not a creator of it. Great companies became pioneers in the application of technology in their business model.[102] The Toyota philosophy towards technology introduction is that it will not readily compromise its principles and goals for something that is merely faster and cheaper. For instance, using information technology as a cost cutting measure may have many unintended consequences radically damaging to corporate culture.[103] Instead, Toyota only incorporates thoroughly reliable and tested technology that serves its people and processes. This is based on four core Toyota principles regarding technology integration:

1. Use technology to support people, not replace them.
2. Conduct actual tests before adopting new technology in business processes, manufacturing systems, or products.

3. Encourage people to consider new technologies when looking into new approaches to work.
4. Quickly implement a thoroughly considered technology if it has been proven in trial and it can improve flow in your processes.[104]

It is not uncommon for mature organizations like the Air Force to attempt to change cultural assumptions by incorporating new technology. New technology causes employees to reexamine their present assumptions and possibly adopt new values, beliefs, and assumptions.[105] While this may indeed be beneficial to the organization, there are often unintended side effects of this seduction by technology.

For instance, new technology is often introduced to enable better communication throughout an organization but instead senior leaders use the information for control purposes and unwittingly increase hierarchical control.[106] The Air Force is about to begin the rollout of its newest technology effort in support of logistics processes. The Expeditionary Combat Support System (ECSS) is designed to enhance warfighter support by enabling "improved availability of mission critical weapon systems."[107] ECSS has been designed to transition Air Force logistics processes to a planning based, cross-functional, integrated (full visibility at all levels), high performance (new metrics) operation.[108] Overall transformation goals for FY2011 are a 20 percent increase in equipment availability and a reduction in annual operating costs by 10 percent or 2.75 billion dollars.[109] Transformational changes from ECSS are expected through integration of the entire supply chain business process and associated personnel roles across the entire value stream. One of the tenets of the system is increased Air Force-wide asset visibility to improve planning along with new metrics on weapons system availability, on-time delivery of maintenance events, cycle times, and others.[110] The Air Force must be cognizant of the unintended abuse of what are referred to as "Make/Repair" activities. These activities are described as enabling centralized oversight of service, maintenance, repair, and overhaul

activities for aircraft, components, facilities, and equipment.[111] Unfortunately, the military has well documented struggles with information technology systems originally designed for reachback and information sharing but ultimately used to facilitate highly centralized operational execution.[112] The Air Force must avoid what Toyota describes as the unintended consequences of information technology application. A move to centrally control base-level repair priorities is in direct contrast with the decentralized concepts that have served the aircraft maintenance community well since they were instituted by General Creech in the 1980s. During ECSS trial runs, thorough consideration of mitigation strategies to avoid increasingly centralized control of base-level maintenance repair will ensure Air Force leadership avoids violating Toyota's fourth rule of technology integration.

Today, the Air Force remains stuck in the nascent stages of its quality transformation. The initial attempt to transform the Air Force in the early 1990s using TQM principles popularized by Deming and Creech was generally recognized as unsuccessful and aborted by service leadership within the decade. More recently, the Air Force made a spirited attempt to embrace quality with its AFSO21 program, vowing not to repeat the mistakes of past programs. While some high profile successes have been achieved, most notably at the Air Logistics Centers, others contend that the Air Force has embraced "partial quality." This partial quality is characterized by a lack of mission focus with the emphasis on efficiency overshadowing effectiveness, leaving many Airmen with the impression that customer service oriented functions like finance and personnel have been degraded. If AFSO21 initiatives don't ultimately lead to improved operational effectiveness, then Airmen have every reason to question their overall utility. Partial quality also drives the impression that AFSO21 is overly focused on management versus leadership with NCOs viewing it as just another level of micromanagement.[113]

Becoming a learning organization and creating empowered Chief Process Officers while eschewing the allure of information technology enabled centralized execution are significant steps towards a permanent, long-term cultural transformation.

Transforming the Culture in Aircraft Maintenance - at the Enterprise Level

If you don't know what you are doing, you keep making the wrong mistakes.

– Yogi Berra[114]

In the 1990s, the failure of Air Force TQM programs to approach the lofty goals promised by their most vocal advocates resulted in waning support from military leaders and professional educators. Airmen who saw the quality movement as a way to increase our military edge and improve efficiency were eventually outnumbered by those who saw it as just another square to fill.[115] The Air Force is now several years into its second attempt at transformational change. While there have been several well publicized AFSO21 success stories, a true Air Force transformational culture change remains an unsettled issue. The aircraft maintenance community has served as a test bed for many successful AFSO21 initiatives. In order to lock in these initial successes and support continued growth, changes in leadership methodology, management, and service policies are required - not just in Air Force aircraft maintenance, but at the Air Force enterprise-level. This includes instilling a "Red is Good" culture and ensuring Airmen leading steady process improvement are rewarded and promoted ahead of their peers is critical for sustained transformation. At the MAJCOM- and Air Force-level, trends toward centralization of

base-level maintenance functions must be avoided. Finally a complete overhaul of the human resource management system for aircraft maintenance leadership should be undertaken Air Force-wide in order to grow a true learning organization.

Changing the culture of any organization the size of the Air Force is hard. Organizational change management is a disciplined process guiding an organization and its stakeholders through significant organizational change, addressing the people issues of transformation, and mobilizing individuals and groups at all levels of the organization to support the transformation.[116] Applied to today's Air Force, the prior experience with TQM and the cultural norms of rank-and-file Airmen resistant to change must also be considered and addressed.[117] In other words, an appropriate response to ongoing skepticism must be constantly considered. Air Force leaders must understand legitimate skepticism and accept personal responsibility to positively work through it. Successful leaders will gain a deep understanding of AFSO21 issues and opportunities and forcefully present the case for change.[118] In aircraft maintenance this could be as simple as asking a wrench turner, "When was the last time someone asked you how the job should be done?"[119] Overcoming cultural norms is a bigger challenge than mitigating AFSO21 skepticism. The Air Force made rational appeals to Airmen on the importance of a continuous process improvement culture declaring that money and manpower pools are drying up. The problem is Airmen at the local operating level don't perceive they are affected. Therefore, saving programmed Air Force dollars is not an attractive selling point. The question, "What is in it for me and why should I care?" is never really answered.[120] In the past, when operational requirements or problems somewhere else in the value stream caused a workload spike, the traditional solution was 12-hour shifts and/or work through the weekend. Instead, a new Lean Air Force paradigm needs to be mutually beneficial at all levels. Enlightened self-interest is very

good as a motivating force. As Colonel Robert Hamm, the Headquarters Air Education and Training Command Deputy Director for Logistics states,

> Let's use our heads and these new Lean tools to fix our processes because, in my opinion, we won't see the major increases in manpower or money necessary to repair our aging aircraft...it's just not realistic. Everybody can get behind 'Let's not work overtime through the weekend to fix this.'[121]

Leaders must insist more people are held accountable for broader measures of business performance across the entire value stream.[122]

Ultimately, any successful cultural transformation is going to be leadership driven. Executive-level leaders are the principle source for the generation and re-infusion of an organization's ideology, articulation of core values, and specification of norms.[123] These leaders, change agent champions, are the ones whose ideas and initiatives must be rewarded through performance reports, compliments, and formal recognition.[124] In the earliest stages, process improvement groups will be led from the top-down because the pressing need is to change the way employees think by direct demonstration of a better way. By the second stage, however, the process improvement group will focus more on making leaders into teachers and Airmen become not just technicians but process engineers. This is Lean transformation critical mass…a point where leaders become coaches rather than dictators and Airmen become proactive learners. This transition is the key to a self-sustaining Lean learning organization.[125] In the vast majority of Air Force units this critical transition point has not been reached.

Air Force maintenance leaders can begin to make the transition when they manage for bottom-line results in the organization's value stream. The ultimate goal for any flying wing is increased combat capability. Leaders need to determine the local measurements, goals, and objectives reflected in combat capability and define the end-to-end core value streams impacting

those measurements. When value streams or processes that improve combat capability are identified, maintenance leaders must align goals strategically across the entire enterprise and assign specific value stream managers. The challenge for senior maintenance leadership becomes finding objective metrics to put the output products in clear focus. When performance is measured correctly, it improves. Furthermore, when performance is correctly measured and compared to goals, historical trends, and like units, it improves more still. Finally, when significant improvement is recognized and rewarded, then productivity soars.[126]

Well constructed value stream metrics are used by leaders to manage processes and drive culture change. Leaders must approach metrics as a tool to fix processes rather than as a way to assign blame.[127] This is the essence of the "Red is Good" culture. In the past the Air Force set out to change culture when instead it should have let culture change come naturally through adherence to metrics and standards. The point is to create a cultural climate where the truth is heard, where red metrics drive questions, dialogue, and debate, not answers. In such a climate, real and intense debate is desired as opposed to translucent dialogue as a process to let Airmen "have their say" so we can all get "buy in" to some predetermined decision. Finally, red metrics must create a climate where bad news can't be ignored because it measures the very core of the value stream output.[128] There are two possible interpretations of a red metric. One is a signal of failure to reach targeted value stream performance while the other is a request for help. In a "Red is Good" climate the focus must be on the requests for help. It is crucial that senior maintenance leaders ensure their entire organization understands that red, yellow, and green stoplights are signals and not grades.[129] A major step the Air Force needs to take to move to a "Red is Good" culture is a reevaluation of their entire inspection culture. To ensure fidelity and execution following a major inspector general visit, a "fix phase" should be incorporated to

allow inspectors and units to interact and correct discrepancies before the inspection team departs the base.[130]

The aircraft maintenance community must remain wary of centralization purported to improve communication, process visibility, and efficiency. General Creech had it right when he stated that a centralized system subordinates ownership and empowerment. He led the original effort to reorganize both flightline and backshop maintenance units so they were specifically responsible for their aircraft or end-item spare parts. Team leaders, who had the same skill sets as the Airmen they led, were given responsibility for their entire value stream. These leaders then had total process visibility and a direct impact on flightline shortages. Accountability for poor performance was easy to track and remedy. Individuals and teams who deserved recognition for stellar process improvement were easy to single out. The Air Force wide centralized environment that existed prior to General Creech's transformation had no specific output measurements of the various maintenance organizations and, most important, no visible linkage with the larger flying mission of the wing.[131] As the Air Force incorporates the ECSS information system into the entire logistics enterprise over the next several years, it must consciously work to avoid unintended consequences by specifically codifying business rules to prevent the natural drift towards centralized repair and unwittingly remove repair process ownership from wing-level and lower organizations.

The Air Force Materiel Command (AFMC) Air Logistics Centers (ALC) are good models to emulate for wing-level flying organizations. The ALC turn-around has been amazing. From fiscal year 1999 to 2002, the AFMC's Programmed Depot Maintenance (PDM) on-time delivery rate, one of the organization's primary value stream measures, was no better than 81 percent. In other words, the war fighter could count on at least one in five aircraft being returned

late from PDM. After AFMC's Lean initiatives, the on-time delivery rate showed dramatic improvement. By fiscal year 2004 it was 92 percent and in 2005 it reached 99 percent, with one ALC achieving 100 percent. In the A-10 aircraft PDM line alone, the 120 day total cycle time was reduced 60 percent to just 51 days.[132] So what differentiates ALC maintainers from those in a flying wing maintenance organization? Many note that ALC depot maintenance work does resemble a commercial production process and therefore is more conducive to waste reduction through Lean principle application. While that may be correct, the biggest difference between the ALCs and flying wing maintenance is that ALCs most closely approximate what Toyota labeled as a learning organization. The ALCs have civil servants in senior production management positions with many years of experience and genuine hands-on knowledge of all the processes in the value streams they manage and lead. This is not the case in a flying wing, where maintenance leaders at both the officer and senior non-commissioned officer levels often find themselves managing value stream processes about which they have only a modicum of hands-on experience. If the Air Force truly hopes to transform wing-level aircraft maintenance into a Lean organization, major changes in the current personnel system must be addressed.

A survey on Change Management published by AMA/Deloitte & Touche had the following conclusion: "It seems that many organizations have to change in order to change. Their *present structures and cultures* tend to disallow the successful implementation of change initiatives (emphasis added by author)."[133] The Air Force personnel system is one of those "present structures" and must change as it currently exists to support maintenance leadership if the Air Force has any hope for true transformational breakthroughs. The basic personnel system in use today is essentially the same system that was adopted from the Army in 1947, when the Air Force became a separate service. That Army system was originally developed in 1890 by

Secretary of War Elihu Root.[134] The core tenets of our personnel system, top-down evaluations in a hierarchical bureaucracy and frequent moves for career development, are nearly a hundred twenty years old![135] Today we have a system that prepares Airmen to function in a vertical, hierarchical bureaucracy that stifles innovation and actually works against the creation of learning organizations.

The first personnel issue that must be addressed is performance evaluation. While the Air Force has tinkered through the years with minor changes such as required evaluation comments, rating categories, and endorsement levels, the system is essentially unchanged. Performance reports are based purely on an evaluation by your rate and your rater's rater.[136] The Air Force needs risk-taking out-of-the-box thinkers to succeed in a Lean AFSO21 transformation but our actual performance evaluation system supports a hierarchical, risk-averse bureaucracy. In this system, red continues to be bad. A single evaluation report that uses moderate praise rather than enthusiastic endorsement will kill an officer's or senior non-commissioned officer's career. An innovative, out-of-the-box thinking officer need only have one risk-averse, control oriented boss and their career is essentially finished.[137] The Air Force needs to move forward in the 21st Century by considering performance evaluation alternatives that support a transformed Lean organization. The answer may be 360-degree system or some other method of rewarding risk-takers and learning rather than officers and senior non-commissioned officers who are naturally driven to become risk-averse careerists. There are many large organizations using similar, successful systems to benchmark. The time is right for Air Force senior leadership to tackle this contradictory, century old evaluation system.

The second personnel policy requiring reform is the assignment policy for maintenance officers and senior non-commissioned officers. In the current Air Force model, frequent moves

and practicing a wide variety of duties are required in the name of career development. The goal is to grow leaders with a wide variety of skills in order to function at the top of the hierarchical pyramid. In fact we've created a host of officers and senior non-commissioned officers who are aircraft maintenance generalists rather than experts. A typical officer's career includes maintenance management on a variety of different aircraft from heavy lift transportation to high-demand, low density reconnaissance aircraft to small fighters, alternating between staff assignments at the field grade level. The same happens, though not as frequently, to non-commissioned officers once they reach the grade of master sergeant and join the senior non-commissioned officer corps. While the basic maintenance organization, procedures, and policies are the same for all these different aircraft, the aircraft specific processes are considerably different. Most maintenance officers and many senior non-commissioned officers are, in effect, amateurs by profession. They never get the chance to spend enough time on one aircraft or in one job to become true experts.[138] This is no way to create a learning organization where value stream leaders are expert-level at every process they control. Again, the Air Force needs to change "present structures" in order to change. The first step is to tie maintenance officers closely to the aircraft they maintain. While this is currently done very loosely with special experience identifiers there is no governing policy that states, for example, once assigned as a career C-5 maintenance officer you will remain a C-5 maintenance officer. Ideally a typical active duty maintenance officer would rotate between C-5 bases in the continental United States as well as assignments at overseas enroute locations primarily supporting C-5s. If assigned to major command or Air Force staff, his focus would be the C-5 if at all possible. Staff tours would be followed by a rotation back to a C-5 field unit. Permanent change of station assignments to primarily maintain other aircraft for career broadening would be the exception

rather than the rule. This may sound like a radical change but in reality mirrors how personnel are currently managed in the rated community. The Air Force would never consider taking a pilot with three years experience flying the U-2 and send him for one year to fly F-16s in Korea and then rotate him back to the United States to fly KC-135s in North Dakota. Perversely, this is routine for Air Force maintenance officers and senior non-commissioned officers. More often than not the resulting outcome at wing-level is field grade aircraft operators with vastly superior system knowledge compared to their aircraft maintenance counterparts on the other side of the table. Toyota and other mature lean firms get brilliant results by giving expertly trained value stream managers complete responsibility for end product success.[139] If the Air Force hopes to break through and do the same it needs leadership at the highest levels to consider bold changes to our outdated personnel system and create learning organizations in wing-level aircraft maintenance.

Summary and Recommendations

By 2012 the average USAF aircraft is projected to be more than 26 years old. Simultaneously, as this trend continues with no end in sight, support funding and manpower are expected to stagnate. The Air Force has no choice but to mitigate the aging air fleet's impact on readiness by transforming its culture to one where continuous process improvement is the accepted way of doing business. Already there have been noteworthy process improvement successes at the ALC depots as well as some flying wings. However, the Air Force enterprise has yet to truly transform where all Airmen actively seek to improve their value stream processes. In the aircraft maintenance community service-wide changes must be incorporated to enable a metrics driven culture change supporting continuous process improvement. These

changes include organizational policies and business rules to ensure that new information technology systems do not result in a drift away from the current highly successful decentralized repair process of aircraft and spare parts. Furthermore, significant changes in the personnel evaluation system, assignment process, and rotation policy for all officer and noncommissioned officer maintenance leaders are in order.

Metrics do drive culture. According to W. Bruce Chew, a Harvard expert on factory productivity, properly created metrics do influence behavior.[140] The best metrics are those developed with an eye towards worker involvement and tie value directly to an organization's customer by ensuring end products are delivered on time with the right quantity, quality, and price.[141] The ultimate goal is to create a "Red is Good" culture where problems are viewed as opportunities and the bearer of bad news is lionized rather than ostracized. In this cultural transformation, metrics are not a pass/fail indicator but instead a measure of process efficiency and effectiveness as well as trend identification.[142]

In order for the Air Force maintenance community to successfully attain a "Red is Good" transformation, current enterprise-level metric deficiencies must first be addressed. Recent AFLMA and GAO research studies raise questions about the validity of aircraft maintenance data as well as the associated goals set by higher headquarters. Studies also demonstrate how non-aligned metrics suboptimized enterprise-level performance in the Air Force. Finally, in too many organizations constant deficiency identification through metrics remains the exception rather than the norm. Instead, a "Green Only" mentality permeates wing leadership who, often due to their own self-preservation instinct, have no tolerance for items marked "Red" for non-compliance.[143]

Only by becoming a true learning organization can the Air Force maintenance community hope to advance its transformation towards a permanent "Red is Good" continuous process improvement culture. The Air Force needs to create an environment that breeds what business reengineering expert Michael Hammer calls "Chief Process Officer" (CPO) leaders. These leaders must be capable of establishing the right process performance metrics, devising improvements, or, if a process is clearly broken, reengineering it and establish a continuous program of process optimization.[144] Air Force-level policies must be changed in order to grow CPOs and enable a service-wide continuous process improvement environment. These include new business rules to ensure the new Expeditionary Combat Support System does not evolve towards maintenance repair centralization. Additionally, the century old Air Force personnel management system needs to be overhauled to support a culture of learning among aircraft maintenance leaders. First, a personnel evaluation system supportive of risk-taking, outside-the-box thinkers needs to be introduced. A method of rewarding these learning leaders with advancement and responsibility must replace the current system which rewards leaders naturally driven to become risk-averse careerists. Second, the Air Force needs to move away from an assignment process that overwhelmingly results in maintenance leaders becoming airplane generalists. Rather, maintenance officers and senior noncommissioned officers should be permanently tied to specific aircraft models in order to become expert-level value stream leaders.

Significant enterprise-level changes are required by the Air Force for a true process improvement culture to take hold. In order to continue effective maintenance of the total force in this era of declining resources there is no choice but to seek out and implement the changes required to enable transformation.

Endnotes

1. Creech, The Five Pillars of TQM, 468.
2. Dudney, The Post-5 June Air Force.
3. Dudney, The Post-5 June Air Force.
4. Meserve, USAF Maintenance Metrics: Looking Forward with Aircraft Availability, slide 5.
5. Ritter, AFSO21 Views You Can Use.
6. Rhea, Lean Metrics: Red is Good, Green is Worthless.
7. Rhea, Lean Metrics: Red is Good, Green is Worthless.
8. Morgan, The Tyranny of Metrics.
9. Hope and Jeremy, Transforming the Bottom Line, 188.
10. Linnean, AFSO21: Identifying Potential Failure Points.
11. Schein, Organizational Change and Leadership, 211.
12. Schein, Organizational Change and Leadership, 255.
13. Schein, Organizational Change and Leadership, 321-322.
14. Powell, Lines of Excellence: Executing a Balanced Organizational Vision.
15. Schein, Organizational Culture and Leadership, 237.
16. Hope and Jeremy, Transforming the Bottom Line, 193.
17. Powell, Lines of Excellence: Executing a Balanced Organizational Vision.
18. Collins, *Good to Great*, 174-177.
19. Kotter, Leading Change, 13.
20. Schein, Organizational Change and Leadership, 187.
21. Miller, Park, and Gregory, Leading for Results course slides.
22. Turk, Is Your Project on Track?, 35.
23. Hamm, Thinking and Fighting as an Enterprise: Building the Culture of AFSO21, 18.
24. Hamm, Thinking and Fighting as an Enterprise: Building the Culture of AFSO21, 20.
25. Dennis, Getting the Right Things Done, 70.
26. Pendley, Thoele, Howe, Antoline, and Golden, *Establishing C-5 TNMCM Standards*, 47.
27. Frisco, Leader Behaviors and Role of Leaders, para 2.0.
28. Turk, Is Your Project on Track?, 35.
29. Turk, Is Your Project on Track?, 37.
30. Frisco, Leader Behaviors and Role of Leaders, para 3.0.
31. Miller, Park, and Gregory, *Leading for Results Course*, slide 22 and 23.
32. Hope and Jeremy, Transforming the Bottom Line, 106-109.
33. Hope and Jeremy, Transforming the Bottom Line, 106-109.
34. Liker, The Toyota Way, 272.
35. Dennis, Getting the Right Things Done, 71-72.
36. Dennis, Getting the Right Things Done, 176.
37. Dudney, The Post-5 June Air Force.
38. George, Lean Six Sigma for Service, 288.
39. Nicol, Design and Analysis of an Enterprise Metrics System, 18.
40. Pendley, Thoele, Howe, Antoline, and Golden, *Establishing C-5 TNMCM Standards*, 14.

41. Pendley, Thoele, Howe, Antoline, and Golden, *Aligning Maintenance Metrics; Improving C-5 TNMCM*, 12.
42. Powell, Lines of Excellence: Executing a Balanced Organizational Vision, 5.
43. Turk, Is Your Project on Track?, 37.
44. Dennis, Getting the Right Things Done, 54.
45. Creech, The Five Pillars of TQM, 318-319.
46. Hope and Jeremy, Transforming the Bottom Line, 91-93.
47. Hope and Jeremy, Transforming the Bottom Line, 95.
48. Nicol, Design and Analysis of an Enterprise Metrics System, 2.
49. Nicol, Design and Analysis of an Enterprise Metrics System, 35.
50. Miller, Park, and Gregory, *Leading for Results Course*, slide 11 notes section.
51. Air Force Journal of Logistics, *Maintenance Metrics*, 3.
52. Pendley, C-5 TNMCM Study II, 80.
53. Dixon, The Maintenance Costs of Aging Aircraft: Insights from Commercial Aviation, 41-42.
54. Air Force Journal of Logistics, *Maintenance Metrics*, 30.
55. Meserve, USAF Maintenance Metrics, slide 7.
56. Air Force Journal of Logistics, *Maintenance Metrics*, 14-15.
57. Pendley, Thoele, Howe, Antoline, and Golden, Aligning Maintenance Metrics; Improving C-5 TNMCM, 15.
58. Livingood, Using Logistics Data to Influence Change.
59. Pettingill and von Hoffman, Air Force Mission Capable Rates and Aircraft Availability Model Requirements, 23.
60. Meserve, USAF Maintenance Metrics, slide 8.
61. George, Lean Six Sigma for Service, 281.
62. Pendley, C-5 TNMCM Study II, 85.
63. Pendley, Thoele, Howe, Antoline, and Golden, *Establishing C-5 TNMCM Standards*, 47-48.
64. Bell and Hardemon, Total Not Mission Capable for Maintenance Study, iv-v.
65. Pendley, Thoele, Howe, Antoline, and Golden, *Establishing C-5 TNMCM Standards*, 45-46.
66. Pendley, Thoele, Howe, Antoline, and Golden, *Establishing C-5 TNMCM Standards*, 45-46.
67. Pendley, Thoele, Howe, Antoline, and Golden, *Establishing C-5 TNMCM Standards*, 46.
68. Pendley, Thoele, Howe, Antoline, and Golden, *Establishing C-5 TNMCM Standards*, 15.
69. Pendley, Thoele, Howe, Antoline, and Golden, *Establishing C-5 TNMCM Standards*, 5.
70. Air Force Journal of Logistics, *Maintenance Metrics*, 6.
71. Pendley, Thoele, Howe, Antoline, and Golden, *Establishing C-5 TNMCM Standards*, 14.
72. Air Force Journal of Logistics, *Maintenance Metrics*, 8.
73. Dailey, On the SECDEF's Argument that the Air Force Lacks a "Culture of Self-Criticism".
74. Rinahart, How the Air Force Embraced "Partial Quality" (and Avoiding Similar Mistakes in New Endeavors)
75. Rinahart, How the Air Force Embraced "Partial Quality" (and Avoiding Similar Mistakes in New Endeavors)
76. Air Force Journal of Logistics, *Maintenance Metrics*, 11-14.
77. Air Force Journal of Logistics, *Maintenance Metrics*, 58-59.
78. Pettingill and von Hoffman, Air Force Mission Capable Rates and Aircraft Availability Model Requirements, 6.
79. Lynch, Drew, George, Tripp, Roll, and Leftwich, The Air Force Chief of Staff Logistics Review: Improving Wing-Level Logistics, 48.
80. Creech, The Five Pillars of TQM, 314.
81. Liker, *The Toyota Way*, 252.
82. Liker, *The Toyota Way*, 261.
83. Liker, *The Toyota Way*, 130.
84. Liker, *The Toyota Way*, 287.
85. Liker, *The Toyota Way*, 182.
86. Liker, *The Toyota Way*, 135.

87. Liker, *The Toyota Way*, 261-263.
88. Liker, *The Toyota Way*, 305.
89. Liker, *The Toyota Way*, 263.
90. Liker, *The Toyota Way*, 290.
91. Liker, *The Toyota Way*, 252.
92. Creech, The Five Pillars of TQM, 383-384.
93. Hammer, The Chief Process Officer.
94. United States Air Force, The Playbook: Leading the ECSS Transformation, 17.
95. United States Air Force, The Playbook: Leading the ECSS Transformation, 15.
96. Linnean, AFSO21: Identifying Potential Failure Points in Sustaining Continuous Process Improvement Across the Air Force.
97. Liker, The Toyota Way, 38.
98. George, What is Lean Six Sigma?, 18.
99. George, What is Lean Six Sigma?, 42-43.
100. George, What is Lean Six Sigma?, 3.
101. George, What is Lean Six Sigma?, 252.
102. Collins, *Good to Great*, 162.
103. Liker, *The Toyota Way*, 158.
104. Liker, *The Toyota Way*, 39.
105. Schein, Organizational Culture and Leadership, 318.
106. Schein, Organizational Culture and Leadership, 320.
107. United States Air Force, *Think ECSS*.
108. United States Air Force, The Playbook: Leading the ECSS Transformation, 5.
109. Livingood, Using Logistics Data to Influence Change.
110. United States Air Force, Designing the Future of Air Force Logistics: The ECSS Integrated Solution, 5.
111. United States Air Force, Designing the Future of Air Force Logistics: The ECSS Integrated Solution, 5.
112. RAND Corporation, Air Power Against Terror: America's Conduct of Operation Enduring Freedom, 295.
113. Rinehart, How the Air Force Embraced "Partial Quality" (and Avoiding Similar Mistakes in New Endeavors).
114. Creech, The Five Pillars of TQM, 367.
115. Rinehart, How the Air Force Embraced "Partial Quality" (and Avoiding Similar Mistakes in New Endeavors).
116. United States Air Force, The Playbook: Leading the ECSS Transformation, 15.
117. Kem, Military Transformation: Ends, Ways, and Means, 2.
118. United States Air Force, *AFSO21 Senior Leader Training*, slide 17.
119. Interview with Robert J. Hamm, 19 December 2008.
120. Linnean, AFSO21: Identifying Potential Failure Points in Sustaining Continuous Process Improvement Across the Air Force.
121. Interview with Robert J. Hamm, 19 December 2008.
122. Kotter, *Leading Change*, 44.
123. United States Air Force, The Playbook: Leading the ECSS Transformation, 13.
124. Hamm, Thinking and Fighting as an Enterprise: Building the Culture of Air Force Smart Operations for the 21st Century, 19.
125. Womack and Jones, *Lean Thinking*, 268-269.
126. Creech, Organization and Leadership Principles for Senior Leaders, 182.
127. Hamm, Thinking and Fighting as an Enterprise: Building the Culture of Air Force Smart Operations for the 21st Century, 17.
128. Collins, *Good to Great*, 73-80.
129. United States Air Force, *AFSO21 Senior Leader Training*, slide 26.
130. Dailey, On the SECDEF's Argument that the USAF Lack's a "Culture of Self-Criticism."
131. Creech, *The Five Pillars of TQM*, 129-131 & 237-239.
132. Carlson, Air Force Materiel Command and Air Force Smart Operations for the Twenty-first Century, 3-4.
133. Creech, *The Five Pillars of TQM*, Introduction.

134. Hammes, The Sling and The Stone, 233.
135. Hammes, The Sling and The Stone, 233-235.
136. Hammes, The Sling and The Stone, 234.
137. Hammes, The Sling and The Stone, 234.
138. Hammes, The Sling and The Stone, 235.
139. Womack and Jones, *Lean Thinking*, 321.
140. Turk, Is Your Project on Track?, 37.
141. Hamm, Thinking and Fighting as an Enterprise: Building the Culture of AFSO21, 20.
142. Pendley, Thoele, Howe, Antoline, and Golden, *Aligning Maintenance Metrics; Improving C-5 TNMCM*, 12.
143. Dailey, On the SECDEF's Argument that the Air Force Lacks a "Culture of Self-Criticism".
144. Hammer, The Chief Process Officer.

Bibliography

Air Force Journal of Logistics. (2001). *Air Force Maintenence Metrics.* Maxwell AFB, Gunter Annex, AL: Air Force Logistics Management Agency.

Bell, J., & Hardemon, R. (2000). *Total Not Mission Capable for Maintenance (TNMCM) Study.* Maxwell AFB, Gunter Annex, AL: Air Force Logistics Management Agency.

Carlson, B. (2006, December 1). *Air Force Materiel Command and Air Force Smart Operations for the Twenty-first Century*. Retrieved November 10, 2008, from Air & Space Power Journal: http://www.airpower.maxwell.af.mil/airchronicles/apj/apj06/win06/carlson.html

Collins, J. (2001). *Good to Great.* New York: HarperCollins Publishers Inc.

Creech, B. (1994). *The Five Pillars of TQM.* New York: Penguin Group.

Creech, W. L. (n.d.). Organizational and Leadership Principles for Senior Leaders. Speech at symposium sponsored by U.S. Air Force's Air University.

Dailey, M. (2008, September). On the SECDEF's Argument that the USAF Lacks a "Culture of Self-Criticism". Maxwell AFB, AL, USA.

Dennis, P. (2006). *Getting the Right Things Done.* Cambridge, MA: The Lean Enterprise Institute, Inc.

Dixon, M. C. (2006). The Maintenance Costs of Aging Aircraft: Insights from Commercial Aviation. Santa Monica, CA, USA.

Dudney, R. S. (2008, June 19). *Air Force Association Magazine.* Retrieved December 16, 2008, from The Post-June 5 Air Force: http://www.airforce-magazine.com/MagazineArchive/Pages/2008/July%202008/0708edit.aspx

Frisco, G. (n.d.). *Leader Behaviors and Role of Leaders.* Retrieved November 11, 2008, from United States Air Force, SAF/SO: http://afso21.af.mil

GAO. (2005). *Defense Transportation: Air Mobility Command Needs to Collect and Analyze Better Data to Assess Aircraft Utilization.* Washington, D.C.: The U.S. Government Accountability Office.

George, M. L. (2003). *Lean Six Sigma for Service.* New York: McGraw-Hill.

George, M., Rowlands, D., & Kastle, B. (2004). *What is Lean Six Sigma?* New York: McGraw-Hill.

Goldfein, D. L. (2001). *Sharing Success-Owning Failure: Preparing to Command in the Twenty-First Century Air Force.* Maxwell AFB, AL: Air University Press.

Hamm, R. J. (2008, December 19). Colonel. (P. J. McAneny, Interviewer)

Hamm, R. J. (2007, Spring). Thinking and Fighting as an Enterprise: Building the Culture of Air Force Smart Operations for the 21st Century. *The Exceptional Release* , pp. 18-21.

Hamm, R., Briggs, R., Peterson, K., & Driscoll, S. (2007, Fall). Thinking and Fighting As an Enterprise: The Culture of Air Force Smart Operations for the 21st Century. *The Exceptional Release* , pp. 16-22.

Hammer, M. (2004, March). *The Chief Process Officer?* Retrieved November 11, 2008, from Optimize Magazine: http://www.af.mil/library/smartops.asp

Hammes, R. X. (2004). *The Sling and the Stone: On War in the 21st Century.* St. Paul, MN: Zenith Press.

Hope, T., & Jeremy, H. (1996). *Transforming the Bottom Line.* London, England: Nicholas Brealey Publishing.

Kem, J. D. (2006, September 1). *Military Transformation: Ends, Ways, and Means*. Retrieved November 10, 2008, from Air & Space Power Journal: http://www.airpower.maxwell.af.mil/airchronicles/apj/apj06/fal06/kem.html

Kotter, J. P. (1996). *Leading Change.* Boston, MA: Harvard Business School Press.

Liker, J. K. (2004). *The Toyota Way.* New York: McGraw-Hill.

Linnean, H. W. (2007, April). AFSO21: Identifying Potential Failure Points in Sustaining Continuous Process Improvement Across the Air Force. Maxwell AFB, AL, USA.

Livingood, T. (2007, February 23). Using Logistic Data to Influence Change. Maxwell AFB, AL, USA.

Lynch, K. F., Drew, J. G., George, D., Tripp, R. S., Roll, C. R., & Leftwich, J. (2005). *The Air Force Chief of Staff Logistics Review: Improving Wing-Level Logistics.* Santa Monica, CA: RAND Corporation.

Matchette, D. R. (2006, July-August). Six Sigma for the DoD. *Defense AT&L* , pp. 19-21.

Meserve, J. (n.d.). USAF Maintenance Metrics: Looking Forward with Aircraft Availability. Air Staff (Pentagon), VA, USA.

Miller, A., Parke, C., & Gregory, H. (2008). Leading for Results. *Center for Executive Education* (pp. 10-28). Knoxville, TN: The University of Tennessee.

Moorman, R. (2007, May 29). *Helos Don't Swim*. Retrieved November 10, 2008, from Aviation Week: http://www.aviationweek.com/aw/generic/.jsp

Morgan, M. (2007, January 22). *The Tyranny of Metrics.* Retrieved November 10, 2008, from Air Force Print News: http://www.warren.af.mil/news/story_print.asp?id=123038396

Morrill, A. B. (1999, March). Transforming Enabling Processes: The Next Step in Logistics Reform. *Buy It, Move It, Sustain It. Selected Readings from Air Force Logistics Management Agency* , pp. 37-40.

Nicol, R. A. (2001). Design and Analysis of an Enterprise Metrics System. Massachusetts Institute of Technology, MA, USA.

Oliver, S. A., Johnson, A. W., White, E. D., & Arostegui, M. A. (Volume XXV, Number 3). Forecasting Readiness. *Air Force Journal of Logistics* , pp. 3, 31-42.

Pendley, S. A. (2008, Spring). C-5 TNMCM Study II. *Air Force Journal of Logistics* , pp. 80-86.

Pendley, S. A., Thoele, B. A., Howe, J. A., Antoline, A. F., & Golden, R. D. (2008, Spring). Aligning Maintenance Metrics; Improving C-5 TNMCM. *Air Force Journal of Logistics* , pp. 12-22.

Pendley, S. A., Thoele, B. A., Howe, J. A., Antoline, A. F., & Golden, R. D. (2008, August). Establishing C-5 TNMCM Standards. *Selected Readings, Air Force Logistics Management Agency* , pp. 40-49.

Pettingill, K., & von Hoffman, C. (2004). *Air Force Mission Capable Rate and Aircraft Availability Model Requirements.* Maxwell AFB, AL: Air Force Logistics Management Agency.

Powell, R. M. (2006, December 1). *Lines of Excellence: Executing a Balanced Organizational Vision.* Retrieved November 10, 2008, from Air & Space Power Journal: http://www.airpower.maxwell.af.mil/airchronicles/apj/apj06/win06/powell.html

RAND Corporation. (2005). *Air Power Against Terror: America's Conduct of Operation Enduring Freedom.* Pittsburgh, PA: RAND.

Rhea, R. (2007). Lean Metrics: Red is Good, Green is Worthless. *The Exceptional Release* , 32-33.

Rinehart, G. W. (2006, December 1). *How the Air Force Embraced "Partial Quality" (and Avoiding Similar Mistakes in New Endeavors).* Retrieved november 10, 2008, from Air & Space Power Journal: http://www.airpower.maxwell.af.mil/airchronicles/apj/apj06/win06/rinehart.html

Ritter, R. (2007, April 17). AFSO21 Views You Can Use.... Special Assistant to the Secretary of the Air Force.

Ritter, R. (2008, December 19). Dr. (P. J. McAneny, Interviewer)

Russell, S. H. (2008, Summer). Earned Value Management: Uses and Misuses. *Air Force Journal of Logistics* , pp. 87-91.

Schein, E. H. (1992). *Organizational Culture and Leadership, 2nd Edition.* San Francisco, CA: Jossey-Bass Inc.

The University of Tennessee. (2008, September 15). *Leading for Results.* Retrieved November 11, 2008, from Center for Executive Education: http://afso21.af.mil

Turk, W. (2007, November-December). Is Your Project On Track? *Defense, AT&L* , pp. 35-38.

United States Air Force. (2008, September 15). *AFSO21 Senior Leader Training.* Retrieved November 11, 2008, from Resource DVD: http://afso21.af.mil

United States Air Force. (2008, October). *Designing the Future of Air Force Logistics: The ECSS Intgegrated Solution*. Retrieved November 11, 2008, from Expeditionary Combat Support System: https://www.ecss.wpafb.af.mil

United States Air Force. (n.d.). *The Playbook: Leading the ECSS Transformation*. Retrieved November 11, 2008, from Expeditionary Combat Support System: https://www.ecss.wpafb.af.mil

United States Air Force. (2008). *Think ECSS.* Retrieved November 10, 2008, from Expeditionary Combat Support System: https://www.ecss.wpafb.af.mil/history.asp

Womack, J. P., & Jones, D. T. (2003). *Lean Thinking.* New York: Free Press.