The Air Force Sustainment Center Presents:
Art of the Possible

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Introduction by the AFSC Commander

The Air Force Sustainment Center delivers combat power for America. Our success is the foundation of the warfighter's success, whether it is ensuring our nation's nuclear deterrent, maintaining air supremacy, fueling the fight, or delivering hope and saving lives. Our warriors in combat cannot succeed without the air, space, and cyberspace capabilities the AFSC produces. We truly are the Air Force's supporting command for readiness.

Behind this war-winning mission, we have an amazing team. If you look at how far the organization has come in the few short years since its inception, it is truly a model for success. Moving forward, we will build on the legacy of greatness already achieved, as we continue to explore the many untapped opportunities for even higher levels of 'Art of the Possible' results and cost-effective readiness.

We must provide greater military capability and improved readiness at less cost than ever before. Every excess dollar spent, is a dollar not available to prepare our Air Force for threats on the horizon. Our mission to support the warfighter is critical and failure is not an option and not in our DNA.

The future of AFSC is replete with challenges that provide a unique opportunity to reach unattained heights. Successfully accomplishing our mission in a time of unprecedented challenges, we will achieve our full potential as we strive for 'Art of The Possible' results. The workforce across our diverse Center has shown the capacity to do remarkable things when given the right focus. The resident knowledge and skill within AFSC bring the words of Thomas Edison to mind who wrote: “If we did all the things we are capable of doing, we would literally astonish ourselves." I am a firm believer in the 'AFSC Way' and in achieving the results that the 'Art of the Possible' can deliver. I have seen it work, you have too. This methodology is not about working harder, cutting corners or jeopardizing workplace safety, it is about recognizing opportunities, understanding and eliminating true limiting constraints, improving processes and maximizing available resources.

As we continue the journey, world-record performance is the common goal of everyone in AFSC in order to provide the cost-effective readiness the Air Force needs. The AFSC of tomorrow must be ready to fight tonight and be ready for tomorrow’s fight. It is what our nation demands.

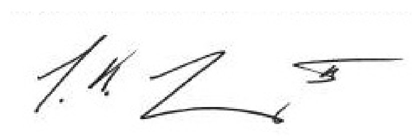

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Table of Contents

Art of the Possible

The Art of the Possible describes the goal of the AFSC to create a culture that is focused on the efficient execution of its processes. The Art of the Possible methodology does this by first creating a goal – vetted through the enterprise – for the pace of execution. This "Road to…" goal provides a common destination and site picture for the enterprise to measure how well the process is executing.

AFSC processes are seen as machines that can be set up to have specific, predictable results once they are understood. There is a science behind the creation of the machine that leads to both the predictable output and the changing of a lexicon to speak in terms of the process machine. Once the process machine is set up according to this science, it is monitored for performance.

The AFSC process machines are based on the principles of standard work with visual displays that help the process doers understand the status of the assets in their process and how the doers affect the process. Careful process monitoring allows the weakest process links to be identified and process improvement techniques applied that result in more efficient processes and execution.

The Art of the Possible creates a culture that is focused daily on identifying and urgently eliminating process constraints affecting the process critical path during execution. This culture relies on the skills, abilities and forward thinking of the entire enterprise to create the necessary team work to enable "Speed." Ultimately, however, "Speed" is neither finite nor limited, and by leveraging the concepts of "Command, Control and Collaboration" organizations can continuously and exponentially increase their "Speed".

Process Speed is the key indicator that the machine is set, and the culture in place, to enable AFSC processes to reach Art of the Possible goals and results. Art of the Possible results within the AFSC will positively affect the cost of sustainment for the Air Force – thereby determining the size of the future Air Force and the ability of our nation to fight and win the next war.

The intent of this book is to communicate the sacred truths and guiding principles of the Art of the Possible to ensure these ideals become the foundation for future innovations that will continue to propel the AFSC toward the Art of the Possible. Embracing the Art of the Possible requires creating a culture of Believers – believers in the machine methodology and the necessity of an enterprise approach in order to attain Art of the Possible results. The AFSC is looking for Believers. Read on, and ask yourself – are you a believer?

This book will explain why the focus on Speed is important and how the execution elements to achieve Speed play into decreasing the cost of sustainment. The book is followed by appendices meant to as stand-alone contributions that contribute to the essence of the Art of the Possible. The appendix may describe a successful case study or may be a self-contained expansion of a concept or practice complementing the Art of the Possible methodology.

Following is a short synopsis of each chapter contained in the book.

Chapter 1: The Value of Speed

This chapter provides a brief description of the role the AFSC and introduces the idea of enterprise involvement in the daily execution of AFSC process machines. The AFSC Game Plan Model is introduced as a depiction of the standardized business practices the AFSC sees as its true north operating principles in order to create efficient process execution.

Chapter 2: Leadership Matters

Leadership is the most important component in the AFSC Business Model. This chapter will convey the essential elements of an engaged leader and the role of leadership in shaping the culture required for executing in an environment focused on Speed. A culture of which constraint identification and resolution are essential elements to creating the environment to achieve Art of the Possible results. The importance placed on leadership by the Sustainment Center is evidenced in its Leadership Model which is explained in detail as an excerpt to this chapter.

Chapter 3: Creating the Vision – a "Road to…"

The pace of production is set to the "Road to.." goal. This goal is defined by balancing both the needs of the customer and the needs of the organization. This chapter outlines the elements to be considered and included when communicating an organization's "Road to…" goals. These elements include: the burning platform, the production machine, frame the challenge and the action plan.

Chapter 4: The Science of Throughput (Production Machine Science V2)

There is logic and science, behind the creation of a production machine. A production machine is not developed adhoc – it is not a pick-up game. The Science of Throughput explains the science behind creating a production machine – whether the organization has a front shop process (such as the repair of aircraft and engines) or a back shop process (such as the repair of individual components). Production Machine Science creates the foundation for production execution and monitoring that execution.

Chapter 5: A Closer Look at Execution

The production machine provides the big picture look at production execution, but once the overarching goals are set, there are specific tools required to aid the daily execution of production processes. A Closer Look at Execution will describe the roles of standard work, visual displays of information and engineering support to enable successful execution of processes paced to a "Road to…" goal.

Chapter 6: A Culture of Problem Solvers

The pace of execution is directly linked to the level of success associated with identifying and resolving constraints encountered during execution. At this point, the ability to leverage the power of the enterprise becomes important and pays the greatest dividends. The Leadership culture must be able to effectively communicate problems encountered during execution that affect the critical path of the production processes. These problems must be resolved quickly, not only for the current impasse, but in an effort to minimize future impacts. A Culture of Problem Solvers will discuss the importance of creating a culture that seeks to solve the problems of today for the long term.

Chapter 7: Monitoring Success

An advantage of the production machine philosophy is the ability it creates to monitor execution in relation to goals. Whether a front shop process measuring execution in gates and work in process (WIP) or a back shop process measuring execution in inventory turns and work in queue (WIQ), success must be monitored incrementally and in a manner that allows the identification of process improvement opportunities. Monitoring Success will discuss how to create vertical and horizontal meeting alignment, using proper metrics, in order to provide the transparency necessary to focus the enterprise on the constraints and progress of process execution. This chapter will also explain the components of the "Radiator Chart" and describe the Maturity Matrix as a method to measure organization maturity toward Art of the Possible methodology.

Chapter 8: The Bottom Line

The bottom line is about cost effectiveness and ultimately reducing the cost of sustaining America's Air Power. The Bottom Line will discuss how the concept of Speed enables reduced costs and will present the Deep Dive process currently being utilized by each Complex to attack the costs of the AFSC doing business in an effort to directly impact the sales rate charged to AFSC customers.

Chapter 9: Command and Control Raised to the Power of Collaboration–(C2)^{C}

AFSC personnel are challenged to be the best possible stewards of people, processes, and resources while unleashing the power of enterprise collaboration. This blended approach, termed Command, Control, and Collaboration, inherits qualities from both 'Command and Control' and 'Collaborative' organizational concepts. This chapter explains why 'Command and Control' alone does not achieve the desired outcomes, how communication spurs collaboration, how collaboration has a multiplicative effect on organizational success, and that common goals are better achieved using team assets.

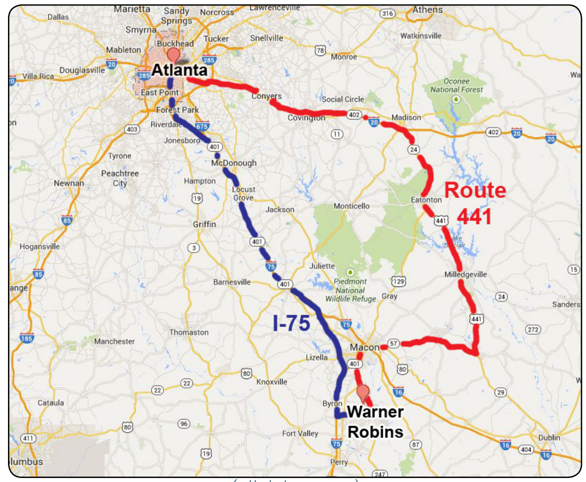
Chapter 10: Art of the Possible

The Art of the Possible is about utilizing a methodical approach to improve processes to improve Speed in order to obtain Art of the Possible results. The AFSC describes Art of the Possible:

It is about reaching beyond today's limitations to grasp previously unimagined heights of performance. It is about challenging each other to recognize opportunities, eliminate constraints, improve processes and optimize resources to achieve world-record results. It isn't about working harder, cutting corners or jeopardizing workplace safety but about expanding our vision of what is truly possible and refusing to settle for marginal improvements.

Chapter 10 will summarize the components of the Art of the Possible, reiterating why a focus on Speed will ultimately reduce the cost of sustainment and strengthen our Air Force. Having trouble understanding how the focus on Speed can lead to reduced costs? Read on to experience the process – the results are impressive.

The term “Speed,” in the Art of the Possible Lexicon, is meant to be synonymous with efficient processes that promote throughput paced to a Road to… goal. In its most basic sense, Speed equals reduced flowtime. The Art of the Possible creates a methodology that measures performance in a manner that focuses the organization on the weakest link in their processes. This focus leads to process improvement initiatives that affect the speed of throughput for the organizational process. “Speed” also means quickly resolving constraints that affect the critical path of the process during execution to enable the process to continue to move forward unheeded. Lt Gen Litchfield explains the idea of “Speed” as follows:



(click to zoom)

> “The first time I had to drive to Warner Robins, and my first time driving through Georgia, I looked over the various route options. I considered the amount of interstate versus state highways, straightest line, sights to see, time I had for the trip and many other details. I considered jumping off the main interstate and driving down highway 441. Well, highway 441 may be more traditional, and probably much more interesting, but it is not nearly as efficient. There was probably a time when highway 441 or some other more rural route would have been the primary route to follow south through Georgia to get to Robins, but today there are much more efficient options. So in AFSC, we could continue to follow the old-way of doing business to complete our processes, and perhaps a great number of people would make that choice. However, considering the time, money, space, people and other severe constraints facing us, we must consider leveraging “Speed.” On our current AFSC mission, there is not time to sight see. So we must not be nostalgic, or cling to an inefficient process out of a fear of change, we must free up limited resources by increasing the speed, or in other words “reducing wasted time and effort.” Speed is not working faster; it is working more efficiently, and thereby increasing value for your customer.”

1

INTRODUCTION- THE VALUE OF SPEED

Chapter Topics

When the AFSC stood up in July 2012, it was a collection of individual depots and supply chain pieces operating with individualized ideas. This merging of supply chain functions under one center presented the opportunity to standardize business practices and adopt guiding operating principles that would become the basis of a new culture: the Art of the Possible. This book will showcase and describe what has come to be known as the "true north" operating principles for the AFSC- the sacred truths that have guided the AFSC through its infancy and will help to shape the Center into the gold standard for the Aerospace Industry.

The methodology described in this book as a whole compliments Air Force methods and goals. The book will serve as a guide to understanding the alignment of the greater Air Force goals with the AFSC methods of doing business. The ideas and methods presented in this book are not new; they are simple ideas. The power is in how the ideas are packaged and the recognition of a process for getting the right results the right way. In broad but basic terms, the tenets of the Air Force Sustainment Center (Figure 1.1) align with the common themes of this and all subsequent chapters.

Figure 1.1: The Tenets of the Air Force Sustainment Center

The AFSC is comprised of both military and civilian personnel working side-by-side to meet the AFSC mission – *Sustain Weapon System Readiness to Generate Airpower for America*. This mission, along with the AFSC vision to be *The Most Effective, Efficient and Innovative Sustainer of Airpower* is based on the motivation of AFSC members. As a governmental organization, AFSC members are not motivated by profit margins - they are motivated by their bond with the American people and those that serve to protect the benefits we enjoy as a free nation.

Whether a new hire or a journeyman, someone working on the floor or in the cubicle, someone touching the engine or supporting the aircraft – AFSC members all have one common ambition. The ambition to be the best at what they do, to make tomorrow better than today – and to support the warfighter: our friends, our neighbors, our relatives that serve at the tip of the spear, in harm's way or poised to deploy in a moment's notice. AFSC members are all proud to be part of something more than a bottom line.

Because of this connection to both the warfighter and to the AFSC shareholders – the American taxpayer – AFSC strives to produce a quality product, in a safe manner, while looking for opportunities to positively influence cost. AFSC members understand that in order to be true stewards of tax payer dollars they must look for innovative ways to reduce the cost of sustaining America's Airpower. The AFSC has found that focusing on Speed provides the impetus for reducing cost and freeing valuable resources, such as people and capacity, for additional workloads.

1.1. The Role of the Air Force Sustainment Center

The AFSC is one of five centers established within Air Force Material Command as depicted in the five center construct model in Figure 1.2. In a memo dated December 9, 2011, the Secretary of the Air Force explained the mission of the AFSC:

"The AFSC will manage, plan, and execute sustainment-related activities, supply chain functions and depot maintenance activities across the Air Force. The AFSC will perform an integrating role and partner with Air Force Life Cycle Management Center in the weapon system support planning for weapon systems across their life cycle, to include early in the acquisition cycle. The AFSC will bring greater synergy of supply and depot maintenance activities and facilitate the implementation of standard business processes across the enterprise. With supply chain management and depot maintenance functions in one organization, the AFSC will analyze and develop sustainment-wide procedures, processes and metrics with the ultimate goal of increasing availability, capability and affordability." (SecAF Memo, 2011).

Simply put, the AFSC consists of the behind the scenes logistics processes that makes the Air Force (and to many degrees) the Department of Defense run. The AFSC delivers depot level repair and modification of aircraft, engines and components to the warfighter customer. By creating standardized business processes, with a foundational focus on Speed, the AFSC has the ability to positively influence the total cost of sustaining America's Air Power.

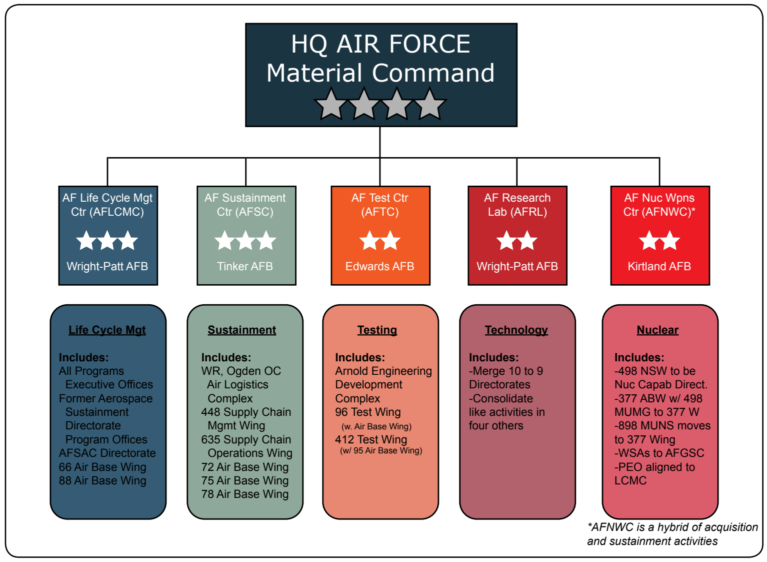


Figure 1.2: The AFMC Five Center Construct (click to zoom)

However, the Sustainment Center cannot perform its mission alone. It is one piece of the Air Force Enterprise and, as a member of that Enterprise, relies on its Enterprise Partners for success. It is, thus, important for the Air Force Enterprise to adopt a "Systems Thinking" approach in order to ensure each Enterprise element is working to optimize the entire Enterprise rather than their individualized elements.

In his book, Building Lean Supply Chains with the Theory of Constraints, Dr. Mandyam M. Srinivasan (2012) stresses the importance of Systems Thinking with regard to creating the ideal supply chain. He notes the traditional approach to building a supply chain is to create autonomous units structured around individual processes so managers could optimize their specific portion of the process. This traditional method created "silo" thinking and did not allow each "silo" to understand their impact to an upstream or downstream "silo." Local optimization does not consider the impact of each element on the whole system – and does not lead to global optimization of the entire supply chain.

The Air Force Life Cycle Management Center, in particular, is a critical enterprise partner for the AFSC within the AF Enterprise. According to the same Dec. 9, 2011 AF memo by the Secretary of the Air Force, the AF Life Cycle Management Center consolidates "design, production and product support decisions under a single manager, [in order to] increase flexibility to respond to changing operational needs and optimize use of program dollars – all necessities to best operate in a resource constrained environment." (SecAF Memo, 2011).

Systems Thinking – the Enterprise Approach – is a critical component to successfully operating in a resource constrained environment as the cost of sustainment can and will determine the size and capabilities of our Air Force. For the Sustainment Center the cost of sustainment begins with the requirements definition and includes engineering analysis and supply chain positioning to support maintenance execution. These steps, executed by our enterprise partners, are critical components to the ability of the AFSC to successfully execute its mission and positively affect the cost of sustainment.

1.2. Balancing Standardization and Innovation

A benefit of the AFSC construct is the ability it creates to leverage the best business operation practices across all three of the Air Logistic Complexes. From its inception the AFSC has worked to create a culture steeped in a standardized set of operating principles – principles that form the foundation of its operations and are protected as foundational sacred truths.

These standardized business practices – these sacred truths – are illustrated and communicated through the AFSC Game Plan Model (Figure 1.3), also known as the "Radiator Chart." This model depicts the idea that utilizing a scientific methodology to both construct organizational goals and measure progress toward those goals, guided by a leadership model that seeks to create a leadership culture that embodies specific leadership traits in order to leverage enterprise-wide processes and capabilities to achieve Art of the Possible results that positively contribute to the bottom line – the cost of sustainment. The essence of the model will be discussed in greater detail in Chapter 7 along with the maturity matrix concept the AFSC utilizes to measure the progress of its organization toward mastery of these sacred truths.

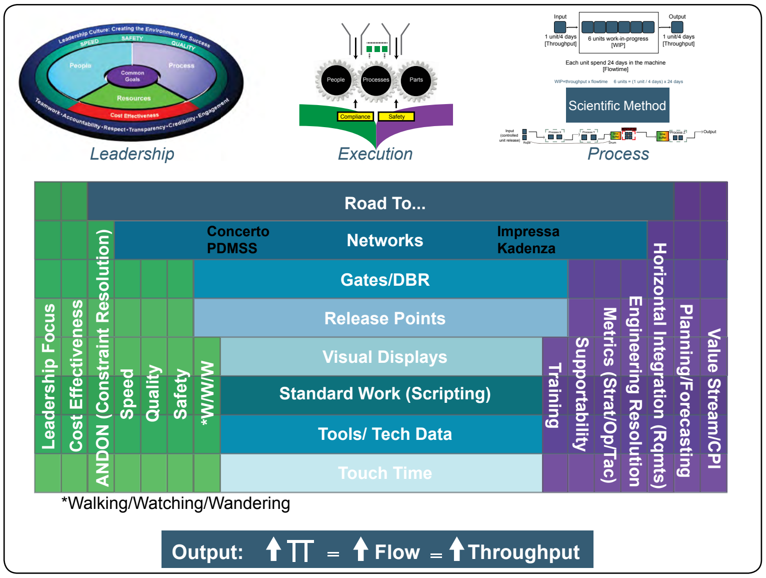


Figure 1.3: AFSC Game Plan "Radiator Chart" Model (click to zoom)

The power of the Game Plan Model is its ability to not only communicate, in a simplistic, easy to understand method, those true north operating principles that form the foundation of the Art of the Possible, but to also enable the passing of these truths from leader to leader, from generation to generation – ensuring this operating model becomes the baseline upon which future innovation is built. This book itself is a method to ensure current leaders and future leaders alike have the information necessary to understand the elements of the model – and to understand that the model provides the baseline of standardization necessary to establish consistent philosophies, tools, methods and structures for success. This structure and understanding will enable future innovations to complement the model and its principles by building upon them rather than building anew.

1.3. It's All About Speed

The game plan, the tools, the science, the philosophies are all in support of increasing Speed. With Speed comes reduced work in process (WIP), with reduced WIP comes reduced resource requirements - less dock space, less shop space, less equipment, less labor costs, less supporting overhead. Speed is good. Focusing on Speed provides the mechanism that will lead to reduced cost and increased capabilities for the Air Force.

It is very important to note that this concept, this idea of Speed, is not a "Speed at any cost" proponent. It is not about hurrying or obtained on the backs of the "doers" in the process. Speed must be achieved through an Enterprise focus and a common agreement and understanding of the goal of Speed. Speed must be mindful of Safety and Quality. The AFSC recognizes that Speed without Quality is not beneficial; therefore the focus on Speed is about understanding the processes that fuel our execution, both on and above the shop floor, and improving those processes with the goal of making the processes more expedient for the "doers" of the process. This focus serves to create Speed while improving Quality, because obstacles for the doer are considered and removed while feedback loops for up and downstream processes are installed – making Quality an integral part of the process. When Speed is accomplished within the context of Safety and Quality, and with the focus of an Enterprise intent on leveraging global optimization capabilities, it can and will reduce the cost of sustaining current and future Air Force assets.

The goal of this book is to explain how Leadership Focus and Production Machine Science can combine to create an execution plan that focuses on eliminating constraints and leveraging process improvement to create Speed and reduce costs. All of this standardization and streamlining - all of this quest for Speed, is in an effort to reduce cost - by removing non-value added steps, reducing waste, and eliminating over-production. Time is money. There is much waste across all AFSC organizations - administrative and production related processes alike. The focus on Speed prescribed in this book enables the AFSC to methodically reduce waste and monitor progress through a structured, standardized process.

2

LEADERSHIP MATTERS

Air Force Sustainment Center: Art of the Possible

Chapter Topics

The Air Force Sustainment Center has developed a Leadership Model to communicate the vision that the Leadership Culture is the foundation that "creates the environment for success." Therefore creating a Leadership Culture that is motivated to both initiate and achieve common goals with an emphasis on the ideals of developing *people*, managing *resources* and improving *processes* under the tenets of *Speed, Safety, Quality and Cost Effectiveness* while embodying the character traits of *Teamwork, Accountability, Respect, Transparency, Credibility and Engagement* is essential in order to establish an environment for attaining *Art of the Possible* goals (Litchfield, 2012). The AFSC Leadership Model is provided as an addendum to this Chapter and provides a valuable overview of the leadership ideals that are vital to the successful execution of the AFSC mission.

The outer ring of the AFSC Leadership Model represents the AFSC culture, along with the character traits essential for sustaining this culture. The focus on a culture of "leadership" is not an accident as setting the stage for *Art of the Possible* results will come only through leadership focus. To put it simply: leadership matters. It is the tie that binds strategic planning with mission execution and makes it possible for the components and tenets of the leadership model to unite as the common goals that are needed for success.

The leadership focus necessary for the successful execution toward common goals is best described as *engaged leadership*. Engaged leadership is distinguished by an assertiveness to ask for what is needed for success rather than accepting status quo reactions that do not promote a "Minutes Matter" mentality. Engaged leadership has many forms; from setting expectations for support from enterprise teammates as well as expecting the best effort from those within their own organizations. Leadership sets the tone for effective constraint identification, elevation and resolution which leads to the execution of efficient processes and achievement of the *Art of the Possible* mindset by the organization. Engaged leaders must continually motivate their organization to identify and resolve problems, in order to continue to move the organization forward.

The engaged leadership style is steeped in the principals of servant leadership. Servant leadership is linked to a participative leadership style which involves employees in decision-making and delegates extensive tasks with the goal of increasing the employee's influence and responsibility. In essence, the goal of the servant leader is to create "thinkers" who can now recognize and resolve constraints and understands when to elevate issues beyond their reach. An engaged leader uses the participative style while not allowing themselves, their employees or the enterprise to settle for actions or reasoning that do not promote the achievement of the agreed upon common goal.

Engaged leadership is a mindset that requires development and begins with a good understanding of expectations. These expectations include how the organization will react when process execution is endangered, as well as nurturing a Continuous Process Improvement culture that utilizes processes to solve the problems of today – today, so they will no longer be problems tomorrow. This section will discuss concepts that help set the stage for an environment of engaged leadership as well as describe what *Leadership Focus* looks like in action.

2.1. Setting the Stage

In his book, *The 21 Irrefutable Laws of Leadership*, John Maxwell talks about the Law of the Inner Circle; "Nobody does anything great alone. A leader's potential is determined by those closest to him. What makes a difference is the leader's inner circle" (Maxwell, 2007 p. 127). An inner circle refers to an organization and its teammates and involves leadership development, relationship building, the ability to influence and the complementary talents and gifts of a leadership team. The necessity for bringing all of these elements together, and why these elements are important in developing an effective leadership team, is the topic of this section.

Development

To quote John Maxwell again, "If you develop yourself, you can experience personal success. If you develop a team, your organization can experience growth. If you develop leaders, your organization can achieve explosive growth" (Maxwell, 2007 p. 249). The thought of developing leaders aligns well with Robert Greenleaf's idea of servant leadership, "A servant-leader focuses primarily on the growth and well-being of people and the communities to which they belong. While traditional leadership generally involves the accumulation and exercise of power by one at the 'top of the pyramid,' servant leadership is different. The servant-leader shares power, puts the needs of others first and helps people develop and perform as highly as possible" (Greenleaf, n.d.). The development of employees to leaders is essential in order to attain the *Art of the Possible* mindset -- and the development must be intentional. Some methods of developing leaders include taking advantage of leadership courses when they are available, but much of the development can be done internally through individual mentoring and creating the opportunity for dialog centered on leadership and critical thinking skills.

Book reviews are one way to create the opportunity for dialogue and can involve discussions of leadership traits and characteristics as well as critical thinking methodologies and tools, to not only focus the organization on the topic of leadership and critical thinking, but to also contribute to the learning of all involved through the shared experiences. Another method is a group review of the process script and goals with a discussion of major constraints and methods to analyze and resolve those constraints utilizing Continuous Process Improvement techniques and problem solving tools. These approaches also contribute to the next topic – relationship building – and improves the relationship of all involved in the review experience by building connections through shared discussions.

Relationship Building

Relationships are at the core of the AFSC leadership model. Creating *a Road to…* vision, with buy-in from the enterprise supply chain, requires the building of relationships in order to unite the enterprise around a common goal. Establishing relationships with mission and supply chain teammates requires an expectation of trust. Each teammate must be able to trust that other teammates will fulfill their role and elevate issues based on data and facts to serve the common goal of the enterprise.

Relationships are built from interactions that create an understanding of each teammate's role and perspective. This understanding can come from forums such as conversations, meetings, brainstorming and process improvement events that facilitate discussions of roles and perspectives as they relate to achieving the enterprise common goals. Building the relationship requires a willingness from each teammate to cooperate and participate in the relationship. Relationships require work, but the work is essential to improve the ability of the enterprise to work together to resolve the issues that negatively affect throughput.

Relationships are important within your organizational span of control as well. Taking the time to build strong relationships with those who work for you and with you is essential for success. Imagine you are a Production Flight Chief in an Aircraft Weapon System. In order to be successful you need a good working relationship with your second and first line supervisors, with your Weapon System Support counterpart and their supervisors, with the Transformation (Process Improvement) Team and with your Facility Engineers. The extent to which these relationships are on sound footing with a common understanding of roles and expectations will determine (and lessen) the amount of negative energy that must be exerted to attain the desired throughput. Good relationships make the job easier because it allows you to work as a team and generates positive rather than negative energy.

Relationships should be built around common goals. A good way to build relationships is to make the process the center of discussion and the constraint the goal to fix. If the process is at the center of discussions and the team meets to bust constraints, the finger points at the constraints rather than the stakeholders, thus, facilitating better business relationships and synergistic problem solving ability. In this way "personality differences" do not interfere with attaining mutual goals. The idea is to build bridges through relationships to overcome obstacles and enable the smooth execution of tasks that lead to positive results.

Influence

Building relationships not only builds trust and a common purpose, but also improves influence. Influence is the single-most important characteristic for leadership. A leader must be able to affect outcomes through their influence of those who are responsible for action. The characteristic of influence is not meant to convey one of positional authority, but rather the use of influence to persuade or convince others using data and facts to build a consensus call for action (Greenleaf, n.d.).

In addition to relationships, a leader relies on their experience and character traits to create influence. Experience in the represented field lends credibility to the leader and helps to amplify influence on related topics. As previously stated, relationships play a huge role in determining the influence available within and outside an organization. To the extent a leader has built bridges and created a unifying purpose, their influence is likely to be increased.

Just to be clear – building relationships does not translate to not "rocking the boat." Job one for a leader is to be engaged – assertively ask for and expect what is needed, based on facts and data, to meet and exceed common goals. However, just because a request has facts and data to support it does not mean the request will be easily accepted. Leadership must use their influence to elevate issues, utilizing the impact to the critical path of the process as the center of discussion, to ensure teammates are able to function within their swim lanes in order to resolve issues. Relationship building can be a rocky road, but should be conducted with the intent of rallying everyone around common goals.

The AFSC Leadership model requires "building the valued traits of our organization around teamwork, accountability, respect, transparency, credibility and engagement each day" (Litchfield, 2012). Amplifying these traits in our organizations and our leaders propels the influence of both within our enterprise supply chain.

Talents, Gifts and Experience

Careful consideration must be given to the chemistry of a team. When building a team it is important to look for members with complimentary talents and gifts – not just people that like each other. One person cannot have all the talents, gifts and experience necessary to handle every issue and look at every situation from all perspectives. Within the best teams, the weakness of one team member is offset by the strength of another team member. In this way, the team is more powerful as a collective than any one individual.

2.2. Leadership Focus in Action

"Good leaders quickly assess where an organization is, project where it needs to go, and have strong ideas about how to get it there. The problem is that most of the time the people and the organization lag behind the leader. For that reason, leaders always feel tension between where they and their people are and where they ought to be" (Maxwell, 2007, p. 248). This describes the idea of "comfortable in red" – a condition to which AFSC leaders must become accustom. Reaching a new goal is meant to be challenging and requires living in red metrics while trying to achieve the next level of performance. The key is to create transparency in the organization by understanding performance gaps(red metrics), identifying the actions that will lead to the step improvement required, and utilizing leadership influence to put the plan into action in order to improve organizational performance. Transparency involves open communication of the gap and action plan tied to improved performance. Living in red implies understanding the problems (gaps) is the first step toward achieving a goal.

Engaged Leadership

Engaged leaders must teach others to be demanding customers. So often employees fall into the trap of thinking they must live with a workaround – "because it has always been that way." AFSC employees do not need to "make do" with less than adequate tooling, equipment, tech data, processes or other necessities for accomplishing their mission. "Engaged," in this sense, means having the fortitude to bring needs and gaps to light in order to allow others the opportunity for resolution.

The first step is to identify the constraint or unacceptable situation – which begins with recognizing the situation is unacceptable in the first place. This recognition comes from looking at the tech data and requirements – what are the rules that govern what is needed for the task at hand? Tech data and requirements provide the data that provides the impetus for getting the right tools, parts, equipment, etc. and leadership sets the expectation that what is written is what is required.

After identifying an unsatisfactory situation the next step is to elevate the issue when it is not immediately resolved. This step is even more difficult and unnatural than the first step of identification. To whom is the issue elevated? How are issues kept in front of leadership and how does leadership determine which issues to work first? The answer is the aggressive use of Leadership tools and processes identified in the AFSC Radiator Chart discussed in Chapter 7. Leadership tools such as *ANDONs* provide a mechanism for elevating and prioritizing issues and constraints, while Process tools like *Value Stream/CPI, Planning/Forecasting, Horizontal Integration (Requirements)* and *Engineering Resolution* provide avenues to not only resolve current issues, but to strategically eliminate them in the first place.

The last step is issue resolution. This step often requires engaged leaders aggressively assert the data and facts behind the need as well as appropriately frame the problem and impact the issue creates. While having the data and facts to support the need can create momentum to resolve an issue, a well understood impact is often what is needed to drive the urgency for resolution. Engaged leaders will ensure that data, facts and the impact of an unsatisfactory situation are well understood by all involved in resolving the issue.

In addition to teaching others to be demanding customers, engaged leaders must also set the expectation for the best effort from those around them. Leaders must expect *Art of the Possible* results in order to attain *Art of the Possible* results. It is tempting to limit our abilities by succumbing to reasoning that places limits on results. When leaders succumb to limitations they give their organization permission to limit themselves. If leaders do not grant this permission, but instead refuse to see the seeming limitation, they can instead inspire their organizations to rise above those limitations and produce results that astound themselves.

Create Thinkers

A key principle of servant leadership is a commitment to the growth of people. "Servant-leaders are deeply committed to a personal, professional, and spiritual growth of each and every individual within the organization" (Greenleaf, n.d.). A leadership focus requires that we create employees who are equipped with knowledge that allows them to understand the enterprise view, where they fit into the enterprise, and gives them the tools and opportunity to think for themselves by coming up with solutions to issues. Leaders can offer advice, provide direction and share thought processes, but developing those around us involves letting others develop answers and the way forward from that information. The key is participation and practice. An expert swimmer is not developed from watching and observing others swim. An expert swimmer is developed from hours of practice and good coaching. If employees are always handed the answer, they do not learn to think through and find the answer for themselves – they do not become *thinkers*.

One pitfall a leader may have is the overuse of advocacy statements -- to state their idea for the resolution of a problem before they hear the thoughts of others. This habit leads to "the boss said" mentality and can shut down the free flow of creative thinking. Who is going to disagree with the boss's idea, or give a dissenting idea, once the boss's idea is spoken? In order to eliminate "the boss said" mentality, the leader can practice letting everyone speak before giving their opinion on a matter. When faced with an issue, make it a requirement for everyone in the room to give their opinion – leaving the leader for last. Interject only as a matter of coaching and to stimulate the conversation. If there has been good flow of ideas and creative thinking – the leader may not need to give an opinion at all! Remember, the goal is not to implement all of the LEADER'S great ideas, but rather to develop those around the leader to become thinkers; thus improving the power of the organization and propelling them toward *Art of the Possible* results.

Create Buy-In

Buy-in is a by-product of creating thinkers. The more employees are involved in working through a problem and crafting a solution, the more ownership they have in the success of that solution. Involvement creates ownership, ownership creates buy-in and buy-in creates results. The difficulty in creating buy-in comes when buy-in is needed from large groups of people – everyone simply cannot participate in working through the problem and crafting solutions. How is buy-in created in this environment?

When everyone cannot participate, the use of respected peers is the best solution. People want to know their perspective and experience will be represented in the problem definition and solution. The extent to which they feel their perspective and experience was represented in crafting a solution will affect their level of buy-in to that solution. The problems faced in the AFSC often require Enterprise solutions, therefore it is important to ensure respected peer-representatives across all disciplines are present and participate in problem solution. This method works to create Enterprise buy-in to solutions and ensures the perspective and experience of the Enterprise is represented in the solution.

Communicate Change

Thus far the means by which engaged leaders exponentially increase the power of their organization -- teaching those around them the concepts of being a demanding customer, creating employees who are thinkers and setting the tone for buy-in to solutions has been discussed. A final step to success is ensuring effective communication of those solutions.

The first step to effective communication is to share the logic and the process behind the solution. People are always interested in the process used to arrive at the solution in front of them. The more buy-in that is needed to execute the solution, the more information about the logic and process of arriving at the solution is needed. This will allow people who were not able to part of the solution process to at least make a judgment that the reasoning behind the solution is sound.

Just as important as what you communicate, the method of communication, and how often the message is communicated, can be essential to the success of the solution as well. When selecting the method of communication, think about the intended audience in order to determine the best message delivery method. Depending on the scope of the change desired, it may be necessary to communicate utilizing several different methods.

These methods of communication could include a briefing delivered to a large group projected on a screen, small group settings with paper copies of a briefing, models of the main ideas that can be displayed to reinforce the desired change (think: the Radiator Chart and Leadership Model), single page instructions that can serve as reference tools for the changed process and posting information on a common share-point site for ease of reference are all methods that can be utilized to get change messages to an audience. Change does not occur overnight, and messages – especially complex messages – may be heard, but not fully understood on the first pass. Be prepared to deliver the message in different formats and many times in order to ensure the message is understood and the intent is clear.

Continuous Process Improvement Culture

Creating a culture that recognizes and utilizes process improvement as a tool is really what *Leadership Focus* in action is all about. This section has talked about utilizing engaged leadership to create demanding customers, thinkers and buy-in and communicating solutions and the need for change in our organizations. All of these elements, along with process improvement tools, are essential leadership tools to be utilized in creating a Continuous Process Improvement Culture, but engaged leadership is the leadership style that makes the culture endure.

Engaged leaders create opportunities to reinforce important concepts and ensure actions stay on track in order to lead to results. Opportunities for reinforcement include Walk-the-Wall Improvement Briefings, Rapid Improvement Event out briefs and updates, and weekly Production meetings where improvement initiatives are tied to gate performance. Reinforcement occurs during these opportunities by setting the tone that progress must be made on initiatives, improvements must be tied to performance, and events and initiatives must be collaborative within the enterprise.

Engaged leaders also look for opportunities to reinforce the culture through the use of Continuous Process Improvement tools to attack the problems they see within their organizations. For example, insistence on the use of the 8-step problem solving model to address issues confronting the organization will eventually lead the organization to naturally turn to the model when faced with a problem. Continued insistence to call together a team of respected peers for a Rapid Improvement Event to address performance gaps will eventually lead the organization to rely on this tool for improvement. Changing a culture requires a continued insistence on the basics of the new culture and a consistent and relentless application of its principals. This is what engaged leaders do in order to fix today's problem for today, so tomorrow you can focus your energies on bigger ideas.

2.3. The Guide to Achieving *Art of The Possible* Results

(click to zoom)

Sustaining weapon system readiness to generate airpower for America is the Air Force Sustainment Center's mission and our overarching focus. Successfully accomplishing our mission in a time of unprecedented challenges demands we achieve our full potential as we strive for *Art of The Possible* results. In an environment where organizations are struggling to survive, AFSC is looking to thrive. We must provide greater military capability, improved readiness at less cost than ever before. It's not about working harder, cutting corners or jeopardizing workplace safety; it's about recognizing opportunities, understanding and eliminating true limiting constraints, improving processes, and maximizing available resources. To achieve our full potential, we must start with a common sight picture that focuses on creating the environment for success. The *Air Force Sustainment Center Leadership Model* provides enduring principles to equip leaders with a holistic approach to gaining effectiveness and efficiency. The model drives us to meet our common goals through three collective components: developing our people, managing our resources and improving our processes, focused around the tenets of speed, quality, safety and cost effectiveness. By creating a leadership construct where teamwork, accountability, respect, transparency, credibility and engagement are paramount, we create an environment where we can achieve the *Art of the Possible*.

AFSC Commander's Intent "is that we meet our mission requirements, take care of our people, and prepare for the future. We will meet our demanding mission through teamwork and empowering our workforce to develop a culture that breaks through constraints. We will take care of our people by driving improvements in workplace safety and enhancing the wingman practices both on- and off-duty. We will develop the right technical skills, focus our energy on capabilities gained through process improvement initiatives and engage our workforce in the development of problem solving skills at all levels within the Center. Lastly, we will capitalize on our current capacity and competencies while preparing for future sustainment requirements."

Common Goals

The common goals are the rallying point for everyone in the AFSC. However, to drive success oriented behavior throughout the organization these goals must be decomposed to relevant objectives that are meaningful at every level and every shop. Each work center has their own accountability to meet mission expectations. The goals drive us to provide world-class sustainment support with the right capability at the least cost. It is imperative that both leaders and the workforce understand their specific work center goals and role in meeting performance targets. We should not expect everyone in the chain to recite a list of organizational goals, but each and every individual should understand what is expected in their work area and how they measure up against specific targets. Understanding roles and expectations, allows everyone to know "if they are having a good day."

To reach these common goals, we must foster a culture of transparency. We are not in the business of looking good…we have a mandate of being good, in fact…world class. To foster that culture, senior leaders must identity the critical focus areas to achieve cutting-edge, innovative and sustainable results from process improvement initiatives. AFSC members need to embrace stretch goals that are intended to be out of reach of current performance levels and forces creative and innovative thinking. Proactive engagement from leadership is essential as we evolve our culture to support a process improvement drive that is championed by everyone. An engaged workforce vested in mission success is the catalyst for *Art of the Possible* results.

People, Resource And Process

Leadership focus on developing our people, managing resources and improving processes will set our course. *The strength of ASFC lies in our dedicated, competent, and professional workforce*. As leaders, we have a responsibility to build confidence and trust that our priorities balance both mission requirements and workforce needs. Our workforce needs the right skills, training, education, and experience to tackle the challenges today and tomorrow. Developing both hard skills and soft skills are paramount to ensure the workforce is ready to achieve mission success. Taking care of our people is of utmost priority. Proper planning and responsible stewardship of *Resources* is an essential prerequisite for success. Leaders are accountable for planning the right work environment and must identify needs lead-time away. Without proper planning and management of facilities, infrastructure, IT Systems, equipment, tools, funding and parts, we severely jeopardize mission capability and readiness. In our resource-constrained environment, we must ensure our workforce has the necessities to accomplish the mission, but understand that they may not have everything they desire. Now it is time to add the third key component, *Process*. Continuous Process Improvement is the lynchpin that binds this model together and the force multiplier that will increase our abilities to meet our demanding mission. In AFSC, the CPI methodology starts with an end-to-end evaluation of the value stream from requirements generation to customer feedback (i.e. Wheels down to wheels up). The Center's battle rhythm allows for review of key performance metrics and identification of gaps and areas for improvement at every level to monitor progress toward achieving common goals. Leaders in AFSC regardless of position or function (strategic, operational and tactical) will use CPI to achieve *Art of the Possible* results. Everyone is accountable for improving the business and *making today better than yesterday, while making tomorrow better than today*.

Speed, Quality And Safety

The next step in the model is to use the people, resources and processes to ensure our tenets of speed, quality and safety are met. *Speed* is NOT about cutting corners or simply working harder and faster. Instead, Speed is enhanced by our ability to quickly identify, elevate and eliminate constraints on the critical path. Our workforce must feel constraint and waste elimination is a valued attribute. We must operate with the same sense of urgency to sustain critical path timelines as we do when facing mission failure. While speed is important, *Quality* is paramount. Defects in our products have the potential for disastrous effects on our warfighter. Leaders reinforce the mandate for quality and take the necessary steps to ensure quality is sacrosanct. Mistakes will happen, but we have the tools to identify and prevent repeats and take proactive steps to eliminate opportunities. We build trust and confidence by doing our jobs right the first time. *Workforce safety* is the priority of everyone. We need to ensure everyone who comes to work in the morning goes home at night ready to give their best the next day. Safety is about taking care of our people and ensuring their work environment and processes keep them safe at all times. A strong Voluntary Protection Program is essential. Keeping the most valued members of our team safe is critical to the success of our organization.

Cost Effectiveness

The defense environment is changing and a heightened awareness of cost is forcing Air Force leadership to take an ever-mindful look into our spending. As Air Force leaders, this is a paradigm shift in the way we operate. Unparalleled declining budgets dictate the need to develop and implement cost effective solutions to reduce operating costs, specifically within AFSC. But, to understand where we can reduce cost, we must first have a firm grasp of what it costs to produce our end items. Once we understand where we spend our money, we can then identify areas to reduce costs and eliminate wastes. The taxpayer and our warfighter customer are counting on us to provide available, affordable and capable weapon systems on time and on cost. Our ability to reduce the cost to sustain weapons systems will affect our ability to defend our nation.

Leadership Culture

Creating the environment for success is the sole responsibility of leadership across the AFSC enterprise. The Air Force poured the foundation by establishing Air Force Core Values of Integrity First, Service before Self and Excellence in all we do. But, it doesn't stop there. We build on this foundation by building the valued traits of our organization around teamwork, accountability, respect, transparency, credibility and engagement each day. The combination of Air Force Core Values coupled with AFSC organizational traits creates the environment for success. As leaders, it is your job to ensure everyone in the organization is successful. To be world class we must get *the right results…the right way*.

Leadership Trait: Teamwork

Work in a collaborative, cooperative and integrated manner with customers, peers and coworkers

Actions to exemplify:

- Pulls together to identify and remove obstacles to achieving common goals; driving to maximum results
- Cooperates with fellow teammates to remove friction between organizations
- Seeks out and learns new skills, takes initiative and shares learning and success with others
- Demonstrates a strong commitment to providing the greatest value to customers both internal and external
- Everyone exhibits consistency of purpose to shift to a change/problem solving mindset

Leadership Trait: Accountability

Do the right thing even when no one is looking--answerable for personal and organizational behavior

Actions to exemplify:

- Demonstrates alignment to the vision, strategic focus and goals
- Sets stretch goals to achieve the *Art of the Possible* results and is personally and organizationally accountable to those goals
- Incorporates guidance, tools, training and standard processes to ensure compliance and individual responsibility
- Utilizes expertise and knowledge of CPI methodology to establish standard work and share best practices
- Demonstrates courage and integrity to tell the truth and use proper procedures to stop production and clearly communicate defects observed or created
- Sets clear expectations

Leadership Trait: Respect

Actively display positive appreciation and consideration for the value and contributions of teammates

Actions to exemplify:

- Ensures teammates and workforce are valued
- Accepts and acts on good ideas and innovation
- Promotes an environment where everyone is passionate about improving their workplace and is respected for it
- Demonstrates willingness to learn and standardize processes to ensure sustainment and maximum utilization of limited resources

Leadership Trait: Transparency

Communication that is open, honest and continuous up, down, across the organizational chains

Actions to exemplify:

- Demonstrates horizontal and vertical integration and collaboration
- Ensures visual management is actively used to depict real-time performance as well as identifying opportunities for improvement
- Identification of constraints is viewed as an opportunity for improvement; not an area for punitive measures
- Demonstrates an openness to listen and learn from others

Leadership Trait: Credibility

Commitment to be the most effective, efficient, innovative and respected world-class organization

Actions to exemplify:

- Builds trust with customers and is recognized as provider of choice
- Leadership, labor management and the workforce exemplify and share a strong sense of pride and ownership in AFSC's reputation
- Encourages innovation to improve performance for current/future requirements and support
- Provides the highest quality products and service to our customers

Leadership Trait: Engagement

Workforce authorized to identify constraints/waste and remove roadblocks to accurate reporting

Actions to exemplify:

- Delegates responsible decision-making authority to the lowest possible level
- Ensures employees are engaged in the implementation and successful sustainment of value-added solutions from CPI initiatives
- Seeks inputs, listens carefully and requires data-driven actions
- Empowers the workforce and inspires identification of improvement opportunities and possible solutions
- Fosters self-directed actions and decisions to support customer requirements

Concept Of Operations

The concept of operations articulates what is required throughout the AFSC to provide greater military capability, improve readiness and operate more efficiently and effectively. The CONOPS begins with the Leadership Model that guides the Center's management approach, followed by the development of an executable plan and strategy that best supports mission requirements today while looking toward the future. This plan and strategy relies heavily on continuous process improvement methodology and is the guidepost to drive efficiencies and improvements across AFSC. In addition, we must keep focused on achieving the mission while maintaining a stable battle rhythm of reviewing key performance metrics at all levels and assessing progress toward achieving common goals and targets. Finally, horizontal and vertical integration must remain in line of sight as CPI is executed; it is critical to pay close attention to the entire value chain. This prevents driving inefficiencies to partners or other processes outside of AFSC.

Governance

Business operations and CPI are governed via the AFSC Corporate Governance structure. This structure is designed to provide a leadership forum to discuss Center-wide issues from an enterprise perspective; maximizing AFSC's decision- making authority. The Wing Commanders, Complex Commanders and Directors in collaboration with the Logistics Director report status/progress toward achieving common goals/targets, CPI and radar scope initiatives. In addition, the AFSC continuous process improvement Champions periodically report CPI strategy results and implementation progress. This is only the beginning, as AFSC matures, so will the governance structure and reporting methods to ensure total transparency across the enterprise.

Summary

Success of AFSC rests on the ability of the Center leadership, at every level, to embrace this model and foster a winning and successful environment based on an effective means of driving process efficiency and consistency across all AFSC organizations. The Leadership Model is not static; we will continue to refine with the help of those across AFSC. The goal is to meet mission requirements, gain efficiency and sustain over the long haul. It's about long-term improvements and achieving bottom line results to ultimately have a positive effect on the warfighter. While the path may be challenging at times, the results are worth the effort. How high we soar in AFSC will come down to our ability as a leadership team to develop a pro-active culture, embrace process improvement, and foster an engaged workforce. The AFSC Leadership Model, including a standard CPI methodology and process, is designed to plan, execute and sustain our direct path to achieve maximum efficiency and weapon system readiness to generate airpower for America. Every day is a great day to fly in the Air Force Sustainment Center!

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3

CREATING THE VISION A ROAD TO....

Air Force Sustainment Center: Art of the Possible

Chapter Topics

A journey of a thousand miles begins with the first step, but careful planning is necessary to ensure that first step is taken in the right direction. This chapter will discuss the planning and communication components necessary to not only guide the organizational direction, but to also ensure the entire enterprise is marching in that direction together!

Creating a Road to… goal is the foundational step in the journey toward achieving an Art of the Possible mindset. Road to…creates a destination for the organization and its teammates enabling the path to be marked with the actions and milestones that will ultimately end in achieving the common goal. A Road to… goal is designed by first evaluating both the needs of the customer and the needs of the organization – current and future.

The needs of the customer can include the pace of production required to meet aircraft availability requirements, engine war readiness levels, inventory turns of high volume components or the given need date of an engineering or contract request. However, the current needs cannot be considered in isolation of future needs. The organization must always be looking forward to examine the landscape of future challenges. Is the fleet size decreasing or increasing? What is the impact of planned future modifications? Are there future changes that could impact the demand rate of any particular component?

Consideration as to the needs of the organization can include understanding capacity requirements such as facility restrictions, future workload requirements for the Complex, and the availability of manpower and equipment resources. Understanding whether capacity and resources are scarce or abundant should be reflected in the organization's Road to… plan. The answer to questions such as these should constantly be examined and drive adjustments to the Road to… goal accordingly.

The next purpose of the Road to… goal is to set the pace of production through the creation of the organization's Production Machine. The AFSC white paper, The Science of the Air Force Sustainment Center's Production Machine, explains the science behind, and the steps necessary to create, the organization's production machine. The concepts of this paper will be discussed in Chapter 4. The production machine is then utilized to create increased throughput paced to the Road to… goal for the organization.

Achieving the required throughput for the Production Machine requires the focus of not only the organization, but also that of its teammates. For this reason, an important element of this phase of the process is to communicate and create buy-in through all levels within the organization and with external teammates throughout the Enterprise itself. External partners include the customer, suppliers and organizations that support the organization's processes. Understanding, and buying-in to, the Road to… goal will provide the signal these external organizations need to pace their processes to that of the organization. The next section will describe the elements necessary to effectively communicate the Road to… goal throughout the Enterprise.

3.1. Elements of Road to…Communication

A successful Road to… communicates the burning platform for the goal – especially when attaining the goal will require a comprehensive shift in cultural norms for the pace of production. Elements that will make the communication successful include:

- Explanation of the reasoning behind the goal – *the burning platform*
- Explanation of the science behind the goal – *the production machine*
- An understanding of the performance history – *frame the challenge*
- An outline of actions necessary to reach the goal – *action plan*

Burning Platform

The burning platform communicates the urgent and compelling reason that establishes the Road to… goal. Look first to the needs of the customer, what is the pace of the customer requirement today? What is on the future horizon for the customer that could affect the current pace? In the case of an aircraft production environment, future modifications or anticipated repair challenges can threaten to extend the time aircraft spend in a depot maintenance environment. Extended flowdays, in turn, can increase the number of aircraft captured in a depot repair setting, increasing the pressure on the customer's aircraft availability goals. A burning platform for an aggressive, Art of the Possible, Road to… goal can be created around the need to maintain a specific depot aircraft captured number in the face of challenges that, unchecked, will increase the number captured.

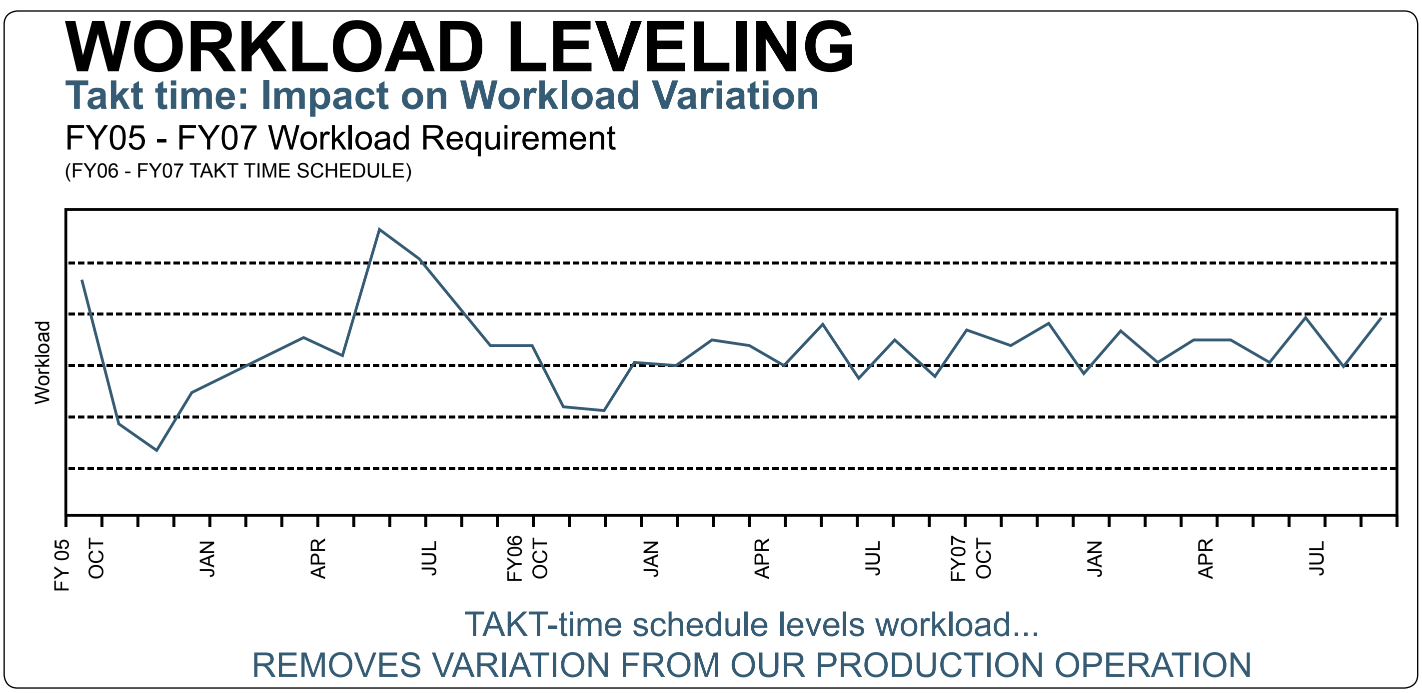
Perhaps the look into the future did not uncover changing needs for the customer. The next question to ask is does the current pace meet the organization's own needs such as facility limitations in a production environment. If the pace of the customer requires 20 aircraft to be captured and in work at one time – does the organization have space for 20 aircraft? Other workloads competing for the same capacity requirements should be reflected in the burning platform of a Road to… goal.

The imaginary Z-28 aircraft weapon system will be used to illustrate the Road to… communication elements. Looking ahead, the Z-28 weapon system noted they had future workload challenges that (under current conditions) would require the aircraft captured total to exceed the depot allowance. The Z-28 community recognized the number of aircraft captured for programmed depot maintenance (PDM) would need to be reduced, and this reduction would require a flow day reduction of 25% -- no simple feat. The Z-28 Road to… burning platform detailed the negative aspects of not reducing flow days. The burning platform communicated that something had to change.

The Production Machine

This communication element explains the mathematical science behind the Road to… goal. Chapter 4 will explain this science in detail, but for now, understand the production machine science elements will create the pace of the machine. The science used to create a particular machine should be communicated so the enterprise understands the science behind the ultimate Road to… goal.

The Z-28 weapon system began their production machine communication by championing a takt-time induction schedule. Figure 3.1 shows the rationale used to garner support for a takt time induction schedule over the current random induction schedule the weapon system utilized prior to their Road to…. goal. The weapon system further utilized production machine math to showcase why the desired number of aircraft equated to the required number of flowdays (Figure 3.2 and 3.3). Together, the takt time induction schedule proposal coupled with the computed number of flowdays, based on the required number of aircraft captured, allowed the weapon system to communicate the mathematical reason for their Road to… goal.



Figures 3.1: Z-28 Workload Leveling through Takt-Time

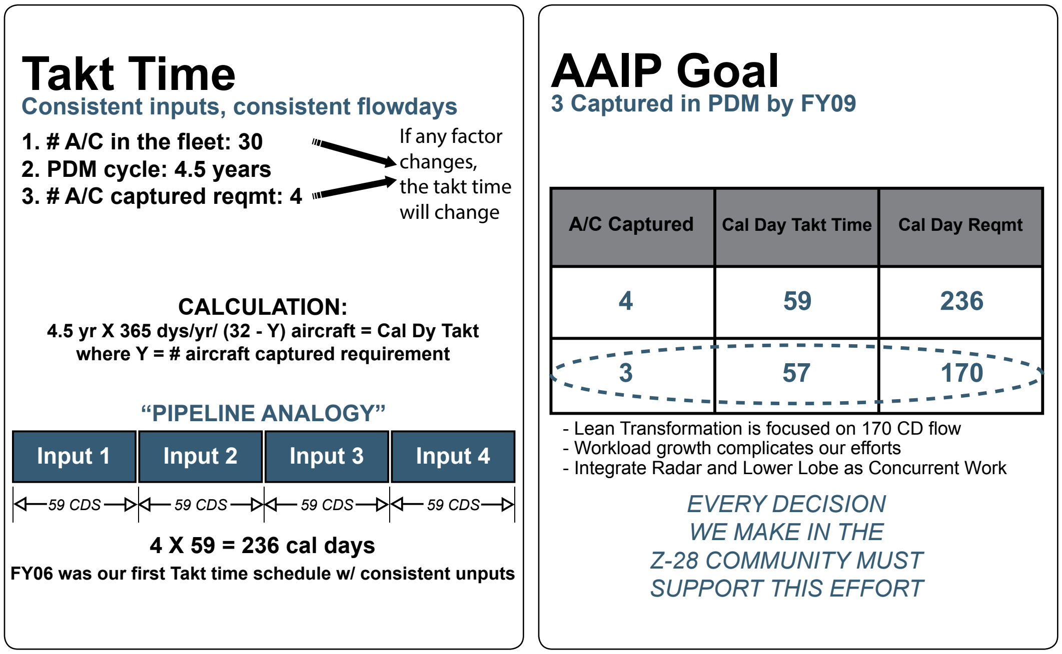


Figure 3.2 and 3.3: Z-28 Road to… Flowday Calculations (click to zoom)

Frame the Challenge

A challenging Road to… goal will not be easy to achieve. Art of the Possible Road to… goals require the organization to closely examine themselves and use data and analysis to uncover the gaps in the organization's current processes. Detailing the gaps between current and desired performance will lead to an understanding of what needs to change in order to meet the ultimate Road to… goal.

Framing the challenge should include comparing current flow day performance to the required future performance. Specifically state the reduction required so the enterprise understands the extent of the challenge. Later, as performance improves, and the organization moves closer to the meeting its Road to… goal, this variance can be used to show the improvement and motivate the enterprise to see that success is possible.

The challenge should be framed from an enterprise view. While an organization should certainly focus on internal processes that can be improved; framing the challenge should be about communicating gaps from an enterprise perspective. Are there specific supportability elements that need to be met? Does engineering need to help develop standard, repeatable repair processes or define processes to enable concurrent work? Does the organization need to develop a standard script for the desired flow? Is there a facility challenge that needs to be overcome? An organization frames the challenge in order to leverage the burning platform to empower and motivate the enterprise to resolve and overcome the challenges currently impeding attaining an Art of the Possible Road to… goal.

In the case of the Z-28 weapon system, the challenge was a 25% flowday reduction to realize their Road to… aircraft captured goal. Challenges to this goal included 1) non-concurrent PDM work completed with the aircraft in a separate facility from the core PDM workload; 2) an upcoming task that, under current conditions, would cause additional non-concurrent work; and 3) the need to better utilize the PDM facility to place a greater emphasis on feeder lines and kitting. Once the challenges were identified, an action plan could be created to communicate the role of the enterprise in attaining the Road to… goal.

Action Plan

The action plan is the key that will set the organization on the road to success. The action plan should make use of Lean and Six Sigma continuous improvement principles and should include target completion dates. The events and actions listed should involve the enterprise. The action plan should consider not only current gaps, but should account for future challenges that could add days to the machine in order to protect machine flow days. The action plan should allow the organization to communicate to the enterprise the "big bucket" actions necessary to achieve ultimate success.

The Z-28 weapon system leveraged their Road to... goal to make major process and facility changes. The Road to… goal, with its burning platform, became the justification for creating concurrent work opportunities. One opportunity involved moving a major portion of the PDM workload from a remote building and integrating it with the primary PDM flow; another opportunity was to find a way to allow significant Corrosion Preventive Compound (CPC) and Paint requirements to be completed concurrent with the PDM flow. An additional overarching improvement opportunity involved better utilization of current low bay hangar space to improve feeder line and kitting activities for the aircraft. The Road to… goal played a major role in securing the funding necessary for the success of each of these projects as the Road to… foundation allowed the Z-28 PDM line to frame the burning platform for the change and the benefit to be derived from the funding. The integration of the previously separately located PDM workload was formerly thought to be impossible to integrate, thus the urgent and compelling Road to… goal was the impetus for a mindset change, and saved the Z-28 weapon system 16% of the required 25% reduction!

As previously mentioned, the needs of a specific customer form the basis for that weapon system's Road to… goal; however, it is not the only component in the formula. Another important component of the formula is the overall capacity of the Complex. The footprint of an individual weapon system, based on its Aircraft Availability calculation alone, may be greater than that available to a Complex given its total workload requirements. There may be cases where increasing the Speed of a weapon system is necessary to reduce its footprint (WIP) in order to free capacity for new or increased workload for the Complex. For this reason, it is important to understand the workload requirements of the Complex in its entirety to ensure the individual Road to… goals allow the Complex to meet its overall workload obligations.

The AFSC has coined the term – Visioneering – to describe the forward-looking process of considering the capacity of a Complex to perform all of the workload it has or is considering. Visioneering methodology creates a data-driven analysis on which to base, not only workload capacity and capability decisions, but also helps direct effective Capital Investment decisions to provide the greatest benefit to the Complex as a whole. Visioneering methodology is discussed extensively in Appendix B and is a solid method to determine if the capacity of the Complex plays into the Road to… equation for a specific weapon system.

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4

THE SCIENCE OF THROUGHPUT

Air Force Sustainment Center: Art of the Possible

Chapter Topics

The previous chapter emphasized the importance of creating a burning platform for a "Road to…"goal around which the enterprise can rally and synchronize efforts to achieve. The chapter briefly discussed the need to have a scientific (mathematical) approach to the goal and touched on the elements of takt-time inductions and cycle time calculations. These calculations help set the Strategic goals for the organization, but do not provide the succinct details required for monitoring throughput in order to achieve the overarching goal.

This chapter will delve further into the calculations and philosophies of designing a production machine that will drive AFSC operations to achieve improved performance, competitiveness and throughput. The science for designing and operating AFSC production machines was first introduced in a white paper authored by Mr. Kevin O'Connor, Vice Director of the Oklahoma City Air Logistics Complex, shortly after the AFSC stood up operations in July 2012. An expanded version of that paper is presented in this chapter which includes new insights that have been noted and refined during the implementation of the Production Machine within the AFSC.

This expanded chapter provides the framework for standardizing production philosophies in order to create a common "throughput" language within the AFSC. It clearly defines a "science" for designing and operating AFSC production machines - ensuring consistent execution philosophies that will stand the test of time. This science is based on fundamental flow principles: Little's Law, Theory of Constraints, and Drum Buffer Rope (DBR) philosophies. These are basic principles for creating *flow* in order to enable throughput. Flow involves having an input, creating value to that input, then creating an output. This scenario can be applied to processes both on and above the shop floor.

Much of the language contained in this Chapter refers specifically to "Production." However, the word "Production" could easily be replaced by almost any process descriptor and placed in front of "Machine" to describe virtually any type of "machine:" the *Service Contract Machine*; the *Installation Projects Machine*; the *Material Ordering Process Machine*, the *Demand Planning Machine*, the *Test Program Sets Machine*. It is possible to take the principles outlined in this chapter – the principles of a gated process and drum-buffer- rope and create a process machine that enables virtually any process to be built on goals based upon mathematical principles and then monitored for performance to those goals. The challenge is to think about those possibilities while first using production principles to gain an understanding of the concepts.

AFSC production machines must be designed to exceed customer expectations and reduce work-in-progress. With reduced WIP comes reduced infrastructure and reduced resource requirements – creating capacity for additional workload and reducing costs. Later in this chapter the relationship between WIP, flowtime and Throughput in the context of Little's Law will be discussed as it is critical for the AFSC to increase the level of throughput through all of our production machines…. *THROUGHPUT IS KING*. A properly designed production machine provides a methodical approach to assessing throughput performance and allows the AFSC to communicate changes and impacts in a common language. A well-built production machine allows the user to adjust for known changes, such as increased or decreased requirements and to understand how to "fine tune" the machine to achieve improved performance. Next will be an examination of the philosophies of Little's Law and the Gated Monitoring System.

4.1. Part I: The Application of Little's Law and a Gated Monitoring System

When examining an AFSC Production Machine utilizing a gated monitoring system one must grasp the concept of Little's Law before the methodology behind the gates can be understood. A brief description of Little's Law below will help shape understanding of important concepts such as throughput, flowtime, WIP and takt time. Little's Law provides the foundation for creating and setting up a production machine. This Section will describe the steps to set up gates for a basic production machine as well as describe how to calculate variable gates to allow one machine to be utilized to monitor a production line with different input configuration requirements. Next, will be a discussion of key aspects to consider when monitoring gate performance as well as insights for setting up work content within a gate. Finally, examples of utilizing the gated monitoring system to manage administrative processes will be provided to illustrate the flexibility of the monitoring process.

Little's Law.

At steady state, all production systems have an average throughput, work-in-progress (WIP), and flowtime. The fundamental relationship between all three is determined by Little's Law: WIP = throughput x flowtime. Throughput is the required output of a production machine expressed in units per time. Flow-time is the average time that a unit stays in a production machine. WIP is the average number of units in work throughout the production machine.

So, let's dissect Little's Law and fully understand the relationship between these three components (WIP, throughput and flowtime) and AFSC's concept of Speed. Speed equals reduced flowtime. For a constant throughput, increasing the Speed of a Production Machine (reducing the flowtime) will reduce WIP. If you have a system with unlimited Demand, and you keep a constant WIP, then increasing the Speed (reducing the flowtime) will result in an increased throughput for your Production Machine. It is important to understand these relationships because your focus on improving Speed will result either in 1) reduced WIP or 2) increased throughput for your Production Machine.

Little's Law Demonstrated in a Simple Production System

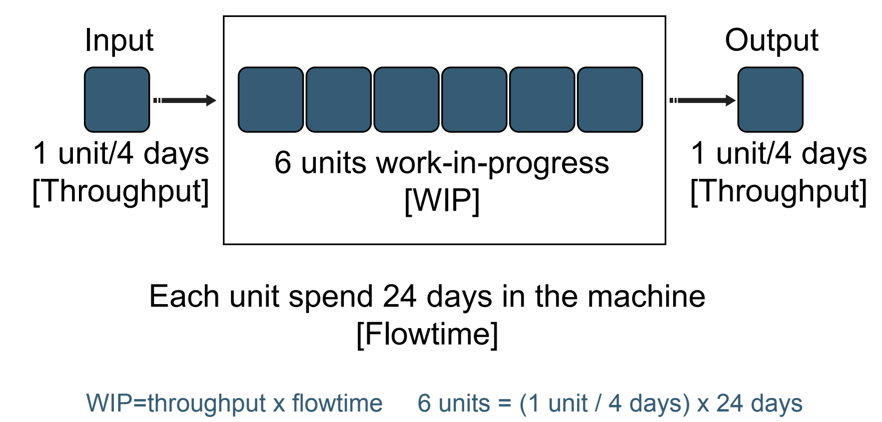


Figure 4.1: Little's Law Demonstrated in a Simple Production System (click to zoom)

For the purposes of an AFSC production machine, we will modify Little's Law to include the concept of *takt* time (Figure 4.1). Takt time is the heartbeat of a production machine. It defines how often a single unit must be produced from a machine. For example, a takt time of 10 days means that the machine must produce one unit every 10 days. Mathematically, it is the reciprocal of throughput as defined above. It is determined by dividing the available time by the required output in that amount of time (expressed in units of time). If a process is required to produce 37 units in 1 year, the throughput is 37 units / 365 days or 0.1 unit per day. The takt time would be 365 days divided by 37 units equal to a takt time of 10 days. Said another way, every 10 days the machine must produce a unit....and all enabling teammates must support this tempo.

The AFSC modified version of Little's Law now becomes: Flowtime = WIP x Takt Time

Production Machine Design

A unique component of the production machine design is that its design begins with the *future state requirement*; it is not designed based on existing performance. The machine must be designed to reduce flowtimes and WIP, subsequently reducing required infrastructure. The reduction of flowtimes (increase of Speed) for a constant throughput requirement will reduce WIP and therefore resources necessary to accomplish that throughput - the ultimate goal of the AFSC Production Machine.

When designing a production machine, two of the three variables in Little's Law must be defined. As an example assume there is a requirement for a production machine to produce 64 aircraft per year with a limited WIP of only 23 aircraft. The production output requirement of 64 aircraft per year is defined by the customer. The WIP target is defined by:

- a) The customer (such as the Aircraft Availability requirement)
- b) An internal goal to reduce cost and create capacity
- c) An actual physical capacity constraint.

The takt time is calculated by dividing days available by the required output in that available time (365 days / 64 units = 5.7 day takt time). Every 5.7 days this machine must output an aircraft. Flowtime then equals WIP x takt time (23 units in WIP x 5.7 day takt = 131 days of flowtime). This production machine must perform at a flowtime of 131 days to output 64 aircraft per year while maintaining a total WIP of only 23 aircraft.

With long flowtime machines, it is critical to break the process into smaller sections or Gates. This provides increased transparency into the performance of the machine, enables more timely constraint identification-elevation-resolution, creates ability to pin-point under-performing gates, and ensures optimum performance of the overall machine. The application of Little's Law is just as critical to the design of these individual Gates as it is to the overall production machine design. Figure 4.2 depicts an example of a production machine broken out into Gates.

Available Time (Days)	Required Output	Takt (Days)	Gate 1 (Pre-Dock)	Gate 2 (Inspect Dock)	Gate 3 (Structures)	Gate 4 (System Ops)	Gate 5 (Post Doc)	TOTALS	
365	64	5.7	2	3	10	3	5	23	WIP
	Req'd Flowtime (Days):		11	17	57	17	29	131	Cal Days

Figure 4.2: Gated Production Machine Example

In this example, the overall flowtime is broken down into five separate Gates. Defining the WIP in each gate is an iterative process that will depend on the physical constraints of the system and/or the amount of work to be accomplished within each Gate. Keep in mind that the Gate flowtime for a future state machine may seem unattainable relative to current performance, but it is critical to properly pro-rate the required overall WIP across the entire machine. The defined WIP within the Gates determines the required flowtime performance for that Gate. As noted above, defining a WIP of 2 in the "Pre-Dock" Gate leads to a required flowtime performance of 11.4 days (Flowtime=WIP x Takt or 2 x 5.7=11.4). Remember, Gate WIPs are designed not to exceed the total WIP threshold of 23 aircraft in this example.

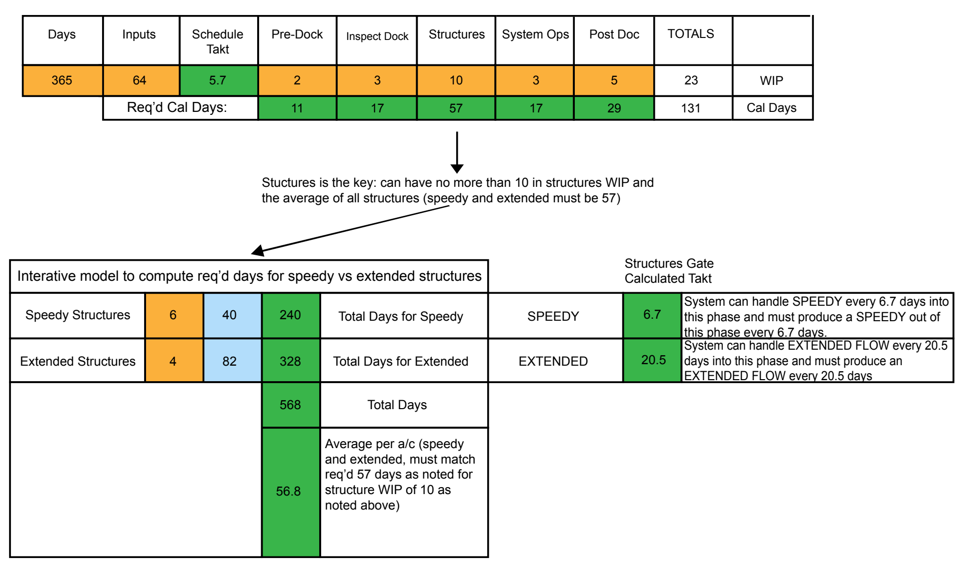


Figure 4.3: Structures Variable Gate Design Example (click to zoom)

Variable Gate Design

Gate designs can become complicated to calculate due to variability. In one sense, variability is expected in depot maintenance – and that variability can be managed within the calculated gate flows. However, there are times the variation is so extreme it necessitates the need to create separate gates to account for and manage the variation. Consider an example of variation in the Structures Gate of the previously calculated production machine to provide insight into this process depicted in Figure 4.3.

In the Figure 4.3 example, the calculation for the Structures Gate was 57 days. At the completion of the Inspection Gate a judgment can be made regarding the concurrency of repair requirements that will occur in the Structures Gate.

The availability of concurrent work opportunities is an important concept for creating Speed. Concurrent work is work that can be accomplished simultaneously within a gate - effectively decreasing flowtime by placing multiple resources to work at the same time. Conversely, sequential work must wait for the task before it to complete prior to starting a new task. This limits the amount of resources that can be applied at one time within each gate. Although there will be some level of sequential tasks within a gate, a larger combination of non-current tasks will serve to increase flowtime.

In this example, repair requirements with little concurrency are classified as Extended Structures and all others are classified as Speedy Structures. The average of the combined gates – Extended and Speedy – must be 57 days or less to keep pace with the machine.

The first step to creating separate gates for Speedy and Extended Structures is to determine the expected occurrence for each scenario. The example projects a 60/40 split between the two scenarios – 60% Speedy and 40% Extended. This occurrence percentage is multiplied by the WIP for the primary gate to determine the WIP for each sub-gate. In this example, Speedy Structures has a WIP of 6 while Extended Structures has a WIP of 4.

The next step is to determine the required days for each sub-gate. As was the case with defining Gate WIP, this too is an iterative process to balance the available days within the primary gate. The WIP for each sub-gate is multiplied by the required days for the sub-gate. The sum of multiplied days for all the sub-gates is divided by the total WIP for the primary gate – with the product not exceeding the total days available for the primary gate. If the product does exceed the primary flow days available, the required days within the sub-gates will need to be adjusted. The sub-gates then replace the primary gate within the Gate Monitoring tools (discussed later in this chapter).

This is an example of how to monitor a gate with enough variable combinations that the primary gate must be divided into sub-gates in order to sufficiently monitor machine throughput. In this example, there are not simply two concrete variables, but rather business rules to guide the choice of selecting one sub-gate over the other given the nature and combination of the variables found during inspection. The over-arching business rule, in this case, is the opportunity for concurrent work. Lack of concurrent repair opportunities is the primary driver in choosing the Extended Structures over the Speedy Structures gate.

This example provided the steps for designing a variable gate with only two choices, but the technique can be extended to include multiple sub-gates if required to monitor throughput within one overarching production machine. Figure 4.4 presents an example of the construct of a production machine with variation based on the installation of different modification package combinations. In this example, the variation of the modification combination is known and in the plan prior to induction. The total number of assets to be inducted is 365 with a takt time of an induction every day. Further assume sequential gates of: Incoming, Mod Work, Flight Test, Paint, RAM and Delivery. The variability in this example is within the Mod Work gate.

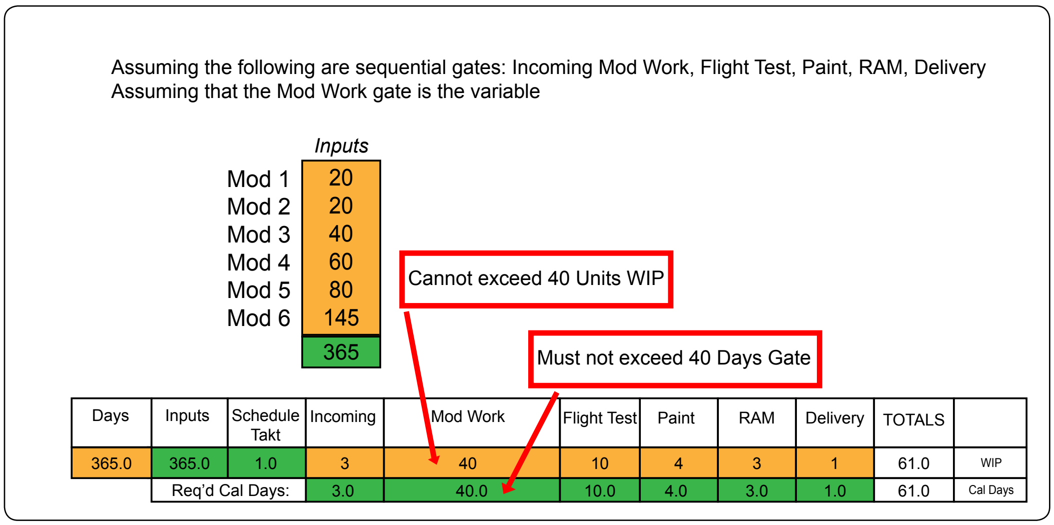


Figure 4.4: Single Production Machine with varying install configurations. (click to zoom)

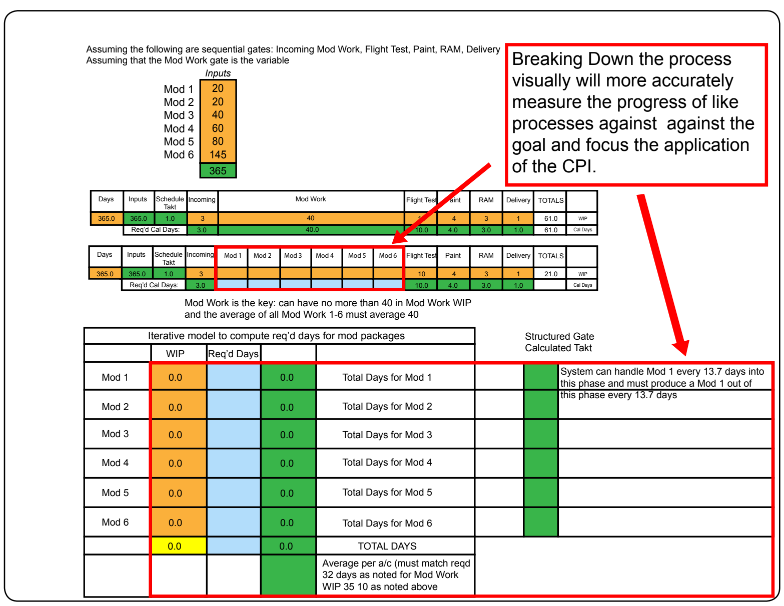


Figure 4.5: As the primary driver for variability, the Mod Work Gate is broken into multiple sub-gates. (click to zoom)

In this example, the variable Mod Work Gate is the key and can have no more than 40 units in work (WIP) and the average flowtime of all modification configurations (1-6) must not exceed the 40 days allocated to the Mod Work Gate (Gate WIP x Schedule Takt). Figure 4.5 depicts the construct for breaking the variable gate into multiple sub-gates to deal with the incoming installation variability.

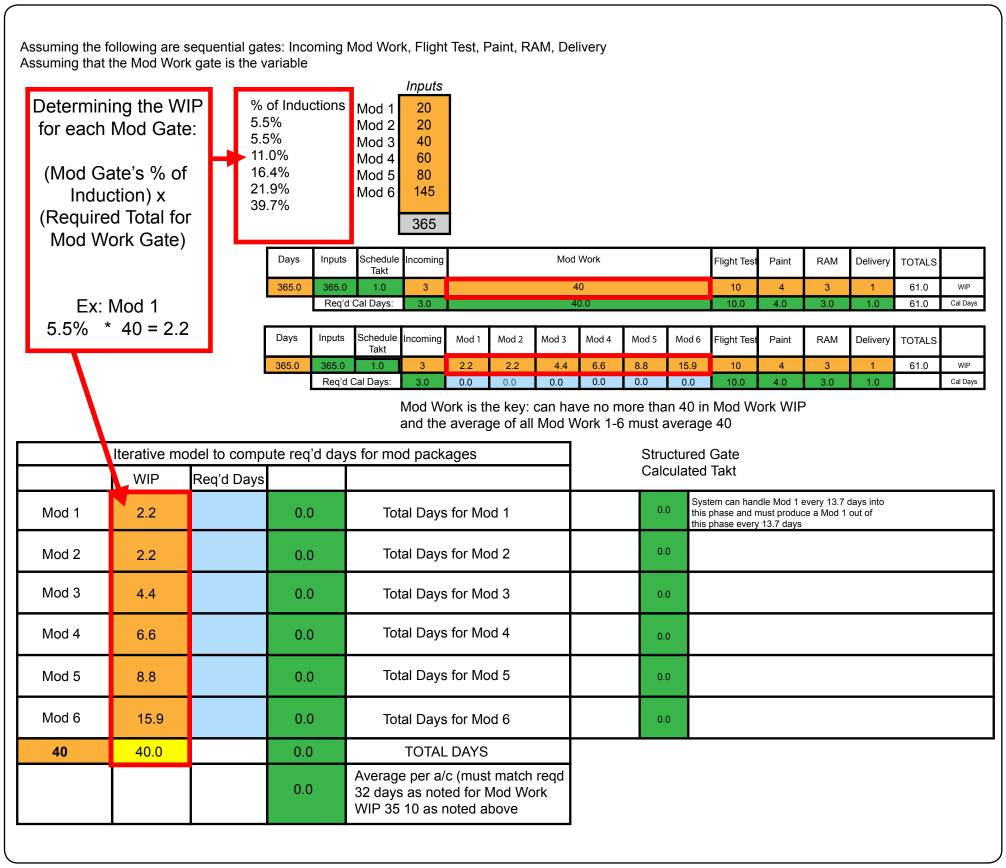


Figure 4.6: Percentage of incoming configuration translates to the amount of WIP in each sub-gate. (click to zoom)

As previously mentioned, the construct of the modification combinations is known prior to induction, thus the contributing percentage of each modification configuration to the whole induction plan can be calculated. This percentage calculation helps determine the required WIP for each modification sub-gate (percentage of whole x modification gate WIP) as depicted in Figure 4.6.

The next step is to determine the required flow days within each modification sub-gate. As in the previous gate variation example, this determination is an iterative process to balance the days available in the primary modification work gate. The WIP for each mod sub-gate is multiplied by the required days for the mod sub-gate. The sum of multiplied days for all the sub-gates (Mod 1) is divided by the total WIP for the primary gate (Mod Work) – with the product not exceeding the total days available for the primary gate. If the product does exceed the primary flow days available, the required days within the sub-gates will need to be adjusted. The sub-gates then replace the primary gate within the Gate Monitoring tools (discussed later in this chapter).

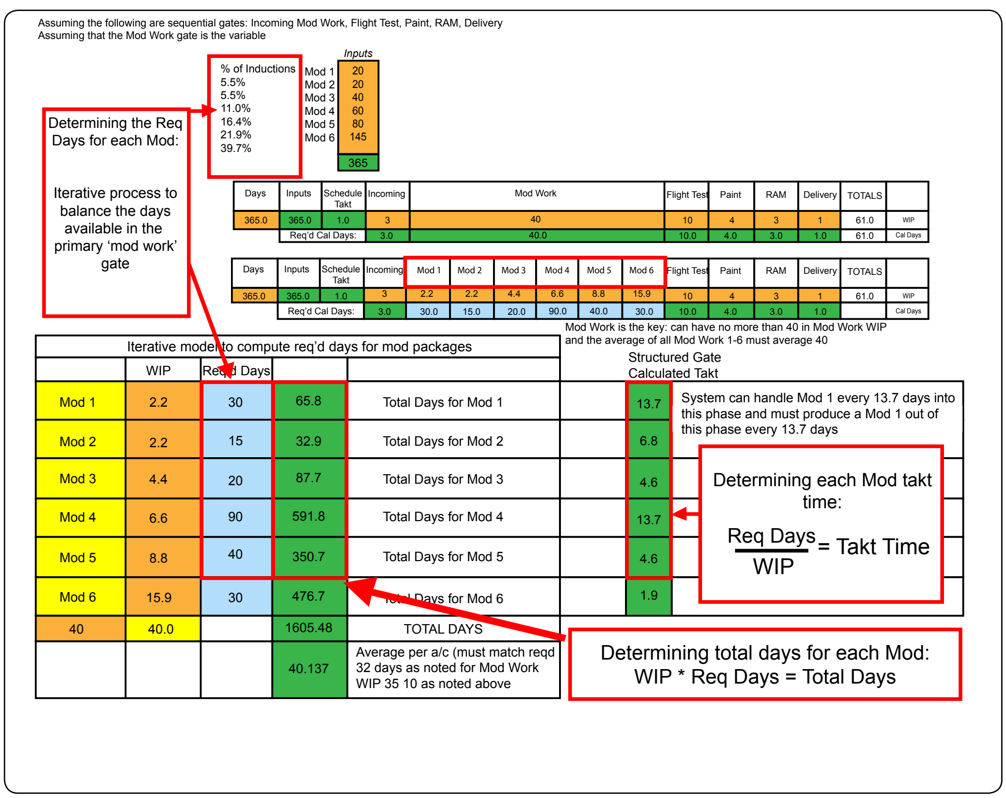


Figure 4.7: Calculate Takt time for each sub-gate. (click to zoom)

The takt-time requirement into and out of each mod sub-gate can be calculated by dividing the Mod sub-gate Required Days by the Mod Sub-gate WIP. In this example, the production machine can handle inducting a Mod Sub-gate 1 every 13.7 days into the Mod Work Gate and must produce a Mod Sub Gate 1 from the Mod Work Gate every 13.7 days as depicted in Figure 4.7.

This final example in Figure 4.8 calculates the Total Flowday requirement for each modification configuration given the variable calculation for the mod work gate and shows the machine is balanced at an average of 61 flowdays given this rate of variable performance as required in the overall production machine structure.

Assuming the following are sequential gates: Incoming Mod Work, Flight Test, Paint, RAM, Delivery
Assuming that the Mod Work gate is the variable

% of Inductions		Inputs	Pre	Mod	Post	Req'd Flowdays	Total Flowdays		
5.5%	Mod 1	20	3.0	30.0	18.0	51.0	1020		
5.5%	Mod 2	20	3.0	15.0	18.0	36.0	720		
11.0%	Mod 3	40	3.0	20.0	18.0	41.0	1640		
16.4%	Mod 4	60	3.0	90.0	18.0	111.0	6660		
21.9%	Mod 5	80	3.0	40.0	18.0	61.0	4880		
39.7%	Mod 6	145	3.0	30.0	18.0	51.0	7395		
		365					22315	365	61.1

This is a good way to check to make sure the machine is calibrated correctly
22315 / 365 = 61.1 avg FDs

Days	Inputs	Schedule Takt	Incoming	Mod Work	Flight Test	Paint	RAM	Delivery	TOTALS	
365.0	365.0	1.0	3	40	10	4	3	1	61.0	WIP
	Req'd Cal Days:		3.0	40.0	10.0	4.0	3.0	1.0	61.0	Avg Cal Days

Days	Inputs	Schedule Takt	Incoming	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Mod 6	Flight Test	Paint	RAM	Delivery	TOTALS	
365.0	365.0	1.0	3	2.2	2.2	4.4	6.6	8.8	15.9	10	4	3	1	61.0	WIP
	Req'd Cal Days:		3.0	30.0	15.0	20.0	90.0	40.0	30.0	10.0	4.0	3.0	1.0		

Mod Work is the key: can have no more than 40 in Mod Work WIP
and the average of all Mod Work 1-6 must average 40

Iterative model to compute req'd days for mod packages						Structured Gate Calculated Takt	
	WIP	Req'd Days					
Mod 1	2.2	30	65.8	Total Days for Mod 1		13.7	System can handle Mod 1 every 13.7 days into this phase and must produce a Mod 1 out of this phase every 13.7 days
Mod 2	2.2	15	32.9	Total Days for Mod 2		6.8	
Mod 3	4.4	20	87.7	Total Days for Mod 3		4.6	
Mod 4	6.6	90	591.8	Total Days for Mod 4		13.7	
Mod 5	8.8	40	350.7	Total Days for Mod 5		4.6	
Mod 6	15.9	30	476.7	Total Days for Mod 6		1.9	
Mod WIP 40	40.0		1605.48	TOTAL DAYS			
			40.137	Average per a/c (must match reqd 32 days as noted for Mod Work WIP 35 10 as noted above			

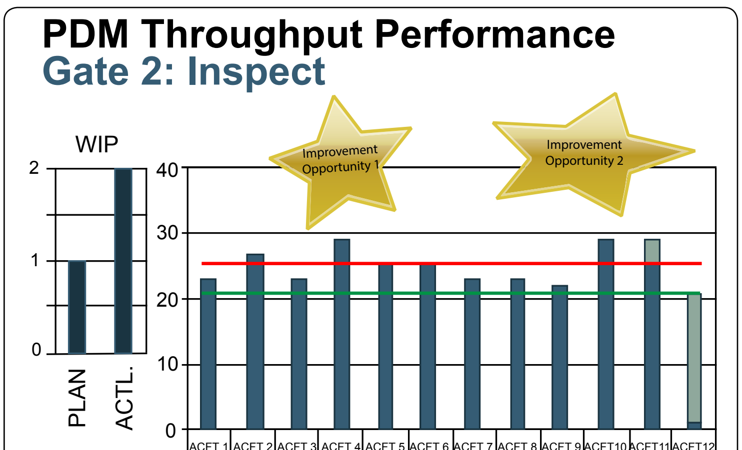
Figure 4.8: Final "Balanced" Variable Configuration Production Machine.

This example provided methodology for calculating a production machine with variable install configurations in order to monitor throughput performance within the confines of one production machine. An earlier example provided methodology for calculating a production machine when the variation was determined during execution of the production machine. These examples are meant to provide insights to methodologies for calculating machines with extreme variations. Situations may exist where numerous configurations create such variability that the variable gate construct leads to an extremely complex production machine. In this case, it may become necessary to create a separate production machine for each known variable.

Gated Monitoring System

Following the mathematical design of a Gated Production Machine, performance must be closely monitored within each Gate. Key aspects of the monitoring system include the performance trends of the aircraft through the gate as well as control of the active WIP within the gate. Monitoring this data allows leadership to ensure there are the proper resources available, preventing task saturation and subsequently a loss of material prioritization. Additionally, this method also allows for the identification of constraints in each gate driving focus to CPI measures.

As depicted in Figure 4.9, the monitoring system consists of a bar graph depicting the performance of the last 10 aircraft that have completed the gate as well as any aircraft that are currently in work for the gate. For aircraft currently in work, a distinction is made between remaining days and actual (completed) days in order to determine the projection for each in work aircraft to complete the gate. The gate monitoring chart also includes a green trend line depicting the required performance for the gate as well as a red Last X Average trend line depicting the actual performance trend based on the performance of each aircraft. Also on the chart is an inset graph depicting the planned and actual active WIP for the gate. The Last X Average is the number of units that would flow through the machine within a two month time frame as two months provides enough time to realize gains from process improvement activities. In this example the representative number is 6.



	ACFT 1	ACFT 2	ACFT 3	ACFT 4	ACFT 5	ACFT 6	ACFT 7	ACFT 8	ACFT 9	ACFT10	ACFT11	ACFT12
Remaining Days											3	20
Actual Days	24	27	24	24	29	26	26	24	23	29	26	1
Total Days	24	27	24	24	29	26	26	24	23	29	29	21
Last 6 Avg.	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2
Requirement	21	21	21	21	21	21	21	21	21	21	21	21
FY 13 QTR #1											3	4

Figure 4.9: Measuring a Production Machine Gate (click to zoom)

As previously mentioned, key aspects of the monitoring system include the performance trends of the aircraft through the gate as well as control of the active WIP within the gate. When reviewing the gate monitoring chart, focus on the location of the red 'last x average' trend line in relation to the green 'requirement' trend line: Is the trend increasing or decreasing flow days? How far apart are the red and green trends? Does the Continuous Process Improvement (CPI) activity identified as starbursts represent enough gains to offset the difference in the red and green trend lines? Also review the planned versus actual WIP in order to determine if the active WIP for the gate is being controlled.

When monitoring the flowtime through a Gate, it is important to drive CPI to the processes in the Gate as opposed to focusing on the individual unit that is flowing through the Gate. In the Figure 4.9 example it is easy to see the trends in the Gate flowtime performance and the CPI initiatives (starbursts) inteded to reduce flowtime. For this example, the Gate 2 WIP and flowtime requirements are 1 aircraft and 21 days.

If a Gate is not performing at its required flowtime, CPI must focus on waste removal, concurrency opportunities, and constraint resolution. Despite these efforts, it may be necessary to queue aircraft prior to the constrained Gate. Work is not performed on an aircraft that is in queue. Queued aircraft are sitting idle while waiting to enter the next gate making queue time non value-added and non-desirable. Queue must be monitored via a queue Gate similar to the Gate 2: Inspect chart shown above, clearly monitoring queue time associated with each aircraft with a requirement to get to zero. Queue, however, can be used as a tool to control active WIP within a gate making queue a critical part of ensuring that subsequent Gate resources (direct labor employees, engineering, tooling, support equipment, parts, etc.) are not overwhelmed and spread too thin causing increased flowtime within the production machine.

To explore the negative impact of spreading resources too thin – also known as multi-tasking – consider the visual representation in Figure 4.10.

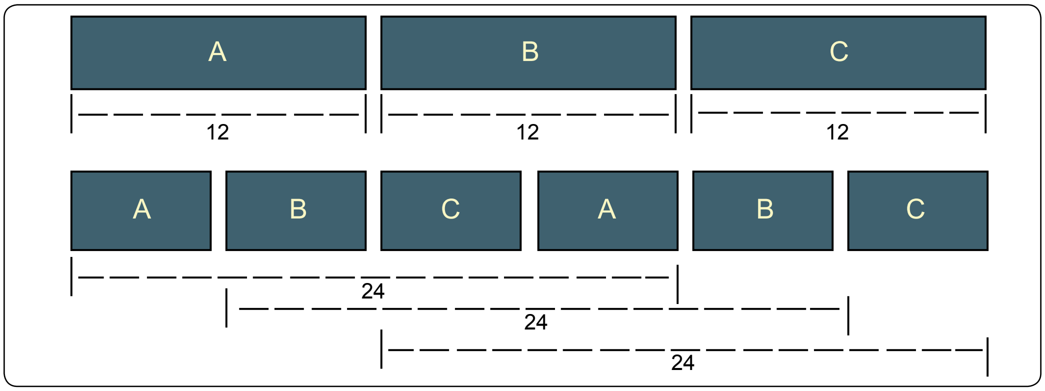


Figure 4.10: Negative effects of multi-tasking.

This diagram depicts a shop with three projects – A, B and C – each with a 12 day lead time – from induction to completion. Unfortunately, many shops are under pressure and feel the need to make progress on all projects – rather than working each project sequentially. Therefore, instead of working each project from start to finish A, B, then C – and finishing each project within 12 days of induction, the shop chooses to work 6 days on each project so they can report progress and make each customer happy that their project is in work.
The result of this decision is depicted in the second diagram – A, B, C, A, B, C – and results in each project taking 24 days from induction. Yes, that's double the original lead time! Furthermore, the sequential scheduling method had project A delivering on day 12, B on day 24 and C on day 36. The multi-tasking method has project A delivering on day 24, B on day 30 and C on day 36. In this case, the shop met the expectations of one customer while completely disappointing the other two! (Goldratt, 1997, p. 125 - 127).

Bottom line: the price of multi-tasking is extended flowtimes. Since excess WIP creates multi-tasking, utilizing queue to control active WIP within a gate keeps the gate from spreading resources just to show "coverage" and serves to increase the throughput through the gate.

Figure 4.11 displays individual Gate performance relative to the machine requirement for all Gates in a production machine. It also shows where the machine is queuing aircraft due to constrained Gates.

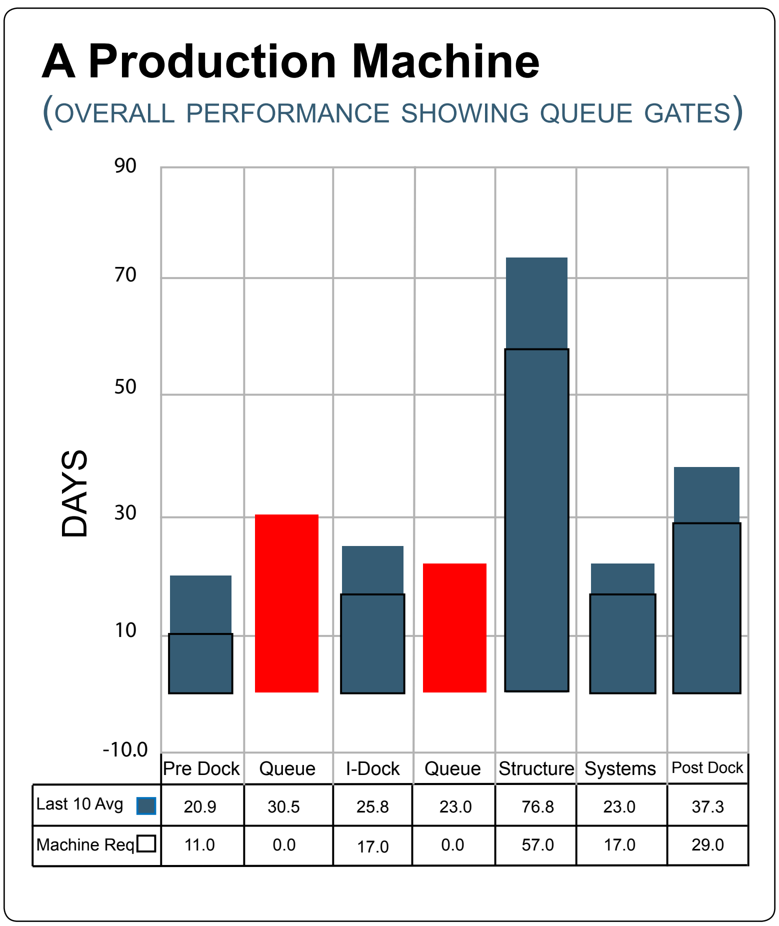


Figure 4.11: Production Machine Gate Performance Summary

Gate Insights

Thus far, this chapter has focused on explaining the *math* and *science* behind designing a gated monitoring system that properly represents the flow of product through the machine. However, there are factors of the gate design that could be considered more of an art form. Those factors can be described as insights that focus on how to determine the construct of the gates in terms of the actual work content as well as the number of gates.

The primary purpose of the gate is to provide succinct data to pin-point under-performing processes and apply CPI techniques in order to improve machine performance. As such, it is imperative gates are constructed to allow this type of visibility. Key factors to consider in the gate construct include work content, concrete (rather than abstract) boundaries, length and total number of gates. These factors work together to construct gates that provide repeatable comparisons.

The length of a gate is an important consideration when constructing the production machine to guard against constructing gates that are too short or too long. Gates should be long enough as to represent a significant portion of the process and can encompass several hand-offs between skill sets in order to make the gate a meaningful length. Similar work scope and content, is a key determinant when constructing gates. For example, all prep work completed before a product enters the primary repair location could be grouped together, even if there are hand-offs within the gate, in order to make the gate a significant representation of the production machine. Gates need to represent the processes of the machine, but do not need to represent every process within the machine. It is also important to ensure the gates are not so long that it becomes difficult to monitor the progress or determine failure points within the gate. The ability (or inability) to consolidate gates based on work scope and content, the production machine critical path and actual product physical constraints work together to determine the number of gates required within a machine.

Gates should be designed with concrete boundaries – ending triggers that need to physically occur in order to complete the gate. Abstract boundaries make consistent application of transition decisions difficult. It is additionally helpful if the concrete boundary is part of the machine critical path. This will drive the behavior of not transitioning the gate without the concrete, critical path boundary requirement being met. For example, transition from a Repair Gate to a Build-Up Gate should not occur unless the actual critical path build-up activity can occur. Good transition habits are dependent upon how well the Repair Gate boundary is clearly defined to trigger the transition.

Clearly defined work content and concrete boundaries also help management better visualize and define "traveling work." Traveling work is work that should have been completed in a prior gate, but is allowed to "travel" to a subsequent gate. Traveling work has the ability to degrade the integrity of the gated production machine process. Too much traveling work puts undo pressure on the subsequent gate and can be the primary cause of not completing the gate on time.

Management review processes must be established to control the transition of units from one gate to the next and must ensure the unit is truly ready to transition. Transitioning a gate with traveling work that impacts the critical path of the subsequent gate should not be allowed. Instead management should utilize the situation to call attention to the constraint that is keeping the critical path work from being completed and create an urgent call to action for the enterprise through the use of urgency tools.

Similar work scope and content is also a helpful determinant when setting up variable gates. When units have variable configurations, look for similar work scope and content in order to group gates that may not be exact. Remember, the gate is monitored based on the average and the trend for the gate, therefore similar work requiring similar flowtime could be grouped into one gate. Pinpointing improvement opportunities would be a result of a review of the individual unit performance to determine initiatives.

The AFSC Leadership Model emphasizes a focus on "Speed, Quality, Safety and Cost Effectiveness" in operations. A properly designed production machine (IAW Little's Law) provides the structure and discipline to drive an organization to attain Art of the Possible goals. Focusing on Speed enables the ability to reach throughput goals. Quality is the organization's reputation as assessed by the customer and Safety preserves the workforce that enables the other three priorities. Finally, as in every organization, Cost-Effectiveness is paramount but, to the AFSC it holds a critical role for the defense of our nation. Lieutenant General Litchfield put it best when he stated that, "It is the cost of sustainment that will determine our nation's fighting force during the next conflict" (2013). Staying disciplined to the production machine with respect to WIP also ensures active WIP control and prevents overwhelming the system with too many units in work -- stretching resources too thin, multi-tasking beyond the capability of the machine, and reducing the speed of the entire system.

4.2. Administrative Application Examples

The gated monitoring system provides an intuitive means of measuring production execution, but has applications beyond the production environment as well. Following are examples of how the basic principles from this process were adapted to monitor the seemingly chaotic processes for service contracts and scheduling shop installation projects. In both cases, the application of the gated monitoring philosophy created succinct, repeatable processes that allowed management the visibility to monitor the process and intervene as necessary to keep the contracts and projects on track. More importantly, the gated processes allowed management to clearly and confidently communicate expectations to their customers as to when service contracts would be passed to Contracting and when installation projects would be executed. This new ability was in stark contrast to the customer's perception of the "black hole" situation that existed prior to the gated process.

Service Contracts

To say that "chaos reigned supreme" would be considered an understatement with regard to the management of passing production related service contracts from the maintenance customer to the contracting specialist prior to implementation of the gated monitoring system. This staff office managed approximately 100 service contracts of which 32 were either late or expired. It was taking an average of 250 days to pass a service contract requirement from the customer to the contracting specialist. This process was negatively impacting production and needed a make-over.

The first step was to determine the length of time passing the requirement *should* take – essentially establishing a "Road to…" goal for the process. This goal was determined to be 65 days – significantly less than the "before" average of 250 days! The next step was to understand the process, to include its critical path, in order to determine how to monitor the progress of the service contracts. The process had 20 natural break points, but monitoring with 20 separate gates proved to be difficult. Therefore, the process was categorized into seven gates, which allowed the employees, leads and management to easily track the progress of a service contract and communicate that progress with their customer.

Implementation of the gated process also created data-driven visibility as to where the team should focus their process improvement efforts. As a result of these improvement efforts, the current average cycle time for passing a requirement from the maintenance customer to the contracting specialist is now 112 days. A significant improvement over the chaos of 250 days! The gated process also led the staff office to start collecting data with regard to customer requirement creation time and contracting processing time to allow a data-driven approach to continuous improvement of the entire process.

Shop Installation Projects Scheduling

Each installation project is unique and varies greatly in scope of both engineering and installation effort. Due to this inherent variability, scheduling shop installation projects were once seen as a cumbersome process where communicating a true project status – let alone an actual installation projection – was thought to be impossible. In this case, a succinct process was complemented with succinct business rules that now has turned the scheduling process into a stable system that allows reliable communication of expectations to customers.

Prior to implementation of the gated process, all installation projects were entered into the "system" based on the priority from the owning customers. This priority could change at each monthly meeting, adding even more variability to the process. Eighty plus project statuses were available to communicate the status of the projects – resulting in non-standard application. Additionally, there was a lack of perceived urgency as there was a huge queue of projects awaiting material.

The new "gated" scheduling process first requires each customer to communicate their priorities – and then stick with them. Prior to inducting a project into the scheduling system, engineering categorizes the project into one of four buckets based on the project's scope. Projects are released to be worked through the engineering, planning and scheduling process based on the WIP at the Installation gate of the process. The new gates for the process now become the status that is communicated to the customer. These gates, along with the target cycle times, have resulted in better communication of the project status and more reliable execution of the projects in general.

As with any gated process, management now has the ability to determine the location of bottlenecks and constraints and can apply process improvement techniques to improve the flow of projects through the gated monitoring system. This new found visibility has allowed management to focus on creating standard processes (discussed more in Chapter 5) that help to minimize the variability caused by unique projects. Standard processes, reliable scheduling, and a management monitoring system not only leads to happier customers, but also contributes to cost effective solutions.

4.3. Part II: The Application of Theory of Constraints and Drum-Buffer-Rope

For production systems with a high volume of throughput (tens of thousands of units per year) and a lot of variation (different applicable processes, induction mix variations, etc.), the application of DBR is more appropriate than a gated monitoring system as discussed in Part I of this paper. A discussion of TOC (next) is necessary prior to introducing DBR.

Theory of Constraints

The premise of TOC is that production systems act much like a chain that is only as strong as their weakest link. The weakest link in a production operation is described as the constraint, which prevents the output of the entire system from meeting the desired performance. The constraint is usually identified as the process or shop that has the most WIP queued upstream (work in queue, WIQ) or the most heavily loaded process or shop in the system. The utilization of TOC requires all CPI to be focused on the constraint. CPI efforts that do not attack the constraint will not improve the overall system performance and could actually make the entire system perform less effectively. The five basic and sequential steps for proper application of TOC are described below (Goldratt, 1997):

Identify the Constraint:

As mentioned earlier, the constraint is usually identified as the most heavily loaded resource or the process with the largest queue of WIP in front of it.

Exploit the Constraint

Usually this involves obtaining the immediate maximum potential out of the constraint without significant investment. As an example, if a 5 axis machine tool was the limit to the system output, exploiting the constraint would be to operate the machine during lunch breaks, second or third shifts, weekends, etc. Buying a second machine tool is not a way to exploit the constraint (see Expand the Constraint below).

Subordinate Everything to the Constraint

It makes no sense to allow non-constrained operations to operate above the level of the constraint because operations upstream of the constraint will simply increase additional work in queue (WIQ) in front of the constraint and downstream operations will run out of work. All operations must match the pace of the exploited constraint until the constraint is expanded.

Expand the Constraint

Expansion of the constraint is elevating the output of the limiting process or shop until overall system performance can be met or until another process or shop becomes the limit to the system. This might include the purchase of additional equipment, addition/realignment of personnel, or preferably an increase in output through waste removal or other CPI activity.

Repeat the Process (steps 1-4)

If a constraint still exists, these steps must be repeated until all constraints are removed. It should be noted that if the desired performance of the system is attained, no limiting constraint requires attention – however, different processes or shops may have different capacities (i.e. the system may not be balanced).

Drum Buffer Rope

DBR is the planning and scheduling methodology for the application of TOC. The definitions of each component follow (Focus 5 Systems Ltd., 1997). 'Drum' is the set schedule based upon the constraint's output capacity. 'Buffer' is a protection against variability and is used to protect the

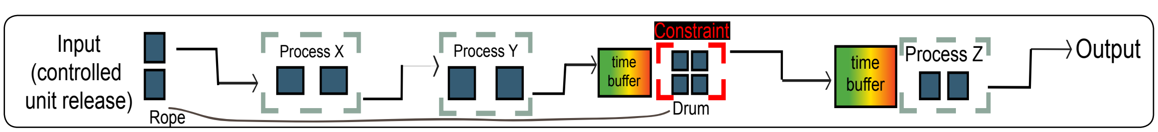


Figure 4.12: DBR demonstrated in a simple production system.

performance of the schedule or drum. In DBR, a time buffer is chosen as opposed to a material or WIP buffer. The 'Rope' is used to subordinate all other processes to the constraint. In essence, the rope synchronizes the schedule of all resources to the drum or limiting constraint (TOC Step 3: Subordinate Everything to the Constraint). Each individual process or shop can utilize Little's Law to determine the appropriate Flowtime, WIP, and Takt relationships, but the overall production machine is synchronized via the DBR system as shown in Figure 4.12.

In order to execute DBR it is important to begin with a commitment to an overall system performance (delivery date of the product). Once this date is established a right to left schedule is established for the drum to execute to the delivery schedule. All the processes that occur downstream of the drum are then scheduled so the delivery date is met. A similar process is applied when scheduling work upstream of the drum to ensure material arrives to the constraint on time. Time buffers and inventory buffers are utilized at critical locations throughout the system to protect the overall delivery of the schedule against variations due to rework, peak demands, unscheduled production interruptions, etc.

An example of a time buffer is the scheduling of a product from the constraint to the delivery point for 25 days even though the product delivery is not expected for 30 days after passing through the constraint. Depending on the existing process variation, the additional 5 days could provide near 100% on time delivery and can essentially remove delivery uncertainty. A similar time buffer, or inventory buffer depending on the process, is often applied upstream of the constraint to ensure the original schedule is protected and the drum (the constraint) never shuts down due to upstream variability (TOC Step 2: Exploit the Constraint).

Application to Exchangeable Workload in AFSC

The Exchangeable workload in the AFSC is a high volume production system with numerous sources of variability. Variability exists due to changing demands, material supportability fluctuations, product mix changes, and EXPRESS drive limitations (capacity, carcasses, funding, parts). Normal

Back Shop Environment

output variation will also exist due to unscheduled equipment or facility failures, single point failures, unplanned rework, etc. Additionally, most Exchangeable backshop production processes require numerous routes to different process monuments creating competing priorities. As discussed earlier competing priorities often create multi-tasking and a lack of focus.

The variability and competing priorities create a very complex production environment that is conducive to individual and independent shop performance metrics that seldom or never drive to optimum overall system performance. Individual shop metrics drive shop performance to aggregate production output numbers regardless of the upstream or downstream priorities or constraints. The end result is a disjointed attempt to manage priorities by which customer screams the loudest. This practice causes excessive overtime, ever changing priorities, batch processing and overall production inefficiencies. DBR provides the solution to all of these challenges.

Even in complex production environments, there is typically only one process (or very few processes) that actually limit the performance of the entire production system. It becomes paramount to focus CPI efforts on the single process (or limited number of processes) to optimize overall system performance…based on the Drum. Time buffers are established and monitored to protect the schedule and when the buffer starts to be consumed it can be mitigated through the open capacity (non-constrained) operations. The utilization of DBR essentially facilitates a steady predictable production output that is independent of the input or production variability common to Exchangeable production.

How do you know if DBR is working? One of the primary metrics used for determining the successful application of DBR for exchangeable production is the amount of Inventory Turns obtained by the production machine. Inventory Turn by definition is the number of times the inventory is turned over each year. Annual Inventory Turn = Annual Throughput / Average WIP. Annual throughput is expressed in units produced per year. Average WIP is the average number of items in work throughout the production machine. An example of an Inventory Turn metric is shown in Figure 4.13.

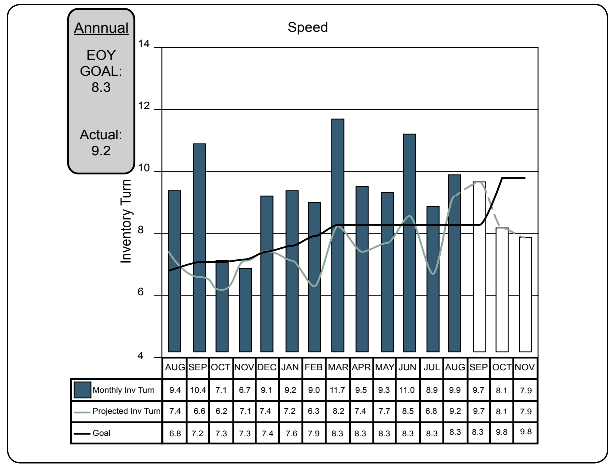


Figure 4.13: Inventory turn Metric Example (click to zoom)

An example of an Inventory Turn calculation follows: in a single fiscal year, a production machine has produced 10,000 components with an average WIP of 1,750 units. The Inventory Turn = 10,000 units per year / 1,750 units per turn or 5.7 turns per year.

Another example based on a single month of data follows: During the month of August, a production machine produced 2,500 assets with an average WIP of 2,200 units. The Inventory Turn = (12 months per year x 2,500 units per month) / 2,200 units per turn or 13.6 turns per year. In a real world application, it is best to use a rolling average that will take into account seasonal variations and eliminate the impact of zero production days that could exist at the beginning of each month, quarter or fiscal year.

It should be noted that the average flowtime is equal to 365 days per year / Inventory Turns per year or in the last example, 365/13.6 = 35 days on average. So, as DBR is executed successfully…..the production machine will achieve higher Inventory Turns, producing more assets with a given amount of WIP. At the same time the production machine becomes more responsive to its customers with reduced flowtimes….increased Speed!

4.4. The Laundry Example

Sometimes it can be beneficial to relate new concepts to everyday practical examples. Furthermore, examining indicators of a problem, then utilizing the concepts to identify what can be done to fix the problem; can help bring a stronger understanding of its principals.

One of the most simple and practical examples of TOC is laundry in a home setting. The laundry workflow consists of two (2) pieces of equipment: the washer and the dryer. The laundry process is often exacerbated by "stock outs" in the form of the lack of clean clothes on shelves and in closets. These stock outs often lead to reactionary fire-fighting in the form of completing a specific load of laundry to resolve the current stock out situation (rushing through a load of clothes containing specifically what is desired to be worn at the time). Everyone is happy for the moment – at least until the next stock out.

In this laundry example, individuals need a way to 1) prevent stock outs from occurring; and 2) respond when a stock out is eminent in order to take measures to prevent the stock out from occurring. The first step is to examine and understand the process. In this case, dirty laundry is collected into a pile. Items from the pile are placed into the washer and then the dryer. Once the laundry completes the dryer step it is ready to be stocked on the shelves and in the closets.

Especially in times of stock outs, one problem that may be apparent in the laundry process is the pile of dirty laundry in front of the washer. This pile of laundry represents work in progress (WIP) in the process - the larger the pile of dirty laundry, the more likely a stock out. Finding a way to minimize WIP would make the process less likely to experience a stock out and; consequently, enter the firefighting mode.

In keeping with the five focusing steps discussed previously in the TOC section, the next step in the laundry example is to identify the constraint in the process. In this case, it takes longer to dry the clothes than it does to wash the clothes; thereby making the dryer the constraint. In order to create the necessary flow through the process it is necessary to exploit the constraint. In this case, exploiting the dryer constraint meant establishing process discipline to ensure the dryer operates any time the WIP exceeds a certain level.

In order to subordinate the process to the constraint, it is necessary to operate the washer only to the extent it allows the dryer to keep drying. Washing loads of clothes and piling clean, but wet, laundry in front of the dryer will result in clothes that are mildewed and in need of washing again (rework). In this case, the process discipline instilled under the step of exploiting the constraint should preclude the necessity of expanding the constraint by purchasing a larger or faster dryer. However, if the process continues to experience stock outs that cannot be resolved with process discipline, then purchasing a new dryer, or more clothes, may be necessary to preclude stock outs!

The laundry example may seem too simple to apply to the complex environment of the aerospace industry. However, let's consider a shop environment example with problems similar to those discovered in the laundry example above.

In the shop example, there are two processes: the overhaul process and the test process. Like the washing machine in the laundry example, the overhaul process can generally out-produce the test (dryer) process. Not surprisingly, there was generally excess WIP in front of the test stands, but amazingly there were also test stands without WIP and not running.

Interestingly enough, in this shop, the normal mode of business was for the overhaul process to produce as fast as they could and point to test as the reason assets were not getting out the door. The overhaul process would continue to overhaul at a higher rater for a variety of reasons to include: an earned hours target; an efficiency target; to stay busy; and to ensure the incoming WIP was not in their process so it was not their fault the assets were not produced.

The explanation for the empty test stands for assets with existing orders was that there were more orders with higher priorities for the assets in front of the busy test stands; therefore, those orders were overhauled first before switching to the smaller, lesser priority orders. The overhaul process was merely processing what was most important based on incoming signals. This resulted in overhaul "pushing" orders to test, rather than test pulling from overhaul based on their limited capacity.

With its full push system, this shop had generated an environment in which everyone looked at their own process to find local efficiencies without considering the entire system and a drive toward global effectiveness. Decisions were continuously made in the overhaul process that failed to optimize the entire shop, but they thought they were doing the right thing.

In order to rectify the situation and create a teaming shop environment that pulled work from overhaul to test based on test capacity, leadership chose to ask questions in an order intended to take those in the process through a learning journey toward improvement. Utilizing questions to enable the process of understanding what is happening and why, served to create thinkers and make the journey continuous as opposed to directing the actions resulting in a one-time improvement.

Some of the questions asked (in the order asked) follow:

1. Why do we overhaul more assets than the test stand can test?

2. If the WIP is high, and there are lots of high priority backorders, why wouldn't we expand test capacity rather than overhaul?

3. What would happen if we expanded test capacity to test more assets? Would the WIP go down?

4. What if the overhaul process did not build more assets than test could produce?

5. What if we decided to put a buffer shelf at the end of the overhaul process for assets that were ready for test? What would it signal to test when those assets were picked up to take to test? What would it signal to overhaul?

6. Why would we overhaul more assets that one test stand could consume even at the expense of not overhauling anything for another, even though there are orders?

7. When test expands and produces more, will overhaul have to produce more?

8. If test decided to expand test and produce more, how will overhaul know to produce more?

9. How would you visually communicate the increased demand to the overhaul shop when test expands?

10. How will everyone in the entire shop know what needs to be produced visually by looking around?

11. When will you know to expand/contract test? Is this based on a budget target?

12. What if we allowed customer demand to flow in freely and the demand exceeded the budget target, would you stop at the target?

13. Why would you not use Minimum WIP as a target? What is minimum WIP? How would you determine Minimum WIP?

14. If buffers were set up and assets only released to overhaul based on the number of assets the test stands could consume, could we determine minimum WIP?

15. Why would minimum WIP be the goal if we: 1) could define minimum WIP; and 2) let customer demand flow freely.

16. If customer demand were allowed to flow in freely, could I make a determination whether or not there was a need to expand/contract the constraint based on the variance from current WIP to minimum WIP?

17. If we always made decisions to respond to minimum WIP and we allowed work to flow in freely, would we be satisfying customer demand?

18. If we got to minimum WIP, would we be moving parts faster through the system? If yes, why? What have we eliminated? Would the inventory turn go up and the flow days go down on all items?

19. Once you are at minimum WIP on an asset, or family of assets, are you done?

20. If lower WIP helps the system to go faster, how could we reduce WIP further?

21. If the goal is increased throughput and WIP reduction, where do the budget targets come in? What is their purpose?

The results were encouraging - first full quarter DBR implementation resulted in the most units produced ever for the shop; in six months backorders were reduced by 70% (54 down to 16) – and, most importantly, the organization continues to learn and improve as more shops in the organization learn the lessons started here.

Many production environments are much more complex than simply being comprised of an overhaul process and a test process. A back shop with varying inputs to stand-alone processes that are not centrally-managed can create an environment that is difficult to manage. In this environment, the shops are organized by process (i.e. machining, welding, plating, plasma, cleaning, NDI, heat treat) rather than by part family. Parts flow through the facility, from one process to the next, without any specific shop owning the majority of the process. In this example, the back shop environment had approximately 800 personnel, covered 750,000 square foot of floor space and literally produced thousands of medium to small refurbished engine components. The implementation of DBR in this environment is a much more complex undertaking that the previous overhaul/test shop example.

Contrasting the overhaul/test example above – it was simpler to see where the constraint was and how to buffer and develop a "pull system" because assets flowed only between two shops and the test stands were dedicated to a few end items. In the complex back shop environment in this example, any one of the shops would have multiple requirements coming from different directions making it nearly impossible to determine appropriate buffer for a machine, much less what the constraints were within the system, --at least in the beginning. For this reason, it was decided to treat the entire system (back shop) as the constraint. This meant buffering the entire system in one location and releasing parts into the system from the buffer.

In the beginning there were approximately 12,000 parts on the floor. It looked like a big warehouse with parts stacked everywhere in front of almost every machine and inventory drop location. Everything looked like a constraint due to the mountain of WIP on the floor. Through some analysis it was determined that the constraint (entire back shop) could produce approximately 200 parts per day. Additional analysis determined and the system began to release 200 parts per day from the buffer. This action obviously minimized the amount of WIP on the floor as the back shop went from 12,000 parts in WIP (where everything looks like a constraint) to about 2500 over a period of two years.

As parts were released and flowed through the back shop, the shop aggressively attacked individual constraints within the system as parts started stacking up in a location. Once one constraint was resolved, the shop moved to the next. There were numerous metrics put in place that helped the shop to see, from a data perspective, where the constraint was (pile of WIP) on any given day. Metrics like days of inventory, WIP, throughput, cycle time, etc. all assisted management in "seeing" where the constraints were or where the constraints moved.

The summary of actions taken in this larger, non-centrally managed back shop example is:

1. Pull all WIP off the floor

2. Release the WIP into the shop at the rate of customer demand

3. Watch where the WIP piles up first as this is the location of the first constraint.

4. If an identified constraint cannot produce at the rate of release (customer demand), then exploit, subordinate and expand the constraint as required. Possibilities for expanding the constraint to satisfy production requirements include:

   a. Multiple shifts
   b. Overtime
   c. Reduction in recycle rates
   d. Secondary pieces of equipment

5. Once the constraint is able to satisfy demand and keep WIP from piling up, continue releasing at the rate of demand and watch for WIP pile up again somewhere else in the process. If it does, continue exploiting, subordinating and expanding constraints until the system has leveled its ability to supply the demand.

In most systems there are only a couple of constraints. Once determined, focus efforts on the constraints to make sure they can keep up with the rate of demand. Leaders often find their days get easier because, instead of focusing on the entire system, you are now focusing only on the constraints within the system. Additional benefits come in the form of WIP and inventory reduction. It is also important to note that the system and its metrics must be continually monitored for new constraints. It is imperative for leadership to instruct their workforce to respond at each new constraint. Always remember, time lost at the constraint is time lost for the entire system!

4.5. Summary

Both Part I and Part II of this paper describe production systems based on constraints based management principles. They provide a methodical approach to defining and monitoring operations in the AFSC. A production machine designed in accordance with Little's Law ensures a well-balanced production line and a disciplined approach to controlling active WIP. Monitoring the performance in each Gate provides increased transparency into the performance of the machine, enables more timely constraint identification-elevation-resolution, and ensures optimum performance of the overall machine. This construct is most applicable for low or medium throughput and high flowtime production machines (i.e. engine overhaul and aircraft PDM). On the other hand, a high throughput, low or medium flowtime production machine (i.e. exchangeable workload…a backshop environment) is most effectively managed by applying the principles of DBR. Identifying the constraint and pacing the entire operation based on that limiting constraint provides an effective framework for managing this production machine. Aggressive CPI is then used to reduce the limitations of this pacing constraint.

All CPI must be analytically driven by data analysis. A strong constraint resolution process must be in place (i.e. ANDON systems, Chapter 6 discusses this more detail). All levels of management must monitor the performance of the Gates and the DBR process. Metrics must be in place from the shop floor to the senior leader conference rooms…and they must be aligned for optimum production machine performance as will be discussed in Chapter 7, Sustaining Success.

While properly designed production machines and the monitoring tools discussed in this paper are meant to limit the impacts of variation on an operation, significant variation will still create serious perturbations to a production machine. Drastically changing the number or mix of units inducting during the year of execution will create ineffectiveness in AFSC operations. This is why accurate and dependable forecasting is critical. Major constraints during the year of execution such as material non-supportability or improper resourcing can also reduce the throughput of the production machines. It is important that everyone recognizes that variation is the enemy….variation driven by funding changes, induction decreases or increases, material non-supportability, etc. will impact AFSC performance and Air Force success.

Even with a strong adoption of the philosophies outlined in Part I and Part II of this chapter and even with aggressive CPI to eliminate waste and constraints, it is imperative to have an active, informed, vigilant, and engaged leadership team. This leadership team must be part of constraint resolution on a regular basis and must continually challenge the production machine for improved performance in order to reach the Art of the Possible!

5

A CLOSER LOOK AT EXECUTION

Chapter Topics

Setting up a Machine paced to the Road to… goal provides the foundation for measuring and monitoring throughput. However, Speed is created by focusing and understanding daily execution. This chapter will examine elements of daily process execution in the AFSC with a focus on the elements of standard work, visual displays and the use of tech data and regulations.

5.1. Standard Work (Scripting)

Standard work speaks to repeatable methods of accomplishing the steps of a particular task. According to Srinivasan (2012, p. 256), "standard work promotes consistency and continuous improvement." Standard work also positively affects safety (and quality). Within the Sustainment Center, tech data is an example of standard work in practice. Technical orders provide standard guidance on general maintenance practices as well as specific details for removing, installing, repairing and operating components. The same could be said for regulations and laws that govern many AFSC processes. For the purpose of this section, standard work will be addressed in terms of the scripting or sequence of the tasks that are accomplished in aircraft, engine and component repair and overhaul. However, the idea of standard work can certainly be applied to any process.

In some processes, the network provides the overarching plan and establishes task dependencies in order to determine the critical path of the schedule. Scripting is the next iteration of the network in that it looks at subsets of the network and determines the sequence of events at a level more relative to the process doer. The standard work approach is difficult in a repair environment due to the variability of such an environment. However, more often than not, the environment contains "known unknowns" for which a plan of attack can be anticipated should the "unknown" occur.

An example of scripting an "unknown known" and the power of scripting can be found in the description of an aircraft engine strut repair during daily task execution. (The need to repair the engine struts is known, but the level of the needed repair is not known.) The repair of the four engine struts in this process involves several hand-offs to complete the repair and prepare the aircraft for the installation of the engines. Aircraft-skill mechanics remove components from the strut; sheetmetal skill mechanics inspect and repair the strut; then aircraft mechanics restore the removed components prior to installing the engines. The depot repair network contains major jobs for the engine strut work divided as the steps are described above. However, what is not captured in the network is the importance of the approach that is taken to repair the struts.

The restoration of the engine strut involves the forward portion of the strut. Therefore, if the sheetmetal-skill mechanics concentrate their efforts here first, they can allow the aircraft-skill mechanics to start their build-up sooner than if no consideration was given to the order of repair. Utilizing a script to facilitate the flow of work allows this concept to be captured and then repeated on every aircraft. Establishing a script for this process not only standardizes the repair approach, but also enables the progress of the repair process to be monitored.

A script basically becomes the representation of step dependencies that communicate the agreed upon order of steps within a process. The process can be an entire gate, a specific repair task, or the overhaul of a specific component. The script is utilized to standardize the order in which the steps of the process are performed. Thus, ensuring downstream dependencies are optimized and enabling the process to be monitored and measured. The script also provides a mechanism for resources (people, parts, equipment, facilities, etc.) to be synchronized to the flow of work as the script is visible to all process doers and enablers.

Synchronization can occur when discipline has been instilled with regard to following the sequence of steps. Discipline means that the ability to "free-lance" with regard to the order the steps will occur has been removed. Any change in the order of the scripted steps needs to be considered by the "team" and the change documented into the agreed upon script. This process allows for continuous improvement as a collective.

A script can also be in the form of any type of guide that sets forth an agreed upon order of steps. Thus in an administrative setting, a checklist, flow chart, or swim lane chart can aide in accomplishing standard work. Standardizing the order of the steps of any task or process is the necessary foundation for building solid, disciplined repeatable processes that will set the stage for Quality, Safety and Speed.

5.2. Visual Displays

Information is power – meaning the sharing of information can make the holders of that information more effective; thereby making the organization as a whole more powerful. In the current reality of increasing computing power and the connectivity that comes with it, there is an increased emphasis on sharing information. However, it is important to promote effective sharing of information in order to avoid information overload.

In order to be effective, the purpose of the communication needs to be considered. For the purpose of this section, the display of production information to help the mechanic, tail team and/or the production support team understand production status as it relates to a particular shop or aircraft, as well as information to help managers and senior leaders understand the overarching production status will be discussed. Communication of information for the shop / aircraft is generally accomplished via Production Status Displays located at the bench, shop or aircraft; while dashboard type documents are often utilized to communicate overarching information to managers and senior leaders.

Some basic elements that will be considered in each type of visual communication include: 1) relevancy; 2) simplicity; and 3) accuracy. An understanding of what is relevant to the intended audience will ensure the communication / display is not “cluttered” with unnecessary information that disrupts the intended message. Another element that can add “clutter” to the message is complexity. A simple and straightforward design enables a more effective information delivery. It goes without saying that information must be accurate in order to be useful. Accuracy can be affected by the discipline behind keeping an accurate reflection of the information and the ease of obtaining the information. Each of these communication elements will be discussed further in relation to the type of visual product produced.

Production Status Displays

An effective Production Status Display exists at the point of work to the level most relevant to the process. A front shop –type (aircraft, whole engines) production status display should communicate the status of a specific gate for a specific serial / tail number; while a back shop – type production status will focus on the mix of items worked in a specific shop. In either case, the displays should reflect information that is important to the mechanic and support team in order to understand what is currently in work, what will be worked next and what constraints could impede progress of the critical path in order to be relevant. Displaying this information in a simplistic manner with an eye towards promoting ease of updating (and thereby promoting accuracy) is key to a successful display. Additionally, a tiered approach to the production status board that allows the gated, or individual shop / component, information to be rolled to the next aggregate level is a bonus.

The F108 engine overhaul line at Oklahoma City offers an excellent example of production status display boards. The overhaul of the F108 engine is broken into 4 gates: 1) Disassembly; 2) Kitting; 3) Assembly and 4) Test and Prep. The process for each gate is broken into steps via a “waterfall” chart that depicts each task in hourly increments (Figure 5.1). The hourly gated process waterfall rolls up

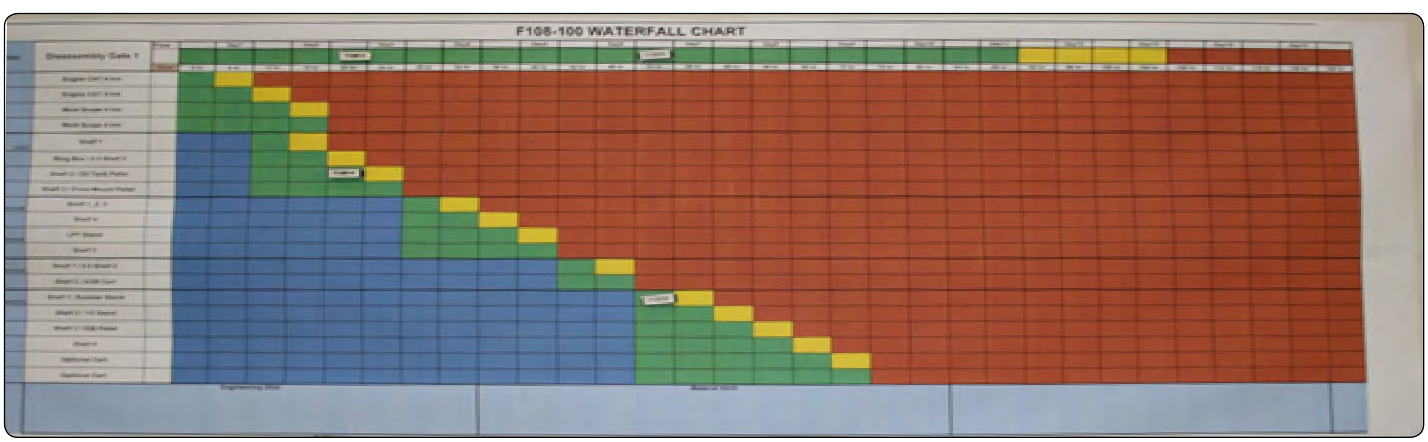


Figure 5.1: F108 Gate 3 Display

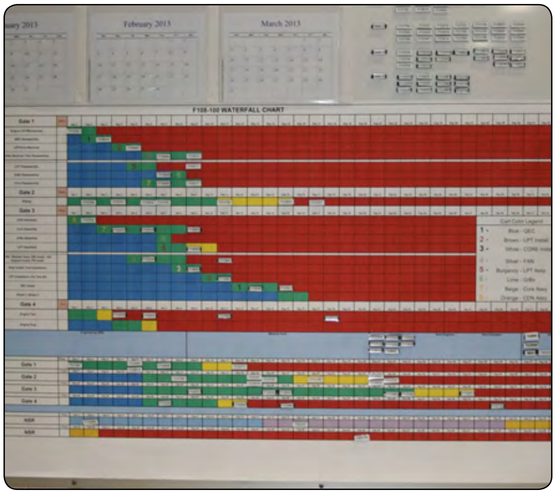


Figure 5.2: F108 Overarching Production Status Waterfall (click to zoom)

into an overarching F108 Production Status Waterfall Chart (Figure 5.2).

When a parts kit is required for a process, the kit number is depicted in the square representing the day of the process on which the kit is required. The serial number for each engine in work is placed on a magnet, with the magnet placed on the day of the process for that particular engine. The progress of the magnet through the waterfall chart easily alerts all concerned when a parts kit is required. The status of the aircraft can be quickly determined by assessing the color of the square on which the magnet is located: Blue = Early; Green = On-Schedule; Yellow = Caution; and Red = Behind Schedule.

Thus, the visual displays for the F108 engine overhaul process meet the criteria. The information is relevant – the mechanics and support team can easily understand what is currently in work; assess if the items in work are on schedule, behind, etc; understand what will happen next; and translate what needs to happen next into action (bring a kit, work a constraint). The display boards communicate this information in a simple, visual manner that makes assessing the situation fairly intuitive and easy to understand and act. The F108 Team has established business rules that define roles and responsibilities with regard to the movement of the magnets that make the update process easy and promotes discipline within the process.

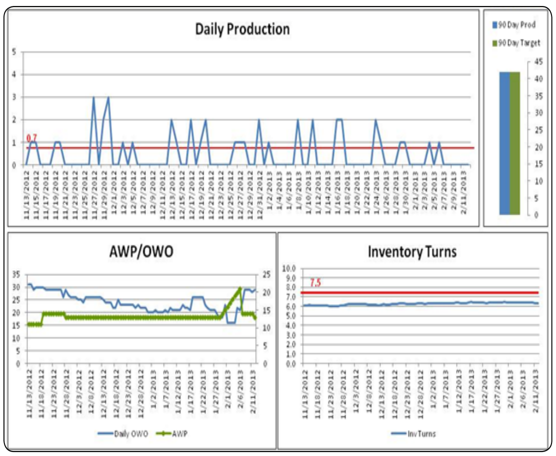


Figure 5.3: Commodities Metric Display for Outboard Flaps Production (click to zoom)

Another good example to include on a production status board is the Commodities chart in Figure 5.3 showing production metrics by individual components. This chart uses the interaction of a moving 30 day production average combined with the number of components awaiting parts (AWP) and on work (OWO) along with the component's inventory turns to provide an assessment of how the shop is performing with regard to this particular component.

Yet another example found in Commodities community is the Daily Production Summary utilized to summarize production metrics from each of its Flights (Figure 5.4). A similar production summary can be found on each Flight's production board as well. Utilizing a standardized product throughout a Squadron to communicate information ensures the information is more readily understood by all.

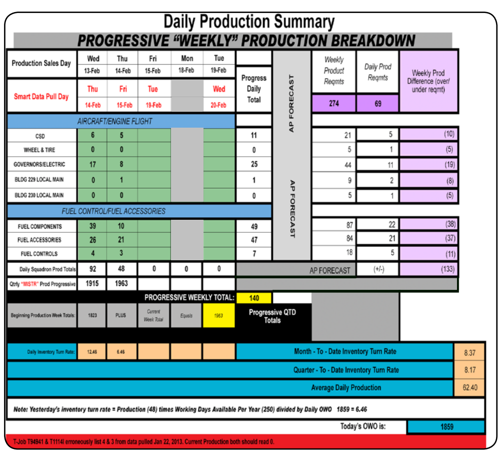


Figure 5.4: Rolled up Commodities Production Status to Squadron Level (click to zoom)

Figure 5.5: Visual Management Board (click to zoom)

A sample Visual Management Board from Ogden Air Logistics Complex is depicted in Figure 5.5. The purpose of the visual management boards is for the technicians working on the production line to be able to tell, "Are we having a good day?" There are ten core functions represented on the boards throughout the Complex. The core functions are: injuries/accidents/equipment damage, ANDONs and action items, WIP, throughput, unscheduled depot level maintenance, critical path parts issues, previous days FCF results and financials.

Dashboard (at-a-glance) Informational Displays

According to Stephen Few (2006, p. 2), "A dashboard is a visual display of the most important information needed to achieve one or more objectives, consolidated and arranged on a single screen so the information can be monitored at a glance." While the examples presented in this section are not dashboards in the most traditional sense, they do represent a visual display of summary data used by management and senior leaders to understand production status. These products are one-page summaries that provide relevant data in a concise and easy to understand manner.

Figure 5.6 is an example of an Aircraft At-A-Glance Report that is used to pictorially represent the location and summary status of each aircraft possessed by an aircraft MDS. The boxes on the chart represent docks and aircraft parking locations in a manner that allows the reader to visualize the actual location of the aircraft. Gate start and transition dates are visible as well, along with quarter and annual production targets and progress. This product is used to communicate aircraft status not only by the management team of a particular MDS, but is also shared with external suppliers as well as customers. This product is prepared by the MDS Master Scheduler, and the format allows management to easily make daily constraint notes regarding each aircraft.

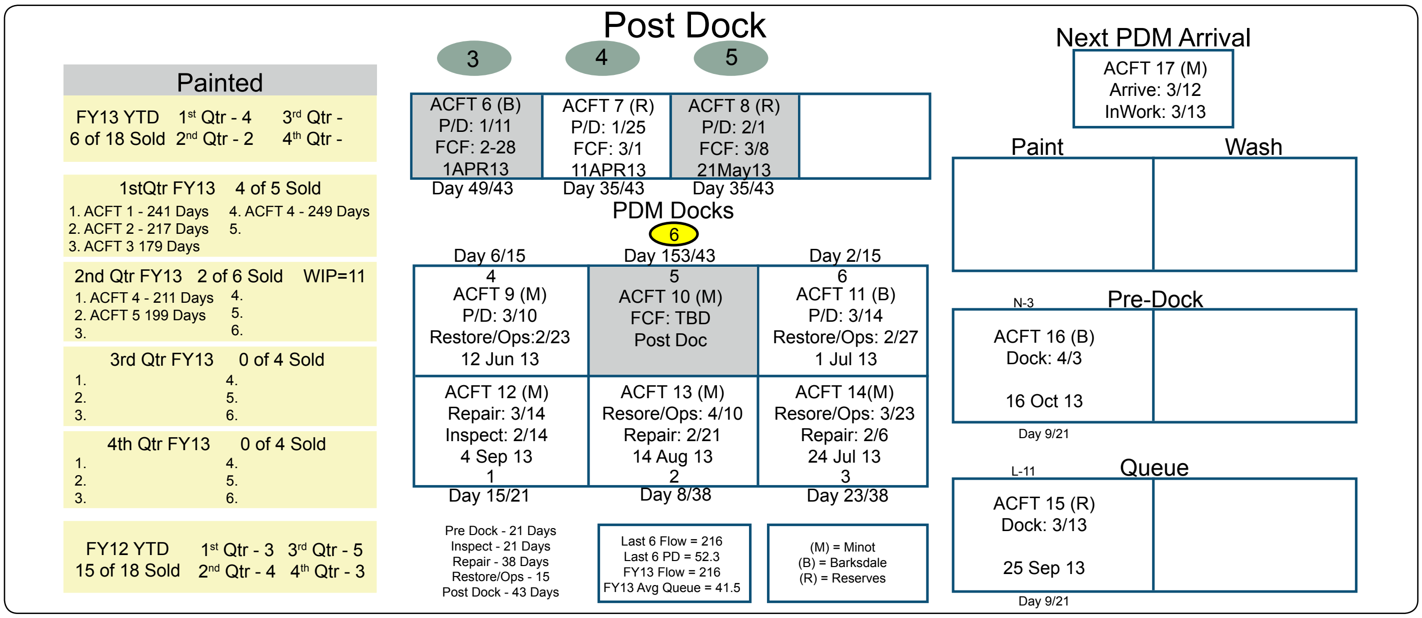
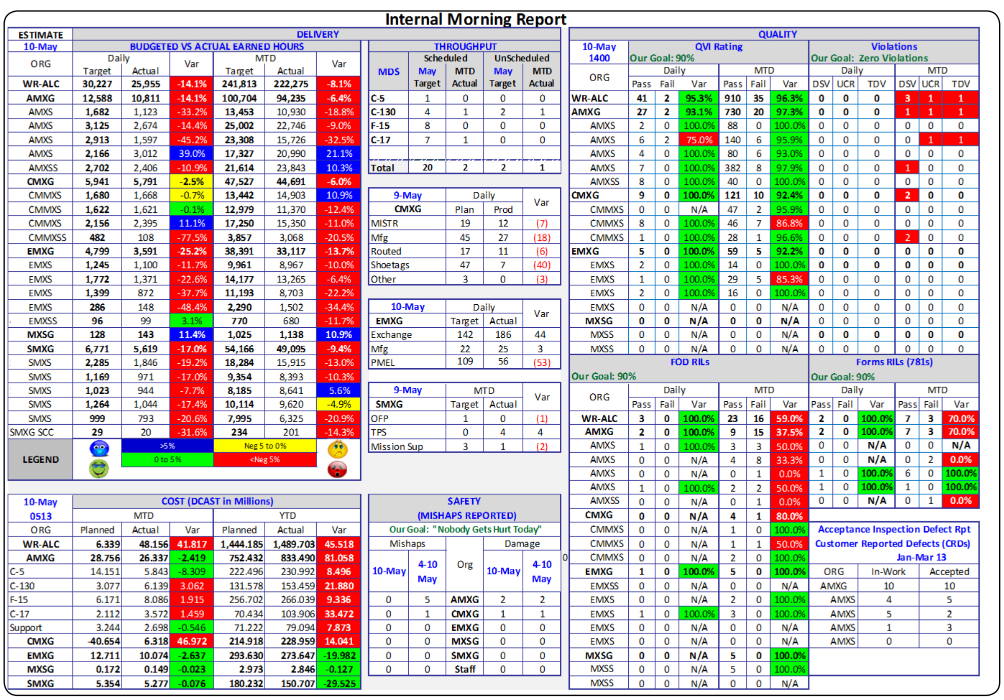


Figure 5.6: Aircraft At-a-Glance Daily Report

Figure 5.7 is an example of an At-A-Glance report for the maintenance activities of an entire Complex. This daily report provides a snapshot of Squadron –level earned hours, production output, quality, cost and safety metrics. This type of report puts the important metrics for the production process in front of Senior Leadership in a simple format on a daily basis.

Each of these reports provides an example of summary products for varying levels of management with relevant data in a simplistic, at-a-glance manner. Dashboard-type, at-a-glance reports provide an easy, simplistic method to communicate key information about a process or organization to those who need to report and act upon it. This type of report makes it easy to



Internal Morning Report

ESTIMATE — DELIVERY

10-May	BUDGETED VS ACTUAL EARNED HOURS					
ORG	Daily Target	Daily Actual	Var	MTD Target	MTD Actual	Var
WR-ALC	30,227	25,955	-14.1%	241,813	222,275	-8.1%
AMXG	12,588	10,811	-14.1%	100,704	94,235	-6.4%
AMXS	1,682	1,123	-33.2%	13,453	10,930	-18.8%
AMXS	3,125	2,674	-14.4%	25,002	22,746	-9.0%
AMXS	2,913	1,597	-45.2%	23,308	15,726	-32.5%
AMXS	2,166	3,012	39.0%	17,327	20,990	21.1%
AMXSS	2,702	2,406	-10.9%	21,614	23,843	10.3%
CMXG	5,941	5,791	-2.5%	47,527	44,691	-6.0%
CMMXS	1,680	1,668	-0.7%	13,442	14,903	10.9%
CMMXS	1,622	1,621	-0.1%	12,979	11,370	-12.4%
CMMXS	2,156	2,395	11.1%	17,250	15,350	-11.0%
CMMXSS	482	108	-77.5%	3,857	3,068	-20.5%
EMXG	4,799	3,591	-25.2%	38,391	33,117	-13.7%
EMXS	1,245	1,100	-11.7%	9,961	8,967	-10.0%
EMXS	1,772	1,371	-22.6%	14,177	13,265	-6.4%
EMXS	1,399	872	-37.7%	11,193	8,703	-22.2%
EMXS	286	148	-48.4%	2,290	1,502	-34.4%
EMXSS	96	99	3.1%	770	680	-11.7%
MXSG	128	143	11.4%	1,025	1,138	10.9%
SMXG	6,771	5,619	-17.0%	54,166	49,095	-9.4%
SMXS	2,285	1,846	-19.2%	18,284	15,915	-13.0%
SMXS	1,169	971	-17.0%	9,354	8,393	-10.3%
SMXS	1,023	944	-7.7%	8,185	8,641	5.6%
SMXS	1,264	1,044	-17.4%	10,114	9,620	-4.9%
SMXS	999	793	-20.6%	7,995	6,325	-20.9%
SMXG SCC	29	20	-31.6%	234	201	-14.3%
LEGEND		>5%	Neg 5 to 0%			
		0 to 5%	<Neg 5%			

THROUGHPUT				
MDS	Scheduled May Target	Scheduled MTD Actual	UnScheduled May Target	UnScheduled MTD Actual
C-5	1	0	0	0
C-130	4	1	2	1
F-15	8	0	0	0
C-17	7	1	0	0
Total	20	2	2	1

9-May CMXG	Daily Plan	Daily Prod	Var
MISTR	19	12	(7)
Mfg	45	27	(18)
Routed	17	11	(6)
Shoetags	47	7	(40)
Other	3	0	(3)

10-May EMXG	Daily Target	Daily Actual	Var
Exchange	142	186	44
Mfg	22	25	3
PMEL	109	56	(53)

9-May SMXG	MTD Target	MTD Actual	Var
OFP	1	0	(1)
TPS	0	4	4
Mission Sup	3	1	(2)

10-May 0513	COST (DCAST in Millions)					
ORG	MTD Planned	MTD Actual	MTD Var	YTD Planned	YTD Actual	YTD Var
WR-ALC	6.339	48.156	41.817	1,444.185	1,489.703	45.518
AMXG	28.756	26.337	-2.419	752.432	833.490	81.058
C-5	14.151	5.843	-8.309	222.496	230.992	8.496
C-130	3.077	6.139	3.062	131.578	153.459	21.880
F-15	6.171	8.086	1.915	256.702	266.039	9.336
C-17	2.112	3.572	1.459	70.434	103.906	33.472
Support	3.244	2.698	-0.546	71.222	79.094	7.873
CMXG	-40.654	6.318	46.972	214.918	228.959	14.041
EMXG	12.711	10.074	-2.637	293.630	273.647	-19.982
MXSG	0.172	0.149	-0.023	2.973	2.846	-0.127
SMXG	5.354	5.277	-0.076	180.232	150.707	-29.525

SAFETY (MISHAPS REPORTED) — Our Goal: "Nobody Gets Hurt Today"

Mishaps 10-May	Mishaps 4-10 May	Org	Damage 10-May	Damage 4-10 May
0	5	AMXG	2	2
0	1	CMXG	1	1
0	0	EMXG	0	0
0	0	MXSG	0	0
0	0	SMXG	0	0
0	0	Staff	0	0

QUALITY — 10-May 1400 — QVI Rating (Our Goal: 90%) — Violations (Our Goal: Zero Violations)

ORG	Daily Pass	Daily Fail	Daily Var	MTD Pass	MTD Fail	MTD Var	Daily DSV	Daily UCR	Daily TDV	MTD DSV	MTD UCR	MTD TDV
WR-ALC	41	2	95.3%	910	35	96.3%	0	0	0	3	1	1
AMXG	27	2	93.1%	730	20	97.3%	0	0	0	1	1	1
AMXS	2	0	100.0%	88	0	100.0%	0	0	0	0	0	0
AMXS	6	2	75.0%	140	6	95.9%	0	0	0	0	1	1
AMXS	4	0	100.0%	80	6	93.0%	0	0	0	0	0	0
AMXS	7	0	100.0%	382	8	97.9%	0	0	0	1	0	0
AMXSS	8	0	100.0%	40	0	100.0%	0	0	0	0	0	0
CMXG	9	0	100.0%	121	10	92.4%	0	0	0	2	0	0
CMMXS	0	0	N/A	47	2	95.9%	0	0	0	0	0	0
CMMXS	8	0	100.0%	46	7	86.8%	0	0	0	0	0	0
CMMXS	1	0	100.0%	28	1	96.6%	0	0	0	2	0	0
EMXG	5	0	100.0%	59	5	92.2%	0	0	0	0	0	0
EMXS	2	0	100.0%	14	0	100.0%	0	0	0	0	0	0
EMXS	1	0	100.0%	29	5	85.3%	0	0	0	0	0	0
EMXS	2	0	100.0%	16	0	100.0%	0	0	0	0	0	0
EMXS	0	0	N/A	0	0	N/A	0	0	0	0	0	0
MXSG	0	0	N/A	0	0	N/A	0	0	0	0	0	0
MXSS	0	0	N/A	0	0	N/A	0	0	0	0	0	0
MXSS	0	0	N/A	0	0	N/A	0	0	0	0	0	0

FOD RILs (Our Goal: 90%) — Forms RILs (781s) (Our Goal: 90%)

ORG	Daily Pass	Daily Fail	Daily Var	MTD Pass	MTD Fail	MTD Var	Daily Pass	Daily Fail	Daily Var	MTD Pass	MTD Fail	MTD Var
WR-ALC	3	0	100.0%	23	16	59.0%	2	0	100.0%	7	3	70.0%
AMXG	2	0	100.0%	9	15	37.5%	2	0	100.0%	7	3	70.0%
AMXS	1	0	100.0%	3	3	50.0%	0	0	N/A	0	0	N/A
AMXS	0	0	N/A	4	8	33.3%	0	0	N/A	0	2	0.0%
AMXS	0	0	N/A	0	1	0.0%	1	0	100.0%	6	0	100.0%
AMXS	1	0	100.0%	2	2	50.0%	1	0	100.0%	1	0	100.0%
AMXSS	0	0	N/A	0	1	0.0%	0	0	N/A	0	1	0.0%
CMXG	0	0	N/A	4	1	80.0%						
CMMXS	0	0	N/A	1	0	100.0%						
CMMXS	0	0	N/A	1	1	50.0%						
CMMXS	0	0	N/A	2	0	100.0%						
EMXG	1	0	100.0%	5	0	100.0%						
EMXSS	0	0	N/A	0	0	N/A						
EMXS	0	0	N/A	2	0	100.0%						
EMXS	1	0	100.0%	3	0	100.0%						
EMXS	0	0	N/A	0	0	N/A						
EMXS	0	0	N/A	0	0	N/A						
MXSG	0	0	N/A	5	0	100.0%						
MXSS	0	0	N/A	5	0	100.0%						
MXSS	0	0	N/A	0	0	N/A						

Acceptance Inspection Defect Rpt — Customer Reported Defects (CRDs) — Jan-Mar 13

ORG	In-Work	Accepted
AMXG	10	10
AMXS	4	5
AMXS	5	2
AMXS	1	3
AMXS	0	0

Figure 5.7: WR-ALC Internal Daily Report (click to zoom)

communicate complex information and keep the organization “on the same page” with regard to key metrics and process drivers.

5.3. Tech Data, Engineering Support

The Air Logistic Complexes rely on technical orders as the primary source of technical data for maintenance repair activities. TOs are developed, delivered and maintained by the system program office having Operational Safety, Suitability and Effectiveness over the weapon system being maintained. AFSC maintainers must follow TO data and can only deviate by following an explicitly defined approval process to obtain a “Nonconforming Technical Assistance Request and Reply” on an AFMC Form 202.

A "202" is used when a maintainer encounters a condition where they cannot accomplish their mission in accordance with the TO. A 202 prompts an engineer with OSS&E responsibility to review the maintenance condition and applicable TO that has resulted in a constraint and create a technically sound way forward. An example of when a 202 might be used is when an aircraft maintainer finds a crack in an area that does not have an explicit repair specified. The responsible engineer in this case would perform an analysis that might lead to no immediate action, additional inspections, or a newly designed repair.

There are three timelines associated with a 202. Part A is the time it takes to formulate and submit the question, part B is the time it takes the engineer to respond, and part C is the time it takes the submitting organization to review the response, make any adjustments necessary, and provide to the maintainer to execute. A 202 has two priority levels -- work stoppage which has a part B response deadline of 5 days, and anticipated work stoppage that has a part B response deadline of 15 days. AFSC has set additional performance targets for 202s: 3 day average part B response time for work stoppage 202s, 7 days average part B response time for anticipated work stoppage 202s. AFSC has also set goals for part C average and maximum response times, however part A is not measured in today's environment. Response times are one of the principal metrics that have been used at the depots to measure program office engineering support to maintenance.

Measuring 202 timelines is important due to the affect the 202 answer can have on AFSC repair processes. In a work stoppage situation, the critical path of the repair process can be impacted by the amount of time for a 202 response as well as by the actual response itself. In the previous example of finding a crack in an area without repair instructions, the 202 response may require the development of a repair that is not immediately supportable. In this case, a collaborative response, that includes engineering, production, and the supply chain support functions will ensure the materials required for the repair are available, thereby precluding the need to resubmit for an additional 202 response due to non-supportable material requirements in the initial response. Formulating the supportable response may require collaboratively looking for acceptable material that is actually available – therefore requiring all parties to work together in the same room to formulate the best response that keeps the asset repair moving forward.

A primary goal in the AFSC is to reduce the number of 202s initiated due to resubmits (back and forth 202s), recurring (same question on multiple assets) and unnecessary (answer can be found in TO). This reduction serves to limit the work in process (202s) for the engineering community and keeps them from spreading their resources thin. For this reason the metrics utilized to measure 202 activity include the number of 202s submitted each month as well as the type (work stoppage versus non work stoppage). If the number of 202s submitted is higher than desired, the 202s should be analyzed to determine if there are any trends of multiple resubmits – meaning the initial 202 answer is not supplying “total technical resolution,” – recurring – meaning recurring 202s are not being incorporated into TOs, - or unnecessary – meaning production is not properly reviewing TOs before submitting in the first place.

The emphasis for improving 202 support requests has been to lean out processes to improve response times which have met with much success and have had a positive effect on AFSC production processes. However, the AFSC is now ready to transcend to a new maturity level. The machine must be intelligent enough to know technical support is needed well in advance of the critical path, thus reducing the urgency of response.

This can be achieved by creating a focus during the inspection gate of AFSC processes to understand the "true condition" of the asset, and order the assessment of the asset in a manner that allows adequate lead time for 202 responses to meet Inspection Gate requirements. This means paying attention to the order of the inspections so unknowns that are more likely to have difficult answers are assessed as early as possible in the process. It may also mean attacking more difficult repairs earlier in the Repair Gate and uncovering areas vulnerable to more extensive corrosion that could require additional 202 requests earlier as well.

Understanding the impact of 202s and how to mitigate a negative impact to our AFSC machines is a key component of the Art of the Possible methodology and an example of the need for an enterprise focus. Engineering authority is an Air Force Life Cycle Management Center resource that plays an important role in the AFSC machines. A continued emphasis on approaching 202s in a manner that creates mutual benefit (minimized engineering WIP for AFLCMC and faster total technical resolution for AFSC) by measuring the process and reacting when the trends indicate the need will lead to a balance that propels Speed within an environment of technically sound repairs.

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6

A CULTURE OF PROBLEM SOLVERS

Air Force Sustainment Center: Art of the Possible

Chapter Topics

Creating an organizational culture that promotes problem solving is necessary for success in an AFSC organization. This culture must include a constant focus on processes and keeping those processes moving forward along their critical paths. Problem solvers are in constant search of roadblocks and constraints to this path. They know how to utilize urgency and process improvement tools to minimize and eliminate the effect of these constraints on the process critical path. A culture of Problem Solvers is essential for creating a mindset of believers. Believers are essential for attaining Art of the Possible goals.

This chapter will describe the components of a Problem Solving Culture as well as tips for how to attain and sustain this culture. It begins with "Changing the Way People Think" by placing the focus on the process – creating process flow, identifying gaps and utilizing process improvement tools to minimize and eliminate those gaps. It continues with "Constraints Based Management and Constraint Resolution" which involves utilizing urgency tools to resolve constraints before they impact the critical path of the process. The chapter ends with "Create a Culture of Problem Solvers" by examining the various sustainment tools available and tips to understand if the Problem-Solving culture has truly been attained.

6.1. Change the Way People Think

Creating a culture of problem solvers begins by changing the way people think – the way they approach daily execution of processes and how they view their role in the process. It involves seeing the process in terms of the bigger picture; the overall "Road to…" Art of the Possible goal, and understanding the gaps that must be addressed to achieve that goal. In order to assure a good understanding of the intended AFSC culture, a quick summarization of the basic components is in order.

The Art of the Possible starts with the foundation of creating flow for any process (shop floor or above). Basic flow principles apply to any process and consist of 1) input; 2) create value; and 3) output. All processes have an input. That input might be an aircraft, an engine, a request for a part, a request for data or a request for resolution to a problem. Once the input is received into the process, the process "doers" take steps to create value for the input. The value may consist of performing depot maintenance on an aircraft or an engine; ordering and/or retrieving a part; researching and compiling information into a report; or researching and assessing a situation then providing a written answer to a resolution request. The output of the process would be the completed depot repair of an aircraft or an engine; handing the requested part to the requestor; handing a completed report to a requestor; or providing the written resolution request. The concept that all processes are based upon basic flow principles is what allows the Art of the Possible methodology to be universally applied throughout the Sustainment Center.

All processes are not created equal. Some processes are relatively simple, while others can be very complicated. In order to better address the flow of a complicated process, the value portion of the process should be broken into buckets or chunks of work. This can be accomplished using the Gated or DBR processes described in Chapter 4, and require the basis of takt time inductions into the process to create a steady-state foundation.

Process execution data is then formed into metrics that allow process execution trends to be analyzed in order to determine process gaps. When using the gated process, gaps are best addressed within the actual gates. Under-performing gates have the highest priority with regard to application of resources to address the gaps. These gaps are seen as opportunities for improvement and should address the primary driver of extended execution time. Addressing the gaps should result in a step change with regard to the speed of a production machine.

These gaps then become the basis for focusing process improvement efforts. Continuous process improvement tools and methodologies are applied to the gaps in order to eliminate process waste and improve touch time within the overall process. These tools and methodologies include, but are not limited to, Value Stream Mapping and Analysis, Root Cause Analysis, 8-Step Problem Solving, and Rapid Improvement Events. These tools are based upon AFSO21 principles and must become "go to" tools for AFSC organizations.

Flow, gap identification, and process improvement efforts all have the overarching objective of first creating consistency within the buckets of process execution and then creating Speed. Additionally, active control of work in progress within any process is extremely important in order to keep from overwhelming the "doers" within the process. WIP is controlled by limiting inductions into the process (or gates of the process) and can be accomplished by either queuing projects/assets at the beginning of or within the overall process, or by limiting the acceptance of inductions to the process. Controlling the amount of WIP into and within the process will ensure the process resources are not overwhelmed within the gates or within the system as a whole.

Controlling WIP is important because it ensures process resources are not spread thin and enables Speed because adequate effort is applied to the project/asset when it is in work. In order to eventually eliminate a queue of projects/assets, it may be necessary to intentionally "break" WIP rules; however, this must be done by considering the impact the induction of the project/asset will have on the resources required. When there are different resources required at the beginning of a bucket of work than at the end, it may make sense to induct a new project or asset during this particular part of the bucket of work in order to reduce the overall queue of projects/assets. This step should be taken only after consistent flow has been established and only to reduce the queue. This is an example of pulling a "lever" of a well-understood machine in order to obtain a specific result. Reduced WIP, and an understanding of gap resolution through process improvement, equates to Speed.

Another key component of the Art of the Possible that requires people to change the way they think is the concept of being comfortable in red. This is the basis of creating Art of the Possible goals; goals that are not easily obtained and may not at first seem possible. In order to achieve these Art of the Possible goals, organizations – and the people in them – must be comfortable with at first not making the goal. This will mean they have to be comfortable with a metric that is red while they are taking steps to create flow, identify gaps, execute improvement action plans and reduce WIP in order to achieve the Art of the Possible goal.

Being comfortable in red is NOT the same as being complacent in red. When an organization is comfortable, rather than complacent (in red), they have identified a goal that is difficult to reach and will require attention to their processes. The goal must seem to be out of reach and will require the organization to challenge the status quo and aggressively work to improve and resolve their process gaps. The goal must make the organization uncomfortable – knowing they will show red to their goal while they make step changes that will move the organization toward the goal. Art of the Possible goals are difficult to achieve and requires the organization to take a leap of faith that says they believe in their ability to achieve what today seems impossible – and not let knowing they will show red to their goal keep them from making that leap.

Once the execution goal is achieved, the organization is still not finished. They will need to take steps to achieve the goal with less total effort – for example, they will need to utilize less overtime, less manpower, less foot print, less cost. All of these measures mean first being red for the metric, then taking steps, through process improvement, to achieve the metric.

Finally, there must be a mindset of constraint based management during execution that is focused on protecting the critical path of the project during execution. This means everyone in the process is focused on identifying and elevating execution constraints and employing the power of the enterprise to urgently resolve those constraints.

The remainder of this chapter will discuss constraints based management, critical path, ANDONs and tips to create and identify a culture of problem solvers – and believers.

6.2. Constraints Based Management

As formerly mentioned, the key to gaining Speed is maintaining focus on the process and the pace of execution. Successful execution is directly linked to creating a culture that recognizes the power of effective constraint resolution in order to protect the critical path during execution of any AFSC process or production machine. This constraints-based culture must understand the need to identify, elevate and urgently resolve constraints.

In a world filled with variability, the one certainty is that problems and issues WILL arise during the execution of a process or production machine. An organization utilizing the Art of the Possible understands the importance of properly reacting to those issues and problems (constraints) so as not to allow an impact to the critical path of execution. The constraints based management culture also understands the more proactive the recognition of the constraint, the more lead time available to resolve the constraint and avoid impact to critical path.

Constraints based management is a mindset of the organization to recognize problems that will delay execution, and frame those problems in a way that allows everyone to understand the impact – when the impact occurs, and what options are available to minimize and eliminate the impact. Much of this information may not be readily available to the impacted organization, thus the culture must require the power of the enterprise be involved in order to determine all possible courses of action and ultimately to resolve the constraint.

Constraints based management requires the use of urgency tools to quickly and collaboratively resolve constraints. These urgency tools are different for each organization, but can include:

- Streamers – identify priority in a batch process type environment
- Special handling 202s (Repair Disposition) – collaborative approach to gaining total technical resolution when the defect directly hinders the critical path of the product
- Constraint Resolution Teams – a horizontally integrated enterprise team that aggressively and collaboratively attacks constraints (may also be called a Maintenance Requirements Supportability Team)
- ANDONs – an alert to the enterprise that an AFSC machine process has encountered a potential critical path impacting constraint

It is important that each AFSC organization creates, understands and utilizes urgency tools designed to resolve constraints for their specific process. The urgency tools will allow constraints to be resolved in order to keep AFSC processes moving forward along their critical paths. A more in-depth discussion of ANDONs, and their relationship to protecting the critical path, follows in the next section.

6.3. Constraint Resolution

Constraint resolution is a critical concept to keep the AFSC process or production machine operating smoothly. There are three concepts key to constraint resolution: protecting the critical path, communicating constraints, and the expected response. Effective constraint resolution is a highly collaborative process as many organizations provide the resources and conditions necessary to achieve "Art of the Possible" results. Each production line is a dynamic organism that relies on the union of a diverse range of synchronized resources executing a well scripted plan--examples include skilled manpower, the right parts, tools, equipment, data, facilities, and technical support. Any resource that is not available at the time and location necessary represents a constraint that must be identified, understood, communicated, elevated, and resolved appropriately. Constraint resolution must be executed judiciously to ensure the right resources are applied to keep the machine on track, without unnecessarily prioritizing resources that are required for more urgent activities.

Understanding the basic definitions of the resolution process is integral to proper communication across organizations as well as up and down the chain of command. Below are a few of the terms that will be used to describe the AFSC methodology.

Constraint is a problem or issue that negatively impacts a production process. It can be a resource that is not available at the "Point of Use" exactly when and where the production schedule requires it. A constraint must be exploited, identified, understood, communicated, elevated, and resolved appropriately. Some causes of constraints may include, but are not limited to: a lack of skilled manpower, the lack of correct parts, improper tools and equipment, funding shortages, conflicting or absent technical date, shortage of facilities, and unresponsive technical support.

Critical Path is a sequence of activities in a project plan which must be completed by a specific time for the project to be completed on its need date. An activity or task on the critical path cannot be started until its predecessor activity is complete. The concept of the critical path is central to the constraint resolution process. When work slows or stops on the critical path, the overall performance of that entire process or production machine is impacted. When work slows or stops off the critical path, processes/tasks may or may not have the ability to adjust and compensate to maintain aggregate performance.

ANDON is a manufacturing term originating in the Toyota Production System referring to a mechanism to notify management, maintenance, and other workers of a quality or process problem. ANDON is the Japanese word for "lantern" and the term is representative of illuminating the problem. In its traditional manufacturing context, an ANDON identifies an issue and stops the production line until that issue is resolved. In AFSC, the concept has been slightly adapted to apply to the AFSC environment where it identifies a constraint that impacts the critical path.

Supported Organization is the organization that owns the critical path or production process affected by the constraint. They are tasked to protect the critical path by identifying constraints, based on and validated with data and engage the appropriate resolution team members, including supporting organizations necessary to initiate analysis of the data.

Supporting Organization(s) is an organization that provides resources to include subject matter expertise as part of the resolution process. Examples of Supporting Organizations may the include Defense Logistics Agency, Supply Chain Management Wing, System Program Offices, air Base Wing, AFSC Staff Offices, etc.

Constraints Types include Contracts, Engineering, Equipment, Facilities, Job Routes (Child Docs), Manpower, Parts, Production Processes, Support Organizations, Technical Orders, Tools, Training, and Work Control Documents. These on some general causes but it is not an all-encompassing list.

Elevation is a means of asking for assistance from the next higher level in the organizational structure.

De-Elevation is a means of lowering the responsibility for the constraint and its resolution to an appropriate level.

Constraint Closing is conducted when the resolution occurs, the constraint no longer impacts production, or the situation no longer meets the definition for any constraint classification.

Constraint Communication

Traditionally an ANDON is associated with a delay. A constraint or ANDON is a negative situation, but the result should be a collaborative effort to understand and resolve the root cause of the delay. Efforts must be made to avoid a culture that attributes a negative message to the initiating organization, or the organization best postured to provide relief, lest the collaborative mindset be lost. The desired response needs to be conditioned by focusing positive efforts on a shared "Road to… goal" rather than attributing blame. ANDON is not a verb. It is not something that one organization does to another in a state of duress! Therefore, it is essential that ANDONs be clearly communicated across organizations, as well as up and down the chain of command, without emotions becoming involved. Effective use of two tactics, focused communication and transparency, are required in order to promote this culture.

The first tactic, Focused Communication requires the ANDON to explicitly state what help is needed and by whom. Requests for support must be crafted to target the individual or organization that is expected to provide assistance and scoped to explicitly articulate the support requested. This tactic is required to articulate exactly the support required by the next level when a constraint is elevated. Focused communication is also utilized when the supported organization requests Constraint Subject Matter Experts (SMEs) from supporting organizations for the resolution effort.

The second tactic, Transparency, provides visibility of the ANDON to all levels of the organization. The constraint resolution process is the mechanism utilized by all stakeholders to eliminate obstacles to Art of the Possible performance. This tactic is necessary to ensure these stakeholders have a common site picture of the health of the machine. When a constraint is elevated, transparency allows the next higher level to review a constraint without an explicit request for support. Transparency has a push component, which includes activities such as including ANDON s in production meetings. It also includes a pull component, which includes activities like allowing stakeholder access to a constraint visibility tool.

Communication begins with the stakeholder. Any stakeholder in the AFSC production machine has the right and responsibility to identify constraints. While the process doer may have the first awareness of some issues, supporting organizations may be in a position to identify other issues early. For example, a DLA employee might recognize a key parts shortage in advance, or a program office engineer might unearth a technical risk that will require mitigation. Again, communicating these discoveries to the correct organization in a timely manner could alleviate the need for an ANDON during process execution and allow for the development of acceptable workarounds or expedited delivery in advance of critical path impact.

Most organizations have had success in utilizing a Tiered communication approach to managing their processes. This approach allows ANDON s to bubble up to the highest Tier and possibly identify group wide trends of certain constraints. A Tiered communication process also helps to keep track of ANDONs until they are resolved, providing visibility of issues to Senior Management. Chapter 7 will provide a more thorough discussion regarding the Tiered communication approach.

Constraint Processes

Classification, elevation, de-elevation and closure of the constraint or ANDON are processes designed to resolve the issue. These processes should be performed by an individual who is positioned to understand the impact to the process or production machine and the resources necessary to achieve resolution. If a process doer identifies a constraint that the local supervisor can resolve immediately, there is likely little value in elevating, although there may be value in collecting data about these events.

In order to determine the need to elevate the constraint or ANDON, the constraint needs to be analyzed to assess the impact to the critical path. If a constraint occurs on the critical path, production is delayed until that constraint is resolved or mitigated. While constraints that occur off the critical path may drive inefficiencies, they do not have an immediate impact to the mission. In order to provide an understanding of what is meant by the potential to "impact critical path" a short discussion of critical path utilizing a simple production machine follows.

Critical Path Example

Figure 6.1 below represents a simple production machine with an overall process that requires five distinct tasks (tasks A, B, C, D and E). Task A starts the process, and happens independently. Tasks B, C, and D cannot start until Task A has been completed, but can be performed concurrently. Task E cannot start until Task B, C, and D are all completed. The duration of Task A, Task B (because it is the longest of the concurrent tasks), and Task E dictate the duration of the entire process. The boxes representing these tasks in the figure below are highlighted in red to show they are the longest path through the process and represent the critical path of the simple production machine. A delay starting or increase in duration to any of these three tasks will result in a delay of the entire process, while reducing the length of these tasks can expedite the entire process.

Task C and Task D have some independence and flexibility. Task C can delay starting or increase in duration by three days without changing the overall process duration, while Task D has fifteen days of flexibility. It is important to understand that the critical path could change if a condition caused Task C or Task D to take longer than 25 days - resulting in a new sequence of activities on the longest path.

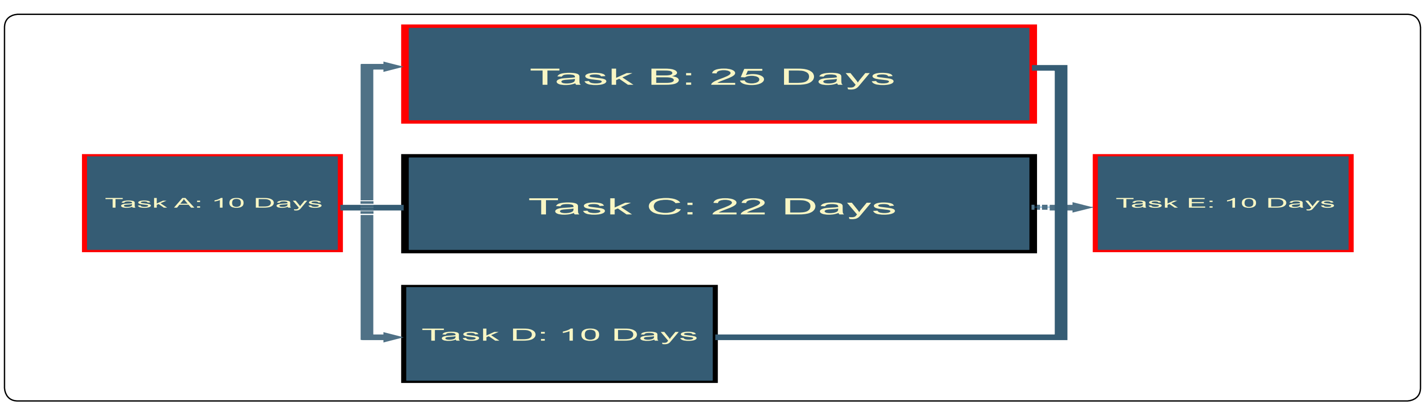


Figure 6.1: Simple Production Machine (click to zoom)

It is said, "flexibility is the key to Airpower," and our expert process doers are adept at using their ingenuity to mitigate constraints to accomplish the mission. We do not want to discourage this mitigating ingenuity, but at the same time it is essential to highlight and fully resolve constraints to protect the critical path and preempt future issues. ANDONs must be handled with the utmost urgency.

Tier Communication helps with elevating constraints based on "tried everything at my level-need your help." This strategy alleviates placing blame and returns the focus to problem solving. Finally, it ensures Tier II has the chance to say, "Tier I, you should be able to solve this." By de-elevating the ANDON or constraint, it places the responsibility for resolution at the proper level. This strategy also requires a change in Leadership mindset. Leadership cannot say, "Do not bring me a problem without a solution," but instead must be willing to take on problems that could not be solved at the lower levels in order to provide solutions previously not thought possible.

Root Cause Analysis

A critical portion of constraint and ANDON resolution is conducting a solid "Root Cause Analysis" that identifies the true cause and not the symptoms of the issue. This RCA aids in exploiting the constraint and developing countermeasures that could eliminate the constraint and prevent recurrence. Data collection is important for constraint identification and allows for proper analysis of all potential constraints to prioritize resolution efforts.

Once the true root cause of the constraint/ ANDON has been identified, the supported and supporting organizations must work together to establish countermeasures that will eliminate the constraint/ ANDON. The effectiveness of the countermeasures and additional identified constraints as a result of the implemented countermeasures should be assessed. Organizational leadership must ensure the same stakeholders addressing the initial constraint address all follow-on issues related to the initial constraint as well. In this way, leadership is ensuring today's problems are solved today so they are no longer problems tomorrow.

Finally, the organization needs to utilize a database or program in order to track, review, assess and communicate the constraint/ANDON issue and solution across the organization. Database options that are central repositories allow all constraint/ANDON data to be kept and documented in order to analyze occurrences and look for statistically significant trends. These databases ensure accountability of action items and long term support by providing data for CPI activities. Communications can also be improved since the databases detail who is responsible for the ANDON and what action items have been assigned/completed. It is important to communicate the identification of the constraint, the Root Cause Analysis, and countermeasure development because it enables all organizations to modify their like processes and prevent recurrence of the constraint.

6.4. Create a Culture of Problem Solvers

In his book Gemba Walks (referring to the place in the process where value is created), Jim Womack (2011,p. 105) talks about the difference between a traditional manager and a lean manager. He states:

> "In short, the traditional manager is usually passive, going through rituals and applying standard remedies to unique problems. By contrast, inside the mind of the lean manager lies a restless desire to continually rethink the organization's problems, probe their root causes, and lead experiments to test the best currently known countermeasures. When this lean mindset is coupled with the proper lean tools, amazing things are continually possible. "

This passage provides an excellent summary of the state of mind the Art of the Possible seeks to create for its organizations and managers. By creating a means to focus on the "buckets" of a complex process, then force the attention to improving the processes that contribute to, power and (especially) inhibit the desired pace of execution of those buckets (Speed), the AFSC seeks to create an environment that allows problems to be solved "where they live, in conversation with the people who live with them and whose current actions are contributing to the problem" (2011, Womack, p. 105). The Art of the Possible of managing processes requires the shift from traditional management of organizations to creating organizations that utilize the Art of the Possible methodology to solve process problems in the continuous pursuit of Art of the Possible results.

Once an organization has truly changed the way it thinks – it will not only have created a culture of problem solvers; it will also have created an organization of believers. Believers in their ability to affect change; believers in elevating constraints; believers in urgent resolution to protect the critical path of their processes; believers in the power of the enterprise; believers in focusing on improving processes in order to create Speed; and, most importantly, believers in the Art of the Possible. This section will provide tips for creating a culture of problem solvers and discuss indicators of true believers.

To this point, there has been extensive discussion on identifying gaps in order to focus process improvement efforts in order to create a step change in performance. But how does an organization leverage process improvement and link those gaps and improvements to execution? In the AFSC, the organization utilizes a Walk-the-Wall format that creates first, second and third level management ownership, involves the enterprise, and is periodically briefed to senior leaders.

AFSC Walk-the-Walls are set up around their process execution buckets. For example, a gated machine process that has Pre-Dock; Inspect; Repair; Ops Check; and Post Dock gates, has a separate quad chart for each respective gate on the wall. Each quad chart has the trend execution metric for the specific gate in one quad; the business rules that guide the gate in another quad; gaps identified for the gate in the third quad; and the improvement opportunities linked to resolving that gap in the last quad (See Figure 6.2). During the Senior Leader briefs, the charts are placed on the wall and each process improvement owner briefs their gate trends, their gaps and their resolution (the process improvement activity) to senior leaders. The owners are typically first and second line supervisors.

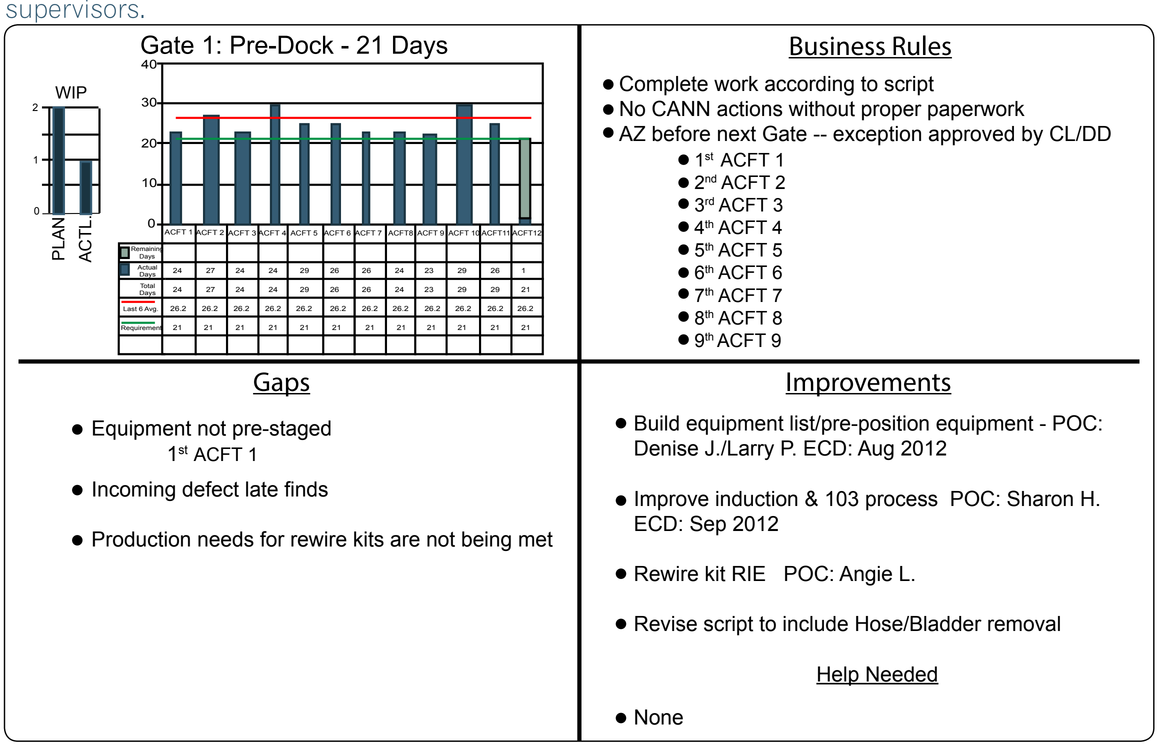


Figure 6.2: Sample Walk-the-Wall Quad Chart (click to zoom)

The power of the Walk-the-Wall methodology is the ownership for the gaps and improvements that is created from Squadron to first-level management. The creation of ownership for a gate, gap and/or improvement initiative is an important component in improving the performance of a process at the level of the process doers. Further, the Walk-the-Wall methodology creates a means for self-sustaining process improvement by the process doers and provides opportunities for both accountability and praise as the improvement initiatives and their results are briefed to senior leadership.

During the Senior Leader briefs, the charts are placed on the wall and each process improvement owner briefs their gate trends, their gaps and their resolution (the process improvement activity) to senior leaders. The owners are typically first and second line supervisors.

As the owners, it is important they are involving the necessary enterprise teammates and subject matter experts to resolve their gaps and improve their processes. Enterprise teammates are also present during these briefings in order to both show support for initiatives in which they play a part and also to continually understand the goals and initiatives of the organization to whom they provide support.

Walk-the-Wall methodology provides an opportunity for senior leaders to stay in touch with the trends, gaps and process improvement opportunities for a particular organization. It also provides an opportunity to provide guidance, encouragement and interaction with levels that formerly have been difficult for senior leadership to affect. In addition, senior leaders can glean a lot of information with regard to organizational maturity from these Walk-the-Wall briefings. Some key indicators for which leaders should look can be put into the context of language and the level of buy-in.

Language, with regard to Walk-the-Wall briefs, has several components. The first component is understanding. Does the owner (briefer) understand the execution data? Can the owner explain the gap? Does the information provided by the briefer appear to be scripted, or does the briefer "own" what is being presented?

Another language component is conviction. Does the briefer have conviction that the gap and its improvement activity will provide the gains necessary to close the gap between current execution and the goal? Can the briefer explain why the activity will make the gains? Does it appear the necessary enterprise teammates are involved in the improvement activity?

A final component of language is the difference between victim and owner mentality. Be wary of words that lead one to believe a gap is out of the control of the owner and is up to someone else to resolve. For example, if the primary driver of a gap is due to supportability of a particular part, a victim mentality would suggest that if the supply chain would make the part supportable, the process would be on track. Conversely, an owner mentality would suggest that 1) there is an understanding of how much of the execution gap is due to supportability; and 2) the owner is actively engaged in pulling together the necessary enterprise teammates to resolve the supportability constraint. Even if the briefer is not responsible for pulling the teammates together, as the owner of the improvement, the briefer should display a good understanding of the positive actions that are being taken for resolution.

Displaying an understanding of the machine, its gaps and what is required to get the machine on track, along with the conviction that what has been identified are positive steps toward achieving goals, complemented by an ownership (rather than victim) mentality are critical indicators that the briefer (and the organization) are maturing with regard to the Art of the Possible of approaching process improvement activities.

As senior leaders listen to Walk-the-Wall briefers, they should also assess the level of buy-in to the identified improvement activities. As the process owner, the briefer is responsible for "selling" the gap and improvement not only to senior leaders, but to those the process owner leads as well. If the briefer is not convicted, if they are not bought in, they will not be able to "sell" the need and method for improvement to the doers and supporters of the process.

There should be clues that the buy-in is not only from the briefer, but also from the process "doers." Look for evidence that the experience and opinions of subject matter experts is being harnessed and that out-of-the-box thinking is being encouraged. Words such as, "we pulled together several of our seasoned contract specialists and asked them to brainstorm ideas for improving this identified gap" or "we held a value stream mapping event that included subject matter experts for every function that touches the process" are indicators that steps are being taken to ensure opinions from those with "hands on" the process are being considered. Involvement of those that touch the process is the best method for not only gaining ideas to improve the process, but sustaining the change to the process as well.

As previously mentioned, in addition to assessing the maturity of the organization, the AFSC Walk-the-Wall methodology also presents the opportunity for senior leaders to provide guidance and encouragement to members of their organization. Senior leaders should not miss the opportunity to open the door for critical thinking and to celebrate small successes. This is an excellent opportunity to coach, mentor and teach everyone in the room at the Walk the Wall briefing.

While listening to the process owners' brief, look for chances to ask questions that drive the right behavior. If it does not appear the gap to the difference between actual performance and the goal has been identified, ask questions that help the briefer think about the true root cause.

Senior leaders should ask questions that challenge the briefers to truly understand the process machine. This does not mean the goal of the senior leader is to stump the briefer by asking difficult or obscure questions. However, do not miss the opportunity to nudge the organization toward a deeper understanding of their own machine and their own realm of the possible.

It is also important to recognize and celebrate small successes along the journey to Art of the Possible goals. However, do not allow these small successes to create complacency toward the larger goal. Encourage out-of-the box thinking to create engagement. With a truly engaged workforce, the boundaries of traditional thinking can be lifted, and freedom from the "good enough" approach can be obtained, as AFSC organizations reach for Art of the Possible results.

The AFSC needs believers. Believers that Art of the Possible results are indeed obtainable. How do organizations know if they have believers?

Believers in the Art of the Possible speak in terms of their machine. They express impacts in the language of the machine. They frame future scenarios in terms of the machine. Everything from furlough and supportability impacts to new workload requirements – are all expressed in terms of how they affect the specific AFSC machine.

True believers in the Art of the Possible no longer see constraints – they see opportunities. Think of the power to be harnessed when an entire Sustainment Center believes that every constraint encountered is an opportunity to examine the process and harness the power of the enterprise to resolve any issue in order to gain the necessary outcomes. The AFSC desires to create a culture of problem solvers intent on identifying and resolving the constraints that provide opportunities for reaching Art of the Possible results to make the Art of the Possible the standard by which all competitors are measured.

The AFSC needs believers. Do you believe?

7

SUSTAINING SUCCESS

Air Force Sustainment Center: Art of the Possible

Chapter Topics

The essential elements of creating an AFSC machine, leveraging the power of the enterprise to eliminate constraints and focusing the organization on improving machine processes in order to create the throughput necessary to deliver AFSC products within its tenants of Speed, Quality, Safety and Cost have been extensively discussed thus far. In order to sustain the desired success to achieve Art of the Possible results, a method must exist to monitor process execution trend data in order to measure process execution results. Additionally, there must be a means of determining the maturity of the organization with regard to its understanding and application of the Art of the Possible.

What are the essential elements to maintaining a successful AFSC machine? Meeting alignment is important because it connects the machine vertically – from the process doer to senior management, and horizontally – to all enabling teammates. Meeting alignment also provides the opportunity to elevate constraints that are affecting the machine during execution. The element of metrics creates the ability to determine how well the machine is working – the velocity and consistency of its throughput.

An additional component of success in the AFSC environment is having a method to measure how well the essential components of the Art of the Possible methodology are understood. Toward this end, the AFSC has created a measure of maturity of the Execution steps depicted on the Radiator chart. This measure is codified in a maturity matrix, which is complemented by a rating system. Methods of utilizing meeting alignment, metrics and maturity matrix methodologies to sustain success are the topics of discussion in the chapter.

7.1. Meeting Alignment

Chapter 5, A Closer Look at Execution, discussed the necessity of following a standard script within an AFSC process. The purpose of the script is to ensure everyone touching the process understands what steps will occur next. This visibility and transparency enables supporting functions to ensure supportability of those next steps prior to their execution with the goal of enabling the process doer to seamlessly move from one task to another. The process script thus becomes the basis for moving the process forward. Any constraints along the critical path of that script needs to be resolved with urgency as discussed in Chapter 6, A Culture of Problem Solvers.

The idea of meeting alignment is to create an environment where all levels of management, from the process doer to the AFSC Commander, have visibility of the progress of the execution of the AFSC process scripts relative to their level of need. As each level is removed from the actual day-to-day execution of the process, less detail of the actual script progression is needed, and more information as to execution trends is necessary. This represents the vertical component of meeting alignment – connecting the process doers through all levels of management to the AFSC Commander.

An additional component of meeting alignment is horizontal visibility. The horizontal component connects the organizations enabling the execution of the process to the process script. It provides supporting organizations the ability to see how they can help move the process forward and prioritize its efforts toward those actions that provide the largest impact. Well executed meeting alignment creates transparency throughout the enterprise both vertically (doers to leadership) and horizontally (teammates) with the foundation of achieving the "Road to…" goal and Art of the Possible results.

Meeting alignment means the information discussed and tracked at the process execution level, rolls up to the next level, culminating with metrics briefed and discussed at the AFSC Command level. As the information transpires and elevates to higher levels, the level of detail with regard to the day-to-day execution of the process diminishes and is replaced with a focus on trends and constraints. In order to accomplish the horizontal component of meeting alignment, attendance by supporting organizations is required at each level of meeting. This presence ensures the supporting organization has the site picture of the constraint and its effect and can engage in active dialogue to extract any missing information.

Examples of meeting alignment application in production environments follow. Please note that although these are examples in a production setting, the ideas promoted can be easily translated for application in any process environment. The key is to understand the process being measured and monitored and create a method to review the process at appropriate intervals to ensure the processes are executing and improving at the necessary pace.

Aircraft Production Setting

Meeting alignment starts daily at the point tasks are assigned to the process doer. Task assignment should include a discussion of the status of the project, along with the current day's goals and objectives, given in the context of longer term goals and objectives (such as how the current day's goals contribute to completing the current process gate) in order to frame the urgency of accomplishing the current day's tasks.

In larger project environments, the next meeting level would be a team of individuals responsible for overseeing the progress of the specific project. In an aircraft production environment, this is called a Tail Team meeting. The Tail Team consists of the aircraft schedulers, planners and first-level supervisors responsible for the execution progress of a particular aircraft (project). This team discusses the progress of the project in relation to the script, noting any problems or resulting changes in sequence of work activities required to keep the project moving forward along its critical path.

Constraints noted during the Tail Team (Project Team) meeting are evaluated for their effect on the critical path. Constraints that are likely not to be resolved prior to their impact to the critical path are elevated to the next level. This elevation must include a description of what the impact to critical path will be, when the impact will occur and a description of the critical elements of the constraint along with details of the efforts that have been undertaken thus far to resolve the constraint. The tail/project team should also discuss what actions need to occur to recover any time lost on the critical path – thus attempting to keep the project on schedule to the organization's "Road to…" goals.

The next meeting level is with the level of leadership that has oversight over all the projects in their organization. For example, in the aircraft production environment, this meeting (called the daily production meeting) is led by the Production and Support Flight Chiefs and is attended by the level of supervision of those participating in the tail team meetings. This meeting discusses each aircraft (project) in the context of its relation to where it is compared to where it should be along its critical path. This meeting is the receiver of the information with regard to critical path constraints that has been elevated from the tail team. The supervisors of the tail team members relay this information in this meeting. This meeting is also attended by members of supporting organizations to allow those organizations to receive the constraint information and engage in dialogue that leads to ultimate resolution of the constraint. This is also an essential meeting for constraint team members to attend – allowing them to quickly react to constraint information and report any actions being taken.

The next level of meeting is led by the next level of leadership in the organization's command chain. For example, in an aircraft production environment, the Squadron Director (supervisor of both the Production and Support Flights) leads a weekly Fixer meeting. This meeting is attended by the same members of the daily production meeting as well as the supporting organizations. This is the meeting where the transition from daily progress status to execution trends begins.

In the Aircraft Fixer meeting, the Squadron Director is briefed on the status of each aircraft and its constraints by the Production and Support Flight Chiefs. The meeting begins with a discussion of open and possible ANDONs for the projects in question. The organization with primary responsibility for the ANDON briefs the status of the ANDON to include a summary of the efforts undertaken to resolve, the current status and current/future impacts of the constraint. Additional help required, or additional actions to keep the resolution of the constraint moving forward can also be discussed.

The briefing of each aircraft is confined to critical path discussion with possible constraints noted and discussed. In addition to the critical path status of each project, the overall trend of each process gate is noted. The briefer must impart an understanding of the cause of any gates that are executing slower than the goal for the gate; thereby providing an indication of the gaps to desired execution performance.

Finally, the briefer addresses improvement initiatives currently underway to improve execution performance within the gate. These initiatives are depicted as starbursts on each gate trend chart. Starbursts (improvement initiatives) are the key to creating a focus on the process with an ultimate goal of positively affecting the overall performance of the process machine. It should be noted that an emphasis on critical path processes will have the most impact on overall execution performance. The next meeting level is at the group level with each squadron briefing the status of their gates. This meeting is known as the Execution Meeting due to its sole focus on the health of each organization's process machine performance to their "Road to…" goals. The meeting primarily follows the process and format discussed above for the squadron Fixer meeting, but with less emphasis on project (aircraft) details, and more emphasis on higher level constraints, to include ANDONs as well as watch items that could keep a project (aircraft) from timely gate transition.

This meeting is attended by the Flight Support and Production Chiefs, with the Support Chief briefing the ANDON constraint and resolution chart and the Production Chief briefing the gate specific progress. Customer (aircraft SPOs) and supply chain representatives for each squadron also attend this weekly meeting.

An additional element available in this meeting is the opportunity for each squadron to hear and learn from the execution constraints and activities in other squadrons. Thus, this meeting provides an opportunity for group leadership to teach, coach and redirect squadron and flight leadership collectively.

Back Shop Production Setting

Back shop type production organizations across the AFSC have adopted a formal meeting alignment approach known as the Tier System. Figure 7.1 depicts the basic Tier System process that begins at the shop floor (Tier 1) and culminates with group leadership (Tier IV) on a daily basis. Similar to the aircraft production alignment approach discussed above, the Tier System is based on the script in place at the shop floor level. The Tier approach also incorporates Speed, Quality and Safety metrics, monitors output, elevates issues and keeps production goals in front of everyone – from mechanics to support organizations to leadership – daily.

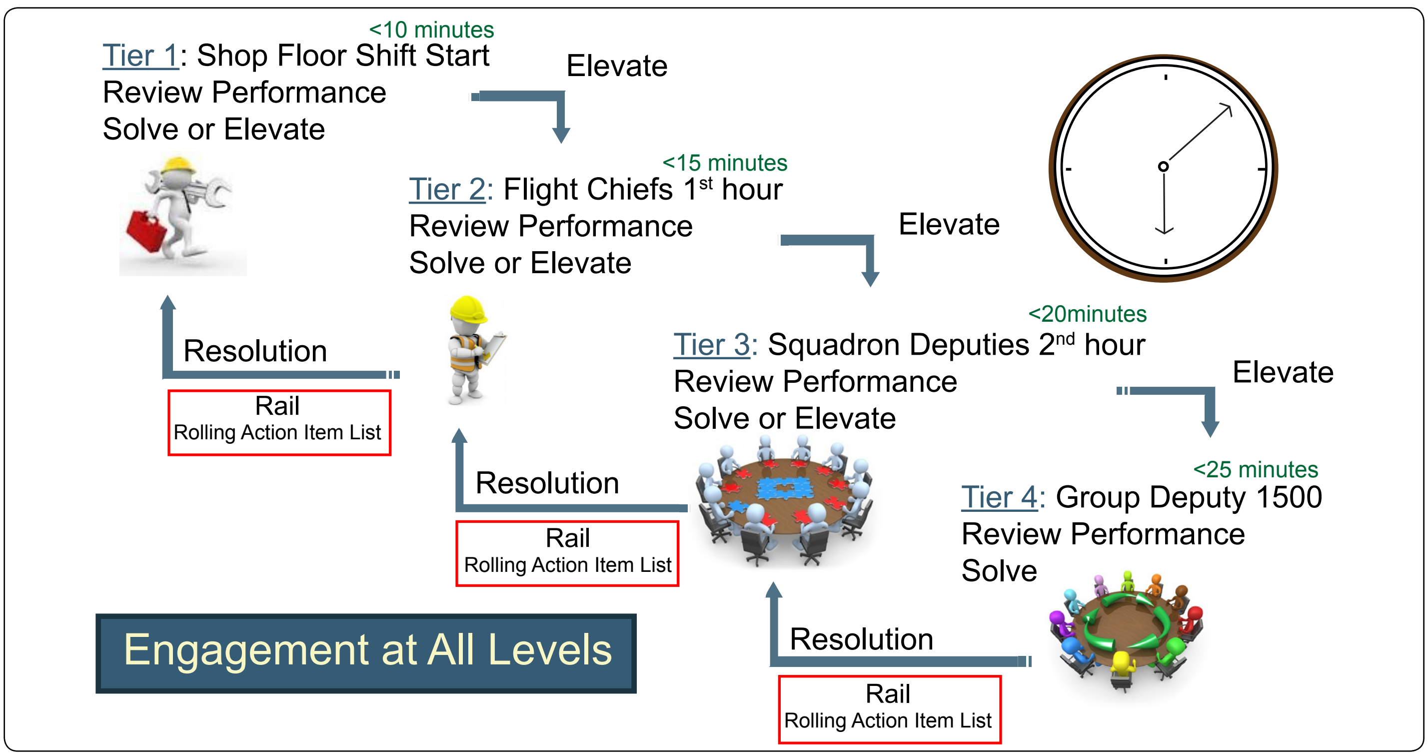


Figure 7.1: Tier Meeting Alignment System

Including the process doers – the shop floor mechanics – in the Tier System gives those doers ownership in solving issues and changing processes in order to meet organizational "Road to…" goals. This process is repeated at the flight (Tier II) and squadron (Tier III) levels. This commitment to daily process review through all organizational tiers sends the message of the importance placed on improving process performance to gain the desired Speed.

Tier meetings encourage problem solving at every level, creating a problem solving synergy that goes beyond the capabilities of even the wisest and most experienced lone Production Manager. A fundamental component of the tier approach is the inclusion of a scripted flow diagram for each meeting level of the system. This script ensures the meeting dialogue is centered on the process and its constraints at each meeting level. Placing the focus on the process removes emotions and allows discussion to concentrate on resolving process constraints. The Tier approach also provides a systematic, standardized format to allow constraints and ANDONs to be communicated and/or elevated to the next level. In the Tier system, unresolved ANDONs are placed on the Recurring Action Item List (RAIL) and persist at the Tier IV level until they are resolved.

Complex and Command Alignment

Lower level reviews should culminate with summary reviews of performance at the Complex and AFSC Command levels. Complex and Command meetings should be less focused on the daily execution details and more focused on the overall performance trends and improvements. Meetings at this level should also include enterprise teammates – customers and support organizations – in order to have focused discussions of resolution efforts to current ANDONs and constraints.

At Complex level meetings (which occur on at least a monthly basis), ANDON resolution status is generally briefed by the organization with primary responsibility for resolving the constraint. Group commanders provide a summary roll up of quarterly and annual execution expectations while Squadron Directors brief their execution status with a review of trends and improvements in specific gates or buckets of activity.

At the AFSC Command level, all complexes and their stakeholders are represented in a review of quarterly execution status. In this review the logistics and supply chain functionalities provide a review of supportability expectations in strategic, operational and tactical views. Group Commander's brief current execution trends for each project family, with projections for the next quarter and compared to execution goals.

Story Alignment

The meeting alignment methodologies discussed previously were very focused on the review of performance of the process to include its execution trends, constraints and improvement initiatives with a concentration on measures of Speed. However, there are other meaningful metrics of measure for any organization. In a production environment, some of those metrics include measures of quality, safety, production hours, efficiency, overtime and yield. All of these measures are based on the "how" of producing the same output of value monitored in the meetings that discuss Speed. Therefore, an additional element of meeting alignment is the idea of story alignment within the various review forums for an organization.

To illustrate the idea of story alignment, picture an organization that is producing assets well ahead of its "Road to…" goal. The expectation would be that the organization would also be ahead of its production hour metrics and there would also be an expectation for good efficiency measures as well. However, if the organization also had high overtime percentages and an increasing quality deficiency rate, the expectation would be for the improvement initiatives discussed in the performance review meetings to encompass initiatives that would ultimately reduce overtime and improve quality. Hence, the story line for the organization in each forum would align.

Although these examples have been very production oriented, it is easy to see how the basic components of meeting alignment can be applied to the review of any process. The review must start at the lowest level – at the point where the process doer is assigned work with the expectation of creating value – and should continue through to each level of management with a focus of understanding the status of the overall process performance in relation to its goals, constraints and intended improvements. Finally, the story line weaved through each forum of organizational measurement should align to paint the same picture of the organization.

7.2. Theory of Metrics

Metrics are used in every organization for a variety of reasons. There is the intended purpose of a metric, which is to monitor and manage specific aspects of organizations. There are also unintended consequences of metrics driving bad behavior. Metrics are used at various levels within the AFSC; strategic, operational, and tactical. The goal of any metric should always be to drive the right behavior and provide insight into the health of the operations. The AFSC is striving to minimize the metrics required to run the organization while at the same time looking out for duplication in metrics. There is an ongoing effort to create and manage with universal metrics that are seen from the AFSC Commander down to the shop floor mechanic.

Metrics are a necessity for any organization to be successful. They provide insight into the organization and the critical information to make data driven decisions to improve performance. AFSC has many, many metrics that have been created over the years. It is necessary to understand which type of metric is the most suitable for any given situation. The goal of the metric should drive the type of metric used. For instance, there are metrics by month, year to date metrics, sand charts, line charts, bar charts, charts comparing multiple years, and statistical charts to name a few.

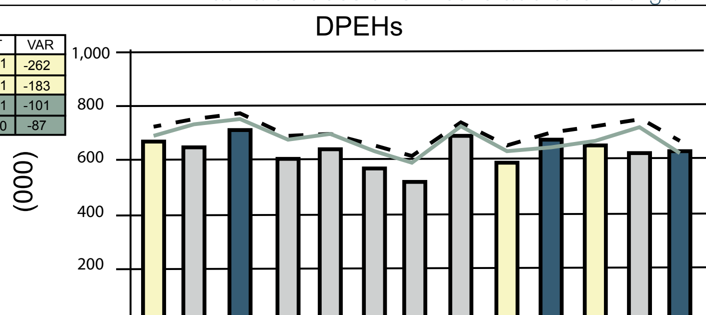
There are a lot of items to think about when looking at a metric to avoid confusion or being misled. One of the most common issues with a chart is the scale. When reviewing a chart be sure the scale of the chart is appropriate, especially if you are comparing multiple charts. The scale of the chart can create the appearance of extreme variances which may lead to drawing the wrong conclusion pertaining to the situation. Another item to be aware of is what is considered to be green or positive for an individual chart. For instance, some charts may require negative numbers to yield positive results. It makes it critical to take the time to understand the aspects of the chart before trying to interpret the chart.

Metrics should evolve with the organizations. Over time the needs of an organization change and so should the metrics. With that thought in mind, continually examine if the metrics of the organization continue to be valid and necessary. There is nothing worse than wasting the time and capabilities of people to populate and maintain metrics that either have no value or never get used. Do not be afraid to challenge the validity of a metric if it doesn't make sense. Just because it has been used for 20 years doesn't mean that it is still value added. There should be a process for reviewing recurring metrics and reports to ensure there is no redundancy and that they are still needed.

The quality of the metric must also be analyzed for effectiveness. The metric is only as good as the data in the metric. Therefore there must be sanity checks on the data going into a metric to ensure accuracy. There have been instances where incorrect/corrupted data has been reported in a metric which has led to bad decisions. Never underestimate the amount of decisions made on metrics. This sole reason is why valid, accurate, effective metrics are critical to the success of an organization.

The driving force behind metrics is to have the organizations critical information available to analyze in order to make strategic, operational, and tactical decisions day to day. If the metric is not assisting that function then the value of the metric should be considered. Upon arriving to an organization it is critical to take the time to understand the metrics within the organization, their purpose, and how they are being used throughout the organization. While going through the process of understanding the metrics consider these questions:

- Is this metric valid to the organizations goals?
- Is the data in the metric accurate and reliable?
- Is the organization measuring the right things?
- What decisions are being made based on this metric?
- What value does this metric add to the organization?



FY YTD	TAR	ACT	VAR
2013	5,893	5,631	-262
2012	5,664	5,481	-183
2011	6,182	6,081	-101
2010	6,267	6,180	-87

	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
MTD Actual	665	662	739	613	637	589	554	674	595	669	656	621	636
MTD AP Target	689	716	749	652	672	621	593	718	625	656	688	719	626
MTD Variance	-24	-54	-10	-39	-35	-32	-39	-44	-30	13	-32	-98	10
WLR Target	707	747	781	680	672	643	614	748	650	683	722	755	657

Figure 7.2: AFSC Production Hours Example (click to zoom)

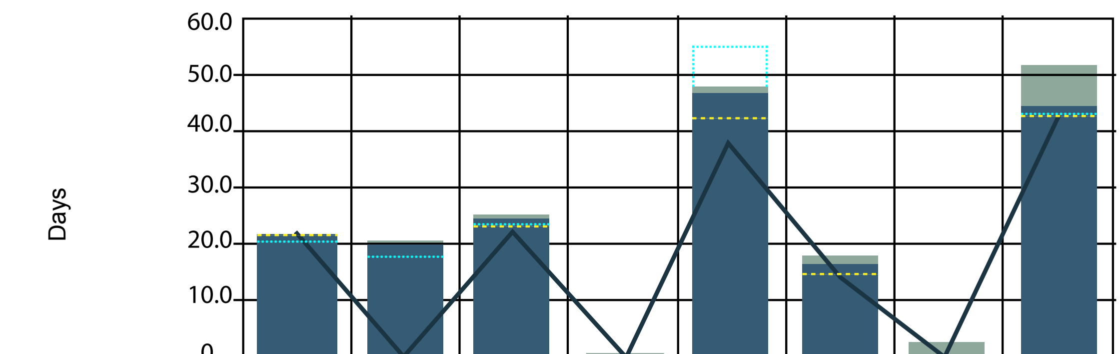
Figure 7.2 is an example of a typical chart within AFSC:

This metric shows actual production hours as it relates to two different targets with a variance. It is charted monthly with previous year information in the upper left hand box. Notice that each bar is color coded based on the variance to target. This chart, like most charts, is full of both useful information as well as deceptive information. It provides monthly trends as well as how this year compares to previous years.

It is important to not assume anything when it comes to metrics or the data within a metric. For instance, a person may draw the conclusion that because this month's number is significantly lower than last year's number the organization is performing poorly. Enough questions to fully understand the dynamics of the information should be asked or the real root cause behind the difference may be missed. For instance, the difference between this year and last may be due to severe weather or other constraints not initially visible by the data alone.

Another important point deals with targets in general. People like to measure themselves and set targets for everything. It is important to keep in mind the first rule of target building is all targets are wrong. This statement is not intended to dismiss the efforts or value of target building, but rather to emphasize the need to understand the purpose of the target. In most cases, targets are built as a general guideline to manage resources. Targets can also be necessary to allocate resources or determine the amount of resources needed to accomplish a given target. When viewing a chart that shows a significant variance between targets and actuals it may be caused by the target. There are almost always changes after the target was developed that may now be causing the variance. Understanding this may prevent driving the organization to accomplish a target that is no longer achievable or, in some cases, valid.

For instance, if the original customer requirement to produce 10 aircraft in a given year changes to a requirement of five during the year of execution due to a change in fleet size changes, how does this affect the target? One way to look at it is to say the original target was 10 aircraft, thus the target remains 10. However, if targets are viewed as a starting point and fluid in nature the target would now be five as the requirement has changed to five. The AFSC philosophy revolves around maximizing the ability to be flexible for the customer and adjust as the requirements change. This may be the single most difficult goal to achieve because of the vast amount of variables and moving parts within the production machine, but the most important to viability and future success of the AFSC.



	Pre Dock	Queue to in dock	Inspection	Queue to repair	Repair	Restore/Ops Check	Post Dock Queue	Post Dock
Last 6 A/C Avg	20.5	19.5	24.0	.8	45.7	15.5	0.0	44.2
End of 2nd Qtr FY13	19.3	20.0	25.4	1.3	48.8	18.2	1.8	51.4
Requirement	21.0	0.0	21.0	0.0	38.0	15.0	0.0	43.0
End of 3rd Qtr FY13(pro)	20.6	17.2	22.8	0.0	54.6	16.2	0.0	43.8
End of 4th Qtr FY13 (pro)	21.0	0.0	22.5	0.0	43.0	15.6	0.0	43.0

Figure 7.3: AFSC Gate Summary Example

Figure 7.3 is an example of one the most common metrics across the AFSC. This metric is referred to as a gated process chart. It typically displays processes broken down into smaller segments and utilizes days as the unit of measure. The gated chart approach is extremely versatile and can be applied to any production process and almost any overhead process as well.

There are many benefits and insights provided by this metric. The step that is slowing the entire process down is immediately visible. The change in execution from quarter to quarter is also visible as well as how a gate is tracking to the requirement. This metric can also provide insight into how the workload is distributed from gate to gate and help to identify traveling work --- defined as work that i should be performed in one gate, but gets pushed to the next gate for a variety of reasons.

The examples provided are intended to guide an understanding of the key components of good metrics and provide a better understanding of pitfalls possible when reviewing a metric. Good metrics are necessary to drive the desired behavior within AFSC organizations. A necessary metric should complement the organizational goals and enable the organization to identify execution gaps that are hindering performance. Metrics should also aide an organization to understand if the gains they have made are being sustained. The real value behind any metric lies with understanding how the target was developed and what circumstances have led to variances from the target.

7.3. Culture Evolution–Maturity Matrix

Thus far, there has been discussion on the importance of leadership with regard to creating "an environment for success" and how establishing a "Road to..." goal provides the foundational step in the journey towards achieving an "Art of the Possible" mindset. There has been discussion of how the foundational production principles of Little's Law, Theory of Constraints, and Drum Buffer Rope can be applied to create the "science" for designing and operating AFSC production machines. There has also been discussion of how standard work, visual management, and tech data/engineering support set the stage for efficient execution and in the preceding chapter discussed the value of creating a culture of problem solvers.

But how does it all come together to ensure the organization moves forward in its evolution of the Art of the Possible? In an effort to answer that question, and to establish a singular sustainment "game plan" for the enterprise, the AFSC Sustainment Execution Model was created. Graphically represented in figure 7.4, the Execution Model brings the leadership focus and the science of throughput together into a single "game-plan" that represents the vision of how an AFSC process machine will be set up to achieve "world class" status and "Art of the Possible" results.

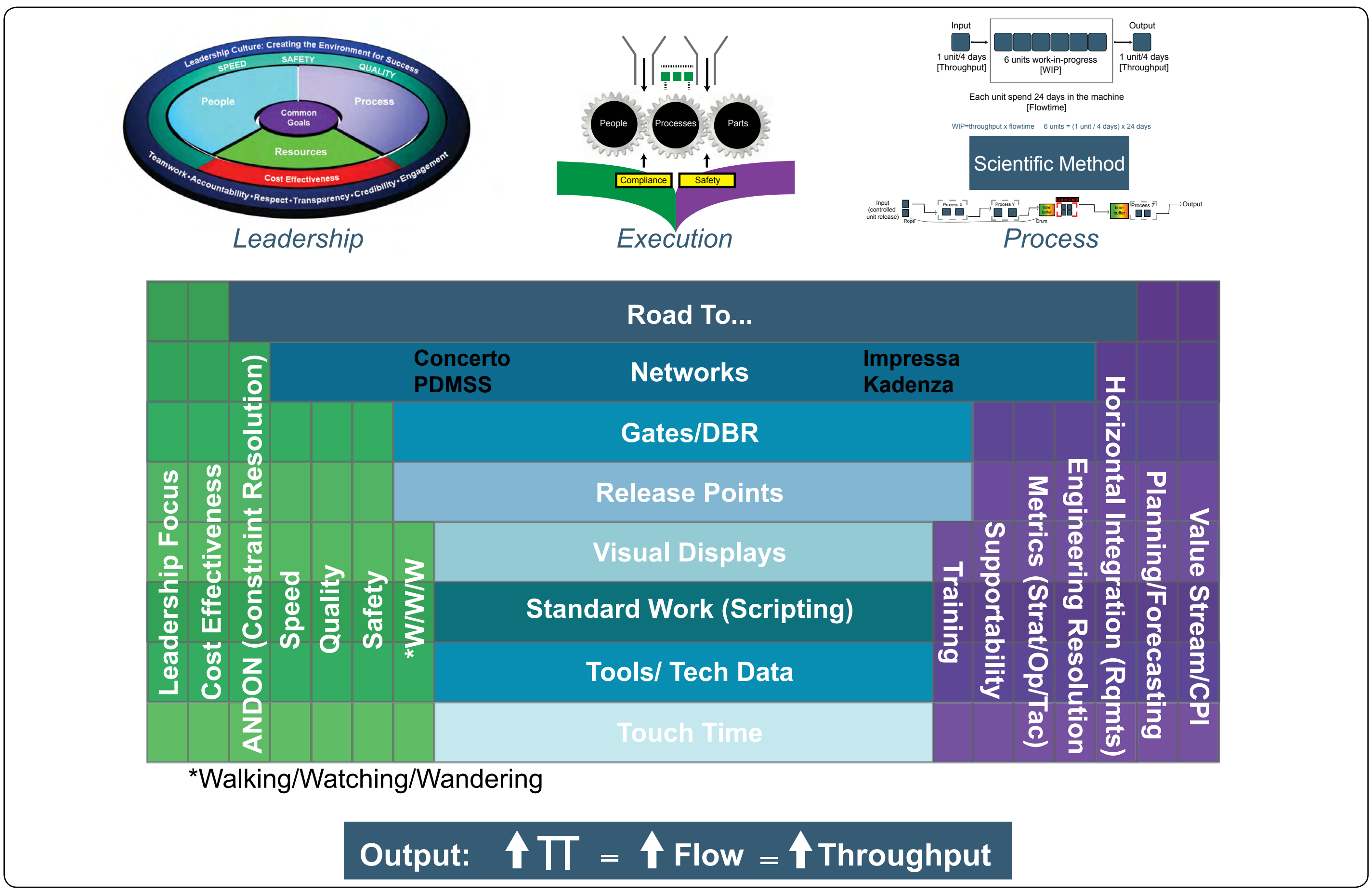


Figure 7.4: AFSC Execution Model (aka The Radiator Chart)

Within the model, the horizontal and vertical lines are intertwined to represent the complexity and interdependence of its components. Focusing on select areas of the model in isolation will not translate to success. Success depends on focus and implementation of all areas of the model as a whole. Leaders will need to utilize and leverage the unique capabilities encompassed within each bar of the model to unite the vertical leadership and process qualities with those of the horizontal execution qualities in order to optimize the flow of products and services through the entire depot process. Following is a discussion of each element (bar) on the model.

Horizontal Bars

There are eight horizontal bars that represent the execution elements or blueprint for setting up the machine. These are in order of strategic to tactical.

"Road to…"

The "Road to…" bar communicates the need for a future-state goal that will be used to set the pace for throughput and focus the Enterprise in the same direction. It is the road map for accomplishing "Art of the Possible" results. It includes the process of communicating the goal up, down, and across the enterprise and requires stakeholders' ownership and integration of the goal into their objectives.

Networks

This is the execution plan, paced to the "Road to…" goal. The network defines the critical path/chain and serves as the basis for creating repeatable, disciplined production processes. Networks are contained within systems (such as PDMSS, Concerto, Impressa and Kadenza) that provide a means to measure and monitor the status and pace of production during project execution. Understanding and protecting the critical path/chain during execution is a foundational concept throughout the Art of the Possible of management.

Gates

Refers to the practice of breaking long flowtime production "machines" into "buckets" or discrete increments of work along the critical path/chain with tangible ending points. The use of gates creates a disciplined monitoring system with a focus on critical path/chain urgency. Continued Process Improvement (CPI) efforts should be tied to improving the performance of under-performing gates.

Release Points

Release Points within the gated process instills both the mindset and the discipline to not pass work and problems to later gates – especially as it relates to the critical path/chain of the production flow. Release points require business rules and checklists to create the culture and awareness that ensure specific actions are taken by critical points in the production process. Creating a culture that uses these rules to create the urgency necessary to elevate and resolve issues prior to the release point (and protect the critical path/chain) is essential to creating the type of throughput that leads to attaining an "Art of the Possible" mindset.

Visual Displays

This is one of the elements that can answer "How do you know you're having a good day". These are boards on the production line which identify Speed, Quality, and Safety. The visual display boards should be mechanic-centric – allowing the mechanic to understand their role especially as it relates to the critical path/chain of execution.

Standard Work (Scripting)

Creating standard work processes through gated scripting efforts allows resources to be synchronized to the needs of the product/project during execution. The focus is to create repeatable processes, which lend themselves to total transparency and are designed to eliminate constraints and enable a predictive repetitive process.

Tools/Tech Data

Follows standard work and involves giving the employees what they need. Addresses all tools required in all areas of the complex that surround and impact the mechanic and critical path. If this bar is achieved properly the next bar, Touch Time, will be positively affected.

Touch Time

Involves keeping hands on the product/project. Kitting of assets needed during execution is an example of touch time reduction efforts. What can be done in any and all areas that surround the mechanic that can positively affective their output along critical path.

Green Vertical Bars

These vertical bars are focused on the leadership aspect of the enterprise and are used to set the organization up for success. Systems and execution tools do not give you permission to not manage process and people. Leadership sets the tone for effective constraint elevation and resolution that leads to the execution of efficient processes and achievement of the "Art of the Possible" mindset by the organization.

Leadership Focus

Leadership is responsible for building the proper environment. Leadership must continually drive their organization to understand where the problems are and determine how to fix those problems in order to move the organization forward. Leadership must be comfortable in red – with a focus to get back onto the critical path.

Cost effectiveness

Means to measure the impact of processes and output. As your processes improve, output should increase without increasing cost. Savings should start to be seen in the form of time and money.

ANDON

Notification of when a process is off the critical path/chain. Refers to identifying, elevating and resolving constraints BEFORE they have a negative effect on the critical path/chain of the project. Involves allowing our Teammates help us resolve issues.

Speed, Quality, and Safety

These are the three important touchstones of the Art of the Possible. Speed - our output and improvement to ensure aircraft availability. Quality- because this is our reputation. Safety – because we need to protect our people. Lead with Safety and Quality – then let Speed catch up.

Walking, Watching, and Wandering (W3)

Using these will aid in answering; "Why are people not on task?" Three things supervision needs to do and three things to ensure mechanics are not doing. Eliminating W3 by the mechanic improves touch time and creates a "Minutes Matter" mentality.

Purple Vertical Bars

These vertical bars are focused on the processes that enable success within the enterprise. Leadership will utilize these "tools" to achieve the "Art of the Possible" mindset throughout their organization. These bars are not intended to just improve performance, but will deliver sustained and enduring performance.

Value Stream (VS/CPI)

Data from established gates and release points gives you the information necessary to identify problem areas to focus process improvement efforts . Success should be measured against your" Road to…" goal. Success is measured by results not activities and comes from obtaining knowledge from the level closest to the process.

Planning/Forecasting

Good planning translates into good forecasts that allow the supply chain to strategically plan for the needs of the enterprise. Collaborative planning with all functions in the supply chain (i.e. SPO, Facility Engineers, Maintenance Planning and Production, DLA and the 848th,etc.) translates into better forecasts for requirements which allows a proactive approach to supportability.

Horizontal Integration

Speaks to the increased "synergy" that is possible when all members of the MDS enterprise adopt and work toward the "Road to…" goal.

Engineering Resolution

This focuses on getting final defect resolution in a timely manner and with minimal 202s. The resolution must be focused on a collaborative solution that provides an airworthy aircraft back to the war fighter while recognizing the time constraints associated with depot repair. Leadership must set the tone as a demanding customer that clearly communicates depot repair needs to be considered in the repair disposition.

Metrics (Strat/Op/Tac)

Metrics are the foundation of a data-driven organization and must be aligned from the strategic through the tactical levels. Metrics should be clear, actionable, and relate to critical path/chain of the product/project. However, leadership discernment is required to react to data and metrics in order to allow experience to drive interpretation of the data as it translates to action.

Supportability

Involves proactive actions to move supportability efforts to strategic and operational based on findings and experience at the tactical level. Aggressive constraint identification-elevation-resolution efforts at the tactical level keep the plan executing along the critical path/chain.

Training

Focused on the mechanic and linked to their tasks. Also involves training mechanics to elevate problems and needs because having what you need eliminates the push to "do what it takes."

The Execution Model horizontal bars represent the standard vision of how production machines across the AFSC will be setup to achieve "world-class" status. As such, these execution elements then become measureable expectations of sub organizations throughout the AFSC and the game-plan to achieving success within the Art of the Possible.

Game-Plan Maturity Matrix

In an effort to measure the transformational progress towards world-class status envisioned by the AFSC, the Game-Plan Maturity Matrix was created. The Maturity Matrix is a measurement tool used by leaders to add transparency to their organizations (Figure 7.5). Typically used at the squadron or business unit level, the Maturity Matrix template provides a common "yardstick" to self-assess how well an organization is implementing the science necessary to reach "art of the possible" results for the AFSC. By assessing unit status for each of the horizontal "execution" bars, the Maturity Matrix helps provide a top-to-bottom view from "Road To…" goals to floor-level "Touch Time."

The three Air Logistic Complex (ALC) Deputy Commanders for Maintenance (DCM) jointly maintain four versions of the Maturity Matrix templates: Gated Process, Exchangeables, Software, and Missile Maintenance. Using the appropriate template, like units across AFSC may self-assess using a common standard. For example, regardless of location, Commodities Maintenance Squadrons at each Complex measure against the

Road to...

	Set-Up		Institutionalization		World Class
	1	2	3	4	5
Road to...	Goal created based on current AFSC or Complex Strategic Plans, future customer requirements, or existing capacity	Goal communicated to Key Stakeholders and Leaders down to the Flight level	EVSM with Mission Partners has been completed; all mission partners accept the Road To goal and path Goal communication to all levels within Complex organization down to the mechanic, and across partnering organizations WIP Reduction, CPI, and Constraint Buster Units are operating and linked directly to Road To Goals	Goal is communicated across AFSC enterprise, supporting organizations in particular (DLA, SCMW, Functionals, Supporting Production Groups) Stakeholder metrics and leadership objectives aligned to Complex metrics and objectives Significant Progress on Road To Goal with incremental goals achieved Targets have been adjusted to achieve stretch goals, second pass EVSM with mission pass complet-ed	ENTERPRISE ALL-INI Goal is adopted and worked toward by all stakeholders; up, down, and across Center, Complex and Stakeholder leadership integrating and influencing strategic objectives and initiatives across all parts of the Sustain-ment and Life Cycle enterprise based on Road To goals Road To goals like production groups across the AFSC (all 3 ALCs) have been integrated to establish a collaborative vs competitive environ-ment

Figure 7.5: Maturity Matrix example (click to zoom)

same "Exchangeables" Maturity Matrix template. Any recommendations to update a Maturity Matrix template should be forwarded to one of the DCMs.

The Maturity Matrix establishes a 1 through 5 grading scale for each Execution Element of the AFSC Execution Model (each of the eight horizontal bars). This grading scale defines stages of maturity moving from initial set-up to institutionalization to the ultimate goal of establishing a "world-class" organization.

Criteria for assessing the organizational stage of maturity are listed within the matrix under the respective grading scale number. The verbiage is succinct in nature, but creates a well-defined common language by which like organizations within AFSC can grade themselves. The criteria for moving from 1-5 on the grading scale becomes progressively more difficult to achieve and drives leaders to reach outside their own organizations for support. This is by design and is intended to strengthen and drive additional collaboration within and even outside of the enterprise.

Leaders utilizing the Maturity Matrix should thoroughly understand the criteria for each stage of maturity and transparently assess their organizations against it. They should also understand that advancing through the stages in the Matrix will be difficult and whereas achieving a level 1 or 2 may be fully within their control, achieving level 3 or beyond may require enterprise alignment and the commitment of external stakeholders. Additionally they should understand that in order to progress to the next level of maturity, **each of the criteria must be met within that level**. (Example: 2 of the 3 criterion for level 3 maturity on the "Road To…" execution element being met means that the organization should be assessed at a level 2 for that element).

The criteria verbiage may appear to be subjective in nature, but when asked to present the assessment, leaders should be prepared to describe and provide evidence of the rating they have chosen. Though presentation requirements may vary from organization to organization, several constants remain: what is your currently assessed maturity rating; what evidence supports your assessment, and what actions will be taken to advance to the next level or desired state? Figure 7.6 depicts an example briefing template that can be used to present the assessment via an established briefing or periodic opportunities.

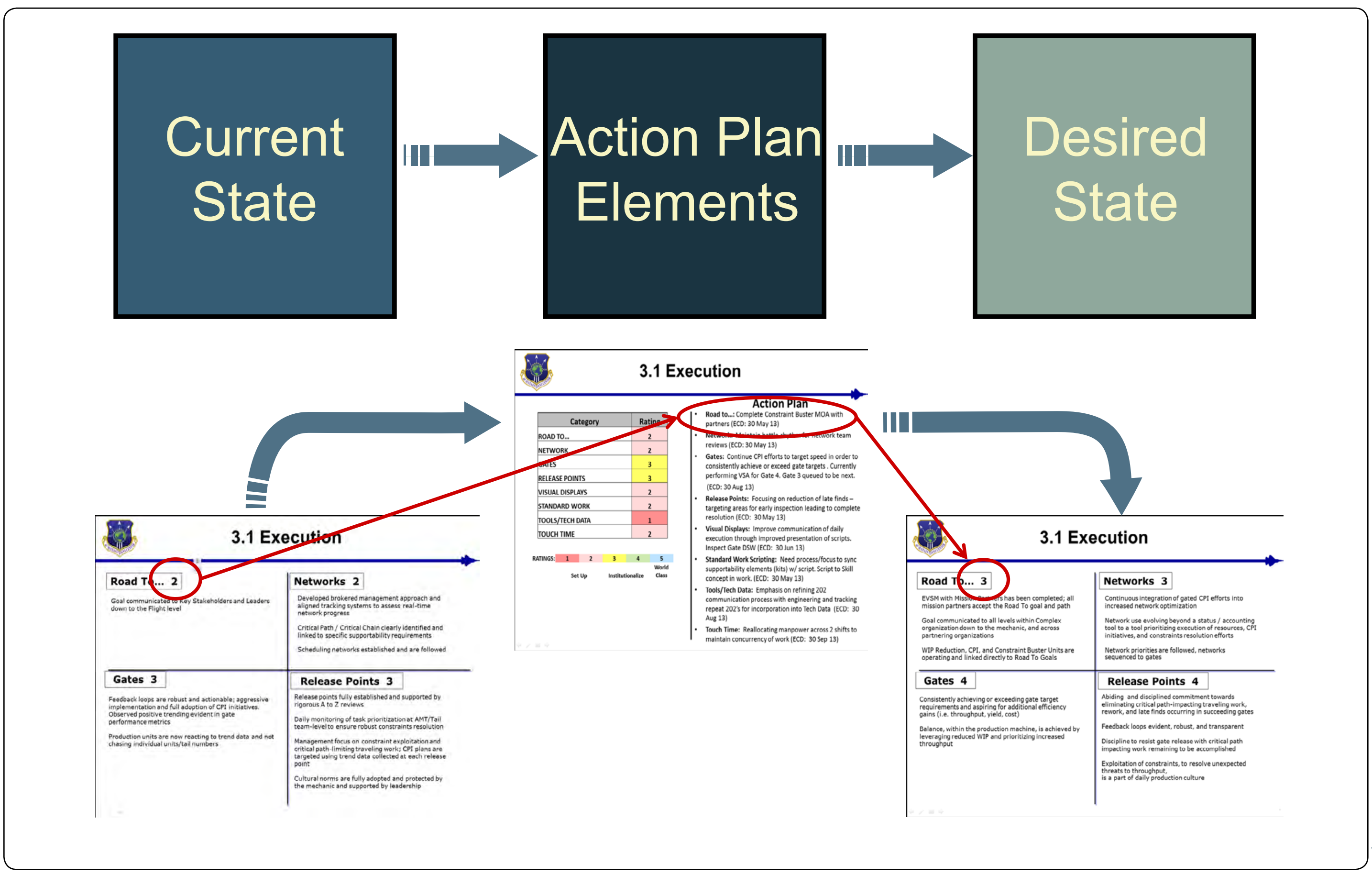


Figure 7.6: Sample Maturity Matrix Briefing Template

Importantly, focus on the Maturity Matrix must not distract attention from actual, day-to-day unit performance. To avoid confusion, it is recommended that Maturity Matrix status be briefed as a standalone meeting, and not simultaneous to a maintenance production meeting. A "maturity" score reflects the state of the unit's production machine, a critical self-awareness of the current maturity level of the unit and how it will progress towards world class. Maturity Matrix scores and associated action plans are intended to inform unit, Complex and Center leadership, but typically are not shared or reported above AFSC level.

The Maturity Matrix is an excellent tool that when used effectively will drive progress towards the world class operation and enterprise alignment that is envisioned by the AFSC. It is an apex of the evolution of the leadership tools developed by the AFSC and embodies the Art of the Possible. Figure 7.7 shows the full evolution of these leadership tools and how one builds on the other with the ultimate focus of making the mechanic the most effective he or she can be.

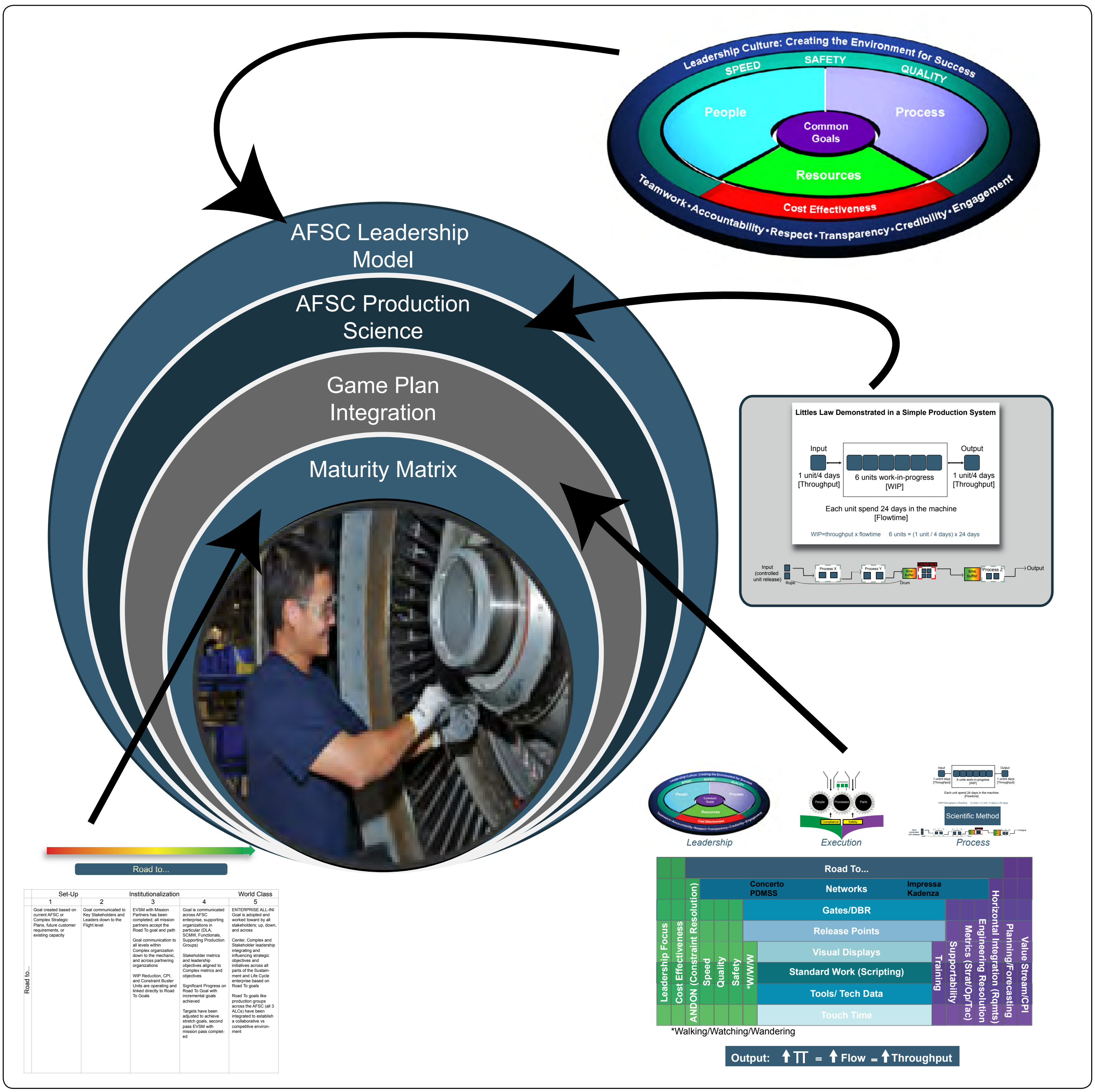


Figure 7.7: AFSC Leadership Tools Evolution

7.4. Greybeard Process

One additional initiative that has proven great success is the use of "Greybeard Assessments." In summary, a "Greybeard Assessment" entails the evaluation of a new or highly visible program/ project by experienced Subject Matter Experts to determine the health of the plan and subsequent execution of the workload; thereby, decreasing risk and ensuring program success.

The Greybeard assessment process is designed to be used sparingly and only in those instances where high visibility or exceptional performance risk projects are identified. This process is not to be considered a standard business practice for all workload efforts and would risk losing its viability if over exercised.

Greybeard principles were derived from successful assessment methodologies in validating a program's (activation) sustainment strategy; and continue to evolve with each new Greybeard assessment, given the inclusion of lessons learned. A "Grey Beard Guide Book" has been developed as an initial approach to execute a Greybeard Assessments– with refinements generated through continuous process improvement and constant updates from actual shared experiences. This guide book can be found in Appendix C of this book.

8

THE BOTTOM LINE

Air Force Sustainment Center: Art of the Possible

Chapter Topics

Understanding the cost of sustainment significantly contributes to the size and structure of Air Force systems and subsequently determines our ability to fight and win future wars drives the necessity to focus on the bottom line of cost effectiveness. A focus on cost effectiveness is a game-changer for the AFSC in a time of transition from a wartime to a peace time budget environment. To emphasize a focus on cost effectiveness, the AFSC has created a “Road to $1 Billion” campaign.

The “Road to $1 Billion” is an internal AFSC goal to focus on savings and cost avoidance. In one year’s time (Oct 2012 – Oct 2013) the maintenance complexes, supply chain management wings, air base wings, staff and support offices, embraced the “Road to $1 Billion” goal and submitted cost savings and cost avoidance projects that have propelled the AFSC more than two-thirds the way toward achieving this lofty goal.

A focus on creating cost effective processes has allowed AFSC organizations to think differently about how they approach processes and to challenge the status quo when it doesn’t make sense from a cost perspective. The campaign for $1 Billion in cost savings and avoidance is one example of the importance the AFSC places on becoming a cost effective organization.

This chapter will examine the positive effect of Speed itself on cost as well as the process currently in use at the Air Logistic Complexes to understand cost drives and positively affect the cost of depot repair to the customer in terms of AFSC sales rates.

8.1. Speed Enables Reduced Cost

One method of affecting cost during the year of execution is through improved throughput – Speed. While Speed may not change the amount of hours or material required to produce the item, Speed can affect the application of overhead costs to the end item. Production Overhead (POH) and General and Administrative (G&A) costs are applied to the end item based on the actual hours allocated to each end item.

Speed has the potential to improve productivity which influences the amount of actual hours allocated per unit, but more importantly, Speed can create capacity. Additional capacity creates the opportunity to produce more hours. It is this ability to increase production and earn more hours that allows fixed overhead costs to be spread over more hours resulting in lower cost rates applied to each unit, resulting in lower overhead cost per unit.

Figure 8.1 illustrates this point by comparing the overhead cost of producing a KC-135 aircraft to the flow days required to produce each aircraft. This chart shows the flow days to produce a KC-135 aircraft in FY12 compared to the overhead costs that are attributed to the specific aircraft. As the flow days decreased by 38% from FY10 to FY12, representing improved performance – speed, additional outputs and hours produced have increased allowing the overhead costs applied to each aircraft to decrease by 18%. After sustaining the additional capacity, the additional hours can be planned into workload review and budget allowing for reduced cost rates to be passed along to our customers through their rates and prices.

8.2. Cost Effectiveness

Performance, in the form of Speed and Quality, is certainly a key component in the value equation for AFSC customers who depend upon the depots to deliver aircraft, engines, components and software at a rate that maintains the health of their respective weapon systems. Speed, Quality and Safety expresses the essence of the depots and the foundation of the AFSC mission. However, if performance comes at too high a price, the ability of our customers to adequately provide for the inspections, repairs and modifications necessary to maintain the health of their weapon systems is limited. Therefore,

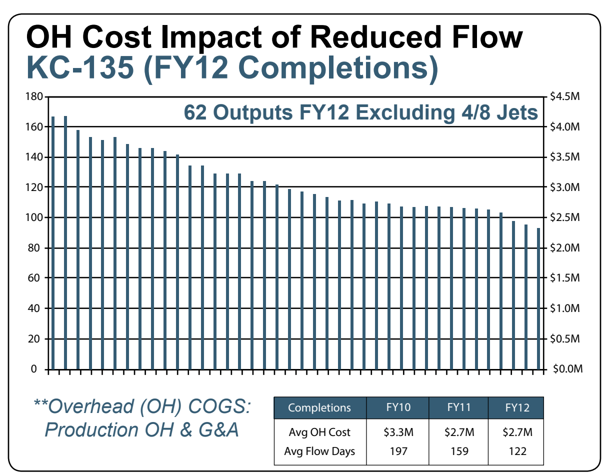


Figure 8.1: KC-135 Overhead Cost Impact to Reduced Flow (click to zoom)

the focus on Speed cannot be with an "at all costs" mentality. For this reason, the "Cost" element was added to the Art of the Possible Model to denote the need for a balance between Speed, Quality, Safety and Cost.

Keep in mind that cost effectiveness is not synonymous with cost cutting. Cost Effectiveness represents being good stewards of tax payer dollars by ensuring effective processes are in place that promote savings and efficiencies. Just as it is with Speed, Cost Effectiveness is about the process and is affected and improved by understanding and focusing on creating sound, disciplined and repeatable processes that result in cost effective practices.

The customer measures cost in terms of the rates and prices they pay for the repair of end item they send to the depots. The sales rate computation is somewhat complicated, especially in a working capital fund environment; however, understanding the components that make up the sales rate is important in order to understand how to positively affect the price the customer pays. Thus, a short explanation of the sales rate will be presented in this section along with a discussion of the approach the depots are utilizing in order to positively affect sales rates.

Sales Rate Components

The Sales Rate computation begins two years prior to the year of execution. Due to the nature of a working capital fund, it is important to note that final rates and prices do not equate to the Cost to Produce. The working capital fund is required to breakeven over time; consequently, sales rates are adjusted. There are three basic components to sales rates/prices: 1) Cost to Produce or Expense Rate; 2) Carryover Adjustment; and 3) Higher Headquarter Adjustments and Surcharges.

Expense Rates + Carryover Adjustment + HHQ Surcharges and Adjustments = Sales Rates.

The Cost to Produce or Expense Rate Component of the Sales Rate is the most important component when it comes to cost effectiveness. The 3x3 Expense Category Model in Figure 8.2 depicts the cost included in this component.

Direct Expenses are labor, material and business operations costs that are in direct support of an end item. Production Overhead represents expenses that support production of the end item, but cannot be directly attributed to a specific end item. General and Administration expenses are those costs that do not directly tie to the production of an end-item and are generally incurred at the Complex-level or higher. As previously stated Cost Effectiveness is about being good stewards of tax payer dollars; therefore, managing our resources or our expenses is critical to achieving cost effectiveness.

The second component of the Sales Rate is the Carryover Adjustment. Because the Working Capital Fund is required to breakeven, Sales Rates are adjusted to breakeven in the Rate Year. The Carryover

	Labor	Material	Bus Ops (Other)
Direct	On-Task Labor Mechanics - Repair Software Engineers Planners, Schedules, PMTS	Material - Direct Consumables Repairables	Direct TDY (field team) Contractor Augmentees Maintenance to Maintenance Contracts
POH	Indirect, CC4 and Shop Support Mechanics - Non-Repair Floor Supervisors Engineers Equipment Maintenance Planners, Schedulers, PMTs Cash Awards	Nuts/Bolts (IPV - Bench Stock) Tools / Equipment Fuel Shop Floor Hazards Hazardous Material PPE IPV Infrastructure (Robins only)	Equipment / Facility Maintenance & Repair Depreciation Utilities / IWTP Contact Services TDY Training
G&A	Staff Offices Workman's Comp Military Reimbursement Cash Awards	Staff Supplies / Equipment DLA Shipping / Receipting IPV Infrastructure (Tinker & Hill Only) Cradle to Grave (Complex)	HQ corporate Bills Local Reimbursables Depreciation Contract Services Custodial Services Hazardous Waste Disposal

Figure 8.2: 3x3 Expense Category Model

Adjustment is the component of the sales rate that compensates for the planned profit/loss on carry-in workload that is projected to be produced in the rate build year. Complexes add this adjustment to the expense rate and together this represents the breakeven posture and is submitted as the baseline for final sales rates.

The last component of the sales rate is driven by Higher Headquarter decisions. This component applies to a series of potential adjustments and/or surcharges that further impact the final Sales Rate. Resource Management Decisions typically impact expenses and are applied to the expense rates. However, RMDs may also impact projected customer orders or change anticipated workload which may also affect the sales rates. Accumulated Operating Result is a surcharge to compensate for profit/loss for previous Fiscal Years that is applied to the Sales Rate. Finally, the Reservation of Cash Surcharge is utilized by HHQ to increase or reduce cash levels in the Working Capital Fund to mandated levels.

Understanding the components of the Sales Rate and taking actions to positively affect those components CAN impact the rate charged to the customer. Because of the required adjustments to the sales rates, it is important to focus and attack the component most within our control and most connected to cost effectiveness – Cost to Produce.

Cost To Produce Deep Dive Approach

As stated previously, affecting the sales rate involves attacking the “Cost to Produce” component of the Sales Rate. The 3x3 Expense Category Model created a simplified view of the elements that make up the Cost to Produce or Expense Rate Component of the Sales Rate. The AFSC Complexes have undertaken a systematic approach that involves forming a Deep Dive Team to attack each cost category and challenge historical business practices. The elements of each of the cost categories are analyzed to provide a better understanding of processes with improvement opportunities. This Deep Dive process involves four basic steps: 1) understand the spend; 2) pareto the spend; 3) understand the factors influencing the spend; and 4) put processes in place to ensure effective use of the spend. The goal is to influence, and ultimately reduce, the rate charged to the customer by applying a systematic approach. In essence, the same Process Improvement techniques that were applied to our Production Processes to gain Speed are now being applied to the processes that affect our Cost of doing business. By focusing efforts on cost elements that specifically affect our rates we can positively impact the cost to our customers. The approach used by each Complex to identify improvement opportunities is discussed below.

Understand the Spend

The first step is to understand how much is being spent on the cost category with regard to the historical and projected spend. This step helps to put the cost category into perspective with regard to Complex Spending and sets the expectation for the potential opportunity within the cost category.

Pareto the Spend

A Pareto of the Spend within the Cost Category, from largest to smallest, exposes the primary expense drivers and helps the team understand where the majority of the cost is generated. This creates a methodical foundation for the team to establish priorities for further deep dives on the top drivers in order to have the largest impact on the category. The process also improves awareness through increased visibility of where the funds are being spent and what requirements are behind the Spend.

Understand Factors Influencing the Spend

The Team takes the largest drivers from the Pareto and further dissects the drivers into the factors that create the Spend. This step of the Deep Dive process requires the use of process improvement tools to identify gaps and opportunities that will positively influence the cost component. These Process Improvement tools include Value Stream Mapping, Root Cause Analysis, Fishbone Diagrams, The Five Whys, etc.

The team is comprised of all stakeholders in the Spend process from across the enterprise when utilizing these PI tools to ensure that everyone that touches the process is represented in the discussion. This creates a keen awareness of all stakeholders and how they affect the process and ultimately influence spend. An enterprise team has the capability of having enterprise influence on the spending process. Once the gaps and opportunities are identified, actions can be created to adjust/influence the Spend.

Create Processes that Ensure Effective Use of the Spend

Up to this point in the process the primary benefit has been a team awareness of the factors that influence and trigger the Spend. The final step requires the team to take steps to change the process, add checks and balances to the process or create greater awareness of how to positively affect the overall spend. This can certainly be a daunting task; thus, having enterprise involvement is of paramount importance to lead to successful implementation results.

The Deep Dive teams are currently breaking ground with regard to attacking Spend and influencing processes that drive the Spend. There is a lot of momentum that can be gained simply through the awareness that is created going through the process to understand the Spend. In order to impact sales rates and prices, it is imperative this work translates into the budget submittals.

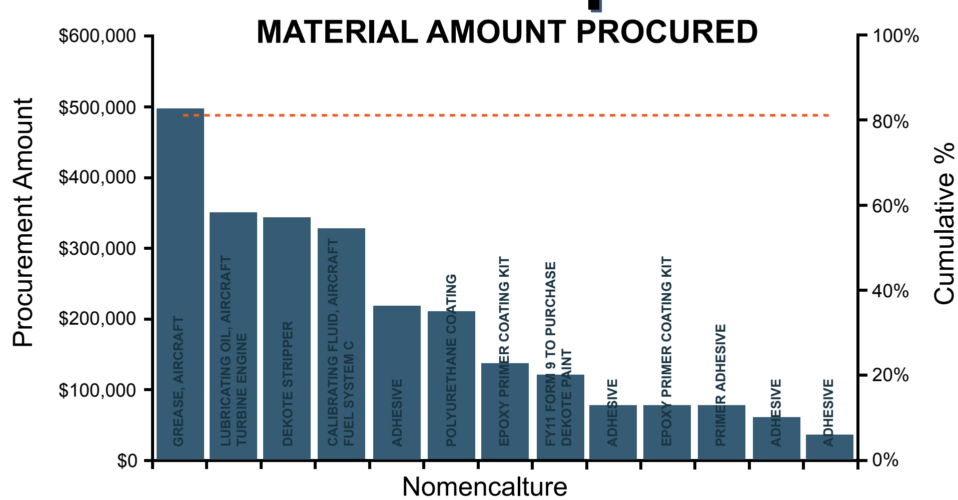
The 76th CMXG Deep Dive into their Hazardous Material Spend offers an illustration of the process. A Quad Chart for the Deep Dive is presented in Figure 8.3.

Hazardous Material falls into the POH Material Category on the 3x3 Cost Component Chart. Therefore, the cost of hazardous material is spread over all the costs of the items produced by CMXG. The first quadrant of the quad chart illustrates the "Understand the Spend" portion of the process. In this example, we see that CMXG's three year average spend for hazardous material is $3.4M – equating to 21.3% of the Complex spending for this category. However, in FY12, CMXG's spend increased

76th CMXG Hazmat Deep Dive

Deep Dive Category: HAZMAT

	($M)	($/DEPH)
Wing 3 yr Avg:	$16.0	$2.10
Org 3 yr Avg:	$3.4	$1.37
% of Wing Total:	21.3%	
FY12 Actual:	$4.6	$0.62
FY13 Target:	$4.0	$1.7
FY14 Submittal:	$4.5	$2.0
Sustainable Goal:	$4.0	$1.7
Begins:	FY13	
$ and % reviewed	$1.5M	33%



Identify Ways to Reduce Cost

- Reduce/Eliminate Waste
- Negotiate/Change Suppliers
- Create/Rationalize Specifications

Actions Taken To Determine Cost Reduction Opportunities

- Established team to analyze Aircraft Grease
- Identified who buys it and where it's used
- Identified current supplier and an alternative
- Reviewed the possibility for substitutions

Actions To Be Taken

- Zero Overpricing Challenge (ZOP) - As Applicable
- Evaluate/Modify Tech Data for suitable substitutes
- Build team to analyze top drivers

NSN	Nomenclature
9150-01-472-7163	GREASE, AIRCRAFT
9150-00-782-2679	LUBRICATING OIL, AIRCRAFT TURBINE ENGINE
6850-C6409	DEKOTE STRIPPER
6850-00-656-0810	CALIBRATING FLUID, AIRCRAFT FUEL SYSTEM

Figure 8.3: 76th CMXG Hazmat Deep Dive Quad Chart.

to $4.6M for hazardous material and CMXG has a budget of $4.5M for FY14. Therefore, a goal of controlling the FY13 hazardous material spend to a sustainable goal of $4.0M will result in an actual reduction of $600K over the previous year.

The upper right quadrant of this quad chart represents the "Pareto the Spend" portion of the process. In this quad, CMXG has identified and charted material that falls into this category in order from largest to smallest spend. A quick study of the Pareto chart reveals that the top four categories represent 40% of the spending for the category.

The lower left quadrant represents the process step of "Understand Factors Influencing the Spend." This quadrant indicates that only $1.5M of the spending for the category – or 33% - was reviewed for this analysis. If the utilization and spending for these four items can be significantly influenced in a positive way, the Spend for this category can be reduced. This reduction may not result in eliminating the entire variance from the goal, but may uncover practices that can be applied throughout this category of spend that will multiply the effect.

The lower right quadrant represents the "Create Processes to Ensure Effective Use of the Spend" portion of the process. Actions that can affect and influence the actual amount spent in the cost category are listed in this quadrant. This particular example determined there should be actions taken to reduce and/or eliminate waste of the material; that negotiations could occur with suppliers, or perhaps a different specification of the material could result in a less expensive price.

How the team determines to affect the process is the KEY component in the Deep Dive Process. There are a multitude of approaches that will result in a positive outcome. The team may decide to implement price challenge triggers into the process; to look at ways to leverage economies of scale through the procurement process; or find a way to avoid the cost altogether. The basic mantra of each Deep Dive Team is to create a "Challenge Everything Mentality" in order to aggressively pursue cost reduction.

Even though this Deep Dive process is in its infancy, the approach is actively engaging stakeholders throughout the AFSC Enterprise and will certainly result in creating a renewed awareness of Cost and actions each person within the AFSC can take to affect how much is spent in the course of our daily business. The collective goal is to tie the reduced cost for the AFSC to reduced cost for our warfighter customer to improve their ability to sustain their weapon systems and positively influence the size and structure of our nation's Air Power.

9

COMMAND AND CONTROL
RAISED TO THE POWER OF COLLABORATION–$(C_2)^C$

Air Force Sustainment Center: Art of the Possible

Chapter Topics

This chapter aims to challenge AFSC personnel to be the best possible stewards of people, processes, and resources while unleashing the power of enterprise collaboration. This blended approach, termed Command, Control, and Collaboration, inherits qualities from both 'Command and Control' and 'Collaborative' organizational concepts.

Air Force doctrine suggests that in command and control, a leader provides overall guidance, but allows flexibility for decision making throughout the chain of command. This guideline applies to the highest ranking senior leaders down to the lowest levels of the organization. Gen. George S. Patton is quoted as saying, "Don't tell people how to do things. Tell them what to do and let them surprise you with their results." Although all DoD organizations require strict compliance with top-down directives (operating instructions, technical orders, etc.), whenever appropriate it is always beneficial to empower people and delegate "the how."

When executing "the how", encourage the workforce to think outside of their swim lane to find the best possible solutions, understanding that some of the best solutions may come from other mission partners. This collaboration is the lynchpin of success for teams across the enterprise. AFSC emphasizes two main points of collaborating: (1) teams work best when they communicate quickly and effectively and (2) the team benefits most when members know and draw on enterprise partner strengths to overcome individual weaknesses.

AFSC believes a command, control and collaboration organizational approach yields "Art of the Possible" results. The pages that follow explain why command and control alone does not achieve the desired outcomes, how communication spurs collaboration, how collaboration has a multiplicative effect on organizational success, and that common goals are better achieved using team assets.

9.1. Why Command And Control Alone Is No Longer Enough

Establishing proper command and control has worked well in the past for our Air Force. Gen. Wilbur L. Creech proved the concept during his career and shared his lessons learned in "The Five Pillars of TQM: How to Make Total Quality Management Work for You". Beginning in 1978, General Creech brought the Tactical Air Command out of the ashes of the "hollow force" by instituting decentralized command and control and Total Quality Management. By giving sufficient people, process, and resource ownership to squadron commanders, units began to flourish and successfully execute their missions. Alternatively, leaders understood that with this ownership came great responsibility and accountability; if their units continued to fail, they alone were responsible.

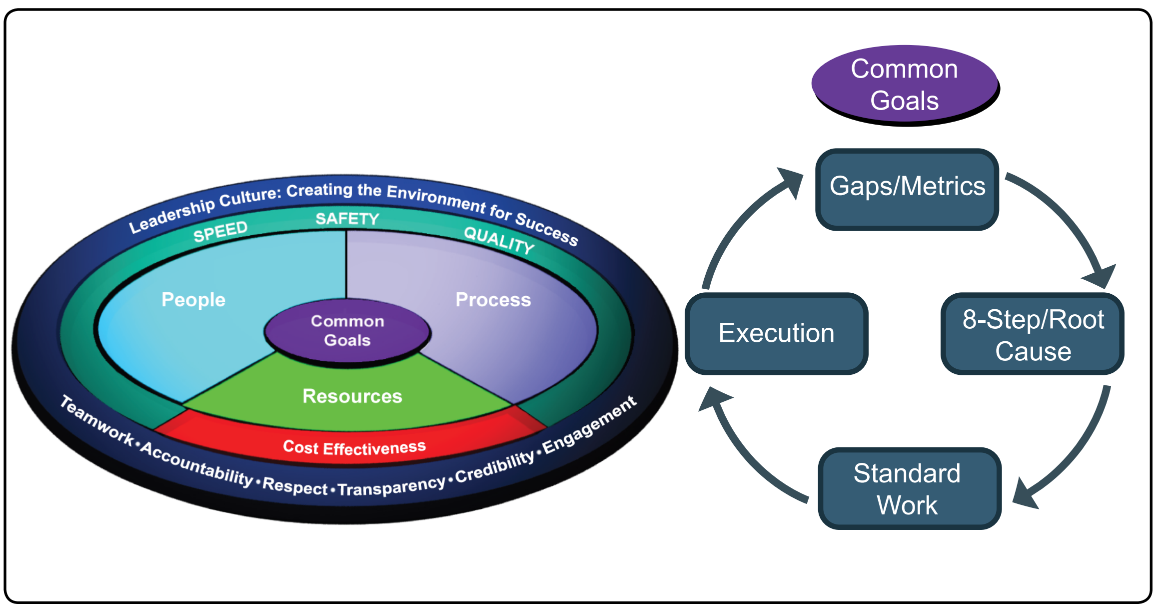


Figure 9.1: The AFSC Synchronous Problem Solving Mode

Similarly, AFSC leaders own command and control within their units. While collaboration is emphasized throughout this chapter, the reality is no one cares more about the process than the process owner. It's a requirement to keep employees accountable for timeliness, correct internal quality problems, and ensure personnel are trained properly. These are command and control examples of tasks that the owning work center performs alone. However, focusing only on internal performance leads to an organization failing to reach its potential, since success in today's environment requires a wider aperture — an enterprise-wide focus.

General Creech's actions were effective within the Air Force of the 1970s. In the face of today's budget-driven manpower and resource cuts, command and control of people and resources has migrated away from local owners toward a more centralized concept. With the loss of people and resources, leaders must rethink their processes in order to tap into now centralized assets. In other words, process improvement is a force multiplier in organizations affected by manpower and resource limitations.

The need to collaborate has never been more important. Therefore, setting and working toward common goals is a logical first step to get team wins. With this in mind, AFSC approaches problem-solving, not as a cycle under the command and control of one leader, but a synchronous effort by all units charged with accomplishing our common goals. Figure 9.1 revisits themes presented earlier in the book: Common Goals (Chapter 2), Gap and Metric Analysis (Chapter 7), Root Cause Analysis (Chapter 6), Standard Work (Chapter 5), and Execution (Chapter 5). As organizations progress through each step in this cycle, collaboration is the fulcrum around which common goals are achieved.

9.2. Collaboration Starts With Communication

At any step in the Synchronous Problem Solving Model, communication is the catalyst for teamwork. This flow of information throughout a unit (or across organizational lines) is what enables real-time command and control, ensuring sound decisions are understood and implemented where the problems actually occur. But that same leader can return the favor to the rest of the team by communicating revealed constraints and solutions to all other levels of the enterprise as quickly as possible. This feedback ensures all stakeholders understand the issue, reveals second and third order effects to the enterprise, and triggers others to adjust their own processes accordingly.

Collaborative communication establishes a culture of informed team members, or "A" and "B" players. An "A" player is a member of the team who knows the problem and knows the actions required to fix it. Similarly, a "B" player has knowledge of a problem, yet, does not know how to fix it. A lack of communication creates "C" players, who don't know they have a problem and so cannot correct it, even though they might possess the skill to do so. Chapters 2 and 6 cover AFSC's plan to increase leadership and problem solving skills to help all "B" and some "C" players know how to fix their problems. If the team wants more "A" players, they should study those chapters in addition to investigating how effectively they communicate.

Don't be misled; sharing data alone is not effective communication. In the Age of Information, data is everywhere. However, only after a data owner processes the data, does it become useful information. Even then, if the intended teammate does not understand the 'information' as presented, it's still just a collection of data that is misunderstood or ignored.

However, properly understood information becomes useful in the hands of the receiver. In the first few milliseconds, the information is mentally digested and automatically compared with other information and knowledge. In an

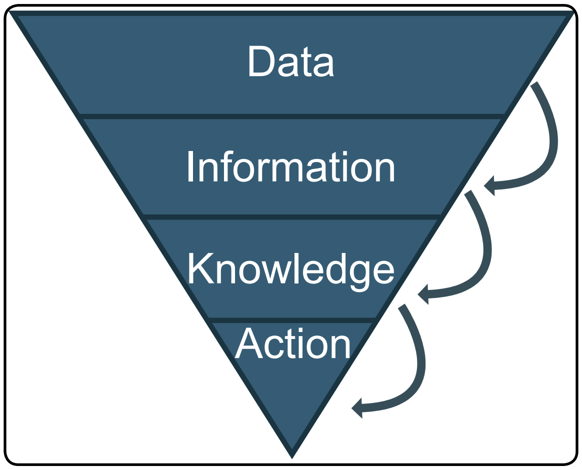


Figure 9.2: The Transformation of Data to Action

organization growing "A" players, increasing knowledge paves the way for effective actions — the ultimate goal of a totally collaborative organization (See Figure 9.2).

9.3. Collaboration Finishes With Execution

Knowledge is generated during the Common Goals, Gaps/Metrics, Root Causes, and Standard Work steps of the AFSC Synchronous Problem Solving Model. Action happens in the Execution step. Look back; this is not the first place execution has been discussed in the book. Recall the AFSC Execution Model (or 'Radiator Chart') in Chapter 7 introduced eight execution elements, shown as horizontal bars (details of interest reproduced as Figure 9.3). In this section, readers are encouraged to focus on actions that make an impact on these elements.

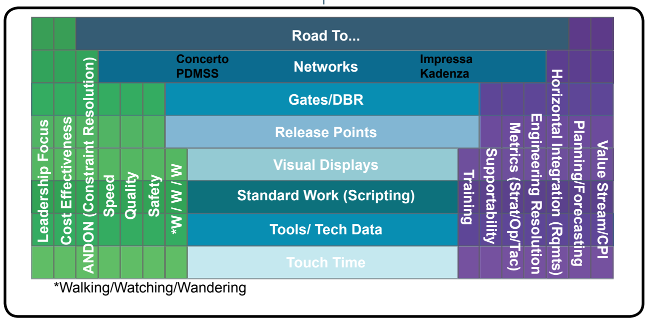


Figure 9.3: Detail showing Horizontal and Vertical Bars of the 'Radiator Chart' (Click to zoom)

Now, consider the vertical bars that overlap each execution element on the Radiator Chart. Think of them as 'Levers' that can influence the operation of a machine when developing a "how to". As a general rule, levers attached to (overlapping) a horizontal bar of the Radiator Chart can affect the production machine in that Execution Element if pulled.

For example, an end item's "touch time" has been struggling. Of note, a supplier is not delivering a key part on time. This delay is causing the workforce to cannibalize the part between end items and decreasing their touch time on value-added efforts during the day. Find a peer in the supplier's organization, and engage them in a discussion which "walks" them backward from the point of delivery to the end item's production line. This discussion helps identify several constraints, to include workers damaging parts during removal before the supplier receives the part for overhaul, which requires more work on the supplier's end. Suggest hosting a CPI event which includes Quality Assurance, with their agreement to assist with additional inspection to help identify and develop a training plan for improving awareness of this issue for the workforce.

By investing time in these collaborative sessions, the team pulled four levers (Speed, Quality, W/W/W, and Value Stream/CPI) that affect Touch Time for this process as symbolized in Figure 9.4.

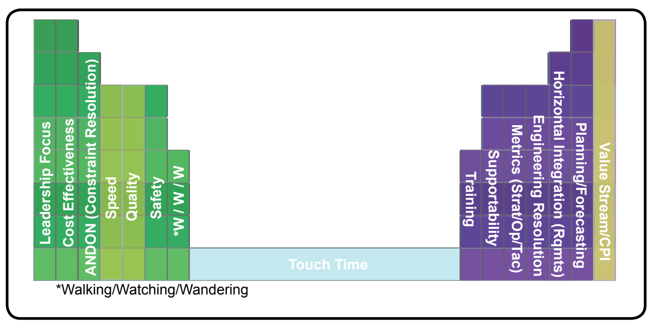


Figure 9.4: Highlighted 'Levers' Pulled in Touch Time Scenario (Click to zoom)

9.4. Conclusion

As discussed, command and control remain vital elements of how we do business. Leaders are still owners of their processes and need to exercise appropriate levels of command and control to keep their house in order. But, in a winning organization, collaboration is a "must have" skill with multiplicative effects on production outcomes.

To foster collaboration within the unit and across the enterprise, consider the players on the team and regularly ask "who else needs to know?" when communicating up, down and across organizational lines. Doing so will enable the growth of more "A" players in the enterprise that are aware of issues and can take action to impact them. Ultimately, awareness strengthens the alliances needed to leverage external people and resources to improve execution of the processes.

As the command, control and collaboration environment begins to mature, refer players to the execution elements of the Radiator Chart frequently as they develop their "how to" skills. Honestly assess the team, then delegate, communicate and execute. Enterprise success hinges on each player doing their part in their unit's journey toward the "Art of the Possible"!

10

THE ART OF THE POSSIBLE

Air Force Sustainment Center: Art of the Possible

Chapter Topics

The AFSC is a $16B enterprise–it is big business! This business is not rocket science, but it is complicated; it is an intertwined, complicated machine with a lot of moving parts. This complication means "by the seat of your pants" management techniques will not lead to success. Success cannot be personality driven. Leadership and success must be tied to a methodology and focused on processes. Process discipline is the key to success. This is a "thinking" person's game.

Achieving *Art of the Possible* results is not about just meeting expectations; it is about achieving the organization's full potential. It is about getting better every day. It is not about working harder–it is about affecting touch time productivity through an integration of enterprise efforts in order to maximize process productivity.

10.1. Keys to Achieving *Art of the Possible* Success

Three keys to achieving *Art of the Possible* success in an organization include:

1) *Effectively lead*. Build an organizational team that believes in the "Road to" and the methods it takes to get there.

2) *Effectively influence*. Develop the circle of networks across the enterprise needed for success.

3) *Effectively execute continuous process improvement*. This requires a disciplined approach to reacting to data and focusing the organization.

Achieving *Art of the Possible* results is about gaining and maintaining momentum. Set a target that does not allow the organization to ever give up – prepare for the future (always look out 10 years ahead) and gain momentum on the backs of processes–not people. Remember that people are a strategic resource in the AFSC.

10.2. Tiered Approach

A tiered approach to process execution review meetings will provide information about the process to determine what is being done to improve process and if the improvements are working. Utilize the right metrics to identify execution gaps in the process. Then utilize continuous process improvement techniques to attack the gaps. Continuous process improvement is a force multiplier that will increase AFSC abilities to meet the mission. Utilize CPI to improve processes while integrating quality into the process. This method serves to reduce touch time, and improve the efficiency with which the processes can execute while involving the enterprise (all process touch points) in the improvement.

Improving the speed of process outputs ensures the AFSC will meet the readiness needs of the Air Force; however, there is an opportunity to have a larger impact in the form of cost effective sustainment. This opportunity requires the examination of inputs to the cost structure in order to further identify opportunities to reduce the cost of readiness in the form of sales price.

Using process improvement techniques based on data, and then involving all enterprise touch points in the process, will enable the application of smart changes that will lead to reduced sales prices and ultimately affect the cost of sustainment for our Air Force. The cost of sustainment will influence the size of our Air Force and will affect our ability to fight and win the next war. The AFSC must react to the realities of a changing environment – one from that of a wartime budget to a peace time budget–while enabling our Air Force to be ready when the environment changes again.

10.3. Culture of Believers

The AFSC must create a culture of believers. This starts with setting the vision for the future and backing up that vision by focusing on improving processes that allow organizations to efficiently obtain that vision. Believe in the vision. Believe in the value of the AFSC people. Believe in the need to focus on the processes. Believe in the power of involving the enterprise. Believe in the Art of the Possible. Believe.

APPENDIX A: CASE STUDIES

Air Force Sustainment Center: Art of the Possible

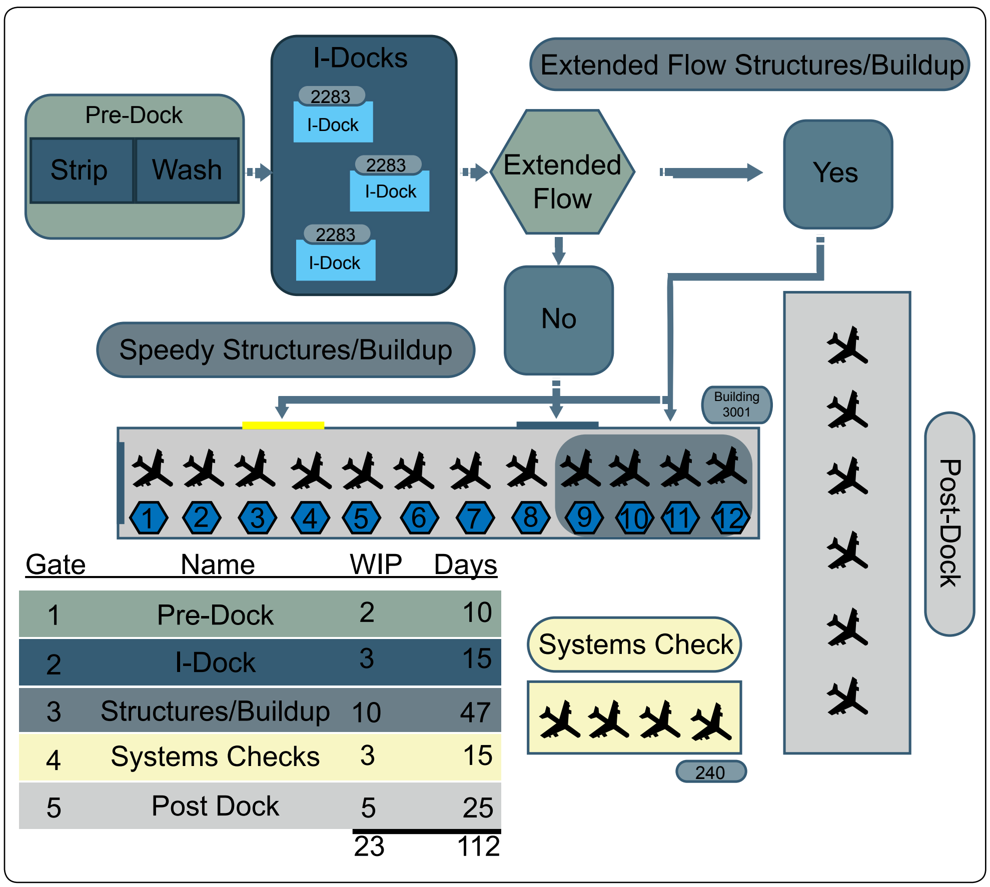
Appendix Topics

There are many examples of success within the AFSC gained by applying the Art of the Possible methodology. The following case studies are provided as examples of that success and to aide in the practical application of the methodologies through additional examples.

A.1. OC-ALC KC-135 Production Machine

The 564th Aircraft Maintenance Squadron has been through a significant four year transformation journey to achieve one goal; increasing throughput. In 2009 the Secretary of the Air Force mandated 50/50 programmed depot maintenance requirements for the KC-135 aircraft. The 50/50 mandate set the required throughput goals at 64 KC-135, to produce annually. The 564 AMXS had to meet the 50/50 mandate by the end of fiscal year 2012. The first step in achieving the new throughput targets required the squadron to redesign how aircraft flowed through the PDM line.

Squadron leadership appointed a group of respected peers in the organization whose primary goal was to take a historical look at the squadrons' successes and failures and develop a new method for flowing the aging KC -135 through the PDM cycle. The Staggered Line concept was developed based on past business models. This first and critical step in the journey is essential to the successes the 564th has achieved. Instead of squadron leadership developing a top down change in business strategy, leadership implemented the floor driven idea from the appointed team; as a result employee buy in was fundamentally instantaneous.



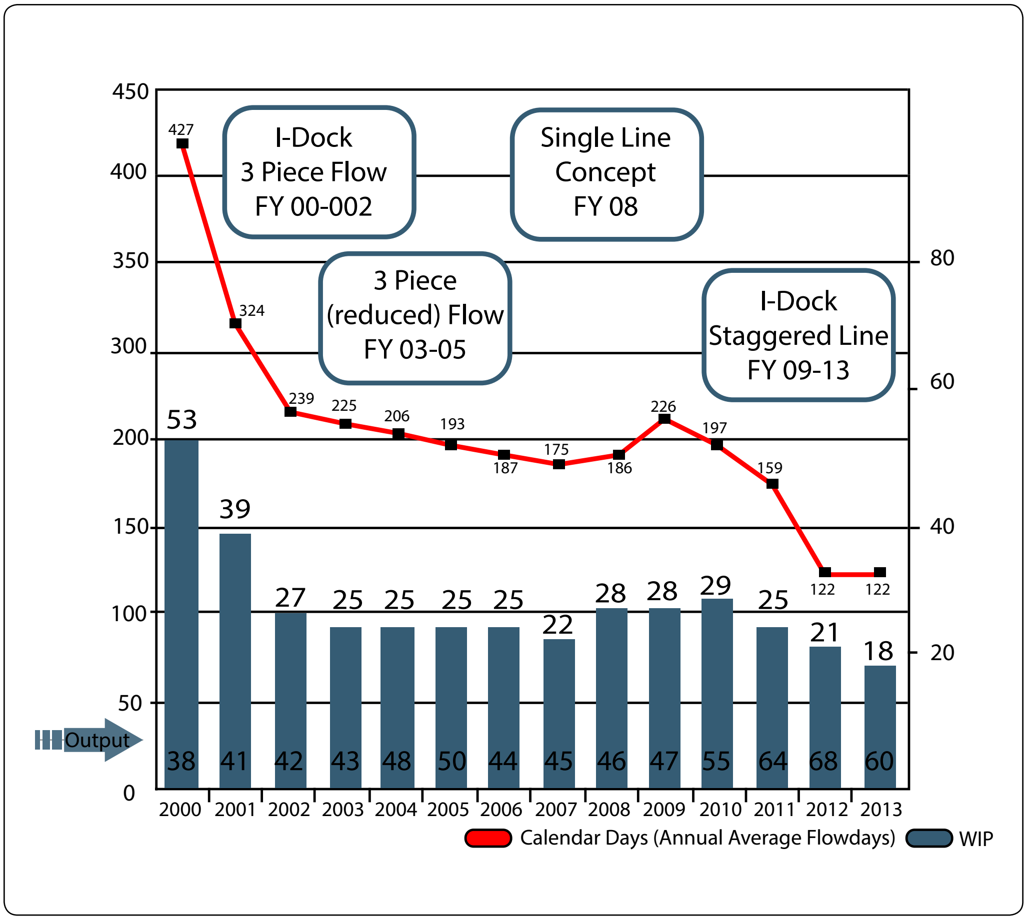
(click to zoom)

The Staggered Line concept is made up of five gates. These gates consist of Pre-Dock, Inspection Dock, Structures Build-up which is broken down into Speedy Structures and Extended Flow, Systems Check and Post Dock. The Staggered Line concept places a premium on knowing the true condition of the aircraft prior to the aircraft being inducted into the heavy maintenance structures gate. Knowing the condition of the aircraft allows the squadron to plan out the required repairs overcoming one of the major constraints the squadron regularly encountered. Structures Build-up takes place in historic building 3001, which is limited by only having 4 hanger doors for 11 structures docks. In building 3001, docks one through nine are in the south end of the building and docks 11 and 12 are in the north end of the building. Knowing the true condition of the aircraft allows the 564th to plan the placement of the aircraft in the structures gate preventing trapped aircraft.

As previously discussed, structures gate is broken down into two categories: Speedy Structures and Extended Flow structure build-up. Speedy Structures aircraft work can be accomplished concurrently, shortening the flow of the aircraft. Extended Flow structures aircraft require some major structural repair that prevents concurrent work. An example of this is a terminal fitting change. The terminal fitting is one of the major structural components where the wing meets the fuselage essentially anchoring the wing to the body of the aircraft. The standalone terminal fitting task prevents any concurrent work thus extending the flow of the aircraft.

Since both Speedy and Extended flow aircraft are co-located in the same building, prior to the Staggered Line, the 564th regularly experienced trapped aircraft. With implementation of the Staggered Line and knowing the true condition of the aircraft prior to induction to the structures phase, the 564th can position the aircraft in building 3001 preventing trapped aircraft. The immediate savings from preventing trapped aircraft was just the beginning of the 564 AMXS transformation journey.

In order to accomplish the throughput goals, a Production Machine was developed using Critical Chain Project Management and the Staggered Line concept to flow aircraft through the PDM process. The Production Machine is a mathematical formula that depicts the required work in progress and flow day goals of each gate of the PDM line. To achieve the 50/50 mandate, the Production Machine revealed a requirement of 64 aircraft produced, 23 aircraft in WIP and a 131 production flow day average. The timeframe to accomplish the 50/50 requirement was set at 3 years. To relay all the information to the workforce and supporting organizations, the Road to 130 was briefed at all levels. In 2009 at the beginning of this journey, 564 AMXS was averaging 226 flow days per aircraft with an average WIP of 28 aircraft. The Road to 130 required a 95 day average reduction in aircraft flow days and streamlined our processes to reduce WIP by five aircraft.



(click to zoom)

Transformation started in fiscal year 2009 when the 564th participated in wheels down to wheels up Enterprise Value Stream Analysis (EVSA) which brought everyone responsible for the Programmed Depot Maintenance of the KC-135 together. This large event encompassed the production squadron as well as supporting organizations such as engineering, commodities and propulsion; basically every shop that aided in the PDM process. The EVSA served two purposes. First it identified what part each organization was responsible for in the KC-135 PDM process. Secondly, it opened lines of communication and identified the requirement for increased speed and throughput of the KC-135 line to all responsible for production.

As a result of the single large event, an additional 47 Rapid Improvement Events were immediately identified. Many of these first events and just go do it's were all driven from the initial EVSA and continue to pay huge dividends for the 564th. An example of the proven success of Rapid Improvement Events can be seen in Tinker AFB first ever Constraint Buster Core Team. The Constraint Buster Core Team is comprised of members from the 564th, including Planners, Production Support Technicians and Procedures and Analysis, System Program Office, Defense Logistics Agency, Supply Chain Management, and engineers. This team, whose primary goal is to resolve constraints, is co-located in one room on the production floor. They are capable of providing reach back support to their respective organizations and can resolve any issue whether it be process, policy or material. To date they have resolved over 260 constraints providing essential support to mechanics.

One of the main benefits of an RIE is that the decisions coming from the event are data based decisions. A mainstay belief in the squadron allows an individual to be entitled to their opinion, but the data drives the decision making process. Data driven decision making has not been more evident than in the first year the Staggered Line Concept and Production Machine were put into place. The data supported the production changes the 564th was experiencing, but the transformation did not happen overnight. The first year the 564th produced 47 aircraft. This was an increase of one aircraft from the previous year. Although production was increasing, of the 47 aircraft, 3 were early to schedule, 33 were on time and 11 still produced late to schedule. Even with late production, no changes were made to the Staggered Line Concept or the Production Machine. During the next fiscal year, the Staggered Line Concept started to hit its stride and major improvements were made.

One of the major barriers the 564th had to overcome to be successful in reaching the Road to 130 was to overcome aircraft queue. Queue is the time an aircraft sits idle without any production being performed. When an aircraft lands for PDM, work it is taken from aircraft availability and put into depot possessed status. It remains in depot possessed status until the aircraft is returned to the owning unit. Once the unit completes inspections, the aircraft can return to the fleet of available aircraft.

Days spent in queue were detrimental to the 564th production machine lengthening the PDM process an average of 30 days per aircraft. On October 1, 2010, the squadron declared war on aircraft queue. Continuous Process Improvement events were held in each gate and an additional I-Dock hanger was stood up to increase capacity. The RIE's were able to identify where the 564th could standardize work and allowed for work scripting. The result of robust RIE's coupled with the additional I-Dock hanger, resulted in the 564th celebrating zero aircraft in queue status in February of 2011. Eliminating queued aircraft provided the squadron with an immediate flowday reduction. The 564 AMXS increased production to 55 aircraft in 2010 with an average of 197 flowdays, a decrease of 29 days from the previous year. There were 31 aircraft produced early, 18 on time and 6 still produced late to schedule. The results were positive and the 564th did not make changes to the Road to 130 goals, Production Machine or the Staggered Line concept.

During fiscal year 2011, the 564th hit their stride, with near flawless execution of the Production Machine and Staggered Line concept. There were still massive gains that needed to be made to reach the Road to 130 goals, and visual production metrics provided targeted areas for CPI. The goals of the squadron never changed (increase throughput or speed and decrease flowdays). The idea of leaning processes had taken off and the entire enterprise embraced Rapid Improvement Events. Mechanics, the subject matter experts of the organization, were able to easily identify constraints to the PDM line and began requesting Rapid Improvement Events. Communication at every level was essential to the successes the squadron saw. Since the Staggered Line Concept is broken down into gates, the squadron could easily identify what gate needed the most CPI. During FY11, Extended Flow Structures Build Up was one of the main focuses.

The KC-135 is a 50 plus year old aircraft. When the aircraft was designed, the service life was not planned for or expected to last 50 years. As a result, when the engineers initially planned and constructed the KC-135, there were parts that were not intended to be interchangeable. The terminal fitting that was previously mentioned is just one of these parts. As the aircraft ages, terminal fitting changes are becoming more common. This single task was averaging 40 to 50 days per side. After multiple terminal fitting CPI events, the time required to change a terminal fitting was reduced by 50%. This example is just one of the many reductions that took place in each gate throughout FY11. The 564th produced 64 aircraft in 2011, averaging 159 flowdays. There were 61 aircraft produced early to schedule and 3 aircraft produced on time. A short three years after the Secretary of the Air Force mandated the 50/50 requirements and one full year ahead of schedule, the 564 AMXS had reached the throughput goals. With the Production Machine and Staggered Line Concept in full swing, the next year produced impressive results.

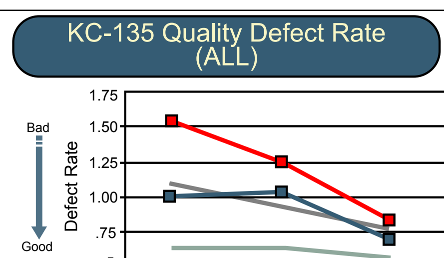
Fiscal year 2012 brought about the realization of the Road to 130. The 564 AMXS continued to use RIE's and other CPI initiatives to reduce flowdays and increase throughput. At the end of FY12, the 564th had reduced the annual average flowday to 122 days. Through the use of Road to Goals, Gated processes, RIE's and CPI events the KC-135 enterprise reduced the average flowdays by more than 100 days in just 4 years. In addition they had increased early production by 95%. The 564th produced 68 aircraft in FY12, 67 early to schedule and one aircraft on time.

A byproduct of increased throughput is increased capacity. The KC-135 PDM work has always consisted of organic and contract PDM sites. Organic PDM work is performed at Tinker Air Force Base and contractual PDM work was performed at Boeing in San Antonio. During FY12, discussion of an all organic KC-135 line began to take place. The 564th was producing aircraft faster and more cost effective than the contract PDM site. In-order to consider an all organic line, the Road to Goal had to change. A new goal, the Road to 112, was developed during FY12. Although the average flowday for KC-135 PDM ended at 122 days for FY12, the last 10 aircraft to cycle through the PDM line during FY 12 averaged 116 days, just 4 days above the new Road to 112 goal. At the end of FY12 the decision was made to make the 564th the sole provider of KC-135 PDM work. The 564th had to achieve the new road to goal.

FY13 presented numerous challenges and successes for the KC-135 PDM line. The 564th started the year outstanding with 14 aircraft produced in the first quarter, and a production average of 108 flowdays; well below the new Road to 112 goal. The 564 had surpassed their original goal of 130 and within a year achieved the new Road to 112 goal. One of the challenges the 564th faced during FY13 was increased voracity inspections for the aft terminal fitting. As previously discussed, the 135 is aging and the new requirement drove an influx aft terminal fitting changes. Since the terminal fitting prevents concurrent work there was an increase in Extended Flow Structures Build Up aircraft. The Structures build-up gate which is made up of Speedy and Extended flow aircraft was planned using a historical look at aircraft that have processed thorough the machine. The 564th found through analysis of 100's of aircraft the split for structures is roughly 60% speedy aircraft and 40% extended flow aircraft. The new requirement drove more aft terminal fittings changes and almost reversed the 60/40 split during FY13. The squadron continued to use CPI to circumvent increased flowdays. As a result of CPI efforts, new processes were established that allowed some terminal fittings to be trimmed. If trimming the terminal fitting was successful and the aircraft did not require additional non–concurrent work, the aircraft would flow into the speedy gate saving flowdays.

Another challenge the 564th faced during FY13 were the effects of sequestration and furloughs. Through 4 years of CPI events and lean processes, the 564th had amassed a wealth of data about each facet of the PDM line. With this data the 564th was able to indicate what critical processes would be affected, predict the effects of aircraft falling out of the schedule, and show how many flowdays the PDM line would increase and the expected recovery time for the PDM line. With the data, the squadron was able to set a game plan for processes that required longer work time and established scripted start times to prevent additional flowdays. Overall during FY13 the 564th produced 60 aircraft averaging 122 flowdays. The 564th continues to drive towards the new Road to 112 goal and expects to reach it during FY14.

Speed increases throughput and throughput is king; although speed should not be sought after at in all cost. In FY11 the squadron had a 1.07 Aircraft Incoming Defect Report rating. This quality rating reflects what the unit finds and writes up once the aircraft is returned to them from the PDM line. As of August FY13 the AIDR rate had fallen to .69 a 36% decrease; the 564th through use of CPI is continuing to drive to the Air Force standard for accepted AIDR rates. The increase in quality is tied to CPI events, Road to Goal, Gated Processes and scripting work. At the beginning of the transformation process the average monthly overtime rate hovered around 20%. In the 4 years the 564th spent focusing on continuous process improvement the overtime rate fell to a 5% average. The responsibility of the 564th is to deliver a quality, on time and on cost KC-135 to the warfighter. Through the use



	FY11	FY12	FY13
A/C Produced	67	81	74
Defects Rptd	103	101	60
Defects Acptd	72	86	51
Reported Rate	1.54	1.25	.81
Accepted Rate	1.07	1.06	0.69
AF Std Acptd	0.66	0.66	0.60

(click to zoom)

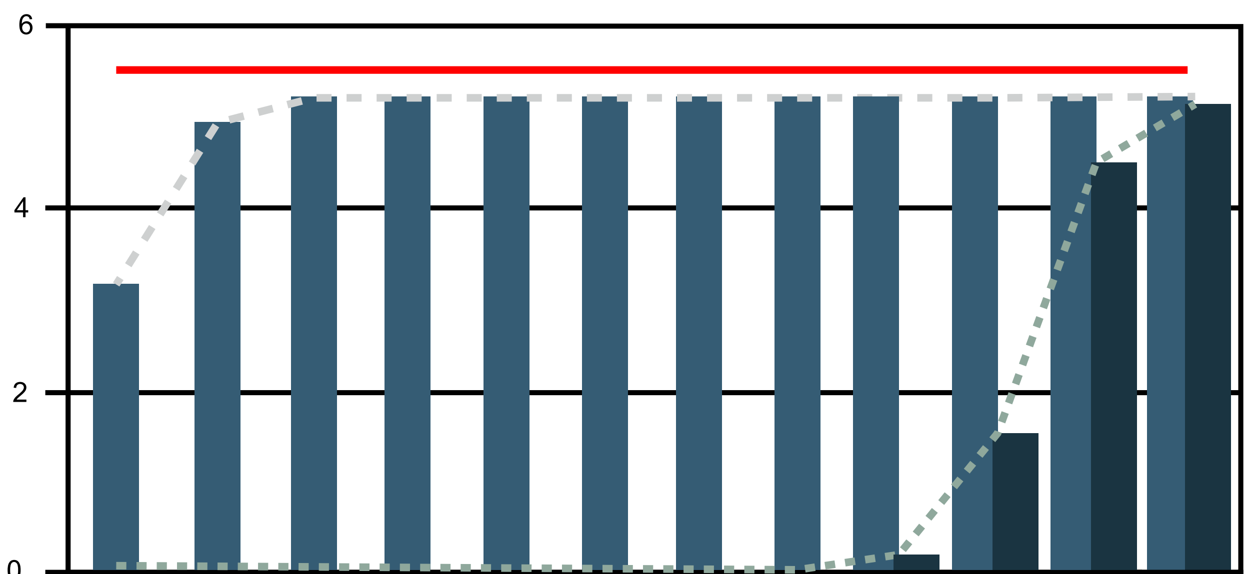
of Continuous Process Improvement Events, Gated Processes, Road to Goals and Scripting Work, speed, quality, capacity and throughout were the byproducts.

A.2. CMXG/QP Indirect Budget Case Study Notes

CMXG/QP Engineering Division investigated the problem of "Poor execution of Purchase Requests submittals and PR expense target throughout the fiscal year (FY)" in CMXG/QP Indirect Budget. The 8 step problem solving process was utilized for this problem. The impact of this problem is that funds are not fully executed within the fiscal year, causing carry over into the next fiscal year's budget. The scope was limited to effecting internal change within CMXG/QP for FY14 based on FY13 baseline performance. The goal for FY14 is to fully execute planned procurements within the fiscal year.

CMXG/QP began looking at this problem by Process Mapping the current process and identifying the performance gaps in the FY13 Indirect Budget execution. Next, the team mapped the future state process map with estimated flowtimes for each sub-process. Procurement estimated flowtimes were obtained from contracting and engineering experience was used to estimate flowtimes for the post contract award times. The procurement flowtimes were broken into 4 categories based on dollar thresholds. The 93 planned (budgeted) procurements were placed in these 4 categories based on dollar values, with Path A being the smallest and Path D being the larger values. The flowtimes are Path A 256 days, Path B 271, Path C 286 days, and Path D 341 days. The post contract area was identified for future opportunities to improve the algorithmic model boundaries and improve confidence levels.

Once the flowtimes were established Production Science could be applied to this process to determine average Work In Process for the fiscal year and the pacing of the PRs to load and unload the system (commit, obligate and expense). Using Little's Law to analyze the data, average WIP was determined to be 3.5 PRs for Path A, 14.1 PRs for Path B, 37.8 PRs for Path C, and 16.8 PRs for Path D. Maximum spacing was allotted for the pacing of the PRs, while still expensing funds in the fiscal year. The pacing for the paths were every 21.8 days (for 5 Path A PRs), every 4.9 days (for 19 Path B PRs), every 1.5 days (for 51 Path C PRs), and every 1.3 days (for 18 Path D PRs). Given this pacing, the last PR for Path D must be in the system by Oct 23. An overall view of all planned PR submissions is shown in Figure 1.



	Oct 13	Nov 13	Dec 13	Jan 14	Feb 14	Mar 14	Apr 14	May 14	Jun 14	Jul 14	Aug 14	Sep 14
S Submitted PRs Actual	3.5	4.7	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
S Expensed Actual	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.5	4.5	5.0
S Submitted PRs Goal	3.5	4.7	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
S Expensed Goal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.5	4.5	5.0
S New Sus Goal	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4

Figure 1: Projected Commit and Expense of Planned Purchase Requests

The analysis also revealed, in Figure 2, that 81 (dark blue line) of the 93 (teal line) planned PRs would be in the contracting flow at once. Contracting (one section, the one that will get the majority of these procurements) has a projected capacity of around 150 PRs at a time. This section supports CMXG, SMXG, PMXG, MXSG, and AMXG requirements.

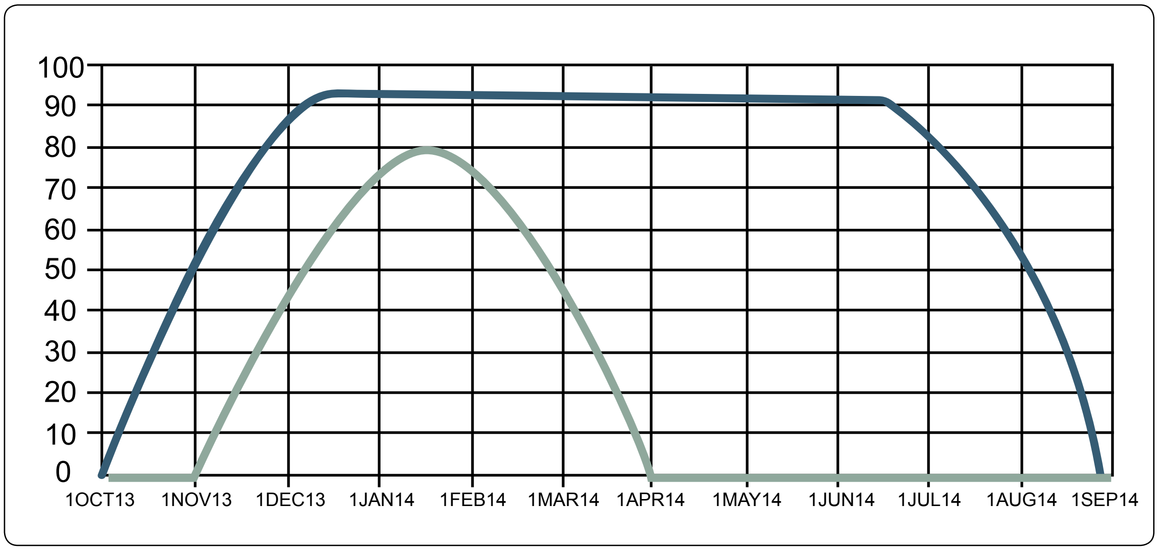


Figure 2: PR packages in work

A schedule was developed using the PR pacing calculated in this analysis. According to the schedule; the last PR needs to be submitted into the system by Dec 29, 2013, shown in Figure 1 blue line. PR's funds should start to expense in May 2014, shown in Figure 1 green line. This schedule has already been impacted due to the Government shutdown, continuation of sequestration guidelines, and mission critical only criteria. Future CPI events will focus on the post contact award areas to improve level loading of resource demands.

A.3. F-108-CF-100 Engine

The US Air Force had experienced excellent performance and reliability in the F108-CF-100 engine (commercial designation CFM56-2B) since its installation on the KC-135 tanker beginning in 1984. However, engines eventually require overhaul to restore their performance to acceptable parameters, as is the case with the F108 engine. Engine removals increased from 46 in FY06 to 80 in FY09 and have generally been increasing ever since. FY11 through FY13 saw removals of 112, 98, and 118, respectively. In response, the F108 engine program office needed increased organic engine production to keep pace with engine removals.

The new requirements passed to the supply chain were first 100 engines in FY08 and increased to 125 by FY10. The 76th Propulsion Maintenance Group, responsible for all organic engine production, followed a traditional path and played a little "5 year old soccer" by throwing all available resources at the problem. Lack of a clear process resulted in wildly varying production, and drove PMXG to three shifts and overtime as high as 20% on the F108 engine line. Along with huge variances in monthly production, annual production cycled as well. Monthly production would range from 3-11 engines per month and annual production ranged cycled 68 to 97 engines. PMXG averaged 106 flowdays to repair an engine. Increased requirements and inconsistent production led Propulsion Sustainment Directorate to offload 15 engines worth of work to an to an outside contractor as a hedge against erratic PMXG in FY12 and FY13.

It was clear at this point that PMXG needed a more effective and efficient process to meet F108 warfighter requirements and prevent future engine offloading. In July 2012, a team was established to work process improvement efforts on the F108 engine line. The team consisted of SMEs from the shop floor (Mechanics), planning, scheduling, PLS (kitting), engineering and management. The team was given the task of developing a standard gated process, giving PMXG a consistent/efficient F108 engine delivery. Right out of the gate the team struggled with change management—or just change in general. The shop had two very distinct dynamics. First, they encountered the newer/less experienced employees, who were eager to have the opportunity to establish a process for themselves. Second, were the more seasoned employees. These folks tended to resist the change, seeing it as just another passing fad. The ah-ha moment for these folks will be discussed later. After the change management meetings were held, the shop was consolidated to one shift and divided into Gates, but overtime was still required to meet the monthly requirement.

With a buy in on change, the team set their sights on the ultimate goal…"First to 55," symbolic of the first gated engine process to execute standard overhaul of an engine in 55 total flowdays. The first task the team tackled was shop layout logistics, specifically whether to move the engines within the shop or move the crews to the engines within the gates. We decided, largely due to the size and weight of the maintenance stands, that the crews would move from engine to engine repeating the same standard task, rather than move the engine itself. Once this was settled, shop flow was addressed. Applying Little's Law, TOC principles, current standards, and the yearly requirement a cycle time of 55 days with a TAKT time of 2.2 days, a WIP requirement of 22 engines was established. From these requirements, each of the gates were assigned individual WIP levels and cycle times. For example, gate one was given a cycle time of 9 workdays or 11 calendar days and a WIP level of 5. The other gates were given similar cycle times and WIP levels (Gate 2, 11 workdays/15 calendar days, WIP 6; Gate 3 16 workdays/22 calendar days; WIP 8; Gate 4 five workdays/seven calendar days; WIP 3). The shop was then divided into gates and then into work cells, reducing maintenance foot print by approximately 8000 sq. ft.

Within thirty days, the team had defined the standard work in Gate 1. While establishing this standard work, the team broke out into a sub-team to build "kit carts". These kit carts were to have all the material the mechanic needed laid out (pitched) in the order in which they were removed from the engine, taking into account how it would need to be reinstalled. What we now call the first generation of the kit carts were finished about sixty days into the event, with many small changes being made along the way. The first engine processed through the gate in 17 calendar days. It took the shop less than a month to hit their stride and start making the cycle time of 11 days…all done WITHOUT overtime. It took the team about another six weeks to nail down the standard work for gate 3. As successful as gate one was, we struggled with gate 3. We were close to meeting the gate cycle time, but could not do so without overtime. Cue the "ah-ha" moment for the seasoned employees who had struggled with finding the motivation to change the way they had been doing business for many years. Most of these folks, having greater experience, had been assigned to the assembly area or gate 3. As this point gate one was enjoying success without overtime, while it was mandatory in gate 3. You might say, everyone likes to work a little overtime…but no one likes to be told they have to work overtime. It wasn't long before the concepts started to take hold and more universal buy-in followed.

After several weeks of monitoring the process, the team noticed "turn backs", work that was completed in one gate having to be corrected in another. The team, in collaboration with Quality, developed an electronic "Issue Resolution" form to capture these turn backs and established an internal "ANDON" process complete with flashing lights. The rules for the process were set up as follows: If the process is impeded in any way, the ANDON light is turned on, an issue resolution form is submitted, and a manager has fifteen minutes to respond. If this manager cannot remedy the problem, they must elevate to the unit/ second level manager who has 4 hours to get it fixed. If unsuccessful, it must be elevated to the Flight level where they are given 8 hours then it becomes a Squadron level ANDON in PMXG's ANDON process. The issue resolution forms were compiled by quality and then sent to the Fixer for analysis. During this analysis the most frequent issues are assigned to a working group of SME's, a root cause determined, and a permanent fix put in place. With issue resolution in place, turn backs trended down, allowing gate 3 to meet flowdays without overtime.

Once the gated process was up and running the team set its sights on how it would be best measured and managed. At this time the waterfall and "script charts" were refined to reflect 4 hour increments. Waterfall chart are used by the production floor for visual execution of their process (visual displays). An additional tool, the "script chart," is the life blood of the process. These charts are updated twice a day by the scheduler and populate all the production and control charts used to measure the process. This process gives the team real time data twice a day and is reviewed every day at the production stand up meeting in the shop. At this meeting all the key players (production supervision, scheduling, planning and material support (PLS)) needed to resolve production issues are present. It's in this meeting the business rules were and continue to be refined. Currently there are three primary rules for the F108 engine process: 1) cannot exceed gate WIP, 2) no engine can be released unsupportable unless the part needed has a forecast meeting the need date in the gate, 3) only Flight level or above can waive any of the business rules.

In summary it took the team eighty nine days to set up the F108 gated process and 220 days to produce their first engine on target with a low flowday total of 49 days. Today despite ebbs and flows in supportability, the machine continues to be a steady and predictable model, giving management and employees alike a clear vision of the tasks needing to be completed, when to be completed, and how long it should take us to get them completed.

A.4. 559 SMXS Test Program Set Development

Test Program Sets are used throughout the Air Force in Depots and Flightlines to provide testing capabilities for weapon system avionics. The following analysis will explore the "Art of the Possible" journey of the 76th Software Maintenance Group, 559th Software Maintenance Squadron over the first year of the TPS Production Machine implementation. This narrative will review the background, implementation, and challenges faced in adapting a Gated Process for use in a software engineering environment.

Background

The 559 SMXS performs TPS development for B-1, B-2, and many other weapons systems repaired both at the depot and in the field. TPSs consist of the test software, interface hardware, and associated documentation necessary to test Line Replaceable Units and Shop Replaceable Units. Electronics engineers with the ability to perform circuit analysis are utilized to design and implement test strategies to evaluate the functionality of a circuit card or box and perform fault isolation to a faulty component or circuit card, respectively.

Historically, on average, it has taken two to three years to field a TPS depending on the complexity of the unit, with very Complex LRUs extending even longer. There are many factors contributing to the cycle time such as availability of technical data, functional assets, and equipment. For example, if technical data is not available, extensive reverse engineering may be required to understand the operation of the unit and develop a TPS. For over 30 years TPSs have been developed within 76 SMXG in a "cradle to grave" operation. In this way, one engineer was assigned a TPS and completed each step within the development process. As depicted in Figure 1, the assigned engineer proceeded through the development process by completing the associated tasks for that TPS ranging from hardware and test design, software coding, and integration of the hardware and software on the automated test equipment. This strategy for TPS development required the engineer to be well-versed in each of these areas in order to effectively complete the TPS. The quality of the product was very dependent on the engineer's overall ability.

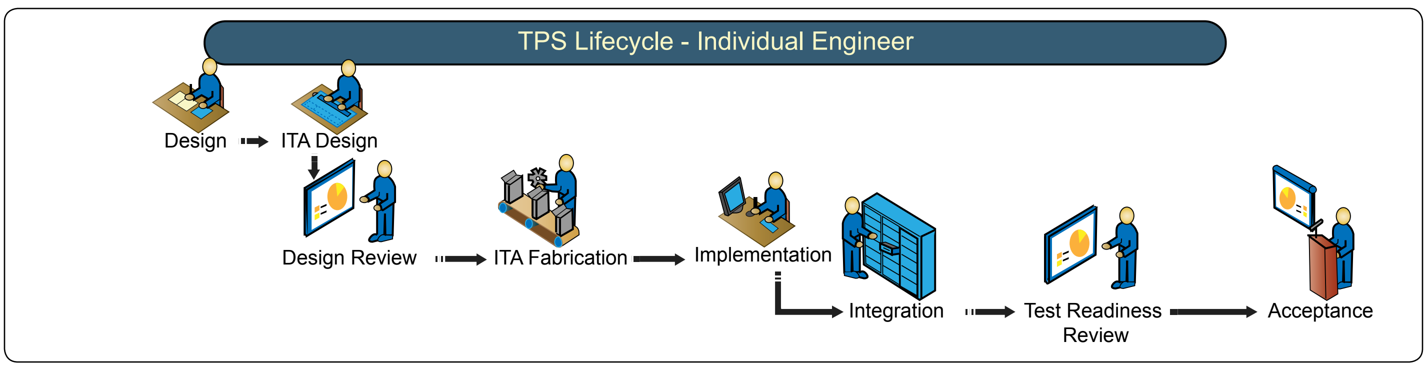


Figure 1: "Cradle to grave" TPS Development

In many cases, as a result of the long cycle times for TPS development, modifications to avionics items have been implemented within the aircraft before the repair capability can be put into place. As a result, program offices are then required to establish Interim Support Contracts to sustain the items. The high costs and long cycle times result in additional Air Force funds being diverted to maintenance that could be used elsewhere in support of the war fighter.

A major B-2 TPS effort began in 2011 which gave SMXG an opportunity to radically change the environment for TPS development. With a focus on continuous process improvement and cost effectiveness, the team began on a journey to reduce cycle time and improve the quality and consistency of TPSs produced by 76 SMXG.

"Art of the Possible" Initial Implementation

In 2012, 559 SMXS began a pilot program to implement a gated approach for TPS development. Two sections with approximately 30 engineers were set aside to develop the processes necessary to implement a gated approach. 60 TPSs of varying complexities were diverted to this team while two other sections continued with the traditional "cradle to grave" development approach. The pilot team designed a gated TPS process, as depicted in Figure 2, in which the TPS development process is divided into the following gates: Test Design, Hardware, Manufacturing, Implementation, Integration, and Acceptance. In addition to breaking the TPS development process into smaller, more manageable pieces, the TPS products pass from one gate to the next allowing engineers to repeatedly perform short duration tasks with the purpose of generating expertise through specialization, reducing multitasking, and better aligning individuals' strengths to the assigned tasks. With the gated approach, the ability to apply principles of Theory of Constraints and Lean manufacturing to TPS development was now feasible.

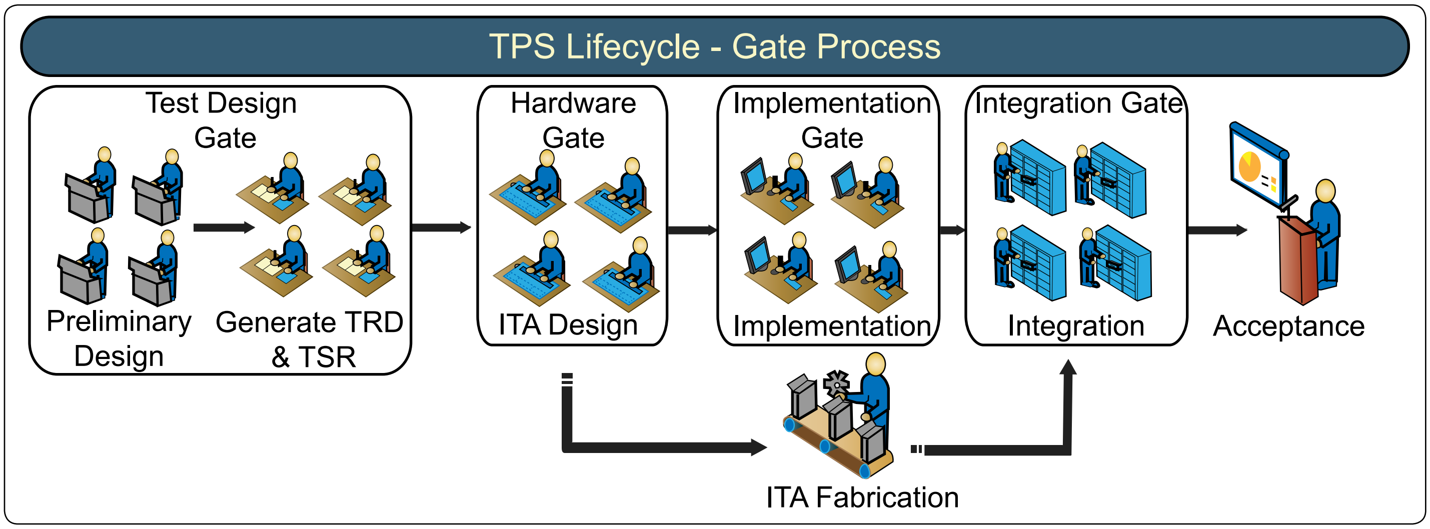


Figure 2: Gated TPS Development Process

In 2013, after a year of the pilot program, gated TPS performance was as good as or better than the performance within the "cradle to grave" sections. With the data at hand and a year of management experience the decision was made to go "all in" with gating all TPS Development within 76 SMXG. Over 120 personnel from three different squadrons in 76 SMXG were consolidated into 559 SMXS. Sections were established for each gate and personnel were assigned accordingly.

Consolidating all TPS development efforts and restructuring the TPS development processes involved a great deal of change. Communication was very important within the implementation strategy. The need for improvement and change was communicated to create buy-in. The logic behind the division of processes within the gated approach was also shared for understanding. Getting buy-in was a long process but very important to the success. Critical to the effort was obtaining support from all leadership involved from the 76 SMXG Director to the section chiefs over the individual gates.

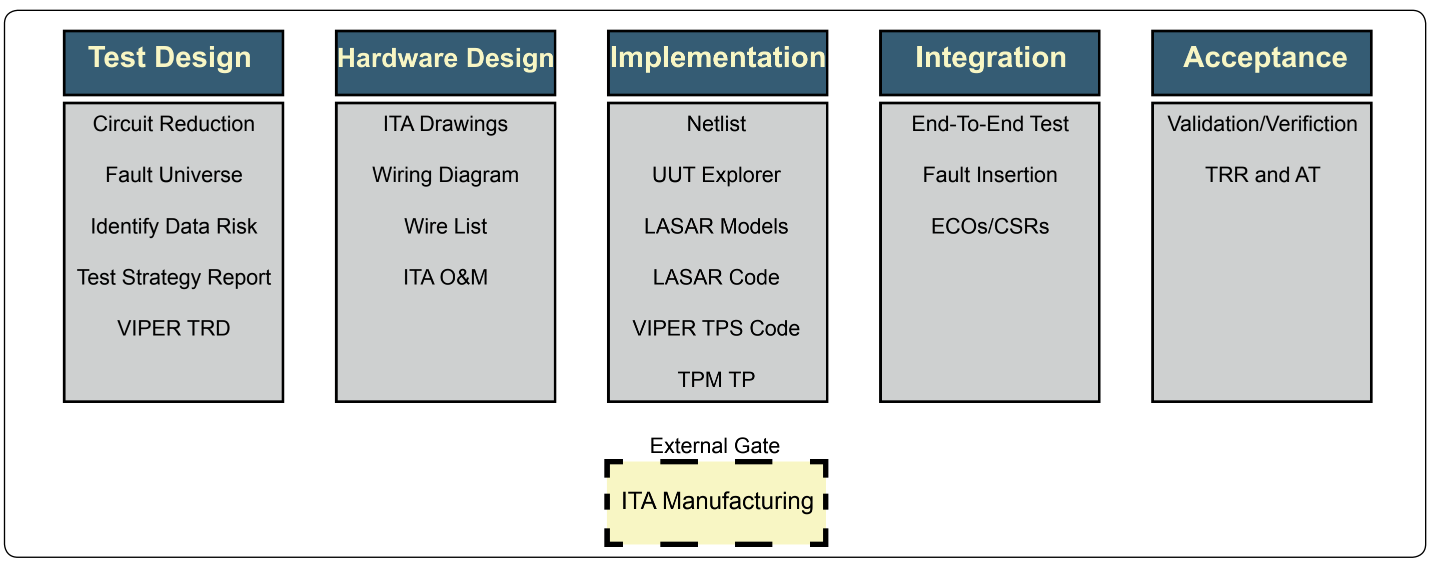


Figure 3: Gated TPS Development Process

Standard work packages or scripting were established for each gate which clearly defined the entry and exit release points. Historical performance data was analyzed for the tasks associate with each gate. Due to the varying complexity of each SRU or LRU, four main complexity categories were established: simple, average, complex, and very complex. Based on complexity, aggressive flow day targets were established for each gate with reductions ranging from 20 to 40 percent from the historical data. All to achieve a "Road To" goal averaging 398 days to develop a TPS, this is an average reduction in schedule by 36 percent and a projected cost savings of 21 percent.

To monitor the flow of work products, a TPS Production Machine Dashboard was established as seen in Figure 4. Each gate is represented with the associated Work in Progress identified as well as the associated queue for each gate. The Dashboard serves as an important tool to monitor flow and identify constraints in the machine. The constraints identified include hardware interfaces, assets, replacement parts, and resource availability.

As depicted in the dashboard, the process with the largest queue of WIP in front of it is the Manufacturing Gate. The Manufacturing Gate is the constraint of the system and sets the speed of which the production machine operates. The output from the Manufacturing Gate is the physical hardware required to interface the unit under test to the ATE. This process is typically performed by an external contractor. In the past, TPS projects were often planned to account for long lead times associated with hardware manufacturing. However, with a focus on speed, the Manufacturing constraint must be addressed. Various improvement initiatives such as organic fabrication and IDIQ contract vehicles are in work to improve the constraint.

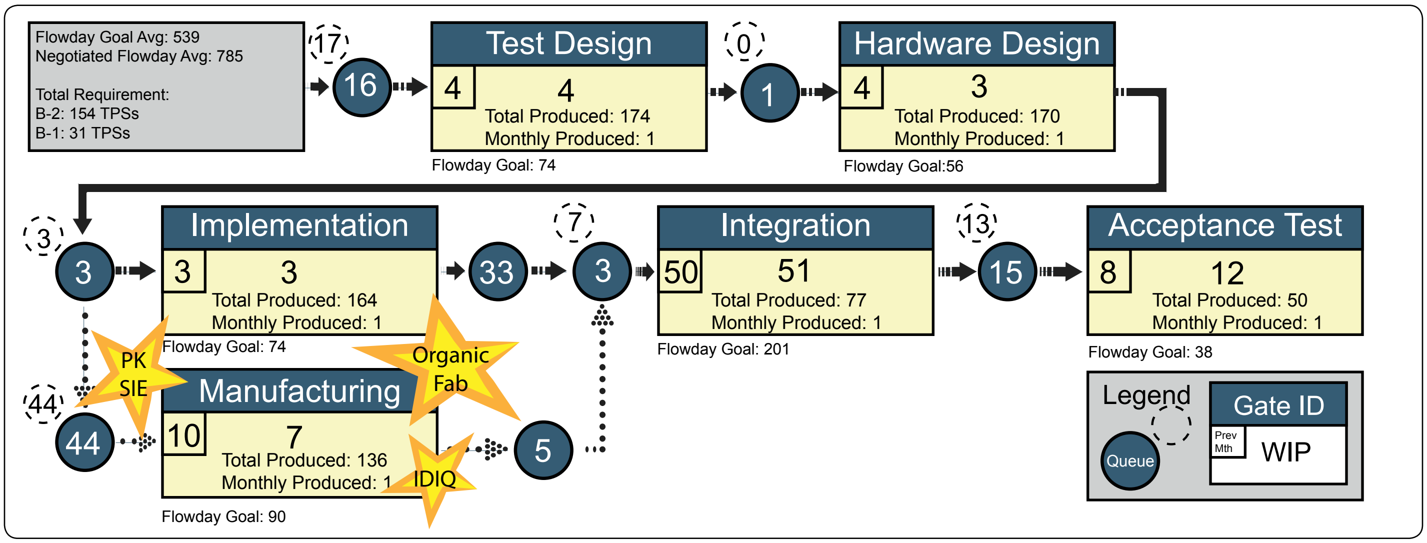


Figure 4: TPS Production Machine Dashboard

For decades, 559 SMXS has utilized Earned Value Management (EVM) philosophy to manage projects; however, with the implementation of the gated structure new performance metrics were developed. These metrics are focused upon flow days, WIP, and queue. Metric charts were established to monitor the performance of each gate on an individual TPS and monthly production basis, see Figure 4. Live data or monthly roll-up data is readily available to monitor and communicate performance.

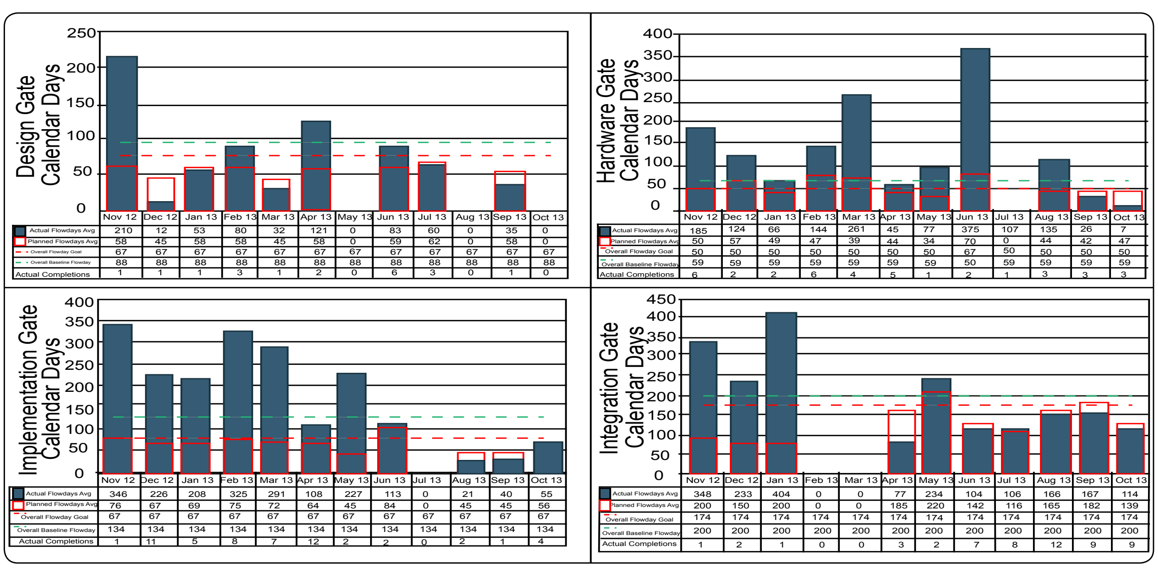
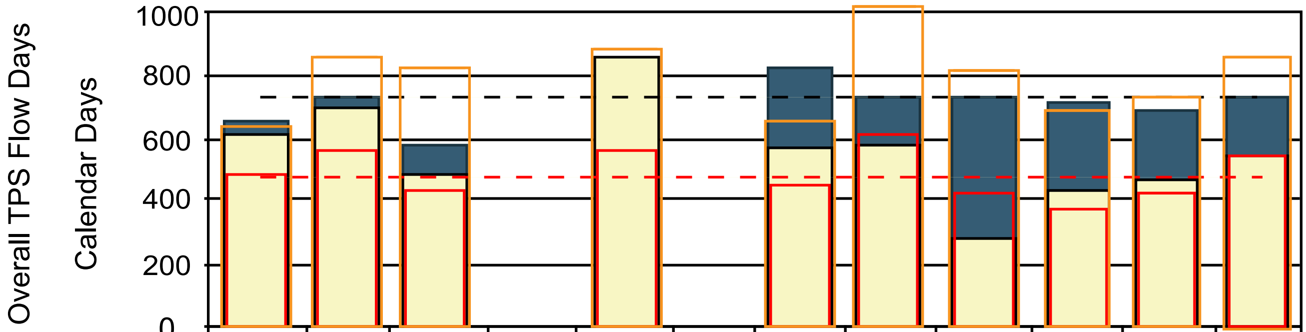


Figure 5: Gate Metrics (click to zoom)

In addition to monitoring individual gate performance, total TPS flow day performance is also monitored as seen in Figure 6. However, prior to conversion to a gated system, many TPSs were started early to provide work for engineers due to delays in manufacturing. These TPSs were then sitting in queue for manufacturing for as much as one year. Therefore, it will likely take one to two years from full gated implementation to see TPSs that were produced from beginning to end in the gated structure. As a result, the performance seen in Figure 6 will not fully reflect the efficiencies gained within the gated system. The chart reflects, in blue, the average queue time for the TPSs produced that month.

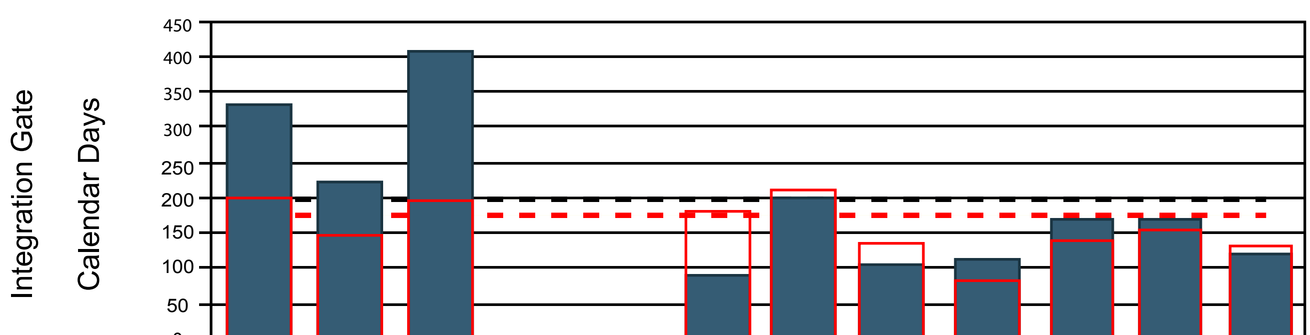


	Nov 12	Dec 12	Jan 13	Feb 13	Mar 13	Apr 13	May 13	Jun 13	Jul 13	Aug 13	Sep 13	Oct 13
Queue Time Avg	37	29	121	0	0	0	251	111	462	310	223	211
Working Time Avg	612	722	451	0	839	0	597	591	287	407	447	553
Total Flowday Avg	549	751	572	0	839	0	818	702	749	717	670	764
Planned Flowdays Avg	475	554	416	0	554	0	455	625	416	377	417	552
Baseline Flowdays Avg	626	882	809	0	867	0	648	1029	809	695	753	850
Overall Flowday Goal	476	476	476	476	476	476	476	476	476	476	476	476
Overall Baseline Flowday	747	747	747	747	747	747	747	747	747	747	747	747
Actual Completions	2	1	2	0	1	0	3	1	1	6	6	8

Figure 6: Overall TPS Flow Days

Challenges Faced and Outcome

It was evident that implementing a major process change would not be easy. Many expressed their concern about the proposed gated TPS development approach. One of the major concerns involved the handing off of software products as many felt it would result in additional time for each engineer to come up to speed on the specifics of the UUT. However, initial findings have shown that only one extra learning curve was created as each gate creates standard work packages. The work package created by the first gate is used by each of the following gates requiring only the Integration Gate to have a more extensive understanding of the UUT. Furthermore, it has been found that the time it takes to come up to speed on a UUT seems to be overcome with increased efficiency through specialization. This can be seen in the performance of the Integration Gate in Figure 7 since full gated implementation in April 2013.



	Nov 12	Dec 12	Jan 13	Feb 13	Mar 13	Apr 13	May 13	Jun 13	Jul 13	Aug 13	Sep 13	Oct 13
Actual Flowday	346	233	404	0	0	77	234	104	106	166	167	114
Planned Flowdays Avg	200	150	200	0	0	185	220	142	116	165	182	139
Overall Flowday Goal	174	174	174	174	174	174	174	174	174	174	174	174
Overall Baseline Flowday	200	200	200	200	200	200	200	200	200	200	200	200
Actual Completions	1	2	1	0	0	3	2	7	8	12	9	9

Figure 7: Integration Gate Performance

In the past, when a TPS had to be handed off to another engineer, the gaining engineer would start all over resulting in increased cost and schedule. However, with the gated system, the processes are designed to be handed off through defined work packages and technical reviews within each gate such that consistent products are passed from one gate to another effectively.

Another major concern of the gated process was the impact that it would have to morale. A common belief was that engineers take pride in completing projects from beginning to end. Would engineers still feel challenged working within the confines of a gate or would they become bored with increased repetition? Contrary to popular belief, within the gated system, engineers have maintained a sense of pride and accomplishment within their individual gates. Gated teams work together to improve processes and achieve flow day targets in much the same way that they did when working "cradle to grave" projects. In many cases, when given the opportunity to move to a different gate, engineers have chosen to stay in the assigned gate to continue to learn, develop, and improve.

Performance Results

The success of the "Art of the Possible" is evident after eight months of production machine execution. Individual gates are already achieving their flow day targets which incorporated between 20 to 40 percent reductions from historical data. Furthermore, this performance was also achieved during a period of six weeks of furloughs and zero overtime. By the end of fiscal year 2013, 559 SMXS delivered over 40 percent more B-2 TPSs than planned.

Gated metrics have moved the focus of 559 SMXS to speed instead of the traditional earned value metrics. The focus is on the reduction of waste and elimination of constraints rather than previous methods to plan constraints into the schedule. One of the greatest benefits thus far is that gates provide more resource flexibility and the ability to better manage the entire talent pool. Not all engineers are created equal. It may be argued that to develop a single TPS the most effective way will always be to just assign it to your top performer. However to develop large numbers of TPSs requires many engineers and unfortunately on average any team consists of only 10 to 15 percent of engineers who fall in to the top performing category.

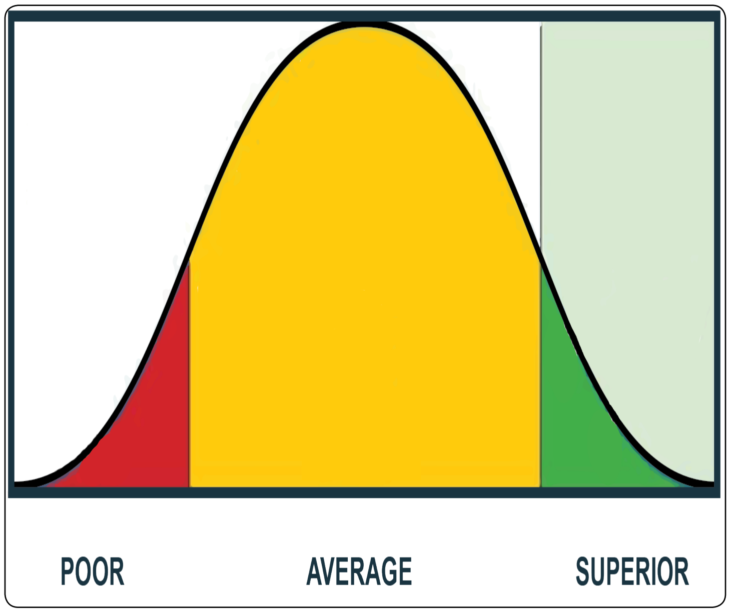


Figure 8 (click to zoom)

Top performers cannot perform all of the work and the system can only be truly optimized when all of the resources are contributing their talents in an efficient, useful manner. A gated process allows the average performers to become more productive as they specialize in specific areas and the poor performers become more productive as managers find tasks that they can do and improve upon through repetition. For example, a "cradle to grave" TPS engineer may complete a hardware design once every two to three years. Now, with the gated processes, a hardware engineer completes eight to ten designs in a year increasing their experience and skills considerably. Top performers become more productive as they get more challenges to solve and can focus on the highest priorities aligned with their areas of expertise. In doing so, the quality of a TPS is less dependent upon the quality of the engineer assigned to do the work. Pride, confidence, and morale of all employees improve as more is accomplished.

Summary and Next Steps

While successful in the first year, the 559th's "Art of the Possible" journey is just beginning. With an everyday focus on process improvement, more opportunities to improve the TPS production machine are revealed. The success of the "Art of the Possible" has been evident with the number of TPSs produced since implementation and the improvements seen within each gate. However, there are many opportunities for continued improvement specifically in areas such as flow management, visual displays, and feedback between gates.

Flow management is critical to the performance of the gated TPS system. TPS products need to be pulled through the system and not pushed. With enhanced flow management and planning, using techniques such as Drum Buffer Rope, more stability in personnel assignments and resource loading can be achieved. 559 SMXS continues to work to improve flow management and use tools such as ProcessModel to optimize flow and resource loading. In addition, 559 SMXS is working to improve queue management such that there are established queue targets and wait time is tracked by specific cause such that systemic constraints can be eliminated.

Another important area for implementation by 559 SMXS is visual displays such that all engineers understand how they are performing and whether they are having “a good day”. It is important that the 559 SMXS team understands their “Road To” goals, how their performance contributes to achieving these goals, and how 559 SMXS overall performance contributes to a better Air Force for tomorrow. Furthermore, our “Walk the Wall” meetings need to focus more on continuous process improvement efforts within each gate in addition to production. With a gated structure in which software products are passed from one engineer to the next, communication and feedback is critical for continuous improvement. Maturing the mechanisms for information exchange and feedback between the gates is an area of focus for 559 SMXS.

The success of the TPS Production Machine would not have been possible without buy-in from all stakeholders. But, that doesn't mean 559 SMXS is finished. As the team achieves their targets within each gate and overall, new “Road To” goals will be established. Process improvement continues as 559 SMXS matures further along the “Art of the Possible” to achieve the Art of the Possible.

A.5. OO-ALC F-22 Production Machine

The F-22 Raptor is the world's most technologically advanced, low observable Air Superiority fighter in active service today. This achievement remains eclipsed only by the maintenance and support system necessary to sustain combat & trainings operations while also increasing its lethality and overall effectiveness through depot-level modification. The analysis in this case study focuses on the 574th Aircraft Maintenance Squadron's (Provisional) "Art of the Possible" journey throughout the first year of AFMC's Five Center Construct overhaul. This narrative covers the impacts, challenges and successes of a modification-based weapon system managed through use of the AFSC Production Machine methodology and philosophy. This study provides an in-depth perspective highlighting the differences between a programmed depot maintenance based implementation and the more fluid modification-based workload of the fighter depot. Finally, this paper will outline the unique challenges posed by implementing the F-22's sustainment concept of operations through a unique Public-Private Partnership. This arrangement between the Air Force, Lockheed Martin and Boeing, reinforces the importance of clear communication, constant collaboration, disciplined management and teamwork.

Background

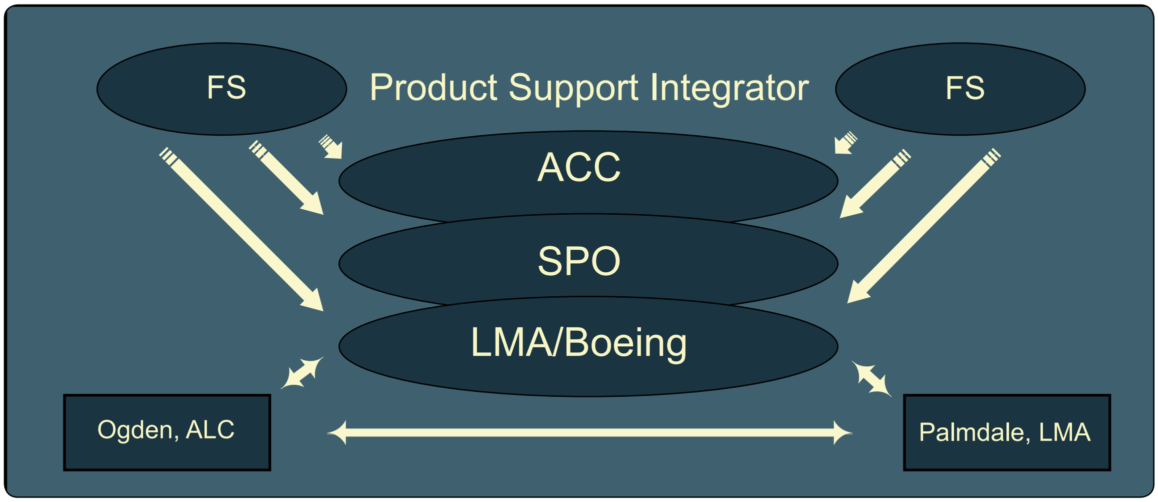
In its relatively short time in the Air Force inventory, the F-22 has experienced significant structural challenges requiring intense structural depot-level maintenance activity. As with most newly developed aircraft, a block of the F-22 fleet required post-production modifications directly after rolling off the production line to bring them to a common configuration. Following this effort, discovery of corrosion in unexpected areas drove depot-level corrosion inspections and repairs to correct the defects. As of today, two separate depot locations provide this support: one managed by the Original Equipment Manufacturer Lockheed Martin in Palmdale California and the second operated by an Air Force organic depot at Hill Air force Base, Utah. Both provide the necessary depot modifications, heavy maintenance, repair and overhaul capabilities to enable current and future flying operations worldwide. Ogden ALC's initial entry into F-22 depot operations began with military support directly to Lockheed's Palmdale operation and provided by the 649th Combat Logistics Support Squadron in 2004. Eight person teams operated on-site at the OEM facility and executed over 165 depot-level time compliance technical orders to bring the earliest block of the fleet to the full-rate production configuration. Following the success of this operation, the 309 AMXG began accepting the first aircraft at Ogden in 2006, nearly 15 months early, to perform the Night-Air-to-Air Refueling modification. This new team proved highly successful and delivered the first 18 aircraft on-time or ahead of schedule. This first depot repair effort was quickly followed by the initial Structural Retrofit Plan modification to combat cracking in several key areas by enhancing the structural integrity of the aircraft by treating the area with glass shot peening process. In addition to SRP-I, the team also established a speed-line operation to mitigate corrosion identified on aluminum panels on upper and lower surfaces.

Since the stand-up and initial modification efforts, the F-22 workload continues to increase and stands at a current average work package of 21,000 hours per aircraft with 12 aircraft in various phases of depot modification at any given time; six aircraft at Palmdale and six at Ogden. The process at Ogden (Hill AFB) has evolved from an initial SRP-I workload to a more in-depth Structures Retrofit Plan package followed by complex and intensive low-observable material restoration effort our PPP contract drives to 114 man-days. To fully understand the significance of the journey over the past year, one needs to understand the relationships within the Air Force structure and with PPP teammates.

Partnerships

As a result of moving away from SAF/AQ's initial acquisition strategy of "Contractor for Life," Air Force leaders at AFMC and OO-ALC established separate partnership agreements with both Lockheed Martin Aero and Boeing. The F-22 System Program Office acts as the central oversight for this sustainment contract ensuring LMA, as the Prime, provides engineering support, supply chain management and depot modifications & heavy maintenance for the F-22. This caused the SPO to provide contractual direction to LMA that fifty percent of the touch-labor for the F-22 fleet be from an AF organic repair operation. LMA essentially subcontracted the 309th Aircraft Maintenance Group, through a direct sales partnership agreement, to provide touch-labor for half of the depot work to fulfill this requirement. This arrangement is a significant departure from most other weapons systems across the Air Force depot enterprise, adding another level of complexity and necessitating a great deal of communication, time and effort to execute the F-22 depot maintenance requirement.

With this in mind, the squadron's journey with the AFSC Production Machine and Leadership models began near the closeout of the FY12 production year. In FY12, the 574 AMXS fulfilled its contract with LMA by producing 12 planned SRP-II modified aircraft and one unplanned drop-in aircraft for low-observable material issues. They accomplished this with a total of six aircraft maintenance production/compression reports extensions and three late aircraft for the year. Overall, the 574th produced aircraft an average of 142 days which represents 28 days slower than the SPO/LMA workload contract stipulated. Squadron leadership knew this overage had to be eliminated with a subsequent increase in speed.



For FY13, the Squadron established an aggressive "Art of the Possible" goal of 100 days. This goal not only meets the 114-day flow day requirement but reflects an approach that, when successful, provides the ability to cover all over-and-above work discovered throughout the flow. This will ensure the warfighter receives their Raptors back to home station on-time, airworthy and combat-ready. Compounding the level of difficulty is the warfighter's Aircraft Availability requirement of 6.4 percent which includes a fixed number of depot-possessed aircraft and therefore drives a nose-to-tail induction schedule. Due to both the flying-hour and calendar-driven grounding corrosion control requirements, the importance of staying on the yearly workload contract is paramount. Consequently, the philosophy and application of the AFSC Production Machine methodology came at the perfect time for the F-22 fleet.

Initial Implementation/Execution

The squadron's leaders rapidly initiated a targeted education campaign of AFSC's Production Machine Science focused on both the leadership and the workforce to provide a basic understanding of the premise. However, although the specifics of "how to execute" proved more elusive for the squadron, the 574th wasted no time in building and molding its production machine model for FY13 operations. Starting with the annual induction requirement from the SPO, communicated through LMA, the 574th shifted from the previously used 'phase approach' of managing production to the rigorous, disciplined and accountable AFSC Production Machine methodology. With the customer requirement of 12 aircraft inductions clearly understood and the initial set of gates established, the squadron applied Little's Law and the Production Machine math to determine the necessary takt time, gate WIP and specific gate durations for the FY13 SRP-II modification requirement.

In late Fall of 2012, the squadron used the 8-step approach to problem solving to take a second run at establishing the optimum critical path and gate construct. Through this second and more experienced effort, the 574th revised the machine to seven gates in the SRP II Modification program to enable optimal production and throughput. Once the critical path was understood and agreed upon by the enterprise and partnership stakeholders, they established their gates and restructured the data networks to support the Production Machine. They also developed protocols for Gate Transfer processes and "A to Z" checklists to ensure complete task closure and no travelling work. In rapid succession, visual management boards were developed and produced for every production dock to clearly illustrate the SRP-II gates, current status of each aircraft within the flow, ANDONs and non-critical path constraints, quality, safety, cost and wingman engagement. The F-22 production boards continue to shine as top-of-the-class within the 309th Aircraft Maintenance Group's six weapon systems. These production boards, along with a series of squadron Goal Boards, enable each member of the 574 AMXS Team to understand and articulate whether he or she as well as the organization is "having a good day."

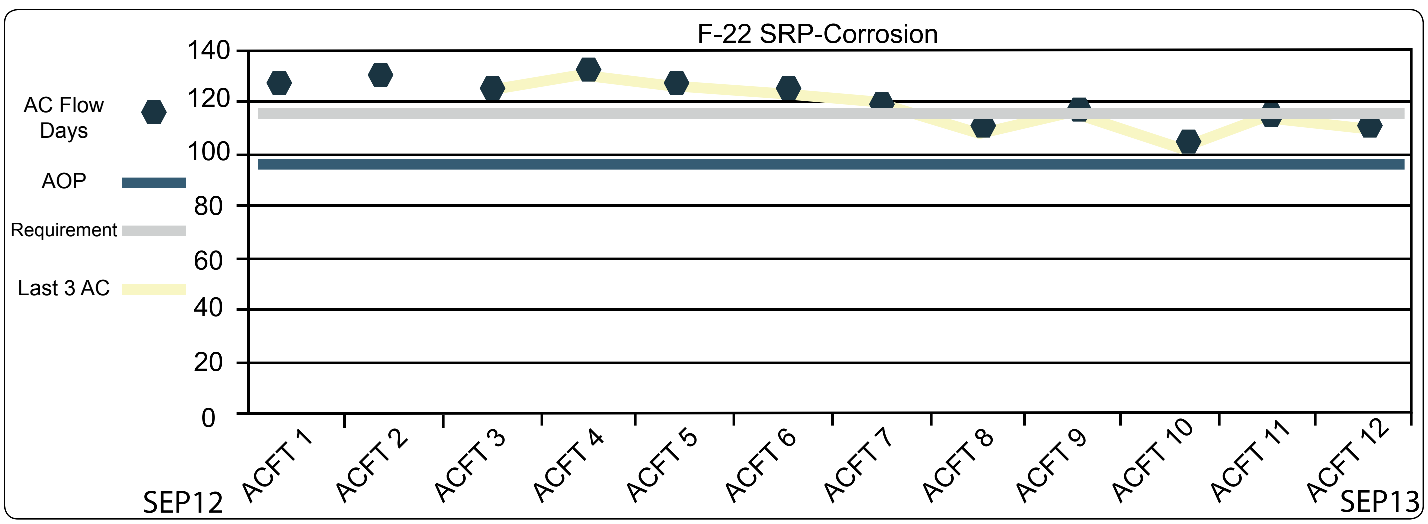
Continuous Process Improvement—Bedrock for Success

With the new machine built, the squadron started executing and this revealed a number of constraints requiring immediate attention. These constraints included everything from an inefficient engineering disposition process to a security clearance process for new employees riddled with delays. Additionally, they discovered inadequate standardization within the structured on-the-job training program and further challenges with effective horizontal integration of critical back-shop support functions all negatively impacting progress on the critical path. The squadron continues to address and confront each of these issues alongside the identification of new constraints that demand immediate resolution.

In October of 2013, the squadron worked with the OO-ALC Transformation Team and conducted an Enterprise Value Stream Analysis (EVSA). This week-long event culminated a 30-day prep period and included participation from all stakeholders to include the SPO/SSO, LMA, Boeing, supply chain, 75 ABW, OO-ALC/OB & EN, 309 CMXG and 309 MXSG as well as multiple functions within the 309 AMXG and 574 AMXS. The event was highly successful and revealed 92 opportunities for improved efficiency in the form of 62 Rapid Improvement Events (RIEs) and 30 Go Do-its thus teeing-up multiple prioritized Continuous Process Improvement opportunities for FY13 & FY14.

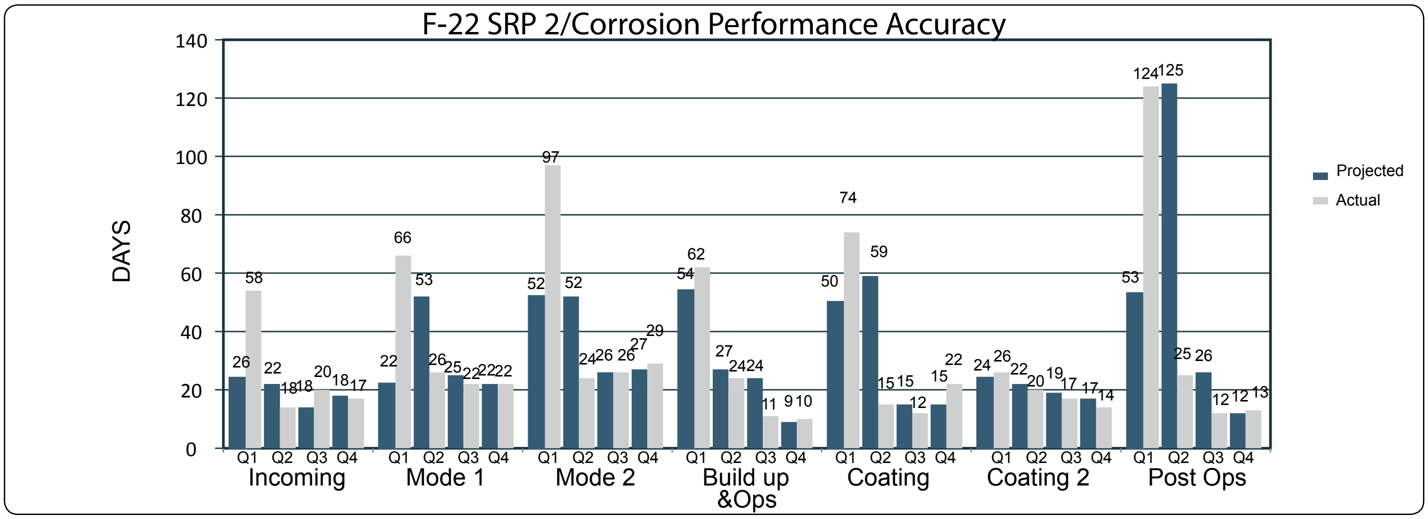
Performance

After 9 months of FY12 production machine execution and despite 6 weeks of furloughed operations limiting the organization to a 32 hour work-week and zero overtime, the 574 AMXS surpassed the F-22 machine requirement. This team managed to achieve a 112 man-day average for the last six FY12 aircraft through the gates—a program milestone. This achievement allowed the squadron to handle most of the over-and-above work without having to request AMREP extensions and delay either delivery to the warfighter or the next scheduled input. The scatter diagram in the table below illustrates a marked improvement between the first and second halves of FY13. Similarly, the graph on the next page illustrates the turbulence in the first two quarters of Production Machine implementation as compared to the last two quarters of FY13 in each gate.



By the end of FY13, the squadron produced 11 of 12 aircraft with the 12th aircraft producing on 1 October, and two late aircraft missing their dates by only 4 days combined. The FY13 increase in speed and improvement in due date performance represents a very positive start to the Art of the Possible journey.

While successful in the first year, the tenets of the Production Machine continually prove that we still have a great deal of improvement opportunities ahead to become "World Class." For the 309 AMXG, "World Class" performance means we've covered every milestone laid out in AFSC's Maturity Matrix and have surpassed our AoP goals. In April 2013, we assessed the 574th AMXS' implementation progress and, on a 0-5 scale with a "5" representing world class operating level, the 574 AMXS



assessed itself as a "1" against the Maturity Matrix. A clear benefit of performing this assessment periodically is that it provides a roadmap to attain each level of maturity. On their next assessment, planned for November 2013, all have high confidence we will see a graduated level of maturity. Often times with improved organizational performance comes increased business opportunities…and in the case of the 574th, opportunity quickly followed.

Depot Consolidation

As mentioned earlier in this paper, the F-22 depot requirement is split between LMA Palmdale and the 574 AMXS at Ogden. In recent years, AF leadership at SAF/IE and AFMC has stated the desire to consolidate all depot operations at Ogden to harvest cost savings. In 2012, the government budget crisis and the declining FYDP budget spurred the AF into action. With all F-22 MILCON projects complete at Hill AFB and the 574 AMXS producing aircraft faster, significantly cheaper and with higher quality than LMA Palmdale the time proved right for a consolidation study. After an initial study in the fall of 2012, the F-22 Raptor Sustainment Council directed the F-22 SPO to conduct a Business Case Analysis (BCA) for consolidating all F-22 depot operations at the Ogden ALC.

Following this direction, the 309 AMXG, OO-ALC and AFSC in concert with the SPO and AFLCMC began developing the BCA. AFSC immediately sent several key members from the 76th AMXG's Visioneering staff from Tinker AFB to the 309 AMXG to help develop a comprehensive business case and consolidation implementation plan. In 2 weeks, the BCA was completed and ready for executive review. As the plan matured, all involved found it clearly apparent that consolidation would net a cost savings of up to $41 million per year and over $747 million throughout the F-22's planned life cycle to 2033. With performance at an all-time low at LMA Palmdale and the 574 AMXS at Ogden using the AFSC Production Machine to reduce flow days and stay on the yearly plan, the Assistant Secretary of the Air Force for Installations & Environment, Commander - Air Force Materiel Command, Deputy Chief of Staff for Logistics, Installations and Mission Support, and the Assistant Secretary of the Air Force for Acquisition approved the Ogden consolidation plan on 8 May 2013.

During a 21 month period beginning September 2014, the additional six WIP from Palmdale will begin transfer to Ogden. In addition, the 574th is posturing to successfully capture an anticipated FY16 increase of approximately four-WIP due to an emerging "low observable coatings reversion recovery" requirement. This massive savings to the taxpayer and workload gain at OO-ALC would not have been possible without the disciplined approach to produce aircraft on-time for the Warfighter and the implementation of the AFSC Production Machine methodology. (FY13 performance in graph below).

Future Challenges

One year into implementation of the AFSC Production Machine, the 574 AMXS still has significant challenges to attack, both internal and external. Several of these include, attaining true horizontal integration from all of our enterprise partners and supporters throughout the Complex. Without full enterprise buy-in, this production management system will not achieve its true potential. Specifically, supporting processes in back shops are just now beginning to gate their workloads versus the long held First-In-First-Out approach. Outside of the Complex, the largest challenge remains attaining full buy-in from both LMA & Boeing and, in part, even our F-22 SPO to support concepts, discipline and accountability inherent in the Production Machine. LMA is just now recognizing the importance of attending Complex production meetings for information or to explain ANDONs. Similarly, getting the SPO to recognize the turbulence unnecessarily induced to the entire machine due to last minute workload changes, often because of inadequate planning, remains a significant challenge. Additionally, fully embedding the AFSC Leadership Models concepts into the fabric of our workforce continue to challenge our leadership yet remains the key to our ultimate success. The 574 AMXS has demonstrated significant improvement in F-22 aircraft production over the first year of the AFSC Production Machine. With persistence and dedication to the Art of the Possible…the sky is truly the limit.

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A.6. F-16 AN/APG-68 Dual Mode Transmitter

The F-16 Dual Mode Transmitter is a substantial part of the AN/APG-68 (F-16C/D) radar group. Specifically, the DMT provides a 24,000 volt radar transmission, contained within a Traveling Wave Tube, necessary to generate amplified Radio Frequency (RF) for the radar antenna system emission. The following analysis will explore the journey of the 309th Electronics Maintenance Group, 523rd Electronics Maintenance Squadron, and the Transmitter Shop implementation of the "Art of the Possible" in just a few short months. This narrative will review the background, root cause analysis, corrective actions, challenges faced and overcome, implementation/use of the AFSC Maturity Matrix and Key Performance Indicators, and the near immediate success and continuing process improvement using the "Art of the Possible".

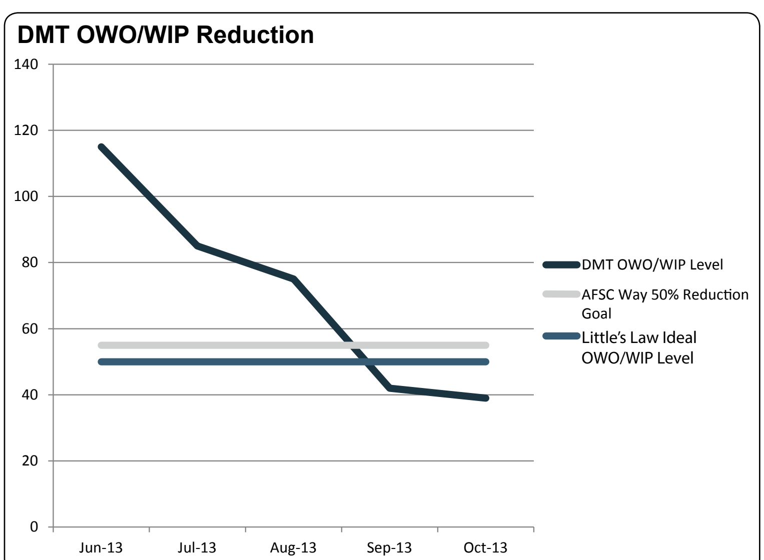
Background

The DMT is a highly technical and expensive asset. Historically, the DMT average acquisition cost is approximately $542.1K per unit. The last acquisition cost was $425.2K per unit. In addition, there are approximately 576 DMT assets in the USAF inventory pipeline representing a total cost of $244.9M based on the last acquisition cost of $425.2K. The DMT is a technically challenging Line Replaceable Unit (LRU) to repair. The DMT has numerous processes requiring a 100K clean room environment and advanced troubleshooting techniques required to maintain the DMT within operational requirements. Historically, it has been difficult for the Depot Maintenance to produce sufficient serviceable DMT assets for supply. In the last five years, the DMT has experienced high backorders, substantial Mission Impaired Capability Awaiting Parts hours, and long Flow-Days. From FY09 through FY13, the DMT accumulated 61.5K MICAP hours and 985 backorders. In FY12, the DMT accumulated 33.5K MICAP hours alone. As a result of Depot Maintenance failure to maintain consistent production levels at or near USAF requirements, a second source of contract repair was required. Currently production requirements are split 83% organic and 17% contractor.

Art of the Possible Initial Implementation

The "Art of the Possible" initial education campaign was initiated by the Director, 309th Electronics Maintenance Group (EMXG). 309 EMXG immediately recognized the advantage of Depot Maintenance and Supply Chain Management organizational alignment within the AFSC structure. Furthermore, 309 EMXG recognized and embraced the "Art of the Possible" concept that successful mission accomplishment was dependent upon performing to our full potential by (1) recognizing opportunities, (2) understanding and eliminating true limiting constraints, (3) improving processes, and (4) maximizing available resources.

In preparation for a 309 EMXG FY13 Strategic Planning Offsite, requests were disseminated for Squadron personnel eager to learn and motivated to improve Group/Squadron business practices… the "Art of the Possible". This multi-day Strategic Planning Offsite resulted in an inspiration from all in attendance, and a desire to change our "business as usual" approach, into the "Art of the Possible" approach. 309 EMXG also initiated a 20% flow day reduction as our Group "Art of the Possible" goal.



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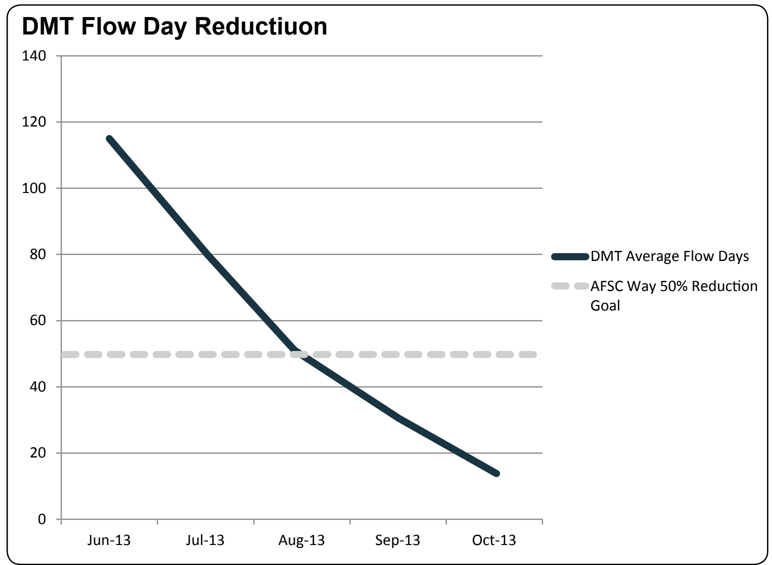
Post the 309 EMXG Strategic Planning Offsite, immediate "Art of the Possible" implementation ensued. The Transmitter team was motivated to improve business practices through implementation of "Art of the Possible". KPI were analyzed and past-practices and the current state of the work center were evaluated, resulting in a consensus that immediate changes were deemed necessary.

Excessive On-Work-Order / Work-In-Progress (OWO/WIP) assets cluttered the maintenance environment. "Hangar Queens" occupied valuable shop space and were being utilized for the purpose of cross-cannibalization of parts. This action extended flow-days, co-mingled components, and created a substantial accountability problem. This high OWO/WIP past-practice enabled technicians to circumvent the supply process, and masked substantial parts constraints from legacy system view.

It was evident that a 20% stretch goal for OWO/WIP reduction would be insufficient, and a 50% stretch goal was implemented instead. Additionally, Little's Law (calculating flow-time over takt-time) was utilized to identify an ideal OWO/WIP working level for DMT production. Rather than allowing the past-practice of driving in over-inductions, EXPRESS was utilized correctly to drive in repairs. This action alone decreased OWO/WIP substantially. As improvements continued, and flow-days decreased, fewer asset inductions were required to maintain production. Current OWO/WIP levels are at a historical low as a result of following established working level rules designed to ensure optimal shop flow.



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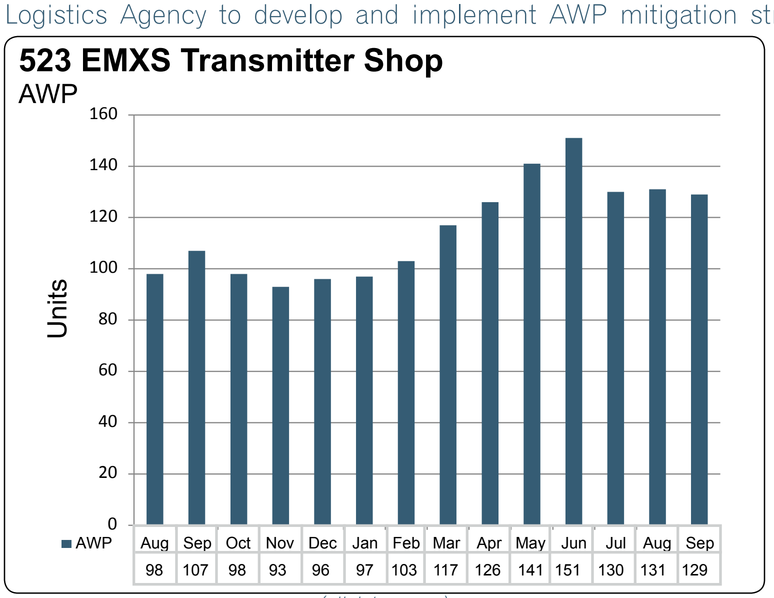
With the implementation of OWO/WIP reductions, a decline in flow-days naturally followed suit. "Hangar Queens" no longer occupied critical shop floor space accruing unnecessary flow-days. Additionally, assets were no longer utilized for piece-parts, or cannibalized for exchangeable parts. A proper 1-in for 1-out speed ratio is now maintained. Furthermore, each DMT asset now has its own repair cart, allowing subcomponents to remain with the DMT higher assembly for more accurate accountability. Additionally, internal processes were scrutinized and AS9100/AS9110 improvements were implemented, further decreasing flow-days and need for excessive OWO/WIP.

Challenges Faced and Overcome

It was evident that technicians were not cross-trained on all the various aspects of DMT production. Lack of cross-trained personnel resulted in constrained production whenever unique skills were unavailable. Occasionally, production actually ceased in various processes, creating production gate bottlenecks. A substantial amount of time was invested to cross-train technicians to ensure that no process would be constrained due to technician non-availability.

With the implementation of OWO/WIP and flow-day reduction improvements, numerous assets transitioned into formal "Awaiting Parts" (AWP) status. As a result, backorders were initiated and parts constraints were no longer hidden from legacy system view. The "Hangar Queen" maintenance practice which enabled technicians to cross-cannibalize parts, and delay placing orders, no longer existed. The only means of obtaining parts was through the proper supply channels. This in turn triggered supply chain D200 computations and buys which would have occurred years earlier, had the parts constraints not been hidden. A Virtual Materiel Management Team (VMMT) was established with all stakeholders including the Transmitter Shop, Supply Chain Management, and the Defense Logistics Agency to develop and implement AWP mitigation strategies. This spawned a much needed "Deep Look" into supply constraints within the Bill of Materials (BOM).



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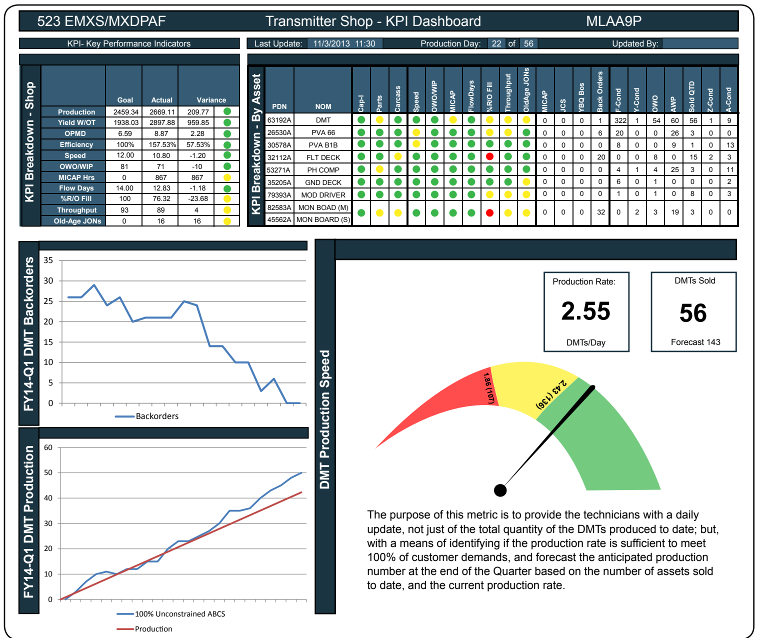
In addition, a Rapid Improvement Event (RIE) Team consisting of the aforementioned stakeholders utilized an A3 Problem Solving Analysis to properly identify constraints which prevented the Transmitter Shop from obtaining the necessary parts. Root Cause Analysis (RCA) revealed that the past cannibalization practices of the Transmitters Shop were predominantly to blame for the current parts constraints.



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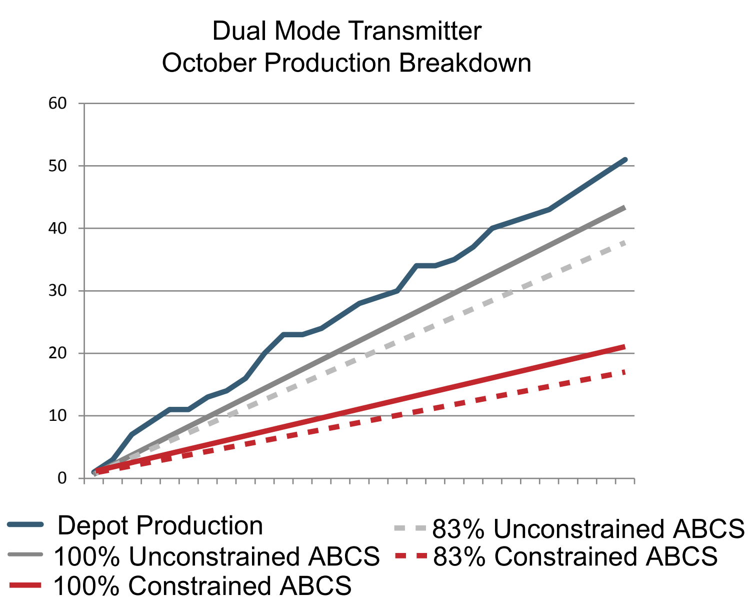
Additional RCAs identified linking issues between Air Force managed components and a general lack of understanding between constrained and unconstrained Automated Budget Computation System requirements. Short, intermediate, and long-term solutions were also developed to mitigate Shop Replaceable Units carcass and component constraints.

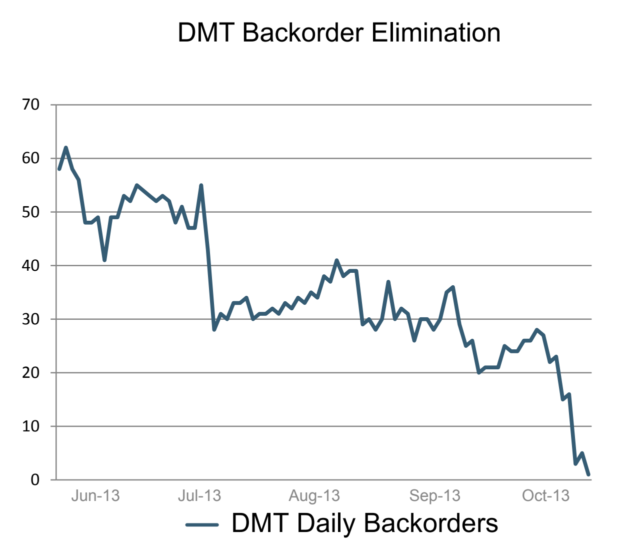
Implementation/Use AFSC Maturity Matrix and Key Performance Indicators

The 523 EMXS performed an AFSC Maturity Matrix assessment in April of 2013 to measure the AFSC Maturity Matrix implementation progress. On a 0-5 scale, with a "5" representing world class operating level, the 523 EMXS assessed itself with a "1" toward "Art of the Possible" maturity on all eight levels. Since implementation, the Transmitter Shop has "set the bar" for maturity within the 523 EMXS in all categories. The Transmitter Shop has substantially exceeded its own stretch goals for OWO/WIP and flow-day reductions. The Transmitter Shop was the first organization within 309 EMXG to implement the Maintenance Repair and Overhaul (MRO) system IMPRESA. IMPRESA will enhance real-time reporting of critical path/gate performance and scanning discipline. The Transmitter Shop implemented standard work and visual displays, providing technicians with near-real time KPI metrics tailored for the technician to answer the question "Are you having a good day"?

Success and Continuous Improvement

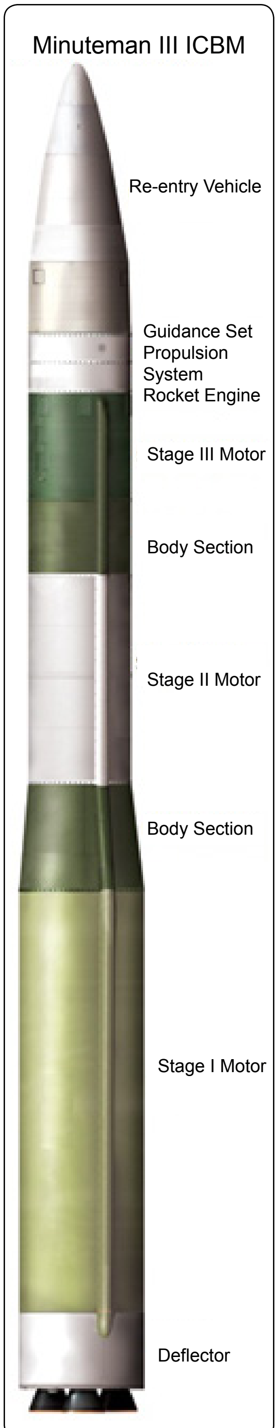
The success of the "Art of the Possible" is evident with the DMT production within the Transmitter Shop. KPIs and visual displays keep technicians on target. In October 2013, the Transmitter Shop met 100% of the customer's unconstrained DMT requirement, demonstrating to our customer, that we can be relied upon to produce at the production levels required.





Additionally, for the first time in two years, the Transmitter Shop reduced backorders to zero. As the backorders have been reduced, so too has the MICAP incidents and the associated MICAP hours. As the Transmitter Shop continues to demonstrate the effects of doing business the "Art of the Possible", serviceable DMT assets are on-the-shelf—something which has not occurred in five years!

The success of the Transmitter shop would not have been possible without buy-in from all stakeholders to include shop floor technicians, management, DLA and Supply Chain Management. The Transmitter Shop is a success story for all. But, that doesn't mean that we are finished. Process improvement continues as we mature further along the "Art of the Possible".



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A.7. 309th Missile Maintenance Group

Mission Accomplishments

The 309th Missile Maintenance Group performed depot-level Intercontinental Ballistic Missile maintenance and repairs for a fleet of 450 ICBMs, launch facilities, and mission unique support equipment. Using Continuous Process Improvement Teams, Air Force Smart Operations for the 21st Century, Lean Logistics, and Theory of Constraints, the 309 MMXG continued strengthening the nuclear enterprise and the nation's nuclear deterrence mission by reducing flow days, increasing throughput, identifying and eliminating bottlenecks and improving on time delivery rates. The focus on quality and the dedication to process improvement from the men and women of the 309th MMXG directly supported the warfighter in reducing MICAPs and increasing Fully Mission Capable rates of nuclear support equipment as well as sustaining the ICBM weapon system through 2030.

Intercontinental Ballistic Missile Mission

The LGM-30G ICBM, known as the Minuteman III, makes up the least expensive and most responsive leg of the United States' Nuclear Triad. The Minuteman weapon system was conceived in the late 1950s and was developed and deployed in the 1960s. Deployment of MM III, the third generation of MM missiles, began in 1970 with an expected life span of 10 years yet 40 years later it still maintains a strategic alert rate of over 99 percent. The current system consists of 450 missiles with 150 missiles each at Malmstrom Air Force Base in Montana, Minot AFB in North Dakota, and F. E. Warren AFB in Wyoming.

The mission of the MM III hardened and dispersed weapon system is to deliver thermonuclear warheads against strategic targets from underground launchers in the continental United States. The MM III consists of a three-stage, solid propellant booster called the downstage, a liquid propellant post-boost propulsion system called the Propulsion System Rocket Engine, an inertial type guidance system called the Missile Guidance Set, and a reentry system. The assembled missile rests upright in the launcher during the ground phase of operation.

The system was designed to deter any aggressor, but if deterrence failed, it is able to withstand an attack and provide instant retaliation capability. From its inception, the Minuteman program was oriented toward mass production of a simple, efficient, and highly survivable ICBM weapon system capable of varying missions with consistent reliability.

The Leadership Model

The 309 MMXG instilled the Air Force Sustainment Center's Leadership Model to ensure an environment of success. The leadership model provided enduring principles to equip leaders with a holistic approach to gaining effectiveness and efficiency. The model drove the 309 MMXG to meet common goals through three collective components: developing people, managing resources and improving processes, by focusing around the tenets of speed, quality, safety and cost effectiveness. By creating a leadership construct where teamwork, accountability, respect, transparency, credibility and engagement were paramount, the 309 MMXG created an environment where they achieved the "Art of the Possible." In FY13, the 309 MMXG generated 616,979 man-hours and executed $77.4 million dollars in depot maintenance. By eliminating waste and improving flow days, the 309 MMXG saved $9.4 million in FY13.

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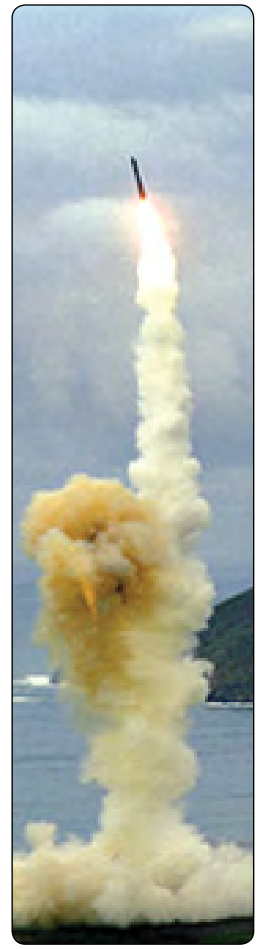
ICBM Programmed Depot Maintenance

Ensuring ICBMs remain a credible, safe, secure, reliable and effective nuclear deterrent is a challenge for those tasked with monitoring, assessing, modifying, modernizing, operating and securing the system. The MM III weapon system was deployed in 1970 with some equipment originating from the MM I and MM II as early as 1963. Issues facing the ICBM weapon system include: aging degradation, diminishing manufacturing sources, and parts obsolescence. Form, fit and function replacements of aged and worn out subsystems may not always be possible or desirable. Although the form may change, the fit and function are more constrained and may not change. Sustaining the weapon system requires modernization when components developed with outdated technology need replacement. The MM III performance requirements encompass the attributes of accuracy, reliability, availability and hardness. Accuracy reflects how close warheads can be delivered to their targets. Reliability is defined as the probability an available sortie will successfully launch, deliver, and detonate a warhead on target. Availability is the capability of a sortie to launch on demand. Hardness of the weapon system reflects the ability to survive a hostile nuclear attack without impairing the ability to accomplish the mission.


Minuteman III Test Launch

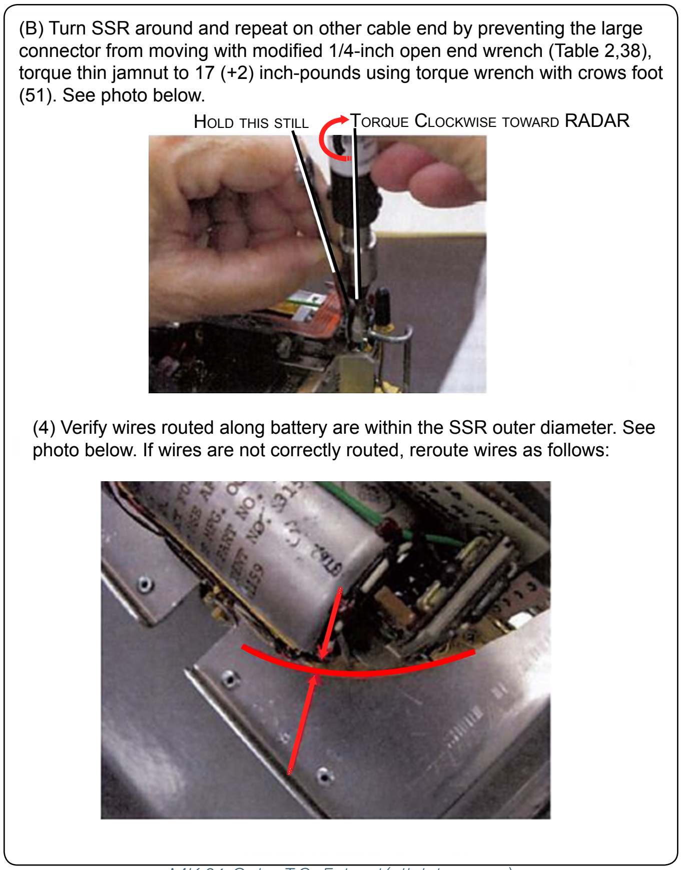
The PDM for the ICBM weapon system includes operational ground support equipment, missile subassemblies, launch control centers, and launch facilities requiring continuous field and rigorous depot maintenance upgrades to sustain the weapon system through 2030. Fiscal year 2013 focused on the Chief of Staff of the Air Force's #1 priority: Continuing to strengthen the nuclear enterprise. The 309 MMXG played a crucial role in sustaining the nuclear enterprise through reliable and maintainable depot maintenance performance. The 309 MMXG's commitment to the sustainment of the nuclear deterrence mission and to Air Force Sustainment Center's key tenants of speed, safety, quality and cost effectiveness catapulted the group to unparalleled successes for Mk-21 fuze refurbishment product demonstration, Transporter Erector programmed depot maintenance, Air Launched Cruise Missile programmed depot maintenance, Rivet Minuteman Integrated Life Extension, and Propulsion System Rocket Engines life extension program.

Mk-21 Arming and Fuzing Assembly Refurbishment

The Mk-21 reentry system contains the W87 nuclear warhead which provides USSTRATCOM unique and desired targeting benefits. The Mk-21 arming and fuzing assembly, or fuze, was not originally designed for life extension modifications. Mk-21 refurbishment includes replacing the launch safety device, solid state radar, silver zinc batteries, thermal batteries, and main flex cable assembly. The original equipment manufacturer, Lockheed Martin Valley Forge, along with the 309 MMXG are refurbishing these fuzes in support of the MM III life extension.

During the Production Demonstration phase of the program, technicians identified process constraints to technical data and production procedures. As a result, leadership instituted several process improvements. First, technicians and engineers reviewed and revalidated all relevant technical orders and time compliance technical orders to match the OEM. QUALITY ACHIEVEMENT! For the first time in Air Force technical data history, technical data included color photos to describe work to be performed. This type of visual management ensured process adherence and continuous production improvement. Secondly, leadership developed standardized data packages for all work performed on the fuze to include chemicals and expiration dates, documenting calibrated equipment, and all test data packages. In conjunction with standardize work control documents; leadership increased training requirements for technicians and quality inspectors prior to handling the fuze. The 309 MMXG developed Structured-On-the-Job Training and four training courses were created and added for Mk-21 Fuze Assembly, Disassembly, Quality Control Inspection, and Operational testing. SOJT included clarification of each step in the process through a systematic standardized approach to include accountability with measurement verified by signatures of the trainee, trainer, and quality inspector for each objective. These courses increased technician proficiency as well as standardization and consistency of work. Furthermore,

(click to zoom)


(B) Turn SSR around and repeat on other cable end by preventing the large connector from moving with modified 1/4-inch open end wrench (Table 2,38), torque thin jamnut to 17 (+2) inch-pounds using torque wrench with crows foot (51). See photo below.

HOLD THIS STILL TORQUE CLOCKWISE TOWARD RADAR

(4) Verify wires routed along battery are within the SSR outer diameter. See photo below. If wires are not correctly routed, reroute wires as follows:

MK-21 Color T.O. Extract(click to zoom)

technicians received NASA certification training for soldering aerospace equipment and polymeric repair certification. This expanded proficiency increased employee satisfaction and task accuracy for this high profile production line. Along with new training requirements, quality inspections were incorporated at 20 different crucial points and added to the work control documents. With these improvements and advanced equipment, technicians discovered several anomalies with critical components not previously identified by the OEM. Identifying and reporting these anomalies led the engineers to initiate stricter tolerances which improved inspection points and quality standards in both production lines, thereby increasing confidence of producing a quality Mk-21 fuze.

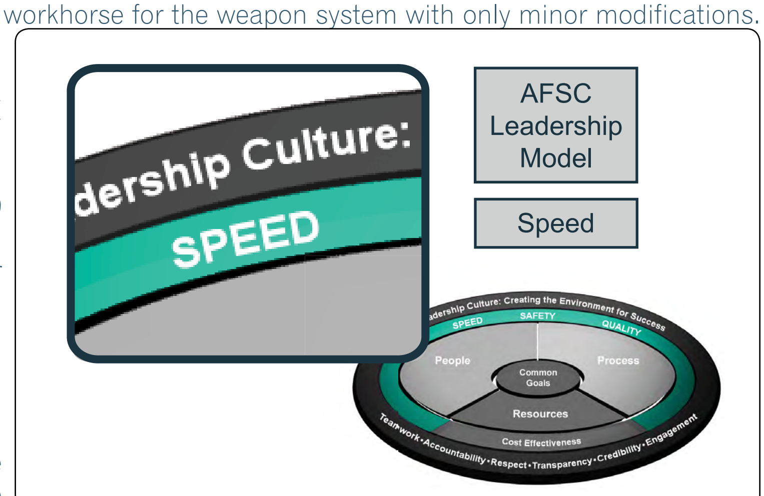
Equally important, leadership developed an organizational structure that fostered development and retained technical experts. The 309 MMXG administered the first-ever nuclear skill retention initiative, a bonus to retain critical nuclear expertise. This initiative improved employee morale and reduced turnover by 10%.

Finally, 309 MMXG increased quality and cost savings when group engineering identified the need for replacement vibration tables due to the large annual maintenance and repair cost of $140,000. Initially, costs to replace the vibration tables estimated to be approximately $2 million dollars but due to the diligent work of the 309 MMXG, three shaker tables were found for less than $500,000. With the purchase of the new vibration tables, the controller software was modified to impose strict access controls and testing limitations. These additional controls drove a drastic increase in quality by eliminating risks to the flight hardware in qualification testing. In addition to the $4.5 million dollar savings, one of the replaced tables was refurbished for use in munitions test saving $150,000 and fulfilling the need for critical vibration data central to Minuteman III aging and surveillance programs.

All of these process improvements resulted in the 309 MMXG remaining on track to produce and field the Mk-21 Arming and Fuzing Assembly in October 2013. This organic capability strengthens the nuclear enterprise by enabling a safer, more reliable nuclear weapon for USSTRATCOM to maintain the United States' deterrence mission.

Transporter Erectors (TE)

The TE is a special purpose vehicle consisting of a tractor and trailer which is used to load, transport, and emplace the Minuteman III booster stack. Specialized environmental control systems, hoists and securing hardware are used to ensure the boosters can be safely and securely transported between the missile support base and the launch facility. The current TE fleet entered service in the early 1990s and has acted as the workhorse for the weapon system with only minor modifications. Heavy use of the TEs increased structural degradation and limited parts availability resulted in the TE fleet being at 50% non-mission capable rate. To offset this and support the warfighter, the 309 MMXG performed TE PDM which consisted of stripping the trailer down to the bare frame, sand blasting, priming and painting the frame, replacing suspension parts, the brake system, steering system and cab assembly, replacing all rubber items on the tractor, and reassembling the

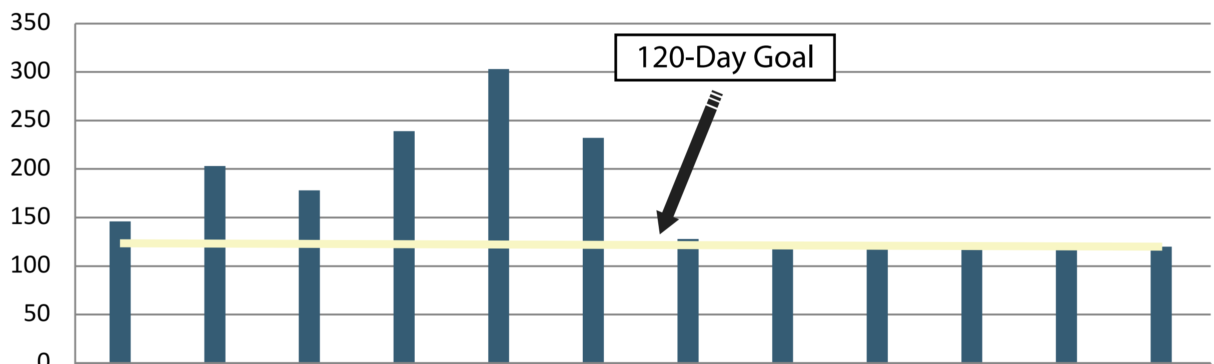


(click to zoom)

tractor from the ground up to a like new condition.

Transporter Erector

SPEED ACHIEVEMENT! For the first time in the two-year history of TE depot maintenance, the 309 MMXG completed two sets of TEs on schedule at 120 days. Leadership assigned skilled technicians to a dedicated process improvement team, which focused on constraints and production process improvements. Planners and technicians partnered in weekly stakeholder meetings with the ICBM System Program Office, Defense Logistics Agency, and supply chain management to tackle parts supportability issues and late non-conforming technical assistance requests and replies. Additionally, the team identified 45 technical data improvements that led to zero delays for procedures. To develop proficiency, leadership divided the depot maintenance team into two separate tractor and trailer crews. This allowed the teams to take pride in ownership as well as improved assembly and disassembly processes which reduced rework. Furthermore, leadership focused on production gates to ensure TEs remained on target through significant milestones and identified constraints so resolution could be quickly accomplished. These lean initiatives, along with employee dedication, reduced TE flowdays from an average of 215 days in FY11 to 120 days at the end of FY12-an astounding 44% reduction and maintained the 120 days throughout FY13



	TE 1/18	TE 15/45	TE 3/20	TE 19/44	TE16/34	TE26/38	TE 20/21	TE 7/46	TE 25/39	TE 29/19	TE 21/32	TE 9/31
Flow days	146	203	178	239	303	232	128	120	120	120	120	120
Start	20-Jan-11	16-Feb-11	5-Apr-11	21-Jul-11	18-Aug-11	22-Jul-11	9-Feb-12	17-Jul-12	21-Aug-12	8-Jan-13	20-Feb-13	14-May-13
Stop	14-Jun-11	6-Sep-11	29-Sep-11	15-Mar-12	15-Jun-12	8-Mar-12	15-Jun-12	13-Nov-12	18-Dec-12	7-May-13	19-Jun-13	10-Sep-13

Transporter Erector Flow Days

Rivet Minuteman Integrated Life Extension

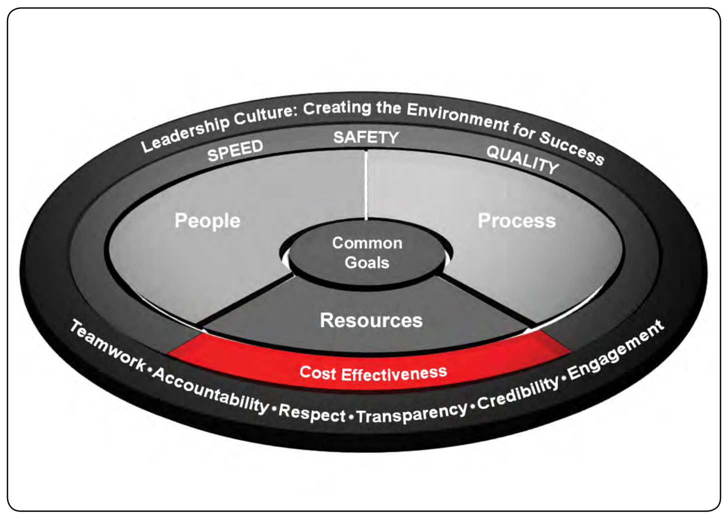
Rivet MILE began in 1983 out of the necessity to manage the maintenance of the aging ICBM weapon system in the field. Identified hardness problems, age degradations and service life extension created a need for on-site depot maintenance team. The 309 MMXG includes four geographically separated Rivet MILE units performing on site depot level periodic maintenance to 450 launch facilities, 45 launch control centers and associated subassemblies within the ICBM weapon system. The continuous refurbishment and update of operational ground equipment and real property installed equipment ensures the viability of the ICBM weapon system beyond 2020. Cost efficiencies are achieved by integrating Rivet MILE personnel and functions into the missile wing structure and eliminating duplication of efforts such as scheduling, supply and vehicle maintenance.

PDM tasks and Master Change Log tasks form the core maintenance tasks to be accomplished during each phase. TCTOs, modification MCLs and non-core PDM are integrated with the PDM core maintenance tasks to form the total Rivet MILE work package.

Rivet MILE tasks related to minor corrosion work, mechanical wear, seal degradation, water leaks, rubber goods degradation and preventative maintenance must be accomplished to keep the weapon system operational. The timely completion of minor repairs and corrective actions preclude catastrophic failure. Minuteman III age related problems become more critical as time goes by. Rivet MILE efforts contributed to maintaining the reliability and hardness of the ICBM weapon system, ensuring the ability to survive a nuclear attack.

Debris bin Before and After River MILE

To meet the demands of the warfighter and improve efficiency, leadership reorganized the Rivet MILE team structures and resources. This reorganization utilized and retained critical skill sets such as Top Secret security clearances and Personnel Reliability Program certifications necessary to complete the ICBM mission. From this reorganization, Rivet MILE units surged to increase depot maintenance completions on launch facilities from three to five a month and overall completion of PDM on 150 launch facilities in FY 13, completing the five year Phase V PDM program.



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Propulsion System Rocket Engine (PSRE) Life Extension Program (LEP)

The PSRE is a prepackaged, liquid bipropellant rocket propulsion system that provides down-range and side-range extension, plus precise attitude-hold and velocity adjustments for the release of the Minuteman III reentry vehicle. The PRSE uses a hypergolic mixture of nitrogen tetroxide as the rocket oxidizer and the mono-methyl-hydrazine as the rocket fuel. To accomplish its mission, the system must initially function as a storage unit for approximately 100 lbs of fuel and 160 lbs of oxidizer maintained under a maximum pressure of 80 psi. Approximately 120 cubic feet of helium is also stored in the PSRE at a nominal pressure of 3200 psi.

The PSREs in use today were produced by Bell Aerospace Corporation between 1969 and 1978 with an original operational life requirement of five years and a goal of 10 years. PSRE LEP refurbishment extends the operational life of the PSRE while maintaining reliability, availability, survivability and accuracy requirements. In FY 13, the 309 MMXG faced unprecedented challenges for PSRE LEP production due to a world-wide helium shortage. The last two production cells of the PSRE require the most helium to test the operational components. 309 MMXG leadership aggressively attacked the helium shortage problem by first, working with Air Force engineering support, safety, and contract engineers to build a safe work around to get the PSRE production to the last two test groups required to finish the LEP process. When the PSREs approached the final test cells, employees placed the PSRE in storage containers. Secondly, the 309 MMXG worked with local helium vendors and DLA, to obtain a steady supply of helium to level out the workload so production could maintain a continuous flow. This partnering effort saved $68,000 in helium costs for the year. Finally leadership, along with personnel inputs, streamlined the work control process which reduced processing time by 7% and reduced end item sales price by $18,000. These improvements directly contributed to the 309 MMXG producing 54 PSREs in FY13 and 24 PSRE's awaiting helium for test groups which enabled the three operational wings to complete fielding throughout the 450 launch facilities. By fielding these PSREs, the ICBM weapon system increased reliability for USSTRATCOM which ensures delivery of the reentry vehicle to its assigned nuclear target.


Testing the Propulsion System Rocket Engine

Effective Support To Warfighters

Through lean initiatives, effective planning and scheduling, the 309 MMXG provided unsurpassed depot maintenance support to the three operational wings and the ICBM flight test squadron. This support directly contributed to the warfighter executing on alert, combat ready ICBMs to the POTUS with a 99.7% strategic alert rate for FY13. This alert rate ensured day to day nuclear deterrence and global strike operations remained intact for strategic use. The 309 MMXG enabled warfighters to provide nuclear top cover for conventional forces worldwide as well as our NATO allies.


Erected TE

Along with the strategic alert rate, support vehicles and equipment mission capable rates increased. Innovative teaming between maintenance and supply enabled FY13 inventory to be slashed by 49% and backorders were decreased by 18.26% in which allowed more support to the warfighter!

To ensure warfighter satisfaction with the depot, the 309 MMXG funded for operational maintenance group personnel to pre-inspect the TE and accomplish an acceptance inspection before the TEs were shipped to the units. The 309 MMXG created inspection checklists to ensure deficiencies were not repeated. This allowed for continuous process improvement with every TE completed. In fact, deficiencies found from the gaining units reduced 82% over a two year time frame. With this pre-inspection and the reduction of flow days for TEs, mission capable rates improved by 5%. These improvements enabled the operational TE fleet to stay above emergency war order levels for two years in a row.

The 309 MMXG also supported the MM III flight test efforts at Vandenberg AFB by transporting the missile downstage and PSRE sections for a Minuteman III operational test launch, GT-206GM, from Vandenberg AFB. Operational testing certified the re-entry vehicles, provided USSTRATCOM capability estimates for nuclear planning factors and gave the POTUS confidence in ICBMs for the day to day deterrence mission.

GT-206GM was unique in the fact that the test launch flew a reentry vehicle with a refurbished Mk-21 arming and fuzing assembly, validating the 309 MMXG and OEM fuze refurbishment process, certifying the accuracy and reliability for USSTRATCOM, and the nuclear deterrence mission.


Munitions Test Prepping MMIII 1st Stage

Part of supporting the warfighter is testing the reliability of the ICBM weapon system. The 309 MMXG Munitions Test Flight conducts static fire testing of the Minuteman III Stage 1, Stage 2, and Stage 3 rocket motors to support age out and reliability studies. In FY13, the 309 MMXG successfully fired one of each stage of the MM III rocket motors, validating the reliability of the propulsion system.

Minuteman III 1st Stage Static Fire

In addition to rocket motors, the 309 MMXG also tested and collected data on components used in other systems of the MM III such as the MUIN 860. The MUIN 860 is an explosive device that allows the reentry vehicle to be deployed by igniting the MUIN 861 Spin Gas Generator that powers the spin system in the reentry vehicle. The 309 MMXG tested the oldest operational ordnance items in use in the Air Force. After accessing the data, the 309 MMXG made a recommendation on extending the life of operational assets. The extension of the service life for these components led to a cost aversion of $70 million dollars for item replacement.

The Strategic Missile Integration Complex provides critical test capabilities to the ICBM weapon system. The SMIC supports weapon system level tests and subsystem testing in support of assessment, modifications, investigations, and fault isolation. The SMIC's launch facilities and launch control centers, along with specially designed labs, provide an ability to conduct viable tests outside of the operational force infrastructure.

In FY 13, the SMIC conducted 86 tests for upgrades to support the warfighter. Among those tests, the SMIC partnered with the Navy to test a nuclear command and control upgrade to the E-6B or Airborne Launch Control Center. The E-6B performs two key missions: first, as the Airborne Launch Control System, the aircraft has the ability to launch MM III ICBMs as back-up to the land-based launch control facilities; second, in its Take Charge and Move Out role, it can relay presidential nuclear control orders to Navy nuclear submarines and Air Force nuclear missiles and bombers' nuclear command, control, and communication. The U.S. NC3 system refers to the collection of activities, processes, and procedures performed by appropriate military commanders and support personnel that, through the chain of command, allow for senior-level decisions on nuclear weapons employment to be made based on relevant information and subsequently allow for those decisions to be communicated to forces for execution. The NC3 system is an essential element to ensure crisis stability, deter attack against the United States and its allies, and maintain the safety, security, and effectiveness of the U.S. nuclear deterrent. The purpose of the NC3 system is to provide the President with the means to authorize the use of nuclear weapons in a crisis and to prevent unauthorized or accidental use. The SMIC tested an upgrade to the NC3 system by coordinating two flyovers of the E-6B and ensuring communication was received and processed as intended. The flyover tests were successfully completed and verified reliability and availability to the upgrade of United States' NC3 operations.

SMIC Launch Control Center Test

Logistics Process Improvements

To create a long-term commitment to develop a quality culture, the 309 MMXG instituted Continuous Process Improvement teams as a way to organize into a fully integrated process improvement system. The CPI teams consisted of subject matter experts and engineers for material control, safety, work control documents, production, and equipment. Additionally, leadership added next generation leaders and supervisors as an opportunity to coach and develop leadership skills as well as facilitate growth in professional development. The CPI teams provided an opportunity for unit members to use and develop their expertise in job related functions, problem solving and interpersonal skills.

The CPI teams met weekly in an assigned work area and systematically looked at technical data, production, work control documents, safety and equipment. The CPI teams identified constraints, root causes, resolved deficiencies, and informed leadership. Through their ability to quickly identify, elevate and eliminate constraints in the critical path, production was enhanced and schedules were met.

Transporter Erector CPI Team

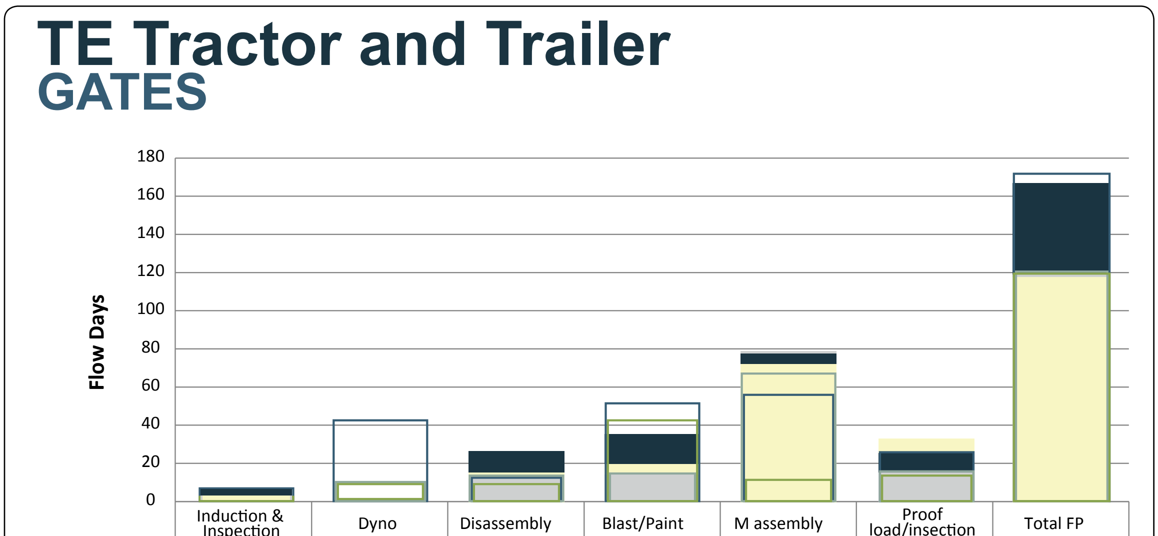
Concurrently, the 309 MMXG prepared for the AS9100/9110 certification which contains the international standards for establishing and maintaining a quality management system. While speed is important, quality is paramount in the 309 MMXG business and defects in the products have the potential for disastrous effects on the warfighter. The CPI team developed a quality management system that addressed provisions for depot level maintenance, spare parts and materials required to consistently produce high quality products.

Overall, the CPI teams sponsored collaboration, strengthened people, and facilitated the long-term development of the organization and process improvement.

The Lean Enterprise

Along with the CPI teams, leadership implemented multiple tools for transparency and visual controls to aid in production performance. Among those were gate charts and visual management boards.

The gated monitoring system breaks the production process down into major tasks or gates. This provides increased transparency in the production process by enabling more time constraint identification-elevation-resolution.



	Induction & Inspection	Dyno	Disassembly	Blast/Paint	M assembly	Proof load/insection	Total FP
Last 4 Tractor Avg	4	41	10	52	56	24	171
Tractor Equipment	1	7	12	15	67	15	120
Tactor 25	1	7	8	42	10	14	120
Last 4 trailer avg	4	0	24	37	78	24	165
Trailer M equipment	1	0	10	15	79	15	120
Trailer 3d	1	0	15	20	71	34	120

TE Tractor and Trailer Gates

Another tool the 309 MMXG utilized was visual management boards. These visual management boards enabled, from technicians to leadership, to see every step in the production process such as quality, safety, gate performance, ANDONs, financials and action items. Furthermore, the boards provided instant feedback to employees making improvements on the production floor.

Sheet Metal Shop Visual Management Board

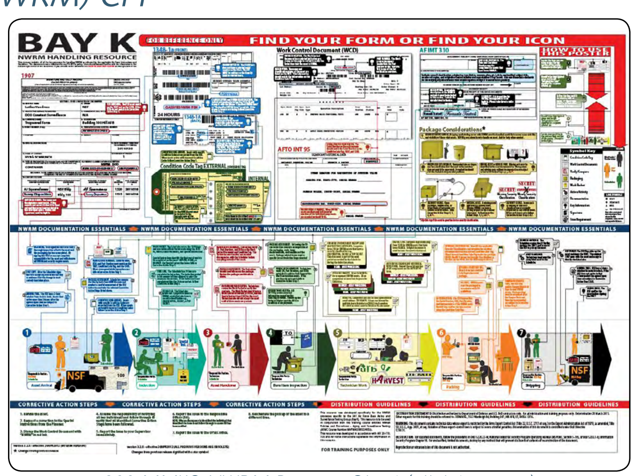
Ground Electronics CPI

Ground electronics provides direct support to the warfighter by repairing circuit card assemblies, electronic drawers that enables the operational wings to keep ICBMs on strategic alert. Ground electronics fields the majority of MICAPs throughout the 309 MMXG. In order to better support the warfighter, leadership focused a CPI team on process changes to identify and eliminate non-value added activities, decrease flow days and increase throughput. To understand the size and flow of the entire process, the team performed a value stream map to comprehend the size and flow of their repair process. After the team mapped the entire process, they found muda, or waste from transportation, inventory, and waiting as technicians could not find assets as they were drawn in from supply or the status of parts during the repair process. The team constructed and implemented an improvement plan which reduced travel time for technicians, implemented standard work, and focused on the AFSO21 "6S" process. With leadership backing, the team produced new visual management boards, established an expeditor, acquired new workstations, and color coded drawers to provide instant status conditions on assets. These visuals ensured assets were consistently returned to their proper place, eliminating wasted search and retrieval time. To ensure standard work, the team produced continuity books with specific and easy to follow instructions, checklists, and examples. This methodology, Quality Function Deployment, permitted teams to standardize work so a technician followed the same approach every time. Through this approach, throughput times were accurately measured and improved upon. These process improvements directly contributed to a 100% reduction in travel time, a 97% on-time delivery, and 70% increase in throughput. Furthermore, ground electronics completed 379 assets above customer forecast and old age job order numbers were decreased by 99%. Because the team had employee buy in, the implementation plan received enthusiastic support and has proven long term sustainable results.

Nuclear Weapons Related Material (NWRM) CPI

Due to the critical nature of nuclear weapons, it remained imperative to ensure nuclear weapons related material was properly accounted for. The 309 MMXG developed a visual representation of the NWRM handling process in order to correctly identify, distribute, document, classify and package NWRM.

This visual representation steps through each process and acts as a reference for specific positions to include technician, scheduler, production support technician or NWRM storage facility.



309 MMXG NWRM Process Chart (click to zoom)

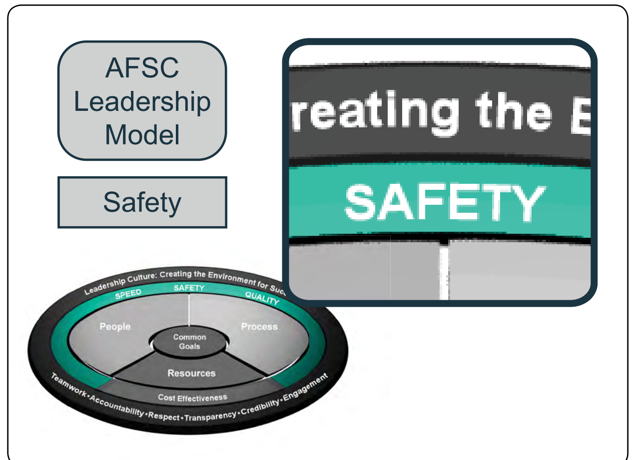
In FY13, the 309 MMXG completed both semi-annual inventories with no discrepencies which ensured critical NWRM was properly accounted for and annotated. Moreover, the 309 MMXG's NWRM process chart became Air Force Materiel Command's benchmark and command standard in handling NWRM.

Planning and Scheduling CPI

The 309 MMXG Production Support Office adopted and continually improved a commercial-off-the-shelf maintenance, repair and overhaul system as a business operating system. The MRO provided production personnel and managers the ability to track material, production, financials, and parts supportability in real time. The system facilitated the sustainment of 22 diverse production shops from sheet metal manufacturing to the Mk-21 fuze. Effective planning and scheduling in partnership with accurate and dependable forecasting, was critical in identifying constraints, reducing material supportability issues, and increasing throughput. Furthermore, scheduling focused on decreasing carryover and closing out old age job order numbers, which contributed to the 49% reduction in inventory and zero unplanned carryover.

Personnel Quality Of Life Programs

From workplace safety initiates to a leadership sponsored Thanksgiving feast, the 309th Missile Maintenance Group continuously strived for improvement to the morale of their most valuable resource--PEOPLE. According to OSHA statistics, falls are the leading cause of death in workplace accidents. Due to the vast size of many ICBM end items, fall protection and safety of employees remained paramount. After identifying a fall potential working on missile suspension systems at Vandenberg Air Force Base, 309 MMXG safety personnel and engineers collaborated on a project to create a fall protection system which would protect employees and have minimum impact on technical operations in the maintenance bays and blast booth. A platform and railing system was designed using aluminum grating which provided a low cost, lightweight and sturdy support system. The technicians approved of the system and it facilitated MSS operations. SAFETY ACHIEVEMENT! For only $15,000, the welfare of 309 MMXG technicians was intact.



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Before and After Vandenberg AFB Fall Protection System

To add to worker's safety and well-being, the 309 MMXG ramrodded Occupational Safety and Health Administration concerns by systematically reviewing every work process in the group. After the OSHA review, 163 noise sources were identified within the group. To facilitate noise reduction, 309 MMXG engineers purchased a noise source frequency analyzer to assist in characterizing the sound spectrum and completed 11 noise reductions. Along with analyzing and reducing noise sources, the 309 MMXG detected a source of cadmium contamination in the main group maintenance facility. Group engineers spearheaded and tested a High Efficiency Particulate Air (HEPA) vacuum cutoff wheel shroud which decreased airborne cadmium by 65% and implementation decreased work area cadmium by 72%. Additionally, the 309 MMXG vastly improved employee exposure to chromium. To combat exposure, group and system program office engineers extensively researched non chromate primer solutions. Due to the nuclear certification of equipment, size and type of aluminum, no alternative primer could be approved; therefore leadership redoubled their efforts to reduce chromium exposure. By implementing a virtual paint training system, purchasing a new paint gun and identifying equipment that could be powder coated instead of painted; the 309 MMXG reduced chromium exposure by 37% and also saved $30,000 a year in paint efficiency.

In addition to OSHA improvements, the 309 MMXG safely transported 6.3 million pounds of explosive solid rocket motors over 172,400 miles and across 18 states with zero incidents!

During FY13, the group advanced the Voluntary Protection Program (VPP) to ensure safe and healthy working conditions. VPP encourages employers and employees to reduce the number of occupational safety and health hazards at their places of employment through management, leadership, employee involvement, worksite analysis, hazard prevention and control, and safety and health training.

The 309 MMXG continually strived to integrate VPP to every area. Before FY13, no areas within the group were certified as VPP sites. By the end of FY13, all 31 areas obtained Bronze certification for VPP. From installing lights to painting floors, VPP radiated throughout the group, identifying 16 near misses and fixing 23 potential safety problems.

To further the morale of the personnel deployed to the Utah Test and Training Range, 309 MMXG leadership purchased internet installation at the UTTR billeting so enlisted personnel could work on Community College of the Air Force degrees, keep current on training and skype with family when they were away for the week. Furthermore, morale improved at the UTTR when leadership spent $21,000 to improve their office furniture and provide all members a desk space and computer.

Lastly, the group's robust morale committee planned and executed a summer picnic and holiday party that included food, games and prizes to boost teambuilding and morale. Throughout the year, the morale committee offered 14 events and raised $4700 to make the picnic and holiday party free for all 600+ personnel. Moreover, 309 MMXG supervisors cooked and served a free Thanksgiving feast for all personnel in the group.

Throughout Fiscal Year 2013, the 309th Missile Maintenance Group consistently provided reliable depot maintenance to fulfill the Air Force's number one priority of sustaining the nuclear enterprise and supporting the nation's nuclear deterrence mission. By focusing on the tenants of speed, safety, quality and cost effectiveness, the 309 MMXG reduced flow days for critical nuclear support equipment, inventory. With a dedicated workforce and game-changing leadership, the 309 MMXG produced 18,077 assets at $77.3 million and saved $9.4 million in program costs.

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A.8. 402d CMXG Production System

The 402d Commodities Maintenance Group under the Warner Robins Air Logistics Complex (WR-ALC) at Robins Air Force Base, Georgia, provides depot maintenance support to major weapons systems (primarily F-15, C-5, C-130, C-17, and Special Operation Forces aircraft) through major structural repair, manufacturing, modification, component and special process repair.

The 402d CMXG Production Management System evolved over a three-year period beginning on May 15 of 2010. On that day, CMXG was notified by the Occupational Safety and Health Administration (OSHA) that CMXG had been cited for 13 violations of the Occupational Safety and Health Standards (OSHA 1910 series). In reviewing these citations, it became apparent that the citations were levied against process outcomes (dust creation, potential exposure of employees to dust, inadequate housekeeping procedures, etc.). In order to correct the process outcomes, CMXG's entire production process had to be examined and redesigned. Efforts focused on reducing/eliminating shop area component sanding, improved personal protective equipment standards and procedures, and improved housekeeping standards monitored with swipe sampling to confirm progress. Once the occupational safety issues were addressed, the redesign effort turned to reducing work in process, backlog, and increasing velocity.

The initial effort came from outside the organization as CMXG was tasked by higher headquarters to get its "Unbilled Balance" accounts under control. A large quantity of unfilled customer orders sitting in a backlog spanning back as far as seven years was tying up money with no output. This effort reduced the backlog to the historical low level but was still higher than needed to achieve the velocity increases anticipated for the significant decrease in aircraft programmed depot maintenance flow days.

Next came the WIP Reduction Plan (which would later be referred to as WIP Management 1.0) implemented in December of 2011 in a phased roll-out starting with the Managed Items Subject To Repair program (which includes about 50% of CMXG's production effort). WIP Reduction involved enforcing a strict limit on the amount of WIP each shop and production line could have based on a calculation of Little's Law (a formula to measure the relationship between WIP, throughput and flowtime).

At first WIP Reduction showed some improvement in system speed but within four months it became apparent that the system was generating large waves of variability that moved through the entire production system. Shops either were overloaded with work or had little to nothing to do. Large bottlenecks developed in the common industrial processes (known as the "Process Shops") consisting primarily of Paint, Depaint, Blasting, Flashjet, and Non-Destructive Inspection. These bottlenecks generated significant and costly spikes in asset movement and overtime required to meet demand. In addition, because the production squadrons were run on monthly targets, there was increasing pressure during the month to produce the month's requirements with output peaking in the late third to the fourth week of the month. The "Hockey Stick" approach led to a six-month period of making production targets one month and missing them the next.

In an attempt to overcome WIP Reduction's variability, a test was conducted in April and May 2012 using only the Paint Facility. It was reasoned at the time that the Paint Shop was the primary "system constraint." A buffer was established for all incoming work. Squadrons could put work in the buffer at their own pace but the Paint Shop would attempt to optimize capacity only with the assets in the buffer and without input from the squadrons. In addition, all overtime was eliminated except for mission critical needs (MICAP, Surge, Blue Streamer, etc.). The test showed limited success but did not stop system-wide variability becausethe Paint Shop turned out to be just one of several processes whose current capacity limited overall CMXG production.

By June 2012, the WIP Reduction Plan had run its course and a new system would have to be implemented. During the period from April to June, the Group studied several options including Lean Pull and Kanban Systems and a traditional Drum, Buffer, Rope approach. Several outside sources presented the idea of combining various management systems primarily consisting of LEAN Manufacturing, the Theory of Constraints, and Six Sigma to fit the specific problem.

Eventually, it was decided that a system would be developed "in-house" based on the knowledge of the unique characteristics of this specific Air Force depot commodity enterprise (the 402d Commodities Maintenance Group). This new Production System is called the CMXG Production Management System and consists of three major components that work together to manage all workloads within CMXG. These three components sit on top of a larger foundation called the Integrated Business Planning (IBP) process, which links production with the other key elements of Group success in financial performance and productivity. The final design included the following three major processes:

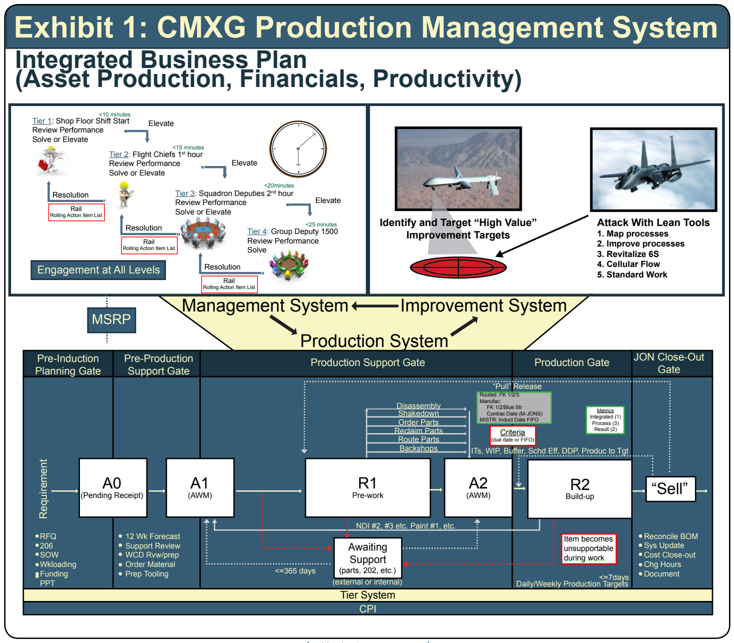


Exhibit 1: CMXG Production Management System

(click to zoom)

- WIP 2.0 – the Production System
- Tier – the Management System
- CPI and Lean – the Improvement System

Three Major Components Of The CMXG Production Management System

In the background of this effort, CMXG received intense pressure from outside the Group regarding its ability to meet past customer needs reliably across the full spectrum of the business and to evolve processes to meet faster turn time expectations. The 402d Aircraft Maintenance Group (AMXG) was in the midst of a Flow Day and WIP Reduction of their own which continues and DLA was moving away from organic manufacturing as a primary source and reducing order quantities. Feedback was solicited from customers to find a sobering message. The report card on CMXG in 2011 can be summarized as follows: "You do not deliver on time. You cost too much. You are difficult to work with." During the time of the WIP Reduction Plan, CMXG had also undertaken a pain-staking top to bottom analysis of the organization. A simple idea emerged: the business model could be reduced to a single transaction. A customer delivers a requirement, which CMXG accepts and then is expected to produce. The fact that there are more than 230 MISTR production lines, 800- 900 part numbered items for PDM, or hundreds of T- and M-JONs sitting in queue is of no concern to them and it should not be. This became known as the "Big Red Box" (Exhibit 2).

A customer expects CMXG to meet their needs and gets no value from having multiple shapes, colors, and varieties inside the system. The "Big Red Box" needs to be managed by CMXG as effectively as possible. By 2011, it was not being managed very well because some workload was preferred over others. For example MISTR has the best data systems and the pace of production was set to a relatively "faceless" customer in the Supply Chain, and the Routed work comes from people known on a personal level and airplanes can be seen right across the fence on the PDM lines.

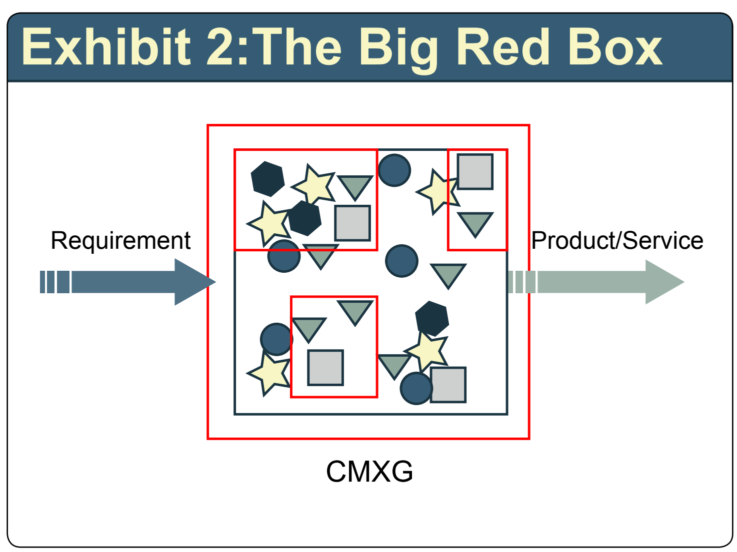


Exhibit 2:The Big Red Box

Other workload was not given preferential treatment. For example T-JONs were difficult because the customer did not always know what they wanted or they might not want to pay what was estimated as the cost for the repair after shakedown inspection. Therefore, many T-JONs were "on hold" as WIP while customers decided. In addition, there was no real incentive to get these done until they became a crisis. Also, Manufacturing efforts just could not keep pace with their demand. A mindset of "all workload is good workload" filled the squadron with WIP that had little hope of being produced. To be honest, no one wanted to turn customers away because that is what CMXG is here for—to support the warfighter. However, best intentions could not overcome the mountain of WIP that built up which masked visibility of the problems. In that environment, only the "hottest" priorities ever had a chance to make it to the shop floor and the squadron was saddled with more than nine different priorities that ultimately forced them to pick and choose between customer priorities because everything looked like a priority. Without much notice, backlogs built to over seven years deep with no real push to produce the delinquent orders.

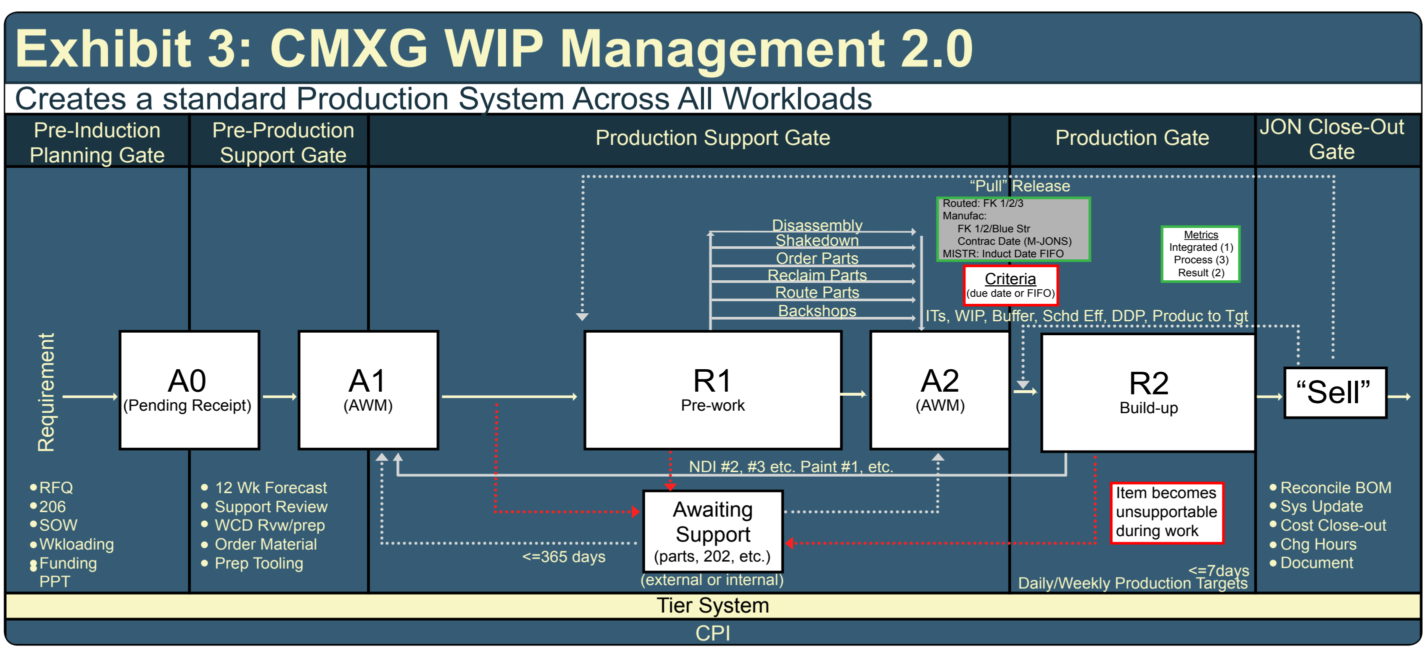
WIP 2.0 Production System – Understanding the Network

In CMXG, commodities are managed in a single organization consisting of three production squadrons processing hundreds of individual item "pipelines" moving through the Group in different quantities, sizes, and speeds, yet all converging through one or more common processes at least once, but more often, at several different points in their flow through the organization. This low volume, high variability workload mix did not seem to lend itself to any standard system.

It seemed obvious from the WIP Reduction Plan experience (WIP Management 1.0) there were "constraints" located all along the production system. This would lend itself to a Theory of Constraints or Drum, Buffer, Rope application. However, there was no easily identifiable constraint. It was apparent that there were at least five distinct constraints, which include Paint, Depaint, Blasting, Flashjet, and NDI. If grouped together they would represent the "system constraint" since, collectively, they limited the maximum speed and output of the system.

With this idea in mind, a DBR alternative was proposed. The problem was obvious. Even after grouping five shops together as the "System constraint" there was no identifiable and consistent "drum beat" (the "Drum" in DBR) that pulsed the entire system (the production process). In other words, there was no distinct and simultaneous pulse from this collection of shops to move the entire production line forward - a pure DBR solution would not work.

A Lean alternative was considered by utilizing pull as a way to move assets through the system. Again, the large variation in production lines did not have a consistent pull mechanism. The best alternative emerged as a hybrid between a DBR system and a Lean system called WIP Management 2.0 (Exhibit 3). In WIP 2.0, the "sale" of an item generates a pull into the production gate from the buffer directly in front of the shop. The back shop, or constraint, acts as a drum that sets the pace for the first three gates in the organization: Pre-Induction Planning, Pre-Production Support, and Production Support gates. Inducting assets into the group at the rate that the back shops can manage through a back shop master production schedule eliminates both the bottlenecks in the back shop as well as build up of WIP in the group.



WIP 2.0 Gates

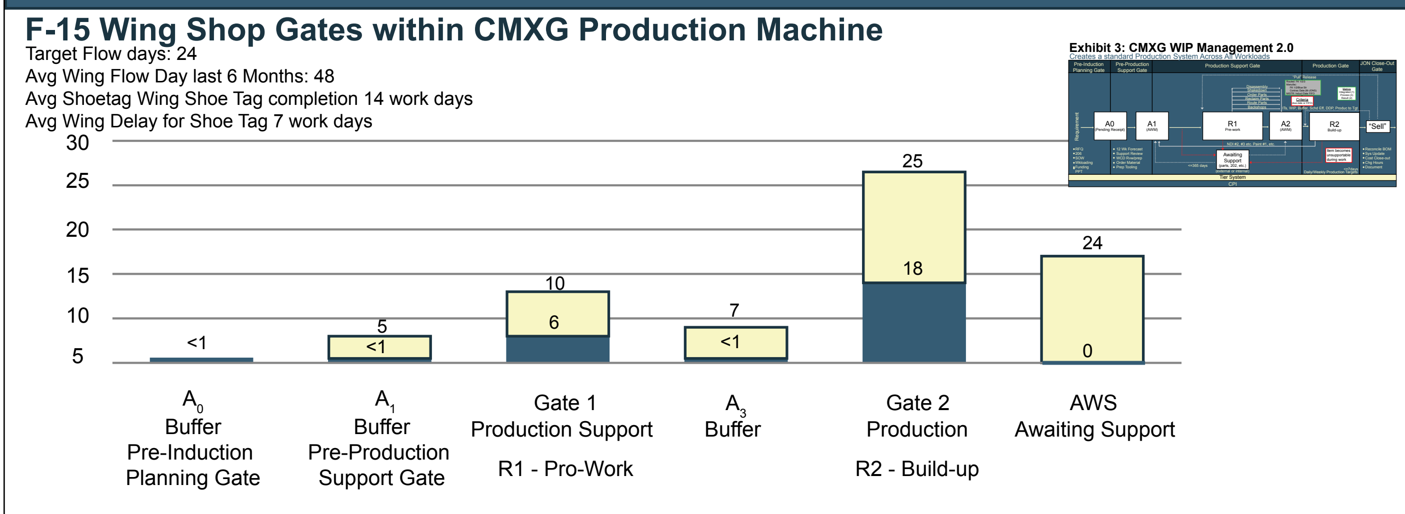
Production is divided into five distinct gates that represent the full production process from pre-induction to sold asset:

- The Pre-Induction Planning Gate - where both known funded and potential workload for the group not yet funded is managed.
- The Pre-Production Support Gate - where funded workload and supportability requirements are managed.
- The Production Support Gate- where Inspection, Evaluation, or Back-shop processing of supportable requirements are managed and when necessary, assets awaiting supportability (AWS) are managed.
- The Production Gate - where assembly, repair, or manufacturing of requirements are managed.
- The JON Close-Out gate where cost reconciliation and closeout, Bills of Material reconciliation, system updates, and final documentation for the asset is managed.

In the WIP 2.0 network (sub-divided into the five major gates), it is critical to monitor asset movement from gate to gate to measure progress. The "Gates" ensure that all workload in the Group is accounted for, allocated to a gate, and monitored within the WIP 2.0 model (Exhibit 4).

In a perfect network, one single Maintenance, Repair, and Overhaul system would be used to track all asset movement from pre-induction to sale of the asset. A singe MRO system does not yet exist in CMXG so ground rules for tracking assets had to be established to meet this same goal.

Exhibit 4: CMXG Gates Chart



NOTE: In the future (2014), Lean Depot Management System production system will track all inducted assets by gate location using criteria outlined below until the Air Force Sustainment Center MRO system is identified and operational.

Pre-Induction Planning Gate

Within the Pre-Induction Planning gate, the buffer A0 holds all known funded work, from the exchangeable and 100% routed PDM line and all "requested" or future workload that has not yet been funded. The Exchangeable Production Support Centers along with their support partners in work loading and Commodities Maintenance Teams manage this gate. Planners process Request for Quotes and plan Routed, Manufacturing, and Exchangeable work; CMTs work toward asset supportability, and work loading secures funding for the management of the assets in the Pre-Induction Planning Gate. The trigger to exit the Pre-Induction Planning Gate is funding for "requested" and PDM work and close term demand for exchangeable. Schedulers trigger the movement/release from the Pre-Induction Planning gate to the pre-production support gate.

Pre-Production Support Gate

The Pre-Production Support Gate buffer, A1, holds funded requirements awaiting evaluation, inspection, and back-shop processing, while supportability issues for the requirement are worked by the CMT. The trigger for the requirement to be released to the Production Support gate by the scheduler is all known supportability issues such as parts, tooling, programming, and labor have been resolved and the Master Production Schedule calls for the requirement. The EPSC has ownership of the requirement and establishes its expected completion date in this gate.

Production Support Gate

The Production Support Gate contains R1 Pre-Work in which the process of evaluation, inspection, programming and/or work performed by the back-shop operations (de-paint, paint, blasting, Flash Jet, heat treat, chroming, NDI) occurs to the requirement. All requirements that flow through the shared back-shop operations adhere to the Master Production Schedule to control flow and synchronize back-shop operations. The trigger or release point from R1 to the A2 Buffer is completion of back-shop processes, Evaluation and Inspection, and parts supportability for all newly discovered parts during E&I. Ownership for requirements in the Production Support Gate is shared between the prime shop scheduler, who controls WIP inducted into the process and into the Prime shop, R1 and the back shop scheduler. The A2 Buffer contains fully supportable requirements awaiting an opening in a shop, R2, for manufacturing, repair, or assembly and exists to remove variability in asset flow to the prime shop, R2.

Master Production Schedule (MPS)

The MPS of the process back-shops acts as the tool by which the “constraint” is maximized in the CMXG Production System. It does so by assigning every asset a time slot for key back-shop operations thereby eliminating variability in asset flow to the back-shops week-to-week and day-to-day. This master production schedule aligns to the Monthly Production Plan submitted by the squadrons each month. The MPS is monitored and updated each day with all schedulers in the daily MPS Meeting.

Production Gate

The Production Gate contains R2, build-up, in which requirements enter the prime shop for build-up, repair, reassembly or manufacturing. Requirements may exit R2 and return to the A1 buffer to be inducted into R1 if additional back-shop operations are necessary to complete asset requirements. The trigger to exit R2 to enter Jon Close-Out Gate is completion and sign-off of all requirements, producing a final product. Demand Rate X Cycle Time in R2 calculates the target WIP for R2. The scheduler has responsibility for induction of the requirement into R2. The first line supervisor has responsibility for executing the schedule to meet the Production Plan and getting the final product to the customer on time at the lowest possible cost without compromising safety or quality.

The JON Close-Out Gate

The JON Close-Out Gate includes all activities required to close-out the JON, system management, budget closeout, productivity closeout, recording of asset production, ensuring all customer requirements were met, credit for hours earned, revenue earned, financials reconciled, and transfer of asset off the CMXG books. The EPSC and work loading are accountable for all requirements in the JON Close-Out Gate.

Awaiting Support (AWS)

If at any time during the process a requirement becomes unsupportable due to engineering, parts availability, labor, or any other necessary resource to produce the final product, the requirement enters AWS. A requirement will remain in AWS until it becomes supportable. The EPSC has ownership of all requirements in AWS and must ensure every effort is taken to make the requirement supportable as soon as possible to include utilizing the Tier process.

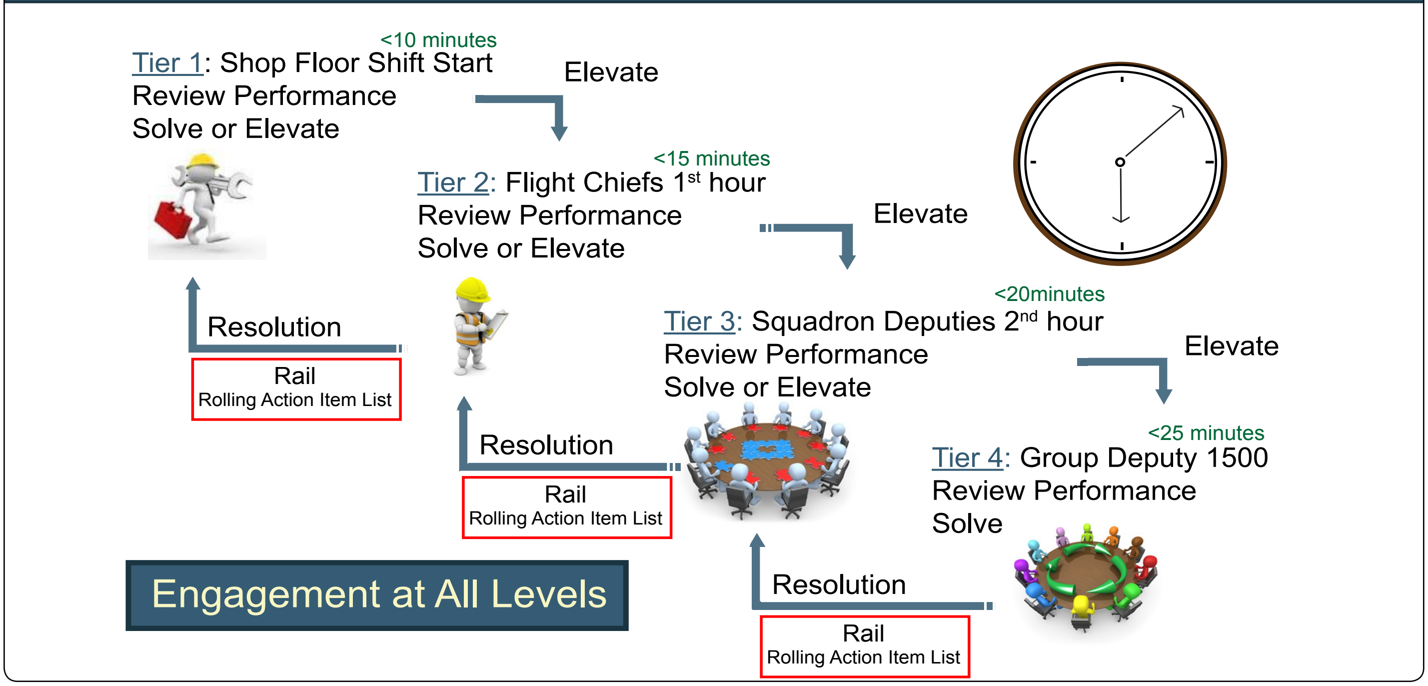
Collectively the five gates enable all requirements to use a standard process by which CMXG can track and manage all assets in the Group. These five gates define the CMXG network and critical processes each requirement will pass through from induction to final product.

The CMXG Production Management System is a work in process and continues to be improved. Shortly after implementation, it became evident that a formal management system was needed to monitor and control all assets going through the shops. In June, 2012, the Director and Deputy Director of the Commodities Maintenance Group visited Hill Air Force Base in Ogden, UT to attend a business summit. While at the summit, the Director and Deputy Director attended a series of management meetings in the production areas. During the meetings, they were introduced to the Tier Management System, which had been successfully implemented at HAFB.

Tier Management System

The Tier Management System (Exhibit 5) is successful for two primary reasons: 1. It is Servant Leadership in action; and 2. It provides a real-time ANDON system for problem resolution and prevention. Servant Leadership is both management and support personnel working in concert to ensure that employees are busy delivering value to customers. For example, workers stay focused on building, welding, sanding, painting, etc. because management has provided a safe work environment, facilities, tools, materials, and processes for the employee to do their jobs. In the event of a work stoppage, for any reason, issues are raised during Tier meetings and then they are immediately addressed by an assigned owner to get the workers busy creating value for customers again.

Exhibit 5: Tier System

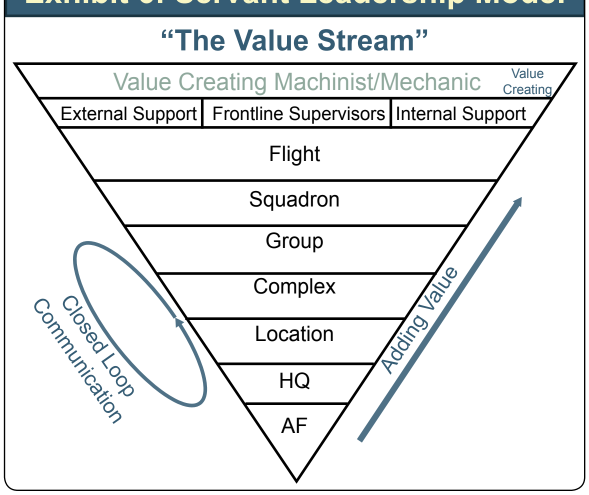


The Servant Leadership Model in use at Hill Air Force Base was leveraged to create a consistent look and feel at Robins AFB. Two management consultants at Warner Robins worked closely with the management consultant at Hill to duplicate materials and processes. Within six weeks, the Tier Management System was up and running at Robins AFB.

Implementing and sustaining the Tier Management System at CMXG has not been easy. The following key activities are essential for success:

- Training for all management personnel (to demonstrate the importance, the Director and Deputy Director delivered all training – it was NOT delegated). To complement the training, a simulation was developed so that training participants could learn by doing while attending the training session.
- Development of business performance metrics. Safety, quality, speed, and cost were the key performance indicators for all areas. Work-in-process, inventory turns, productivity, and cycle time were also metrics reported at the group level.
- Creation of all Tier Management boards which were used to facilitate the meetings. The meeting process included discussions related to safety, quality, and production

Exhibit 6: Servant Leadership Model



delivery performance. Additionally, all equipment, facilities, and material issues were documented and discussed. All systemic performance issues were also captured and assigned for resolution.

- A focused change management plan to ensure sustainability. A separate team of assessors was also formed to randomly attend Tier meetings at all levels to provide coaching and mentoring to facilitators to ensure consistency in application.

The Tier Management System has been operational in the Commodities Maintenance Group since August 1, 2012. Every day since then, the Tier process has been used to manage the business. Tier meetings are held at Resource Cost Centers at 7 a.m., flights at 8 a.m., squadrons at 9 a.m., and at the group at 3 p.m.

The real-time ANDON process works well. When problems are identified, action is taken to solve and prevent reoccurrences. The Tier Management System is a lens to identify where CPI efforts should be targeted.

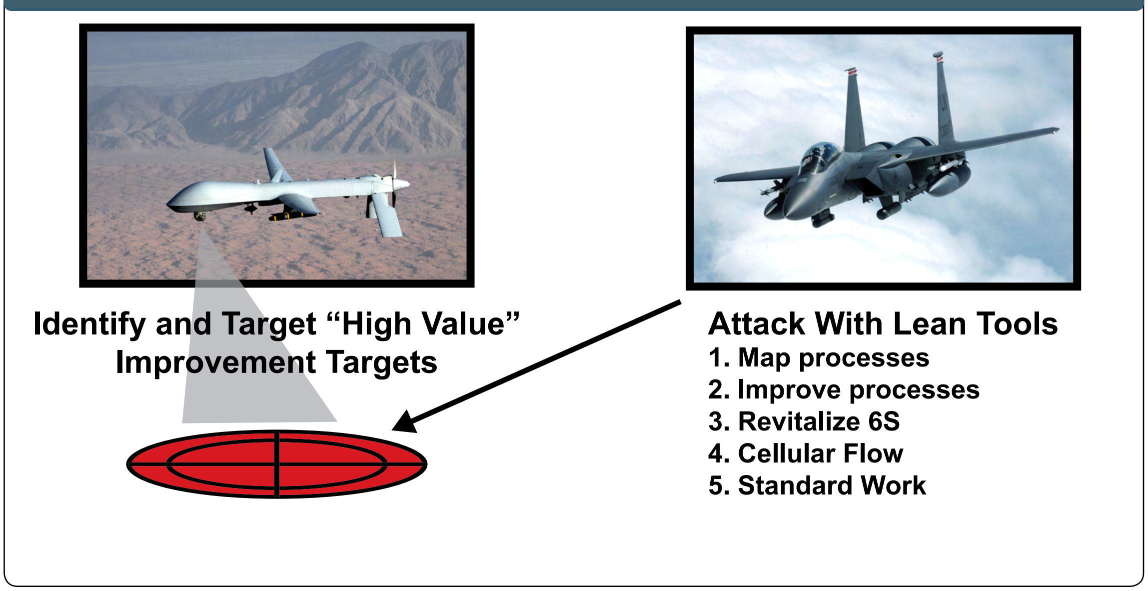
Continuous Process Improvement

CMXG has been involved in CPI for many years. Numerous Lean events have been conducted. In many cases, events were completed but actions were not completed which resulted in little to no benefit. In other cases, events were held, actions were completed, but the net effect on improving safety, quality, speed, and cost performance was negligible because the improvement was not a key driver to impact overall CMXG performance. CPI initiatives lacked discipline and focus.

Now, process initiatives are selected based on the need to improve the production management system. Currently, performance for each RCC is monitored daily. Local production teams deal with non-systemic issues. Any issues impacting production that cannot be resolved by the RCC team are escalated to the Group and Deputy Director.

Continuous Process Improvement Approach - The Group and Deputy Director, based on the need to improve safety, quality, speed, and cost, now sponsors Rapid Improvement Events. For example, an RIE was conducted recently to improve the output of the F-15 Ramps Production area because the output was not meeting expectations – the throughput was not high enough to meet demands and the quality was not meeting customer expectations. The process underwent a complete end-to-end redesign and key metrics were established to monitor flow days, WIP, and first pass yield.

Exhibit 7: CMXG Continuous Process Improvement



Within a few months, the throughput increased by 25%, flow days decreased by 40%, WIP is within tolerances set, and first pass yield is now being measured and is currently averaging 75%. These metrics are updated daily and the team meets weekly to discuss actions required to continue to drive improvement to meet the goals established at the RIE.

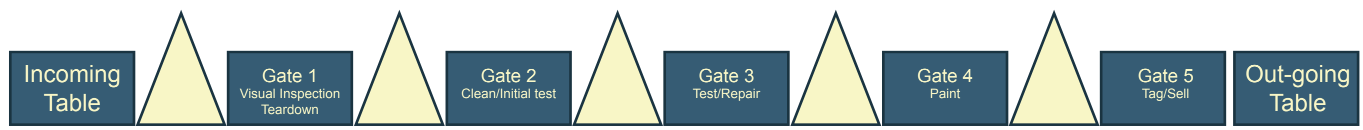
Summary

Managing a commodities manufacturing and repair business is difficult. The high mix, low volume nature of the business adds another level of complexity. In addition, doing all of this without an integrated MRO IT System makes it extremely challenging.

The CMXG Production Management System continues to evolve. The production system along with the management system and the improvement system are in place. Expectations continue to be high for increased safety, quality, throughput, speed, at a reasonable cost. The CMXG Team at Warner Robins will continue to commit resources to drive improvements. Doing it Right, Supporting the Fight.

A.9. 402d EMXG Production Machine (Robins AFB, GA)

In the Electronics (Exchangeable) world, creating flow is vital to efficiently process items through the production machine. This can be accomplished by breaking the work down into smaller operations and establishing a gated system. We used the value stream mapping process to establish gates at the most logical points. After each gate, release points are utilized to assure that the machine is always running to meet the customers demand. The longest and most complex part of the value stream is the test/repair gate because this is where the most variability in the process is located. In the test/repair gate, the unit is initially tested to find the fault that has caused the item to fail in its function. The initial test may not identify everything that is wrong with the unit, and as a result, this part of the process may require several iterations before the real problem is identified and repaired. The Theory of Constraints is applied at this gate to maximize the efficiency of the entire process. As an item leaves the test/repair gate, there should be another item waiting to enter this part of the process. The triangles in the diagram below represent release points that have a certain amount of WIP at these points in the process. The number of WIP at these points is calculated using Little's Law. See Gate example below.



After establishing flow within the process, standard work needs to be developed for each gate. The T.O. gives the technician general repair information but there needs to be one consistent "scripted" way to repair the units. The use of combination sheets posted at the gate gives the technicians step by step guidance and also shows the duration of each step in the gate. This scripting facilitates training new technicians as the entire shop follows the same repeatable process.

To help manage the process, visual management is used to maintain flow of the assets. Production Control Boards are used to show the day to day productivity for the process. These boards display data including the number of units that should be produced that day, if that number was produced and if not the reason(s) why. The Production Flow Board shows where each unit is in the process and clearly indicates where a constraint exists and is causing a bottleneck. If the shop has fallen behind on their production, they then need to develop a plan to get well. See examples below.

Example # 1: Environmental Control Unit Production Team

The 566th Electronics Maintenance Squadron's ECU production team repairs Low Altitude Navigation and Targeting Infrared for Night precision attack pods navigation and targeting cooling units. For several months the shop experienced production shortfalls with an associated increase in work in process. Production problems were further highlighted by an increase in MICAPs, Surges, and backorders. As a result, this shop was targeted for continuous process improvement. Three formal events were scheduled. The first event was a Value Stream Mapping event to study and document how assets flowed through the shop. Both value-added and non-value added tasks were analyzed for possible waste elimination/reduction. Individual tasks were grouped into gates with logical break points after taking Takt time into account. These changes resulted in a new shop layout to support one-piece flow. Second, an event targeting standard work produced a step-by-step repeatable process which carefully reviewed T.O. and WCD requirements to remove variability. The newly developed standard work broke the work down to requirements for each gate making it easier to cross train new employees that may be moved into the area. The final event in the area was implementing visual management to help control work in process and increase accountability. A production flow board was developed to clearly indicate to team members as well as outsiders where each asset is physically located and where it is in the process. The board provided the ability to quickly answer "where, what, and when" questions. Shift changes became smoother because technicians on both shifts could check the status of any asset with a glance at the flow board. Ultimately the boards drove behavior by providing visibility to production performance and striving to meet daily production targets became a source of motivation and pride.

Central to the team's approach was finding root causes and developing a corrective action plan that focused on delivery, cost, quality, and safety.

Delivery:

- Reorganized shop layout to support one-piece flow, enabling better cross training and increasing production numbers; met/exceeded targets for the last seven months
- Utilized AFSO21 tools; WIP went from 60 to 25 units; backorders reduced from 55 to 15
- Customer focused! Minimum EXPRESS ranking improved from low of 53 to presently 25,161
- Improvement conscious! Closed 17 of 17 open action items from B-SMART action plan

Cost:

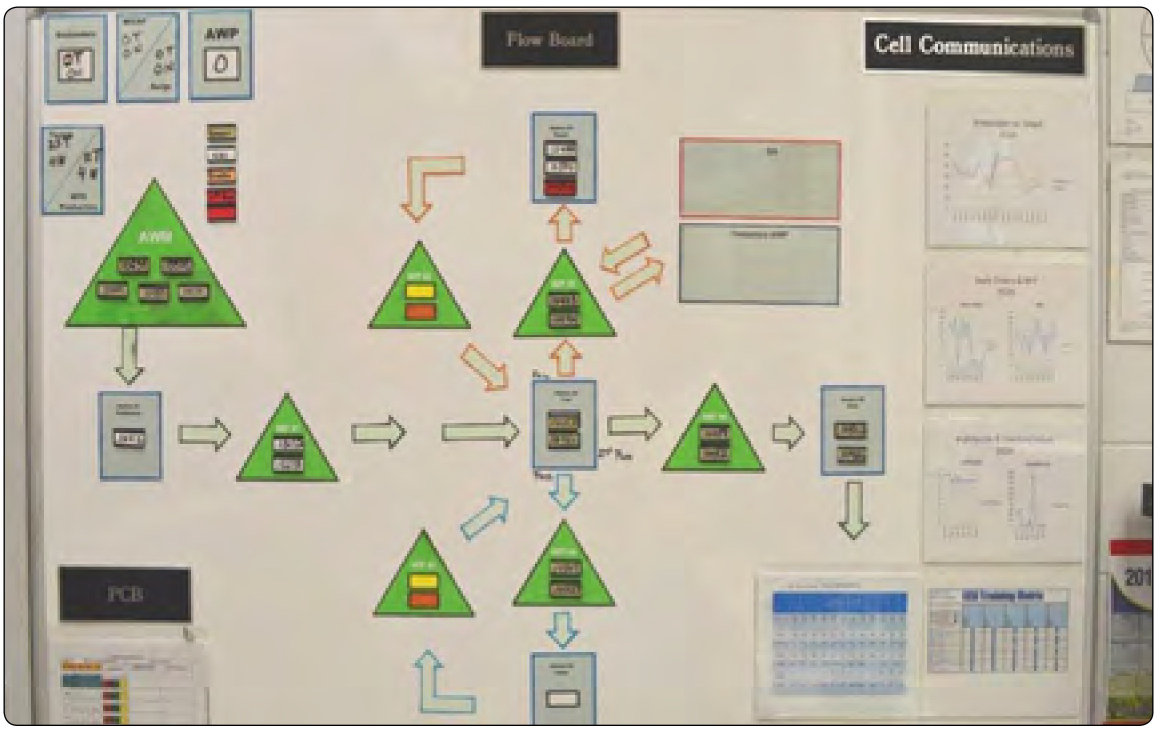
- Streamlined maintenance process, allowing workforce to shift two technicians to support workloads throughout the flight
- Concerned about return on investment; wanted to give customer product at most reasonable price; reduced required overtime from 209 to 0 hours

Quality:

- Zero reported workmanship quality deficiency reports for the last 10 months
- Striving to become the best; cell assessment score 3.0 out of 4.0; focused on eliminating re-work in the repair process

Safety:

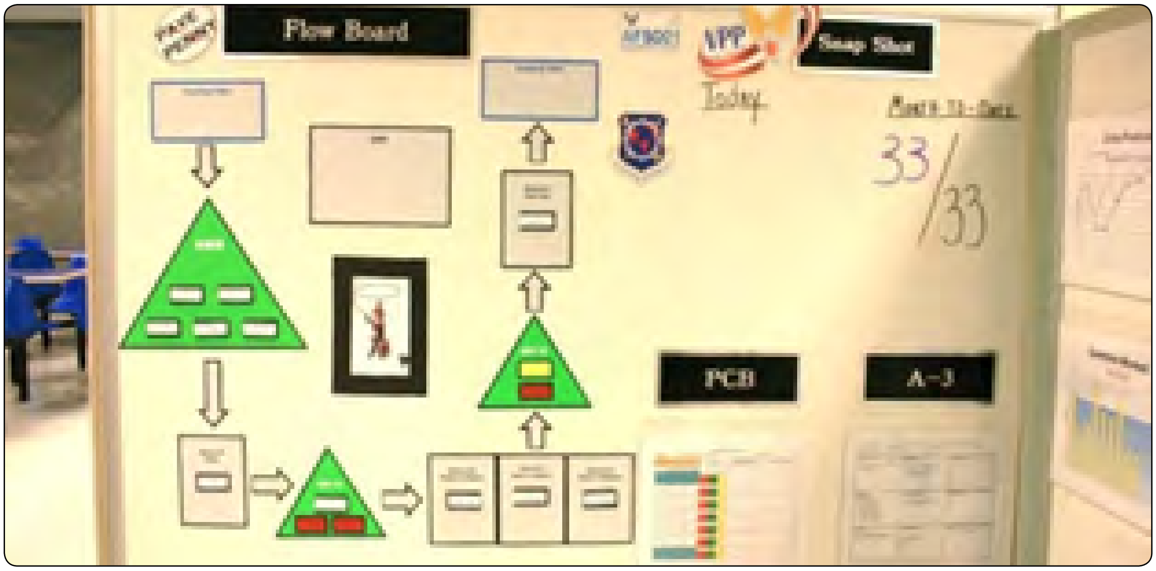
- Team confronted serious bio-environmental issues using continuous process improvement knowledge; quickly developed safer process, enabling team to meet customer demand.



ECU Production Flow, Control and Communication Board

Example #2: Altimeter Network Transformation Team

The 566th Electronics Maintenance Squadron formed the Altimeter Network Transformation Team after various production issues resulted in the customer considering the option to seek a second source of repair for the ASQ-141 radio altimeter and the associated shop replaceable units. The ASQ-141 radio altimeter is utilized on the KC-135 and the E-8 Joint Surveillance Target Attack Radar System platforms to provide an accurate indication of the aircraft's altitude from 2,500 feet to touchdown. Due to the criticality of this asset, meeting customer demand was crucial. To provide transparency and ensure the customer understood our goals and commitment we invited the customer to participate on the team. The initial meeting set the tone for the team's lean journey and set the expectation that to ensure long term work we had to increase production, reduce work in progress and reduce backorders without driving up cost by automatically defaulting to additional people and overtime. The team develop a roadmap and determined that establishing a flow cell concept would be the main thrust of their effort. Three formal events would supplement the flow cell effort: Value Stream Mapping, Standard Work and Visual Management. In order to ensure continuous improvement, the team adopted the Flow Cell Assessment process.



Line Replaceable Unit (LRU) Production Flow Board

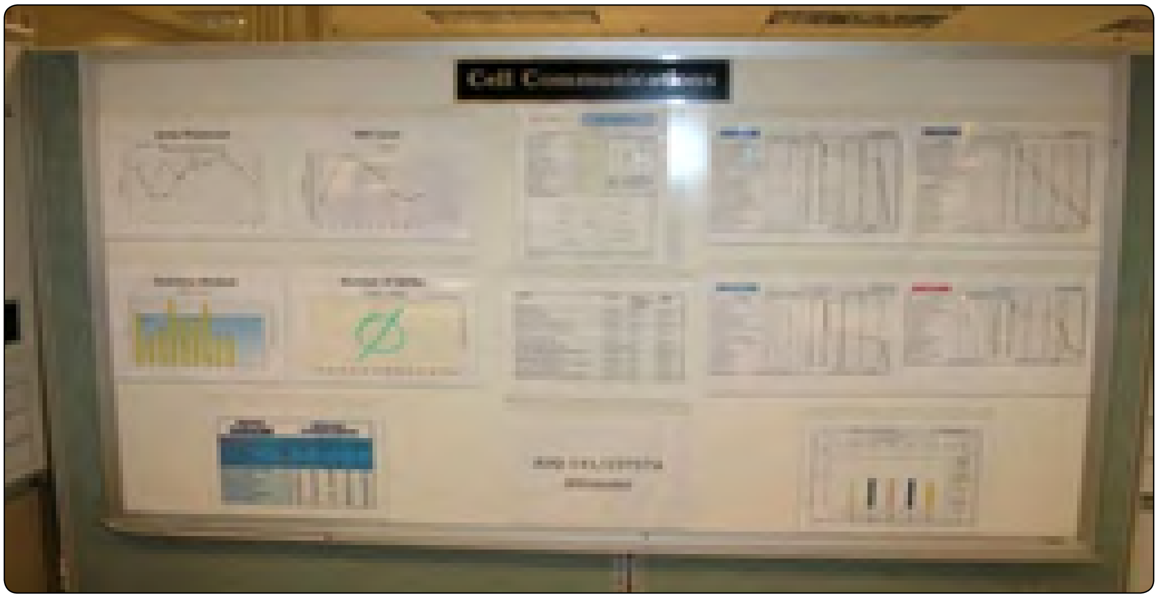
During the Value Stream Mapping Event, the team used several Lean tools to include a Supplier, Input, Process, Output, Customer chart , a Strength, Weaknesses, Opportunities and Threats (SWOT) analysis, a spaghetti diagram, a fishbone diagram and a value stream map to break down the process and understand the various inputs, constraints and process flow. The value stream map facilitated the process of grouping tasks into gates or stations of work. WIP points or release points with assigned number of assets were established between each gate to ensure continuous flow. Based on the results of these steps, the shop was rearranged to support the one piece flow depicted on the value stream map.

Gates were identified and arranged to facilitate the transition from one gate to the next. WIP points were strategically placed between the gates and were arranged to support First-In/First-Out.

Shop Layout To Support One Piece Flow

A Standard Work Event focused the team on developing and posting a step by step, repeatable list of tasks required to complete the work at each gate. The team developed combination sheets that listed each step in simple language and provided the amount of time to complete each step. These sheets did not replace the T.O. or the WCD but broke down the repair process into details steps. The combination sheets were posted at each gate and on the Cell Communication Board. Other important metrics including units produced, WIP level, OT worked and QDRs were also posted on the Cell Communication Board.

With a new shop layout and Flow Board, the team realized that visual displays would emphasize accountability and facilitate sustainment. Daily production performance and MICAP and Surge numbers were posted. Additionally, WIP management was included as part of expected work. The team also created a cross training matrix to identify single point failures and increase the flexibility of assigned technicians. To monitor cost, the team developed a chart showing the estimated labor cost of producing each unit.



Altimeter Cell Communication Board

During this Lean Journey the shop deepened the culture of responding to customer expectations. For the next 16 months, unit production either met or exceeded customer demand. WIP levels plummeted from 114 units to 40 units. Backorders were eliminated, cut from 77 to 0. Frequent MICAP and Surge requirements were replaced with serviceable condition assets on the shelf. The customer was so pleased they halted their search for a second source of repair and instead lauded the team for their incredible turnaround.

A.10. 402d EMXG Group Control Center

The 402 EMXGs Group Control Center (GCC) has become a model of LEAN principles applied in administrative areas. Three examples of LEAN in an administrative area are the Suppliers, Inputs, Processes, Outputs and Customers or SIPOC model, standard work template and cross training matrixes. In the past, some have believed that the principles of LEAN could only be successfully applied in a manufacturing or production area containing redundant processes or simply wasteful practices. Thus, a need arose to supplement the repair environment with more innovative tools to increase efficiency at the floor level to senior management and decision makers.

Supplier Who is the supplier?	**Input** What input do suppliers provide?	**Process** What do you do with it?	**Output** What is the product or deliverable?	**Customer** Who receives this output?
PAD (Profiles of the Air Force Depot)	Inductions, Production, Backorders	Analysis, validation & verification, research details if trend fluctuates, transfer to report	Unit Production, MTD Planned, Produced, Variance, MICAP, & Backorder information for the Group Meetings	Group and Squadron Commanders
CPPM (Cost Production Performance Module)	Budget vs Actual Data	Get data from CPPM calculate flex formulas, research details if trend fluctuates or variance from budget, transfer to report	Production data for Group Meetings	Group and Squadron Commanders
Head Quarters	Funding For Budget	Convert dollars to hours and hours to production indicators	EMXG Budget	Group, Wing, Base, Head Quarters
Squadron Reps	Narrative on noteworthy activities or accomplishments within Group	Collect, consolidate, format, submit to WCC	War Report	WCC

(click to zoom)

Quick successes such as implementing "6S" and visual management were quickly implemented but more robust lean applications were required due to our constrained environment (must do more with less). First, the large, time consuming processes were analyzed using the SIPOC model. Those same lengthy processes were quickly exposed, vetted and determined to either be non-value added or in some cases completely unnecessary. For example, tedious financial monthly slides, although a worthy vision at one time, were no longer needed freeing up time better spent elsewhere. Other processes were redirected or better defined to yield useful data or informational products.

Secondly, a standard work template was developed with descriptions for daily, weekly, monthly and quarterly duties. All too often production administrative or operational offices are tasked with non –standard work or "walk in" requests always with the highest of priority. Therefore, the daily work template allows the manager to see which regular tasks will be pushed to the right to accommodate the unexpected. The standard work template can easily be adapted to each skillset such as an analyst, work loader, security, emergency management etc. While each employee has his or her standard daily tasks, there is also a need to document individual processes and steps for execution in one convenient place. A continuity book was chosen outlining each task, step by step, so anyone with basic computer skills can complete them. This concept has been a hands-on way of training when bringing on new employees and getting them started.

MODEL CELL STANDARD WORK - MXVOWW - ANALYST

Monday	Tuesday	Wednesday	Thursday	Friday
ATACS MORNING STANDUP SURVEY EMAIL UPDATE CPPM REPORTS SURGE REPORTS EMXG MORNING REPORT BACKORDER ALERTS WIP CHARTS DIGITAL SIGNAGE TARGET FOLLOWUP J025A REPORT	ATACS MORNING STANDUP SURVEY EMAIL UPDATE CPPM REPORTS SURGE REPORTS EMXG MORNING REPORT BACKORDER ALERTS WIP CHARTS DIGITAL SIGNAGE TARGET FOLLOWUP J025A REPORT	ATACS MORNING STANDUP SURVEY EMAIL UPDATE CPPM REPORTS SURGE REPORTS EMXG MORNING REPORT BACKORDER ALERTS WIP CHARTS DIGITAL SIGNAGE TARGET FOLLOWUP J025A REPORT	ATACS MORNING STANDUP SURVEY EMAIL UPDATE CPPM REPORTS SURGE REPORTS EMXG MORNING REPORT BACKORDER ALERTS WIP CHARTS DIGITAL SIGNAGE TARGET FOLLOWUP J025A REPORT	ATACS MORNING STANDUP SURVEY EMAIL UPDATE CPPM REPORTS SURGE REPORTS EMXG MORNING REPORT BACKORDER ALERTS WIP CHARTS DIGITAL SIGNAGE TARGET FOLLOWUP J025A REPORT
Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**
BATTLE STAFF REPORT EXTENDED HORIZON OVERTIME REPORT SUPER USERS MEETING CIV FITNESS PROGRAM	BATTLE STAFF REPORT EXTENDED HORIZON OVERTIME REPORT SUPER USERS MEETING CIV FITNESS PROGRAM	BATTLE STAFF REPORT EXTENDED HORIZON OVERTIME REPORT SUPER USERS MEETING CIV FITNESS PROGRAM	BATTLE STAFF REPORT EXTENDED HORIZON OVERTIME REPORT SUPER USERS MEETING CIV FITNESS PROGRAM	BATTLE STAFF REPORT EXTENDED HORIZON OVERTIME REPORT SUPER USERS MEETING CIV FITNESS PROGRAM

MONTHLY			QUARTERLY		
TARGET SETTING MID MONTH ADJUST FLOW DAYS EXPRESS OWO/HRS	DREP CHARTS SA & D WIP RATIO CHARTS BLACK BOX AWARDS	WAR (SPECIAL INTEREST ITEMS) LSET/UCI CHECKLIST	G005 PLANNER INDEX	G005 PLANNER INDEX REPORT	

Lastly, a further iteration of the standard work chart was needed by assigning TAKT times (duration) in minutes along with the frequency of each task using a simple cross train matrix. Office personnel were identified on who was the primary and alternate, who was currently trained or who needed to be trained. Once the numbers were formalized (hours to yield ratio), an office manager could determine the staffing levels given the amount of work generated. This real data allows decision making based upon the facts and not emotion. The impact of not accurately defining tasks only fosters the old adage, "the squeaky wheel gets the grease".

Hours/ Yr	Personnel
17,786	10.7

GCC Standard Work and Cross Train Chart

Note: does not include as required (AR) or special projects

FREO	Minutes	Hours/Yr	FUNCTION	Supv: Mike Poole	JULIE	MARK	CATHY	TAMMY	DAVID	BOB	LAUREN	PHILLIP	DONNA	LEE	DARRICK
				PRODUCTION											
D	30	125	A	PREP FOR and FACILITATE GEMBA		T	T	P	T	T				T	
M	60	12	A	TARGET SETTING		T		T	T	T			T	T	T
M	30	6	A	MID MONTH TARGET ADJUSTMENT		T		T	T	T	T		T	T	T
D	60	250	A	TARGET FOLLOWUP/ANALYSIS (CHANGE REQUEST)		T		T	T	T			T	T	T
M	60	12	W	WORKLOAD STAFFING REQUIREMENTS		T			T					P	
D	90	375	A	PRODUCTION ANALYSIS (FOR SHOPS, NSNs, etc.)		T		T	T	T			T	P	T
D	60	250	W	MISC REPORTS		T		T	A	T			T	T	T
D	600	2500	A	SHOP SUPPORT		T		T	T	T			T	T	T
M	60	12	O	MONTHLY DATA PULL FOR PRODUCTION HISTORY					T				P	A	
M	960	192	A	MONTHLY RESET MORNING REPORTS	T				A					P	
D	30	125	A	EMXG MORNING REPORT	A				A					P	
D	10	41.7	A	SHOP FLOOR METRICS DATA (AUTOMATED)	A				A					P	
D	30	125	A	WIP				P	T				A	T	
M	30	6	A	TREND CHART/WIP>90									P	A	

A.11. 402d MXSG Case Study Notes

The 402nd Maintenance Support Group is in the business of providing industrial and engineering support services to the WR-ALC's Maintenance Complex's production customers. Continuous Process Improvement is the cornerstone for MXSG's on-going efforts in understanding the multiple customers' requirements and focusing on being an enabler and partner in meeting and/or exceeding their production goals.

The CPI methodology begins with consulting our customers and together with them, identifying and prioritizing their requirements. Once priority requirements have been determined, performance metrics are developed to measure and track the degree to which we are giving our customers what they need in terms of response time, due date delivery, on-time performance, and first pass yield.

Based on monthly Strategic Alignment and Deployment Reviews at Flight and Squadron levels, MXSG leadership engage in CPI by targeting those processes that fall short of their established performance goals. SA&D performance targets are stretch goals so achieving a new goal is meant to be challenging and requires living in red metrics while trying to reach the next level of performance (we're not afraid of red). Leadership insists on the use of the structured 8-step problem solving model to address any process issues. In conjunction with the 8-step model, rapid improvement events are conducted in partnership with customers, other participants in the process, and stakeholders – calling together a team of respected peers and subject matter experts who review current conditions, establish common goals, identify gaps and their causal factors, and then develop and implement countermeasures that break the constraints to performance excellence. In doing this, team members additionally ensure that tenets of speed/throughput, quality, and safety are met. The following chart defines our Performance Focus:

402 MXG's
Performance Focus

Case-for-CHANGE

- We **MUST** continue to **IMPROVE** our **PRODUCTION SUPPORT SERVICES' VALUE** to **ENABLE** our **CUSTOMERS** to **MEET** their **INTERNAL & EXTERNAL CUSTOMERS' DEMANDS** or they'll **OUTSOURCE** even at a **HIGHER COST**!

Key Drivers

- **KEY DRIVERS:**
- **MUST Form Partnerships** with our Customer Groups to Understand their Customers' Demands & Increase our Value without Increasting Costs
- **MUST Improve our Internal Process Quality** to better Posture our Ability to Respond to New & Changing Requirements of Multiple Customers
- **MUST Reduce Costs** thru more Efficient Business Operations
- **MUST Continue our TRANSFORMATIONAL Journey** through Enhanced CPI.

Case Study #1: 802 MXSS – Chem. Lab's Swipe Sample Analysis Process

This case study is meant to illustrate how the very same CPI principles and techniques used in the production arena can be applied in service processes to achieve desired performance objectives.

a. Reason for Action

Swipe sample testing has been directed by OSHA for all industrial areas. The Chem. Lab's initial swipe sample process was capable of analyzing 40 swipe samples every four days. It now became necessary to increase the Lab's capability by 400% (from 40 samples to 200 samples per week).

b. Current Conditions

A CPI event was initiated by Chem. Lab team members. They began by constructing a Value Stream Map of the current state process; the process steps were categorized as follows – receiving the sample, prepping the sample for analysis, conducting chemical analysis, interpreting the data and calculations, and completing the analysis report. Total flowtime for these five gates was 1,211 minutes, while the actual touch time was 438 minutes (ie, 64 % non-value added time).

It became obvious that by eliminating the non-value added portion of the flowtime, the process speed/throughput would increase thereby creating greater capacity.

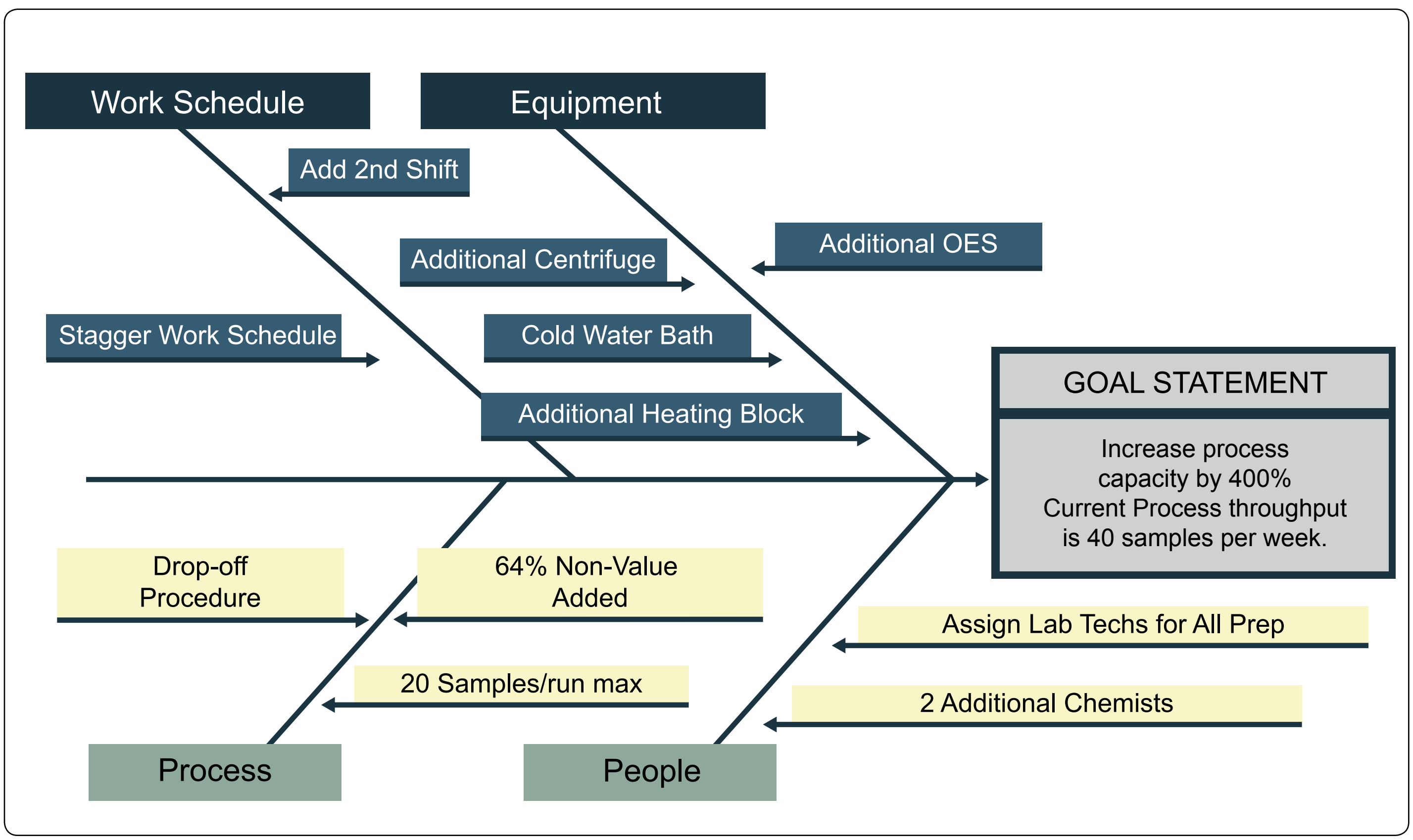
c. Improvement Target

Based on the anticipated workload, the process would need to be capable of processing 200 swipe samples per week, 20 samples per analysis run, with a turn-around time of two days. The team also noted the location of constraints/backlog in the process and determined that the purchase of certain equipment items would allow concurrent dual work streams at these sticking points; specifically, obtaining an additional heating block and a centrifuge would break the process constraint.

Phase (of the process flow)	Flow Time	Touch Time	% NVA
Receiving the Sample	185 min	(10 min)	94.6%
Preparing the Sample	425 min	(92 min)	78.4%
Doing Chemical Analysis	266 min	(131 min)	50.8%
Interpret Data, Calculate, Write Report	335 min	(205 min)	38.8%
Total Time =	1,211 min	(438 min)	63.8%

d. Gap Analysis

The team conducted a cause and effect analysis using the fishbone diagram to determine factors that would bring about increased throughput. The countermeasures which were developed through C&E analysis were to be incorporated into a future state process that had the capability to meet the increased throughput targets.



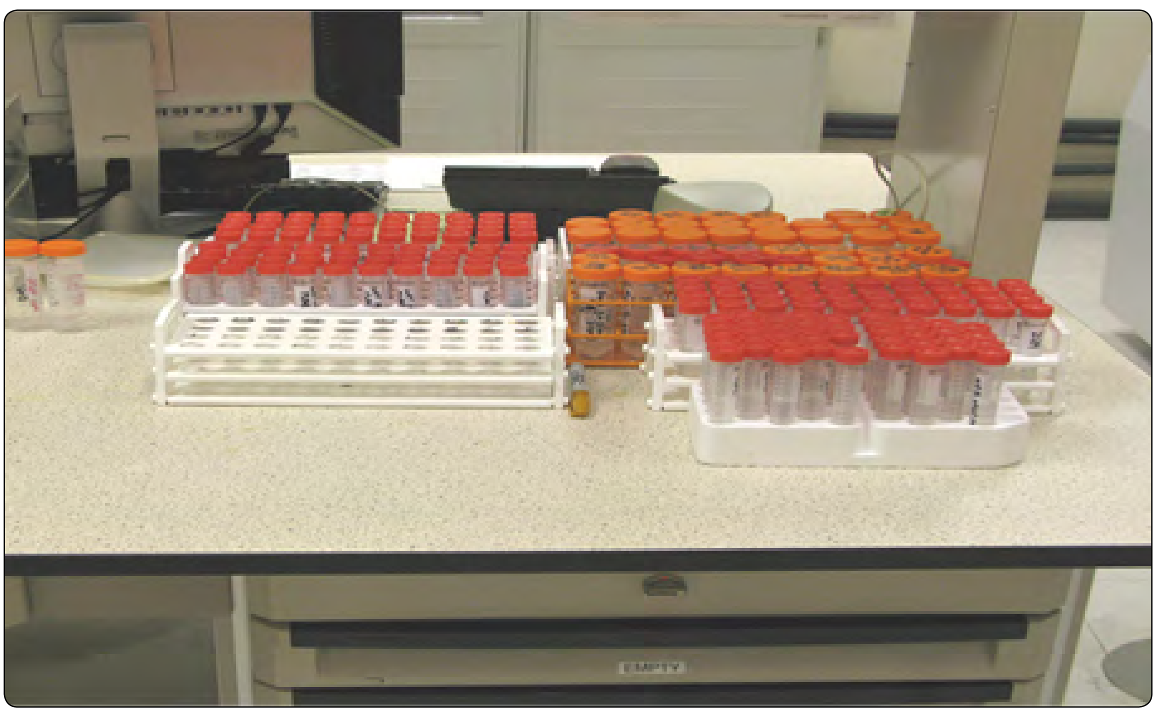
e. Action Plan

In order to transition from the current state to the future state process, an Action Plan was developed which detailed what initiatives needed to be implemented, the OPR for each initiative, closing criteria for completion, and the estimated completion date.

Type: E (event); P (Project); DI (do-it)	AFSO21 ACTION PLAN						
	EVENT TITLE: Chem Lab's Swipe Sample Analysis Process TEAM LEADER: Stan W. and Leonard A.			TEAM MEMBERS: Leonard A, Benjamin T, Stanley W, Dustin C, Marcus B, Veronica W, Lt. Bacon, Rupert W, Johnny J			Status (BLUE, GREEN, YELLOW, RED)
	Action Item Description	OPR	Catchball: (org sym)	CLOSING Criteria	TARGET Dates		
					Start	Finish	
DI	Train a Lab Tech to do Sample Prep for swipe sample analysis	Tom Y.		A Lab tech is trained and ready to move to swipe sample prep when needed	6/24/11	7/29/2011	COMPLETE
P	Automate analysis report generation	Max H.	IT	Automation accomplished for data export, calculations, report prep - eliminate rqmt' for supervisor signature on report	6/24/11	9/30/11	BEING WORKED
DI	Determine by experimentation: a) is less time in the centrifuge possible? b) is less time in the heat block possible?	Aaron W.		It was determined that the centrifuge time and the heat time should remain as is	7/29/11	7/29/11	COMPLETE
DI	Use of Automated Heating Block to Heat Samples	Tom Y.		Auto blocks are in use to heat swipe samples	7/29/11	7/29/11	COMPLETE
P	Purchase Additional Lab Equipment as Prescribed by Option #3	Tom Y.	Vendor	Additional equipment has been received and installed	7/29/11	9/30/11	BEING WORKED
DI	Hire Additional Chemists and Lab Techs as prescribed by Option #3	Tom Y.	DP	Additional positions filled	7/29/11	7/29/12	BEING WORKED

f. Confirm Results of the CPI Event

The swipe sample analysis process currently has the capability to process 200 swipe samples per week using two concurrent analysis lines with a maximum of 20 samples per analysis run. The turn-around time for each analysis run is two days.



Case Study #2: 402 MXSS (Industrial Services Squadron) Warehouse Optimization

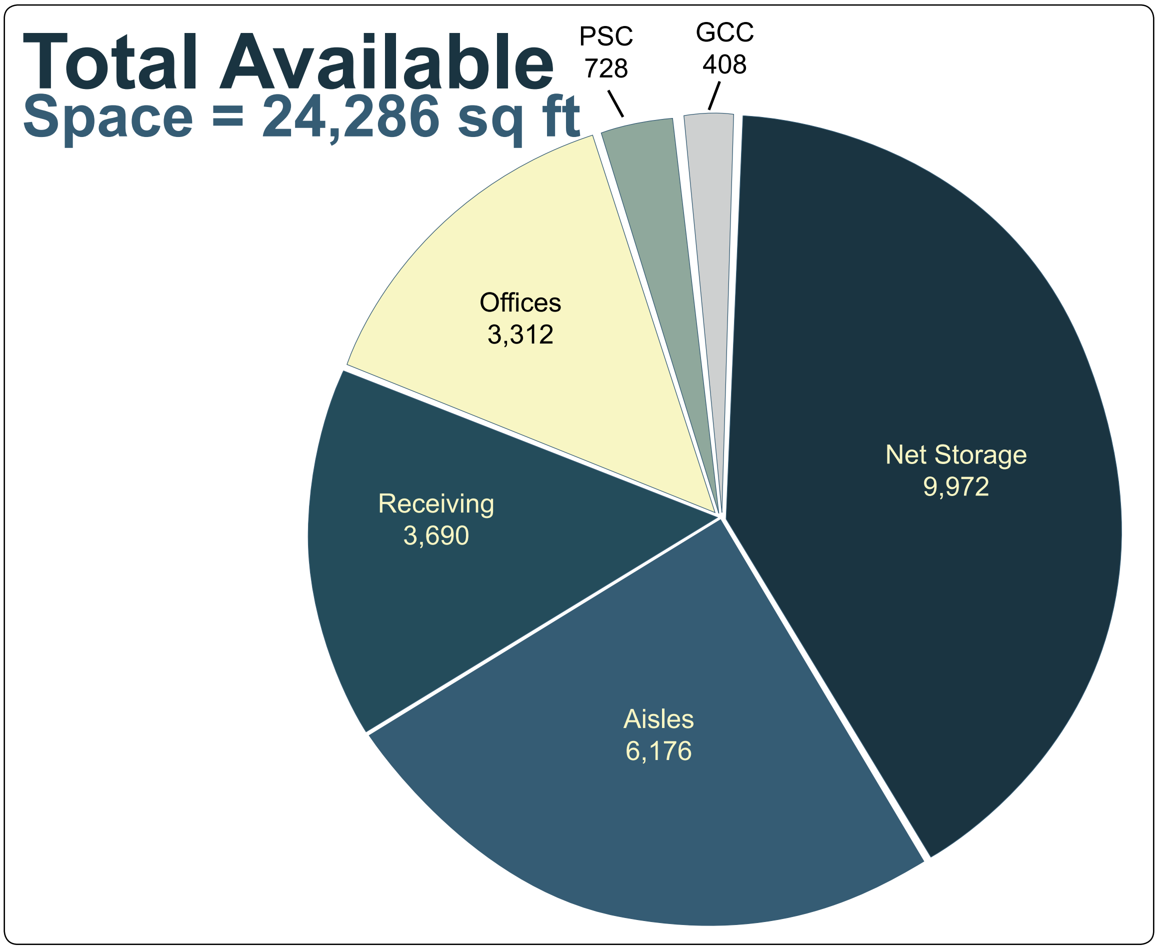
This case study is meant to illustrate how the very same CPI principles and techniques used in the production arena can be applied in service processes to achieve desired performance objectives.

a. Reason for Action

Space is needed to store critical/long lead-time spare parts to support preventive and corrective maintenance on industrial plant equipment. In addition, the Production Support Center needed to be expanded in order to consolidate all its assets in a single location.

b. Current Conditions

A Rapid Improvement Event was conducted by personnel from the warehouse and the various shops. The team determined that 50% of the items currently being stored were either obsolete or did not need to be kept in quantity since they were locally available with same day delivery. The existing PSC cage was 736 square feet and would need to be twice that size in order to consolidate items from three different storage locations.



The total footprint of the warehouse was 24, 286 square feet, but when we deducted the spaces used for aisle ways and purposes other than for item storage, the net storage area was about 10,000 square feet – which translates to 180,000 cubic feet.

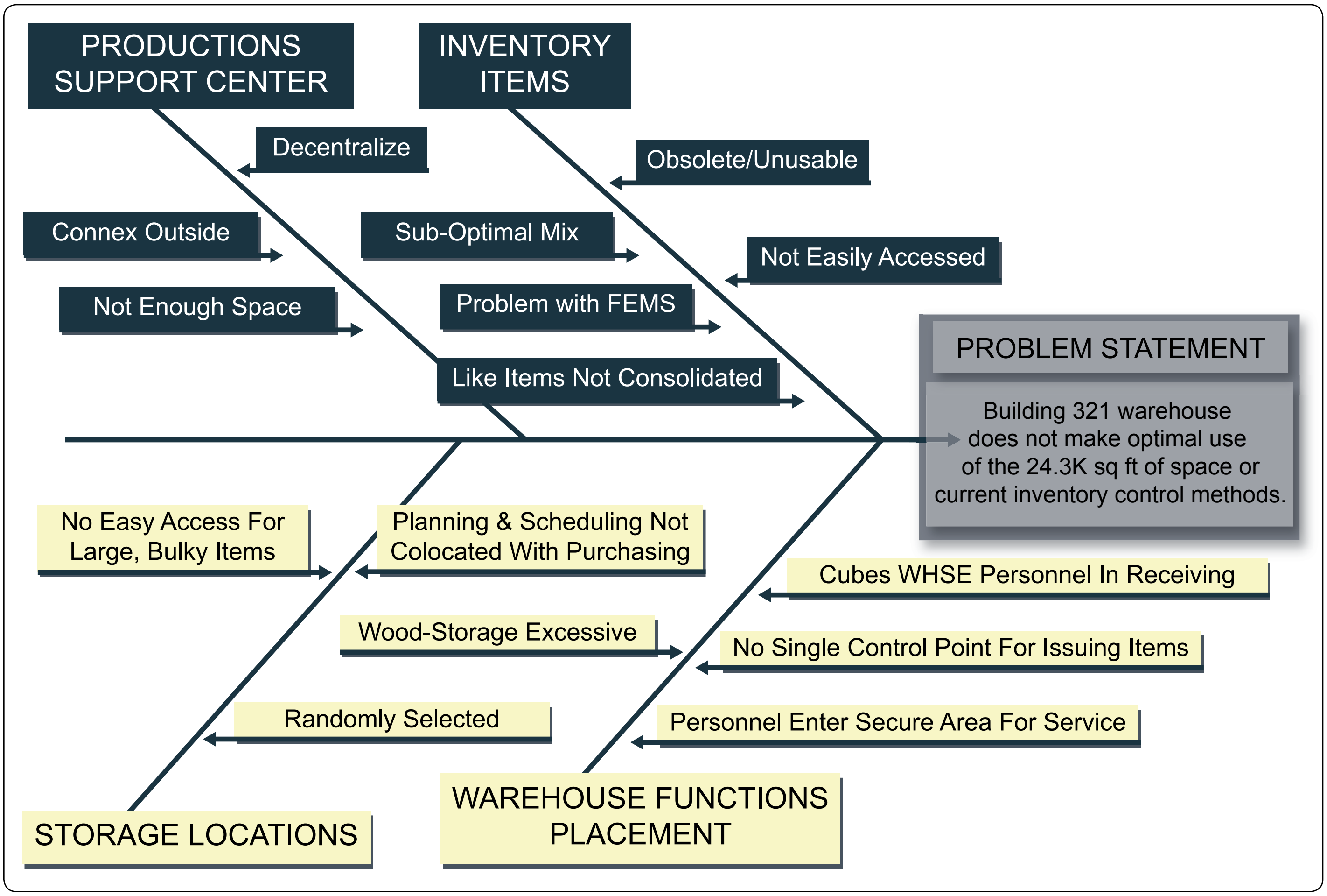
c. Improvement Target

Four primary initiatives were identified by the warehouse optimization team:

1) create 10% additional storage space for critical parts
2) adjust the mix of stored items to conform to the following standard: 40% common use items, 30% preventive maintenance, 15% corrective maintenance, and 15% material for projects
3) relocate stored items to the most effective/ easy access locations
4) relocate warehouse functions for better and faster response to warehouse customers.

d. Gap Analysis

The team conducted a cause and effect analysis using the fishbone diagram to determine causal factors that made the existing warehouse configuration sub-optimal.



Based on the above analysis, the team members developed countermeasures for each relevant causal factor that was identified. It is notable that the team accomplished 85% of the initiatives in their Action Plan during the week of this Rapid Improvement Event.

Solution Approach	Initiatives
1. Create Additional Storage Space	a. Relocate the wood-storage area
	b. Determine minimal wood inventory
	c. Remove obsolete/unstable items
	d. Move racks to South outer whse. Wall
	e. Replace racks in large shelter
	f. Enlarge tool crib
2. Adjust the Inventory	a. Identify most commonly used items
	b. Rearrange items by like material and size
	c. Reload items into FEMS-set new min/max
	d. Have shops determine on-hand levels
3. Relocate Stored Items to Most Effective Locations	a. Locate large, bulky items near R/U door
	b. Move ladders for easy access
	c. Build kits for Preventive Maintenance
	d. Put all personnel lockers-common loc.
	e. Move PCS Connex items to PSC Cage
4. Reposition Warehouse Functions to Most Effective Locations	a. Move tool crib to new location
	b. Configure an entry control point
	c. Relocate warehouse offices

e. Action Plan

An action plan is depicted in the below figure.

Title: Warehouse Optimization	Planning Team: Steve S., Steve W., Michael H., Robert H., Charles G., Clark S., Erio (Jamie) S., Terry A., Juan S., Joey W., Jimmy G., Wayne N.							
Type Action	Action Item Title	OPR	OCR	"Optimization" Criteria Satisfied	Target Dates		Status	Result/Impact
					Start	Finish		
DI	#1. Relocate the wood-storage area	Jamie S.	Michael H.	Create additional storage space	16-Oct-12	22-Oct-12	Complete	Gained additional 7,010 cf for the PSC expansion
DI	#2. Determine the Minimal wood inventory required (keep only a "buffer" stock)	Joey W.	Wood S.	Create additional storage space	17-Oct-12	31-Oct-12	Complete	Reduced the on-hand number inventory by 50%
DI	#3. Remove obsolete/unstable items from storage; give to other orgns; return to vndor for refund	Jimmy G.	Connie W.	Create additional storage space	1-Aug-12	30-Nov-12	Complete	As of 30 Oct: have freed-up 2,484 cf of storage space
DI	#4. Relocate large, bulky items near roll-up door (easy access for truck)	Charles G.	Jimmy G.	Relocate stored items to the best/most effective location	27-Oct-12	30-Nov-12	Complete	50% complete
DI	#5. Identify: Common-use items, where to locate, and quantities required	Steve W.	Wayne N., Terry A., Juan S., Jimmy G., Josh C., & Charles G.	Adjust the inventory to attain the desired type/mix of items & levels. Relocate stored items to the best/most effective location	13-Oct-12	30-Nov-12	Behind Schedule	As of 30 Oct: 3 shops have ID'd their high-use items; there are 3 more shops that need to do so: FEM system up-dates are required
DI	#6. Remove wood-storage racks & relocate to wharehouse outer wall, station #15	Jamie S.	Michael H.	Create additional storage space	16-Oct-12	22-Oct-12	Complete	Freed-up 3,120 cf of storage space
DI	#7. Remove 80 ft run of storage racks from outside (large storage shelter) & replace with racks removed from south outer wall at station #15	Jamie S.	Michael H.	Create additional storage space	16-Oct-12	22-Oct-12	Complete	Gained additional 720 cf of storage in outside shelter; replaced outdated rackes with new, stronger, high-weight capacity racks
DI	#8. Move ladders to an area that is easily accessible by mechanic's carts	Clark S.	Marlin S.	Relocate stored items to the best/most effective location	TBD	30-Nov-12	On Schedule	As of 30 Oct: awaiting movement of the PSC cage to its new location
DI	#9. Consolidate like, high-use items in the PSC	Steve W.	Clark S.	Relocate stored items to the best/most effective location	TBD	30-Nov-12	Complete	As of 30 Oct: awaiting movement of the PSC cage to its new location
DI	#10. Build kits for preventive maintenance	Jimmy G.	Charles G. & Freddie D.	Relocate stored items to the best/most effective location	TBD	30-Nov-12	Complete	As of 30 Oct: kits for PM are being built and staged for pick-up as needed
DI	#11. Move all personnel lockers to a common location	Jamie S.	Michael H.	Relocate stored items to the best/most effective location	TBD	30-Nov-12	Complete	As of 30 Oct: lockers have been moved to a temporary location
DI	#12. Move tool crib cage to new location	Robert H.	Jamie S. & John F.	Create additional storage space. Position warehouse functions at the most effective location	TBD	30-Nov-12	Complete	As of 30 Oct: additional cage panels are on order; awaiting delivery of these materials
DI	#13. Move PCS Connex items from the outside yard to the new PSC location	Clark S.	Marlin S.	Relocate stored items to the best/most effective location	TBD	30-Nov-12	Complete	As of 30 Oct: awaiting movement of the PSC cage to its new location
LTP	#14. Install racks (taken from large outside shelter) in the smaller lean-to shed	Jamie S.	Michael H.	Create additional storage space	TBD	May-13	In Planning	This is a long-term initiative planned for late FY 2013
LTP	#15. a) Configure the rear of the warehouse to serve as the Entry Control Point for issuing material; b) Relocate warehouse office area and personnel cubicles	Steve W.	Michael H.	Position warehouse functions at the most effective location	TBD	13-May	In Planning	This is a long-term initiative planned for late FY 2013

f. Confirm Results of the Rapid Improvement Event:

- freed up 13,334 cf storage space for critical spare parts (cm & pm)
- established kitting for cm & pm parts & materials
- shortened customer response time
- first pass yield increased on cm & pm work orders
- improved vendor relationships; pull system initiated (kanban)
- reduce potential injuries & near misses
- common use items prioritized
- resolved employee concerns with handling of ladders
- high/low use items identified
- fem min/max level set
- reduce inventory - cost savings/cost avoidance

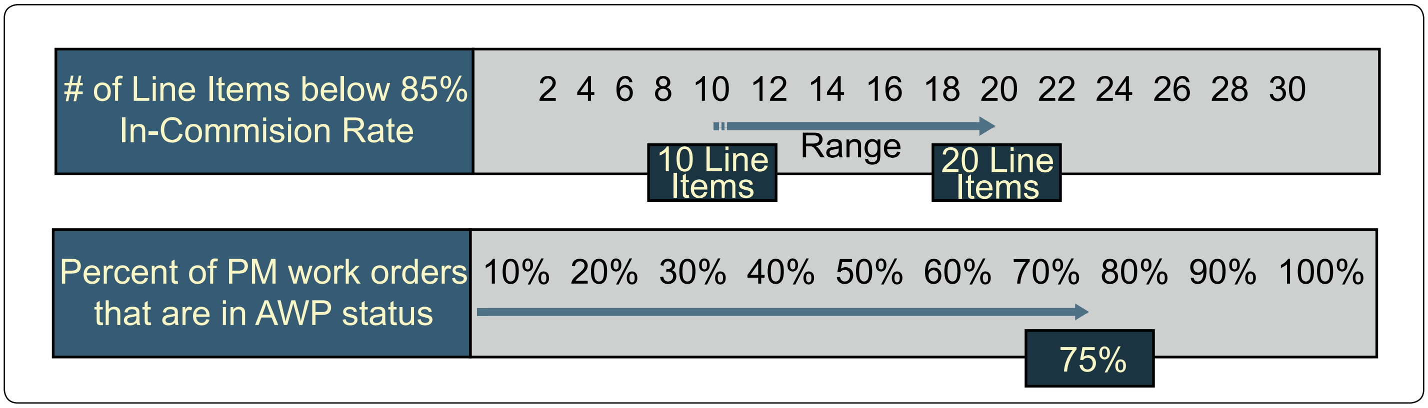
Objective	Baseline	Target	Results
Free-up storage space by removing obsolete/unusable items and by re-configuring storage locations	179,500 cubic feet	10%=17,950 cub feet	Gained 13,334 cubic feet of storage space
Increase the size of the PSC and consolidate into one location	736 square feet	1100 square feet	PSC consolidated one location; 1120
Adjust the inventory to obtain the desired mix of items and levels	Not aligned with the workload	PM items-30% CM items-15% Common use-40% Project Mat'L-15%	The targets have been achieved

Case Study #3: 402 MXSS & First Support Services – Partnership Event

a. Reason for Action

First Support Services has the contract award for Ground Support Equipment; the contract is managed by 402 MXSS – Industrial Services. The contract's performance work statement calls for a GSE in-commission rate of 85% for each line item; however, there are typically 5 to 10 line items per month that fall below the established target. This improvement initiative has been internally generated, jointly by 402 MXSS GSE program management and First Support Services.

b. Current Conditions



In addition to the GSE In-Commission Rate not meeting the 85% target, the team found that three-fourths of all GSE preventive maintenance work orders were held up in 'awaiting parts' status. The partnership team now knew that the AWP problem had to be addressed if there was to be improvement in the GSE In-Commission Rate.

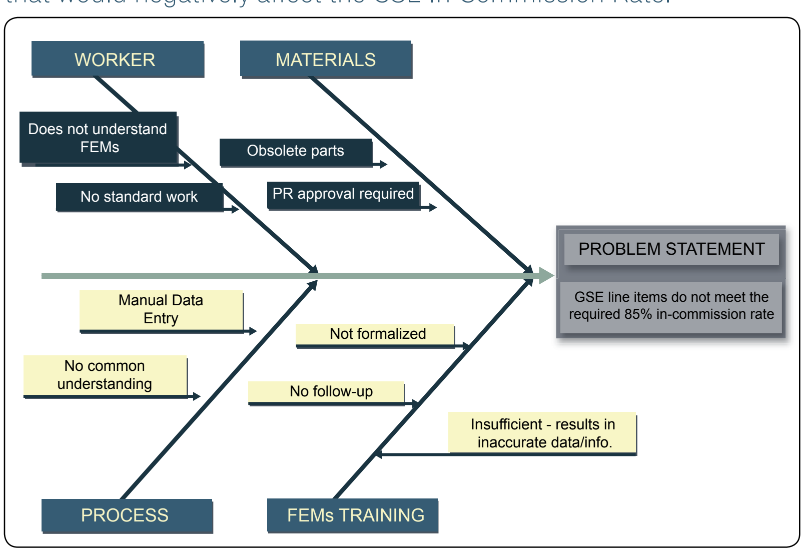
c. Improvement Target

GSE PMI needed to be completed on-time; materials had to be on-hand, kitted, and ready to issue.

GSE PMI completed "on-time"	100%
PMI Materials Kits complete/ready	95%
GSE "in-commission" rate	85% per line item

d. Break-Down the Problem/Identify Performance Gaps

The team conducted a cause and effect analysis using the fishbone diagram to determine factors that would negatively affect the GSE In-Commission Rate.



Cause and Effect Analysis (click to zoom)

This analysis brought out two significant findings: 1) the automated system being used to manage GSE activity (Facility Equipment Maintenance System) was not well understood by the users and therefore, had inaccurate data; 2) a major error in FEMs was preventive maintenance work orders were being combined with corrective maintenance work orders – this caused system users to report a 75% AWP status for PM work orders.

Determine the "Core" Problem; THE FIVE "WHYs"

Problem: GSE line items are not meeting the 85% "In-Commission" Rate

1. **Why**: "GSE Due PMI" report shows **75%** of PM W/O's are AWP status
2. **Why**: Line items needing PM and also, Line items needing CM are combined in FEM Report
3. **Why**: System users were unaware that CMs are included in the "PMI W/Os (AWP)" count
4. **Why**: System users do not understand how the AWP Report is generated
5. **Why**: Insufficient FEM system training

Core Problem: Limited FEM initial training/no follow-on, recurring training

e. Action Plan

In order to transition from the current state to the future state process, an Action Plan was developed which detailed what initiatives needed to be implemented. Ninety percent of the Action Items were accomplished during the week of the Event since they involved FEM system program changes which were made by the FEM system specialist – a member of the Event team.

f. Action Items to Implement Countermeasures

Action items to implement countermeasures is depicted in the below figure.

D/I	-	FEM pop-up notification to dispatcher: "Overdue for PMI"
D/I	-	Create a Ready Line Report which shows PMI due, 30 days out
D/I	-	Create a predefined query for "open dispatches"
D/I	-	Modify the Dispatch Office Center for quicker access to open dispatches
D/I	-	Modify the Dispatch detail screen to list the next due date on line items
D/I	-	Calendar with PMI dates
D/I	-	Next due date displayed on the Dispactch Screen
D/I	-	Add "In Commision Rate" to GSE non-availability report
D/I	-	Add Vendor to Purchase Acquisition Screen
D/I	-	Report: PMI due for items on ready line
D/I	-	Send notification to Supply for items at or below minimum level

g. Confirm Results

FEM system data was tracked for six months to verify that the countermeasures implemented actually resulted in improved performance.

Metric	Performance Baseline	Current Performance	Change
Lead time to obtain parts from vendor	Jan 2011=16.5 days	Sep 2011=8.2 days	50.3% reduction
Lead time for purchase orders submission	Jan 2011=14.9 days	Sep 2011=4.94 days	66.8% reduction
% PMIs completed on due date	Jan 2011=25%	Sep 2011=92%	67% increase
% PMI materials kits complete	Jan 2011=40%	Sep 2011=85%	45% increase

A.12. N-1 Gyro Case Study Notes

AFSO21 is the adaptation of improvement methods and operating concepts from Lean, Six Sigma, Theory of Constraints, and Business Process Reengineering. Fundamentally, AFSO21 is a mindset to select and use the right tools and techniques to identify and eliminate non-value added activities. The objectives of AFSO21 are listed below:

- Provide a standard AF approach to continuously improve all processes that employ AF capabilities to deliver required effects.
- Develop a culture which promotes elimination of waste, sharing of best practices, and reduction of cycle times across all products and services, and involvement of all Airmen in the relentless pursuit of excellence.
- Ensure that all Airmen understand their role, develop the ability to effect change and continuously learn new ways to improve processes in their daily activities in order to save resources and eliminate waste.

In the exchangeable machine the implementation of AFSO21 is required to maximize throughput. A key component to meeting mission requirements is implementing the cell concept. A cell is like a home - a location or process within a value stream that serves as the best representation for demonstrating the five principles of lean. When fully developed, a model cell will be the showcase and training avenue for full-scale Lean implementation within an organization. A model cell is linked to the Value Stream and has Standard Work, 6S, and Flow and Pull, supported by Visual Management and emphasized Root Cause Corrective Action.

The N-1 Gyro Depot Maintenance Repair Team was losing their customer's confidence due to unstable N-1 repair sustainment. N-1 gyro production was plagued with parts problems, increased demands and MICAPS. The backorder numbers had increased to 122 units with MICAP hours averaging 8800 hours. Monthly units produced were approximately 25 units against a monthly target of 60 units. The System Program Office considered outsourcing the N-1 gyro repair and the Avionics and Instrument flight was presented with a waiver letter requesting authorization to identify a second source of repair. The team went into action, ultimately turning their production performance into a success story by applying AFSO21 principles that revamped the N-1 gyro repair line into the prototype cell for their squadron, 402 EMXG and the Air Force. This positive engagement of AFSO21 practices eliminated warfighter delay time of critical assets and halted outsourcing efforts.

The journey to turn production around began with a value stream map event. Production workers and support personnel such as planners, schedulers and supervision came together and critically reviewed the process, documenting bottlenecks and identifying solutions to work smarter. A VSM event was initiated and involved the Defense Logistics Agency, the 402 EMXG Precision Measurement Equipment Laboratory, the 402 EMXG Quality Office AND the customer. The VSM team aptly designed and implemented a future state that ensured steady output and postured the work center for future workload.

The transformation incorporated:

(1) Rearranging the cellular layout into one-piece flow to more effectively support Takt time

(2) Invoking production control boards and flow boards as visual management tools, communicating workload requirements to the workforce and controlling work in process

(3) Applying stringent 6S (sort, straighten, scrub, safety, standardize and sustain) to their work area, resulting in a more organized and efficient work environment

(4) Streamlining the flow cell process which maximized use of scarce resources, keeping overtime to a minimum

(5) Capitalizing on cross-training resulting in a versatile workforce; team members used their extensive experience and job knowledge to mentor within; training was streamlined so every technician does not have to learn the whole N-1 repair process

(6) Teaming with equipment specialist to train technicians on improving high failure rate process, improving future production reliability

(7) Fostering a partnership with DLA and the System Program Office through a dynamic involvement in monthly Exchangeables meetings which improved communications, assured better parts supportability and fixed high MICAP drivers

(8) Collaboration with system engineers and equipment specialist to update technical orders and streamline calibration procedures

The N-1 gyro team drastically improved their performance by utilizing Lean, boasting an impressive 2007 record for repair and return by producing 314 N-1 directional gyros. Backorders dropped from 137 to 0, MICAP hours were reduced from 8793 to 0 and total MICAP units were slashed from 333 to 0. Production numbers were averaging 46 units per month but the team attained the production target of 60 units for 3 consecutive months. WIP decreased 50 percent. In effect, the customer requirements were realized 100%. The increased productivity allowed 6 technicians to transition to other critical workloads. The team has met or exceeded every key strategic alignment and deployment metric for their organization. Their contributions were vital in the Logistics Standardization and Evaluation Team "excellent" rating for the group and for the group's exceptional production.

B

APPENDIX B: VISIONEERING

AIR FORCE SUSTAINMENT CENTER: ART OF THE POSSIBLE

Appendix Topics

B.1. Introduction

Strategic Planning and Alignment is paramount to future strength, flexibility and sustainment of the AFSC traits, constructs and philosophies. One of the strongest partnerships in assessing the long-term health and sustainment of a complex system, such as Air Power MRO (Maintenance, Repair and Overhaul), is that between engineering practices and techniques with the long-term vision and focus of the enterprise. This critical blending of Strategic Vision and Engineering led to the development of the moniker "Visioneering". Visioneering survives through the partnership of stakeholders and common game plans that are focused not on the current horizon, but on the requirements beyond (10, 20, 30+ years out). This document assumes the reader is knowledgeable of Production Machine Science, Gated Monitoring System, Drum-Buffer-Rope, Takt Time and Little's Law (O'Connor, et al, 2012). This document goes beyond and establishes a firm foundation for data-driven strategic positioning techniques and constructs. The art of Visioneering takes the AFSC mission along with corporate goals and molds them with engineering principles to determine the future strategic requirements and postures for building an executable strategic plan. As projects are defined and aligned with capital budgets and resources, more data becomes available to increase the confidence in the financial decisions. Contracts and timelines are finalized and projects are executed to meet the workload demands.

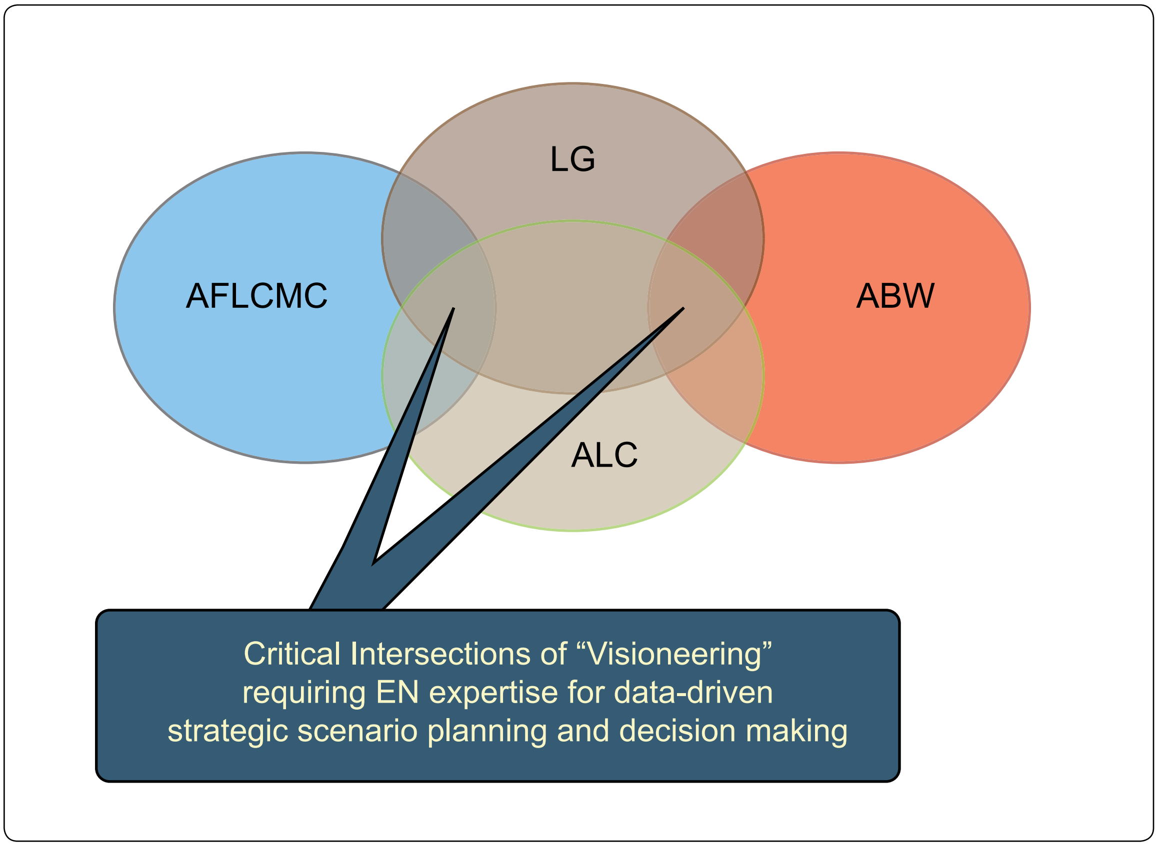


Figure B.1. Visioneering Focus

The strategic planning spectrum varies in complexity and fidelity from abstract data and Area Development Planning to concrete execution by tactical Production Support Branches or teams. At the abstract level, information and goals can be disjointed, sparse and assumption rich. Through the use of engineering and mathematical practices, the gaps in the data / information streams can be forecasted (predicted) and historical information, lessons and challenges are reviewed for trends, trade space and risk assessments to form a more solid plan for execution and sustainment. As the strategic planning begins to develop data-centric knowledge, the plans become clearer, resources and budgets begin to formulate until clarity leads to defined contracts and timelines. It is at this position the development shifts from a strategic team construct to a PSB/T focus. The PSB/Ts will execute the data-driven plan to affect a strong long-term posture for the complex and ultimately the Center.

B.2. Team Composition and Skills

Teamwork is one of the governing AFSC Leadership traits and this trait must be maintained and improved throughout the AFSC life Cycle. Strategic Planning and Alignment is based on a team concept that blends different functional and operational disciplines to achieve a synergy that sustains mission changes, attrition and personnel adjustments.

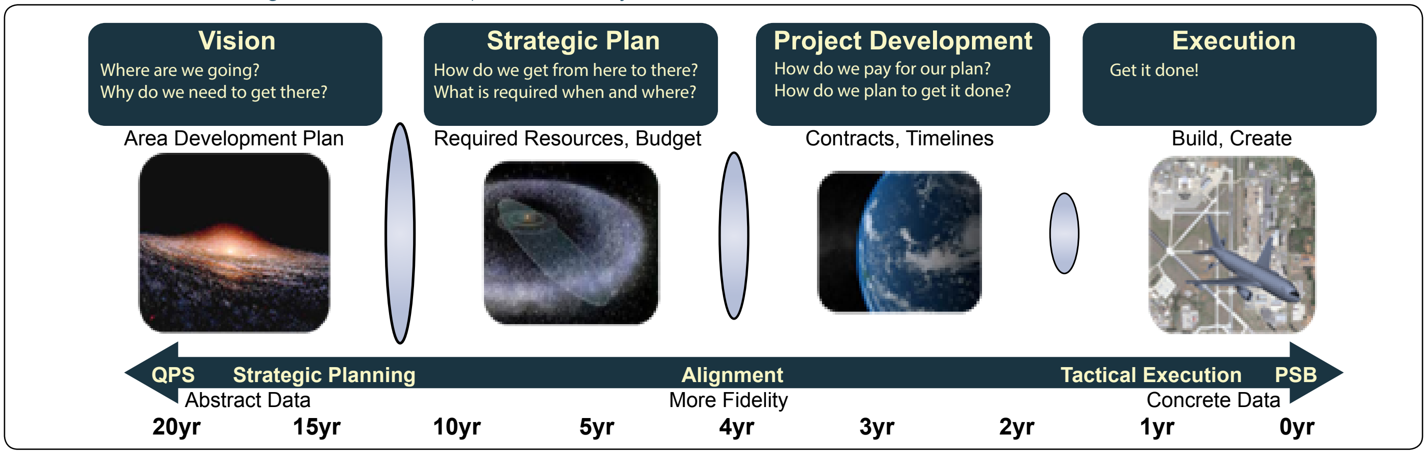


Figure B.2. Strategic Planning Spectrum

The team must:

- Have the mindset to develop the strategic (vision) plan to answer the "tactical" aspects of the immediate problem.
- Include developed problem solving skills focusing on problem statement development, operations research, statistical analysis, engineering economics, mathematical modeling, and maintain a desire to work at the detail levels.
- Have experience working with all stakeholders (System Program Offices, Production Lines, Strategic Planners …) in order to serve them as customers and obtain data for the analyses.
- Have a mix of experience (skill levels) in Industrial Engineering, Operations Research, Capital Investments, Data Analysis, Dynamic Spreadsheets, Presentation Development and Execution along with a strong back ground in Software Development and Computer Programming.

Desire to immerse one in the details of data collections, statistical analysis and information visualization has been shown to be a major trait Visioneers must possess. Individuals that feed on immediate return or recognition and short burst assignments, find the pace and intense analysis of a Visioneer's career to be sublime and often meaningless. This desire must go beyond the casual interest, to work detailed problem analysis over a long period of time; being able to revisit previous analyses more than one time. This is truly a team effort as not one person has the skills or ability to view the vision completely.

Time and patience are also traits that must be present in the Visioneering Operations. Unless an experienced team is available, time must be invested to develop the team so they can bond together and innovate. The team must be guided and insulated from tactical distractions that will rob them of time to research, analyze, and innovate. Solutions expected tomorrow will lead to frustration and disillusionment. A good leader is required to guide and orchestrate the individuals lest they get "wrapped around the axle". The team must be empowered to be curious and innovative in order to develop the best strategic plans.

B.3. Planning and Systems Analysis

Planning in the Visioneering operations begins with forecasting and process mapping activities to understand and document the existing enterprise under evaluation or analysis. This planning relies heavily on understanding the System of Systems that comprise the Enterprise View and Operations as well as forecasting future enterprise interactions, resources or performance metrics. Planning involves the affects or impacts to execute work within a specific timeframe, quantity and type. This component which is used in conjunction with forecasts drives a formulation of short and long-term plans to achieve the required capability by eliminating constraints. The planning approach and Concept of Operations (Litchfield, 1012, pg. 1) is evaluated at many different maturity states. The Area Development Plan is an example of the strategic planning activity that provides in-sight to the future state. Planning, based on data driven results and discussed openly (transparency) with customers and stakeholders, provides the communication to meeting the common goal of sustaining weapon system readiness. Strategic plans cannot exist without continuous research and analysis. Management, visionary teams and stakeholders must work together to plan for and address future challenges.

Process Mapping

Process mapping provides a view into a system by answering “what happens when” (sequence & precedence), “how long does it take” (time) and “with whom” (relationships). Process mapping identifies constraints and waste in the system, data streams (process metrics, health assessments, system inputs, etc.) and identifies the characteristics of the system. It is the characteristics that identify trends and opportunities to exploit and provides tangible feedback to what and how the system changes over time. An example output of forecasting is the capacity analysis. Capacity analysis identifies the workload demand on capacity, contrasts this against the current capability and thereby identifies future requirements. Forecasting provides the “what is needed”, “when it is needed”, and “opportunities to exploit”.

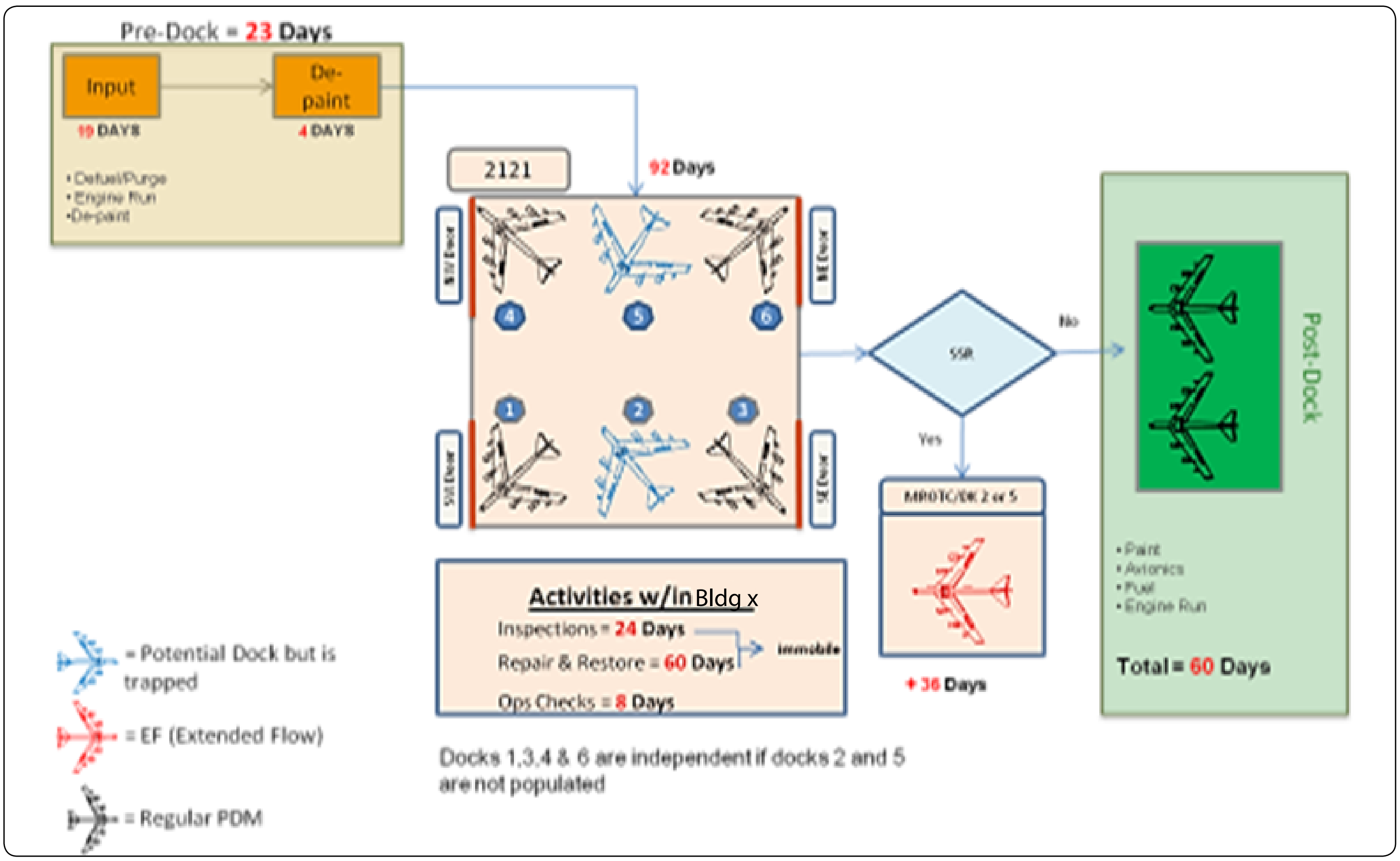


Figure B.3. Process Map

System of Systems

SoS in systems engineering is used to define a complex system by breaking down or analyzing its constituent (lower-level) systems. The system of systems will involve all processes including shared, constrained or even standalone resources that operate within a production machine. These support decision making process, which drive future readiness and effectiveness to meet AFSC goals both tactically and strategically.

An enterprise perspective provides the framework for today's and tomorrow's maintenance approach resulting in an action plan. This approach drives a need to develop a robust enterprise view of the processes that describes maintenance within a SoS.

One of the first steps in the Visioneering operations is to define and understand the SoS that comprise the entire framework of analysis. This complex system is comprised of several Mission Design Series flow plans, metrics, interactions and resources grouped together and interfaced with shared resources (e.g. Corrosion Control Operations, Fuel/Defuel and Engine Run) to provide a complete Enterprise View. Ultimately, this Enterprise View can grow as different product group operations, supply chain and external suppliers are added to form a more Complex-level View. If you are just beginning your journey in Visioneering, it is best practice to begin defining your Enterprise View at the lowest levels and build into a more complex view. An example would be the Gates of a Gated Monitoring System in the aircraft production environment (O'Connor, et al, 2012). This would be the lowest level and first point of understanding and documentation. You build full understanding of a single gate's flow, metrics and resources, and then build knowledge of additional gates until the entire MDS is known. Then build the MDS's into Product Group Views and merge Product Group Views into the Complex View.

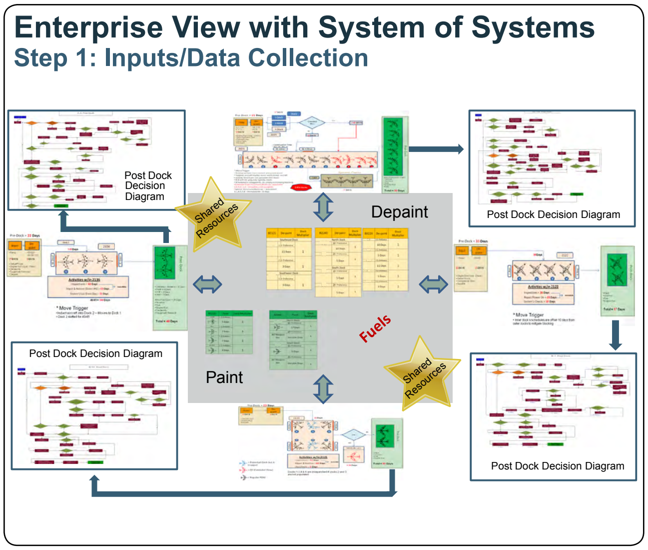


Figure B.4. Enterprise View with System of Systems (click to zoom)

Forecasting

Forecasting is a predictive analysis based on historical data, trends and underlying factors that might influence the information being developed, analyzed or not yet observed. Example could be to forecast (predict) the growth rate of a queue in an unbalanced system or the forecast of when a system will run out of work (in the case of workload reductions). These are typically used early in the planning cycle to establish baseline assumptions (estimates) that will be revised as data fidelity improves across the spectrum.

Forecasts can be based on formal statistical methods or judgment from experience, expectations and observations. Forecasting starts with an in-depth understanding of the enterprise view through process mapping and data collection. Since forecasts do not have high degrees of fidelity, it is paramount they are wrapped with risk assessments, degrees of certainty (confidence levels) and sensitivity analysis (effect of assumptions on the outcome) to clearly identify the assumptions, input data streams and data providers. Forecasting tasks often answers the question, "What will … look like in the future?" and basic quantitative techniques include: Time Series, Regression Analysis, Descriptive Statistics, Probabilities and distribution fitting.

Considering this approach, a maintenance environment's focus is driven by accurate forecasts and keeps in mind the Concept of Operations viewpoint (Litchfield, 2012). Forecasts pave the way to evaluate future work minimizing impacts to current initiatives. Forecast evaluations at an enterprise level are very dynamic and initially described in a generic state. The forecast then becomes an iterative approach as data fidelity increases. This is why it is imperative to know your system and establish communication between the customer and stakeholders. Process Mapping, System of Systems Documentation and Forecasting are the main principles of planning. These principles and culture push the mindset to consider future perspectives and place us in the best possible position to respond to the warfighter's needs.

Capabilities and Capacity Planning

Capacity Analysis is the strategic function of understanding how our capabilities compare to our workload from a holistic Value Stream perspective. Capacity analysis identifies gaps between our capabilities and our demands. Once we have knowledge of these gaps, we can be proactive toward removing them. The first step in determining capacities and capabilities is in the understanding of resources and priorities and efficiencies. You need to completely document the equipment (servers), their capacities (number of components per time period), the priority in which a component is issued to a server and the efficiency of server operations. For example, if you were analyzing the capacity of aircraft docks, you would first need to fully understand the characteristics of your aircraft (width, height, clearances …), the characteristics of your docks (unobstructed width and height, aircraft preference priority, distance to supporting resources …) and view the aircraft docks as servers servicing aircraft, the docks have a priority preference for a specific aircraft type and an efficiency of dock utilizations (number of aircraft per dock). Once the characteristics of the system are fully understood, it is time to begin building event-based scenarios of workloads. This would include building a model of each workload induction scheduled, process flow and cycle times. Iterate the events until the induction system is satisfied and the final asset has exited the system. Capturing information with each event (server availability, number of assets through a server, average wait time for a server, total assets processed by the server …) will give you an understanding of the system's capacity.

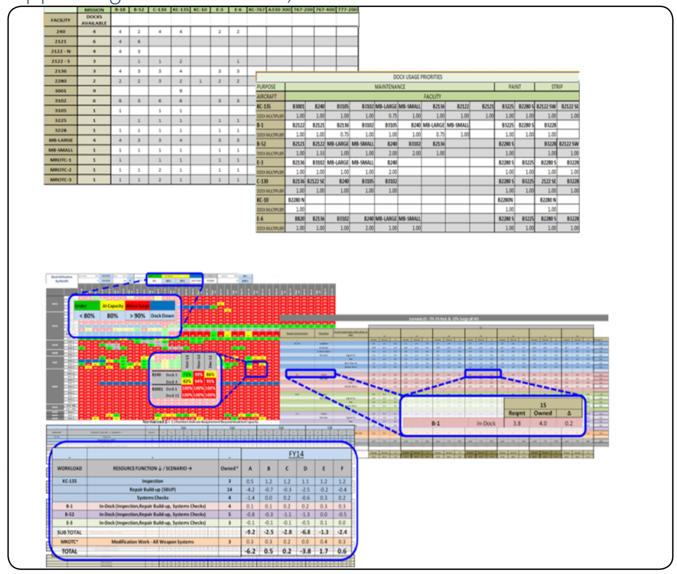


Figure B.5. Capacity Planning & Documentation (click to zoom)

B.4. The Art of Analysis

The Art of Analysis is the engine that allows us to make "today better than yesterday, while making tomorrow better than today" (Litchfield, 2012). By working together to analyze our current capabilities and our future possibilities, we are able to identify opportunities and risks and to recommend action plans that allow us to leverage scarce resources including infrastructure, intellectual talent and budgets to get "the right results . . . the right way" (Litchfield, 2012).

AoA leverages the creative, mathematical and scientific skills of the Visioneers to blend theory and analytical tools with a robust modeling methodology to solve enterprise shaping challenges. This is not just a tactical focus as the time horizon for analysis ranges from next month to 50 years in the future. The scope of the analysis can be limited to a single process or resource to an entire Complex or Center. The analysis does not happen in a vacuum as credibility of the analysis results from engaging stakeholders.

AoA requires the blending of theory, methodology and the appropriate selection of tools to carry out the analysis. The selection of the model is based on what question is being asked and what metrics are needed to supply data-driven recommendations with clear risk assessments and options. The process is iterative, with results driving new questions and new analyses. Models are developed with increasing complexity and adapted to answer new questions in more depth than their predecessors. The art is in the selection of the applicable model or tool and in the interpretation of the results. It is also in the interpretation of the original question which could drive multiple analyses looking at different aspects and assessing available trade space.

A robust methodology is needed to ensure consistent, repeatable and credible results. Visioneering uses a 5-step Modeling Methodology: 1. Collect Data, 2. Define the Problem, 3. Model and Iterate, 4. Formulate Analyses and 5. Recommend and Implement.

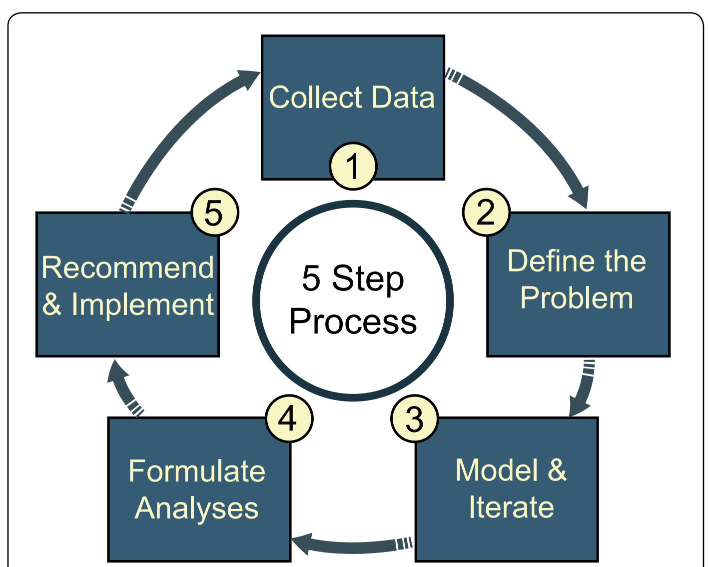


Figure B.6. M&M Cycle

Collect Data

The reliability of the analyses is directly related to the accuracy and volume of data used to generate the results. The reliability of the data can be assessed using applied statistics being mindful that better answers come from better data. Before analysis can begin, the analyst must develop a thorough understanding of the system to be analyzed and modeled. There are many sources for data such as production meetings, databases, observation, reports, previous analyses and interviews with schedulers, planners, supervisors and other stakeholders. Process maps are essential to show relationships between processes, resources and workloads. Visioneers keep a repository of data that includes the raw data, its source, and the date it was acquired.

System Statistics and Inferences

Applied statistics are used to assess data; determine its characteristics, structure and shape; and to develop inferences about the population. Data should be ordered by a specific attribute (chronologically, aircraft type, part dimension …). Graphing the sample data may indicate there is more than one population represented or trends within the data. Two common types of graphs are the histogram and the scatterplot. An example of data that represents more than one population is process times for a repair process where there are two different times based on the extent of maintenance performed (Speedy vs. Extended Flow). In this case, the data will be separated into the two populations to avoid forming false conclusions about the mixed data. An example of trending would be decreasing process times due to implementation of continuous process improvement or increasing coatings removal (de-paint) times due to colder weather.

Trend analysis is normally performed on chronological data. Trend analysis is accomplished by graphing the data in chronological order along with the mean and looking for patterns. Generally, five sequential data points are required to indicate a trend. If a trend is found, it can be used to forecast future behavior, such as process times. Caution should be used to ensure the data evaluated belongs to the same population. Trends may be cyclical (seasonal) or uniform.

The next step is to look at the descriptive statistics for the sample. Descriptive statistics include the sample size, mean (average), median (center), mode (most frequent occurrence), range, minimum, maximum, variance, standard deviation, kurtosis (peakedness) and skewness (slantedness). The mean, median and mode are measures of central tendency and when they are equal, it indicates the sample data is well balanced around the mean. The following figures illustrate Measures of Central Tendency and Skewness (Figure B.6.) and Skew (Figure B.7.). Understanding the data's variability and centeredness is the beginning of the analysis.

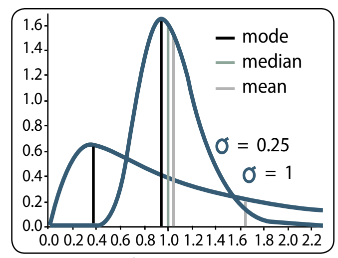


Figure B.7. Central Tendency and Skewness

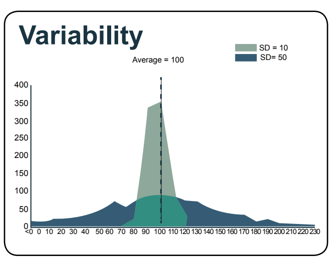


Figure B.8. Variability (click to zoom)

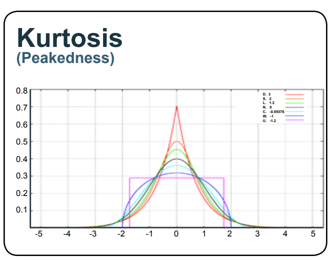


Figure B.9. Kurtosis (Peakedness) (click to zoom)

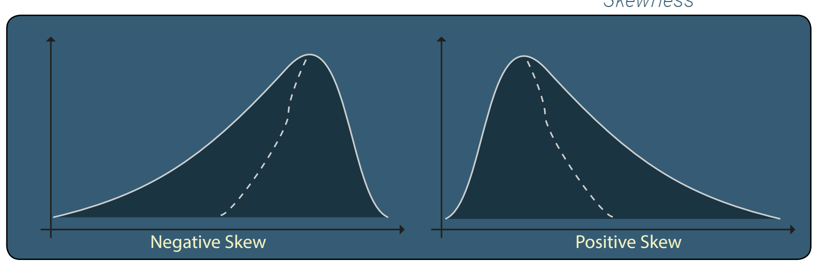


Figure B.10. Skewness (click to zoom)

Data collection is a continual process and independent of the questions posed. The analyst may not have quality data at the outset of the analytical effort, but should strive to identify new data requirements and sources while using what is available.

Define the Problem (or Goal)

When an analysis is requested, the Visioneer should develop a problem statement or goal and identify required input data and output metrics. They should define potential scenarios to be created, scope of analysis, business rules and assumptions to be used. At this point, we identify additional data required to answer the question. It is imperative that the analyst understand what output will satisfy the question and what data is available to input into the model. What-if questions are often posed in a general way such as "What is the impact of . . .?" without explicitly stating the responses that should be measured. Stakeholders should be engaged during problem definition to ensure the right information, assumptions and rules are utilized and the right question answered. Problem definition is critical to getting an appropriate analysis and meeting the expectations of the customer.

Model and Iterate

A model is a mathematical representation of a system under analysis. The selection of an appropriate model is critical to the success of the analysis. Model selection depends on the question or goal, available data, complexity of the system, and the time available to perform the modeling effort. The models used by Visioneers range from simple equations calculated by hand to discrete event simulation models. A new model may be developed or an existing model may be reused with new or updated data. The analyst should validate that the model represents the current system and problem scope. During model development, additional data may be required and the problem statement may need refinement. When a satisfactory current state model is complete, it is then modified to reflect the future or "what-if" state. This may include changing resource availability, schedules, timelines or workloads or even adding additional logic structures to the model.

The Production Machine is an example of a simple model that uses Little's Law as modified in the science paper (O'Connor, et al, 2012).

$$\text{Flowtime} = \text{WIP x Takt Time}$$

Figure B.11. Modified Little's Law

A derivative of this is the equation used to determine the number of facilities or resources required for a workload.

$$\text{Facilities}_{FY} = \frac{\sum_{i=1}^{n} \text{Inductions}_i * \text{Work\_Package}_i}{\text{Burn\_Rate}}$$

Figure B.12. Capacity Equation

The top of this equation (numerator) in Figure B.9. is controlled by the program office, which controls the number of aircraft and the work package. The bottom of the equation (denominator) is controlled by Maintenance, which manages the burn rate (the earned hours worked in a year per dock or resource). Figure B.10. shows the many factors that contribute to work package, inductions and burn rate.

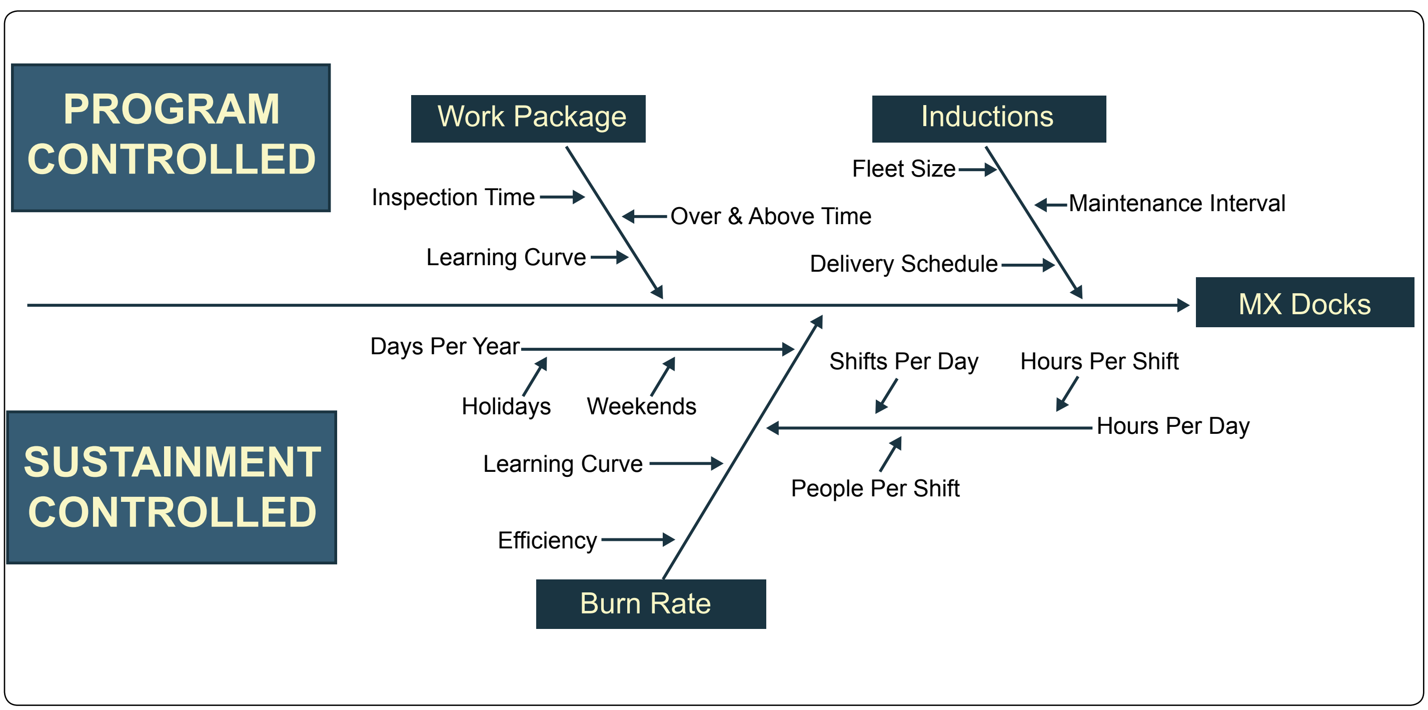


Figure B.13. Capacity Equation Relationships

For example, the capacity model for a sample weapon system is based on the second formula (Figure B.9.). Excel was used to project facility requirements into the future by Fiscal Year and is illustrated below in Figure B.11.

Fiscal Year		2018	2019	2020	
Depot MX C1 C2 C3 D		0 0 3 4	3 4 4 3	6 6 4 3 0 0 3 4	The mix of maintenance types was developed from the schedule. ($Inductions_i$)
Total Inductions		7	14	26	
Depot Hrs C1 C2 C3 D	MX 5300 hrs 6800 hrs 8700 hrs 13500 hrs	37,100	74,200	100,700 47,600	The number of hours for each type of maintenance was found for each year. $(\sum Inductions_i * Work\_Package)$
Total MX Induction (Hrs)		37,100	74,200	148,300	
Depot Days (Math) C1 C2 C3 D	250 Days/Yr 18 Days 23 Days 29 Days 45 Days	0.5	1.0	1.3 0.6	The number of facilities was calculated for each type of maintenance. $Facilities_{FY} = \frac{\sum_{i=1}^{n} Inductions_i * Work\_Package_i}{Burn\_Rate}$
Total MX DOCKS (Math)		0.5	1.0	2.0	
Minimum Number of MX DOCKS		1	1	2	
Maximum Number of MX DOCKS		1	1	3	

Figure B.14. Excerpt of Capacity Model for Sample Program

Queuing theory analyzes the number of items waiting to be serviced and the time they wait. The basic rule in queuing theory is that the service rate must be faster than the arrival rate or the queue will grow. A growing queue indicates insufficient resources are available and the system is out of balance. A continuously increasing queue indicates a capacity constraint that must be resolved either by increasing the number of resources available, decreasing the service times or decreasing the amount of workload passing through the queue. Knowing the length and time of queue will help develop a capacity plan, understand wait time and determine if more resources (facilities, machines, personnel, etc.) are needed to maintain production levels. This enables us to quickly identify, elevate, and eliminate or mitigate the constraints that impact weapon system readiness.

Design of Experiments is a tool used to systematically evaluate the impact of multiple variables on the output. It is the identification and execution of a series of purposeful changes to the inputs of a given model in order to observe the changes in the outputs. DOE gives the analyst insight into how an input variable affects the system. The models could be simple equations or more complex simulations. DOE can be used to compare and contrast multiple options of scenarios, to develop a better understanding of a system under stress (or relief). The changed input variables could include schedules, resource availability, process times, or workload volume. The analyst can use these variables to drive the system to the desired output performance.

Discrete Event Simulation is a robust tool that is well suited to model complex systems with shared resources and interactions between workloads. The strength of simulation lies in the use of probabilistic data for inputs and the repeated runs of the model to generate outputs that can be statistically analyzed. Simulation models take time and resources to develop properly. They may be developed in spirals, gradually increasing the granularity, complexity and accuracy. When properly

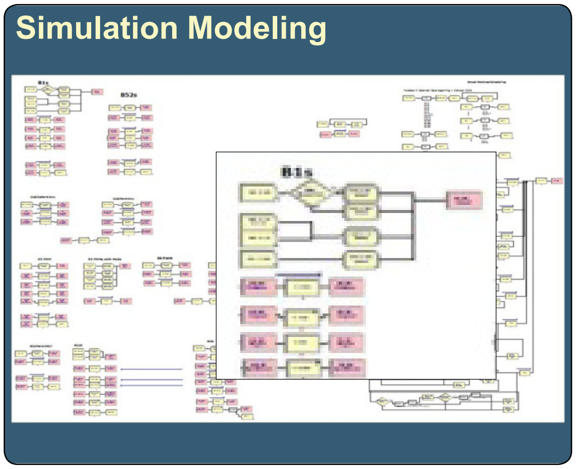


Figure B.15. Sensitivity Graphs

developed, simulation models may be adapted, modified and reused to analyze a variety of scenarios for the system modeled. Combined with DOE, it is a powerful analytical tool.

Before moving on to analysis, the analyst should verify and validate the model and ensure the outputs produced are sufficient to answer the questions posed. Known adjustments should be made and validation of output changes should be performed on all new models.

Formulate Analyses

In this step, the modeling results are analyzed and compared to current state. Modeling produces raw data that requires further analysis to gain information about the performance of the system. Common analytical tools are sensitivity analysis, regression analysis and optimization.

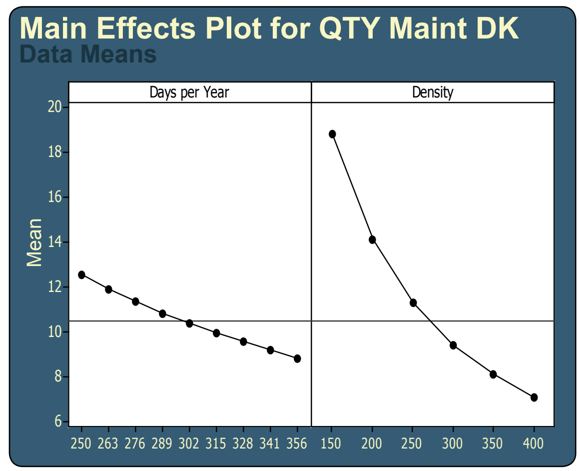


Figure B.16. Sensitivity Graphs

Sensitivity analysis is the study of how changes in inputs, or combination of inputs, affect the response of a system. Sensitivity analysis can help determine how much risk is associated with a given assumption or answer. If small variations in the input lead to significant changes in the response, the system is very sensitive to that input. If large variations in the input lead to very small changes in the response, then the system is relatively insensitive to that input. DOE may be used to perform sensitivity analysis. Look at the pair of graphs in Figure B.12. which represent the impact of workdays per year (left) and total hours earned per day per facility (right) on number of facilities required. You can see the number of workdays per year has less of an impact on the number of facilities required than the total number of hours earned per day. Figure B.13. shows the results of sensitivity analysis that provided a risk assessment for leadership. This shows the impact of increased days in dock and the number of aircraft per year on the number of docks required. Sensitivity analysis should be performed whenever there is data has less fidelity (fuzzy) or variation in the input variables.

Dock Requirements Based on Number of Aircraft and Days in Dock

Total Calendar Days	Days in Dock	Days in Structures	64	66	68	70	72	74	76	78	80
167	124	82	22.0	23.0	23.5	24.5	25.0	26.0	26.5	27.0	27.5
145	105	71	18.5	19.5	20.0	21.0	21.5	21.5	22.5	23.0	23.5
130	90	56	16.0	17.0	17.0	18.0	18.5	18.5	19.5	19.5	20.0
112	80	47	14.5	15.0	15.5	16.0	16.5	17.0	17.0	17.5	18.0

Figure B.17. Sensitivity and Risk Assessment

Regression analysis is done to codify the relationship between an input variable and an output response. Linear regression finds the line that fits the data points. Curve fitting is another technique that evaluates the data and determines which statistical distribution best represents the underlying population. Both techniques express relationships between an input data set and the output response as a mathematical expression. This is particularly useful in predicting future trends or for use in future analyses.

Optimization is the evaluation of an objective at many different states and constraints arriving at the best decision possible or optimal solution. An example of an objective may be to minimize travel time given a set of routes, method and velocity. This technique is best applied when questions arise to which is the best approach subject to these conditions. The Optimization tool can also be used to evaluate a set of states comparing the feasible to the true optimal solution and result in a series of recommendations in which management can make decisions based on important factors.

Additional types of analyses may also be performed including risk analyses, business case analyses, and life cycle cost analyses. Analysis is an iterative process and is not complete until the question is answered to the satisfaction of the stakeholders.

Recommend and Implement

Based on the analyses, the Visioneer summarizes the results into an answer to the original question. The results can range from a Yes/No answer to a full complement of options with comparisons, cost analyses and sensitivity analyses. The format of the recommendation is tailored to meet the needs of the customer. In general, each recommendation will include the answer, a plan to implement, the impact on current production with potential mitigations, the assumptions that were used and a summary of the analyses performed. It will include enough information for leadership to make a data-driven decision.

Recommendations fall into two categories: abstract and concrete. Abstract recommendations inform policy or provide guidance. The Area Development Plan is an example of an abstract recommendation. It provides an overarching plan for the use of space by the various weapons systems. Concrete recommendations require action when approved, such as installation of a new dock door. Both types of recommendations require alignment of resources to sustain weapon system readiness to generate airpower for America.

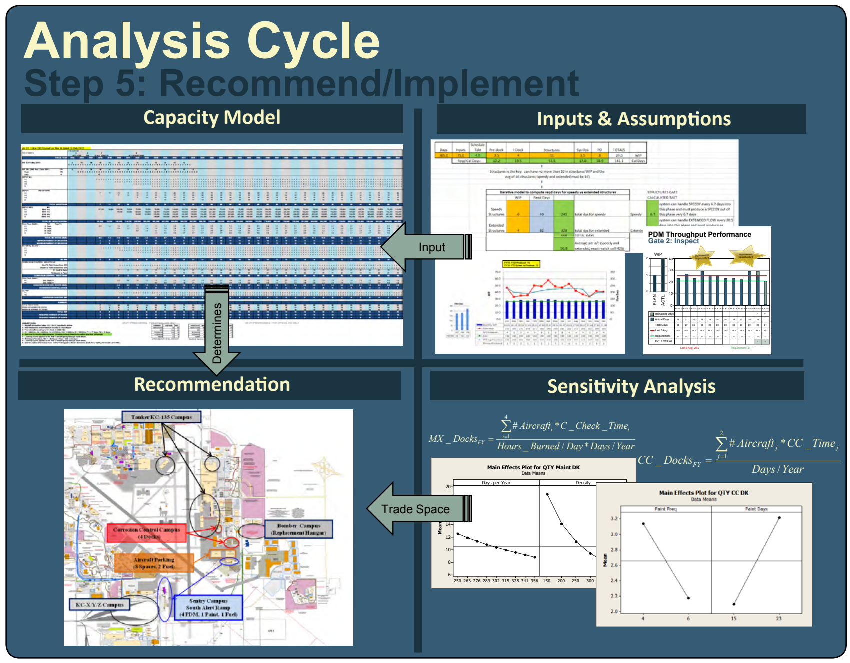


Figure B.18. Analysis Cycle

B.5. Alignment, Budgeting and Execution

The AFSC Leadership Model observes that without proper planning and management of infrastructure, we severely jeopardize mission capability and readiness. Across the AFSC, we are entrusted with many millions of dollars in capital investments (people, space, MILCON, M&R and CIP). Capital Investments require strong stewardship of the taxpayers' money and as the stewards of AFSC capital investments; we align our resources with the recommendation from the strategic planning and analysis processes.

Alignment

Alignment is the process of ensuring that we make smart decisions with Capital Investments. Alignment ensures that near-term tactical expenditures agree with mid-term and long-term strategic needs. The process of alignment accepts the recommendations of Strategic Planning and Analysis as inputs to keep acquisitions on track and moving toward the strategic objective. To accomplish this, we illuminate the Capital Investment process with the three components of alignment – Capacity Analysis, Health Assessments, and Prioritization.

Health Assessment

Health Assessment is the process we use to understand the efficacy of our facilities, processes, and equipment. Our Production Support Branches are accountable to maintain real-time health assessments of our infrastructure. This provides feedback into the strategic planning process as inputs to identify mid-term to long-term requirements or improvements.

Prioritization

Prioritization is the process of separating the needs from the wants. We use multi-criteria decision-making methodology to help establish a priority system when evaluating and prioritizing our projects for alignments with funding. MCDM can handle a large number of distinct criteria simultaneously. It allows us to make data-driven decisions about diverse and seemingly unrelated projects. Using MCDM we can make reasonable comparisons between the relative importances between buying a new aircraft work stand versus buying a new slab of concrete.

Capacity Analysis, Health Assessments, and Prioritization are made possible by data. Collecting and maintaining data on our infrastructure enables us to determine the best ways to make the money count. Each of our Production Support Branches continuously collects data on existing assets and compares our production capacities of today with not only the projected capacity demands of tomorrow but also with the projected life-cycles of our assets.

An example of aligning Capital Investments to achieve strategic objectives is seen in the transformation of aircraft ramps. Strategic Planning forecasted a critical shortage in ramp space several years out to accommodate new workloads. We aligned a MILCON project with multiple CIP and M&R projects to transform an existing ramp into a more efficient ramp with greatly expanded capabilities. By aligning the various capital investment capabilities with the strategic need, we were able to focus the money in a way to best accomplish our current mission and posture us to avoid the future constraint.

Budgeting

Budgeting aligns the monetary funds with the developed plans for contract development and project execution. New workloads, forecasting and planning drives the infrastructure requirements. This requirement results in a budgeting driven approach for the Capital Investments programs evaluated by capacity analyses, weapon system need and funding availability. The focus in this area is to gain the required facility funding, enhancements and timelines to start improvements that meet the needs of the production machine. Thus, relieving capacity constraints through “People, Resources and Process” (Leadership Model) minimizing impact to current work or mission requirements. While forecasting, planning and budgeting are extremely important areas it is the mission that drives the Production machine.

Execution

We have taken input from an enterprise perspective forecasting model and aligned them into acquisition strategies. Using our diverse capital investment tools discussed above, we bring all of the requirements together in a single coherent execution to achieve the best results possible. We have been able to leverage our collective knowledge in ways that have strengthened our stewardship across AFSC. We have learned some best practices along the way.

By maintaining health assessments of our processes and infrastructure; and, by knowledge of capacity, we understand precisely what infrastructure needs to be replaced, expanded or even retired. Without this knowledge, it is easy in a complex production machine to make redundant capital investments without knowing the desired capability already exists.

Our separate groups – aircraft, commodities, propulsion – have implemented a cross-check communications channel to look for excess capacities in parallel units before making major capital investments. This helps to make sure each group is doing the right work. If one group already has a capability, it does not make sense to duplicate infrastructure.

By making data-driven decisions and prioritizing we make sure we are buying needs instead of wants. By implementing Mistake Proofing programs, peer-review programs, well defined weighting criteria, and business case analysis, we make sure we are not only buying the right things, but also buying them in the right way at the right time.

C

APPENDIX C: "GREYBEARD"

Air Force Sustainment Center: Art of the Possible

Appendix Topics

C.1. Foreword

The Air Force Sustainment Center continues to address the challenges associated with a 21st century sustainment enterprise. With the creation of the AFSC Leadership Model and striving for "Art of the Possible" results, depot maintenance communities have united in a common goal of improving their speed, quality, safety and cost effectiveness by recognizing opportunities, understanding and eliminating true limiting constraints, improving processes, and maximizing available resources, while sustaining war-winning capabilities. As a result, the depot maintenance enterprise has benefitted from AFSC's Production Machine and Program Earned Value Stream Analysis sustainment initiatives. One additional initiative that has proven great success is the use of "Greybeard Assessments." In summary, a "Greybeard Assessment" entails the evaluation of a new or highly visible program/project by experienced Subject Matter Experts to determine the health of the plan and subsequent execution of the workload; thereby, decreasing risk and ensuring program success.

NOTE: The Greybeard assessment process is to be used sparingly and only in those instances where high visibility or exceptional performance risk projects are identified. This process is not to be considered a standard business practice for all workload efforts and would risk losing its viability if over exercised.

C.2. Background

Greybeard principles were derived from successful assessment methodologies in validating a program's (activation) sustainment strategy; and continue to evolve with each new Greybeard assessment, given the inclusion of lessons learned. This document has been developed as an initial approach to execute a Greybeard Assessment – with refinements generated through continuous process improvement. Past assessments include:

- T-38 Site Evaluation (air vehicle) – Randolph AFB, December 2009
- F-35 Site Evaluation (air vehicle) – Ogden ALC, May 2011
- T-38 PCIII Assessment – Randolph AFB, November 2012
- F-22 SRPII Assessment – Ogden ALC, May 2013

C.3. Objective

This Greybeard Assessment Guide Book is focused on identifying key aspects of a repeatable assessment process that ensures effective evaluation, thorough analysis and clear unambiguous communication regarding project intent, status, risk and accomplishment. It is a forward-looking roadmap that will help guide AFSC to achieve its vision in a unified manner. It applies to most personnel and organizations throughout the sustainment enterprise, when executed. This includes the areas of production, planning, programming, procurement, acquisition, sustainment, storage, distribution, maintenance, etc. for weapon systems, commodities, equipment, and infrastructure. It is not meant to replace creativity or detract from good ideas, it is meant to challenge everyone to channel energy and creativity in a collaborative manner to resolve problems, manage constraints, mitigate risks and identify best practices. While this Greybeard Assessment Guide Book details "what" needs to be accomplished in order to facilitate an effective evaluation, the specific "how" will be at the discretion of the responsible organization or tailored to the Champions objective and project specifics.

C.4. Administration

This Guide Book is a living document. This document will be reviewed annually with updates incorporated as a result of lessons learned and best practices identified. OO-ALC/EN will be responsible for configuration control, process oversight and the capture and review of systemic issues that fall across multiple assessments.

C.5. Purpose

The purpose of this Greybeard Assessment Guide Book is to:

- Ensure System Program intent adequately articulates service capabilities and processes at all operations levels -- tactical, operational, and strategic.
- Create an integrated process for a Greybeard project planning assessment. This effort incorporates planning documents (i.e. Depot Flow Plan, Integrated Master Schedule, and Business Case Analysis) and information (i.e. program/project briefings) from the Program Office, Product Support Integrator (when applicable), Maintenance Community and Supply Chain Management (i.e. 448 SCMW and DLA).
- Establish the assessment infrastructure to assess the maturity of the Greybeard project's information exchange throughout the sustainment enterprise. Ensure the Complex Commander has full situational awareness to the level-of-effort intended for project review.
- Codify practices by applying lessons learned to the AFSC enterprise. Structure our resources and policies to effectively and more efficiently maintain, account for, and deliver promised capabilities and services on time and on cost. Institutionalize the Greybeard Assessment process so that the goals, objectives, tasks, and subtasks of this plan become an integral part of the day-to-day activities for all responsible organizations.
- Increase accountability and effectiveness of program/project stakeholders. Ensure Complex business practices are commensurate with and directly support sustainment capabilities and commitments. Each task, initiative and objective has a designated office of primary responsibility, office of collateral responsibility and a proposed (estimated) completion date. The OPR and OCR will establish baseline, end-state, and action plans for their tasks.

C.6. Assessment Methodology

This AFSC Greybeard Assessment Guide Book is a conceptual framework that enables us to identify strengths, weaknesses, and a confidence level associated with high-visibility workload activations or workload transfers, by validating the project's planning and execution strategies.

In answering the question "How do we manage our processes", the Greybeard Guide Book addresses three major principles of process management: *leadership, risk management and process control*.

Leadership

Leadership drives risk management and process control. Through the provision of clear goals and direction, coupled with empowerment initiatives aimed at driving out inefficiencies, leadership addresses problems with organization, communication and motivation by emphasizing the core Air Force values of Integrity first, Service before self and Excellence in all we do.

Risk Management

Risk management drives process control. As potential constraints are identified and corrective actions are deployed, we look to optimize resources, gain efficiencies and realize potential. The ability to identify risk and its associated cause and effect is the difference between marginal assessment success and contributing to the "Art of the Possible."

Process Control

Process control systematically reduces variability by clearly defining and tracking the processes necessary to accomplish project/program objectives. In addition, corrective action plans are developed to mitigate constraints and to keep projects moving towards their defined goals. Key attributes to process control include:

- Standardization – Documented, repeatable processes across organizations
- Control – Documented plans and defined measures
- Coordination – Integration between organizations and processes
- Communication – Clear goals and directions with quantifiable outputs

The following is a pictorial illustration providing an overview of the major tenants of the Greybeard assessment methodology. Specific details and step-by-step procedures will be explained in further detail later in the document.

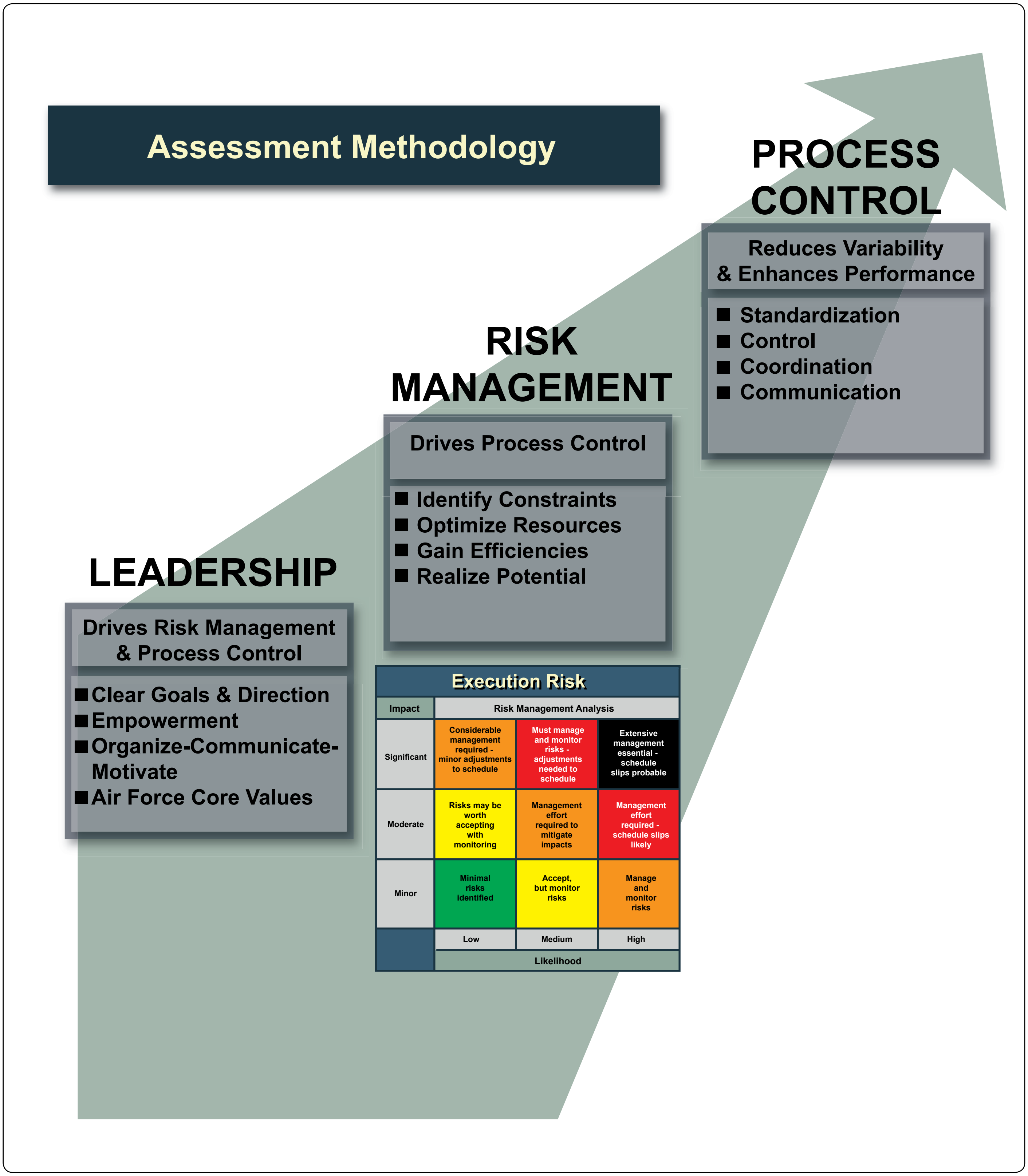


Figure C.1. Assessment Methodology

C.7. Assessment Development

The following are the high level steps of a Greybeard Assessment; however, specific examples and/or templates and tools are provided in the subsequent section (Ref VIII), given prior assessment's best practices.

STEP 1 - Organize

New weapon system activations, significant workload transfers, major air system modifications and ineffective production machines are but a few examples associated with depot operations that may prompt the need for increased awareness and a thorough Greybeard assessment. Expand the band-width from that of a single organization to that of an enterprise. Assemble the Core team, document the commander's intent, initiative objective, team roles and responsibilities in the Event Charter. Identifying an organization's current state entails capturing a full site picture utilized to support legacy operations. The following functional elements (at a minimum) facilitate Maintenance, Repair & Modification activities and should be selected based on applicability in order to establish the scope of the initiative:

- Security – Personnel, physical and IT security on station & in place to support air vehicle MRM
- Support Equipment – Common & peculiar equipment required to perform maintenance operations, depot repairs and modifications
- Facilities – Facility transformation plan incorporating utility & security requirements to support maintenance operations
- Training – Training plan, to include requirements developed and training courses completed to support MRM tasks
- Manpower – Phased staffing plan (direct & indirect) that coincides with WIP increases and expanded maintenance capability
- Supply Chain – The management and execution of supply support for air vehicle MRM responsibilities
- Integrated Master Schedule – The compilation of all functional element activation/expansion schedules into a single, manageable document
- Flight Ops – Ability to conduct air operations (receive, test & fly) for air vehicles while in depot status
- Back-shops – Operations necessary to support air vehicle maintenance throughput
- Engineering – The engineering authority required to address Problem Reporting & Resolution and MRM requirements to meet Time Compliant Technical Order objectives
- Agreements – Documented working relationships between OO-ALC and internal/ external entities for air vehicle MRM activities
- Technical Data – The development, management, delivery and access to all technical data required for MRM
- Maintenance Planning – The planning & scheduling support to receive, inspect, modify, test & launch aircraft
- Environment and Safety Occupational Health – Complex, Command, State & Federal (bio) environmental, safety and occupational health requirements necessary to support MRM activities
- Funding – The timely and effective synchronization of requirements, capabilities, money or allocations, & associated systems of record
- Airfield Mgmt. – The flight line protocols (runway, taxi & crash recovery) required to support air vehicle processing
- Packaging Handling Shipping and Transportation – The packaging, handling, storage and transportation capabilities necessary to execute support of MRM activities
- Contracting – Timely processing of contracts and associated documentation required for procurement of goods and services supporting expansion or activation of MRM capabilities
- Information Systems – System of Records (i.e. IMIS, ALIS, PDMSS, G004, etc.) supporting O-Level operations, maintenance tasks, Supply Chain Management & activities related to Time Compliance Technical Directives

- Comm/IT – Required telecommunications & computer software (licenses) and hardware in place to support direct & indirect MRM tasks
- Tooling – Hand tools and Special tooling in place to support production efforts
- Software Management – Weapons System or Automated Test Station unique software control, tracking and configuration management
- Configuration Management – Tracking and control of Process Orders, Work Control Documents, local manufactured tooling and other elements required to support production and eliminate variation

Key Component
Identify the Program Initiative and its associated requirement, build a team and document the critical information in the Event Charter.

STEP 2 - Execute
It's important to recognize sustainment from an enterprise perspective. In the past, assessment parameters simply involved "depot maintenance" within the fence-line of the Center. Today, the frame-of-reference moves well beyond the boundaries of the Complex to include key aspects of the Program Office, the Supply Chain Management, and the contractor(s) responsible for Product Support Integration. Event coordination is vital when addressing numerous functional elements and interviewing a myriad of personnel. Scheduling should include in-briefs (process owners), interviews (functional element POCs), tours and walk-throughs, and out-briefs (process owners and event Champion). With each element the Greybeard Team must assess the speed, quality, safety and cost-effectiveness recognized in its current state, as well as the level of detail and potential effectiveness associated with the element's plan.

Key Component
Schedule events and meetings concisely, ensure collaboration with all affected communities, and evaluate effectively.

STEP 3 - Assess
The purpose of the assessment is to identify the gap(s) between the current state and the end state given the system sustainment requirements and supporting organizations capabilities and the corresponding steps necessary to close the gap(s). Tools used to accomplish this step include the Greybeard Assessment Tool, Gant Chart, Integrated Master Schedules and Plan. Risk assessments provide fidelity based on the likelihood of occurrence, degree of impact, understanding the organizations ability to execute the plan and potential second and third order impacts on their capability.

Key Component
Identify the Gap: proper identification of each element's current state and a clear understanding of its future state requirement provide the basis for gap assessments. Identify the Risk: once we understand what is required in the end state, take the next step in determining degree of difficulty and level of effort to get to the agreed upon end state.

STEP 4 - Report
While identification of "operational gaps" associated with any maintenance or sustainment strategy may be an early target – developing a high level recommendation for closing the "gaps" in activating new or expanding existing capabilities or workloads provide organizations the road maps necessary for maturing from good to great. The assessment out-briefs must tell the story of engagement, evaluation, information and recommendations in relation to this high level assessment. It is not the responsibility of the Greybeard Team to provide the specific action plans, but provide high level recommendations. The detailed plans will be the responsibility of the owning organization of the identified gap and the associated OCRs, as needed.

Key Component
Tell the Story: Identify what was done in the assessment, what was found (gaps and risks), and what needs to be corrected or developed in order to mitigate the risks, close the gaps and realize the full

potential or a successful execution (Recommendations).

The high level steps of an assessment development overview as described above are pictorially represented in Figure C.2. below.

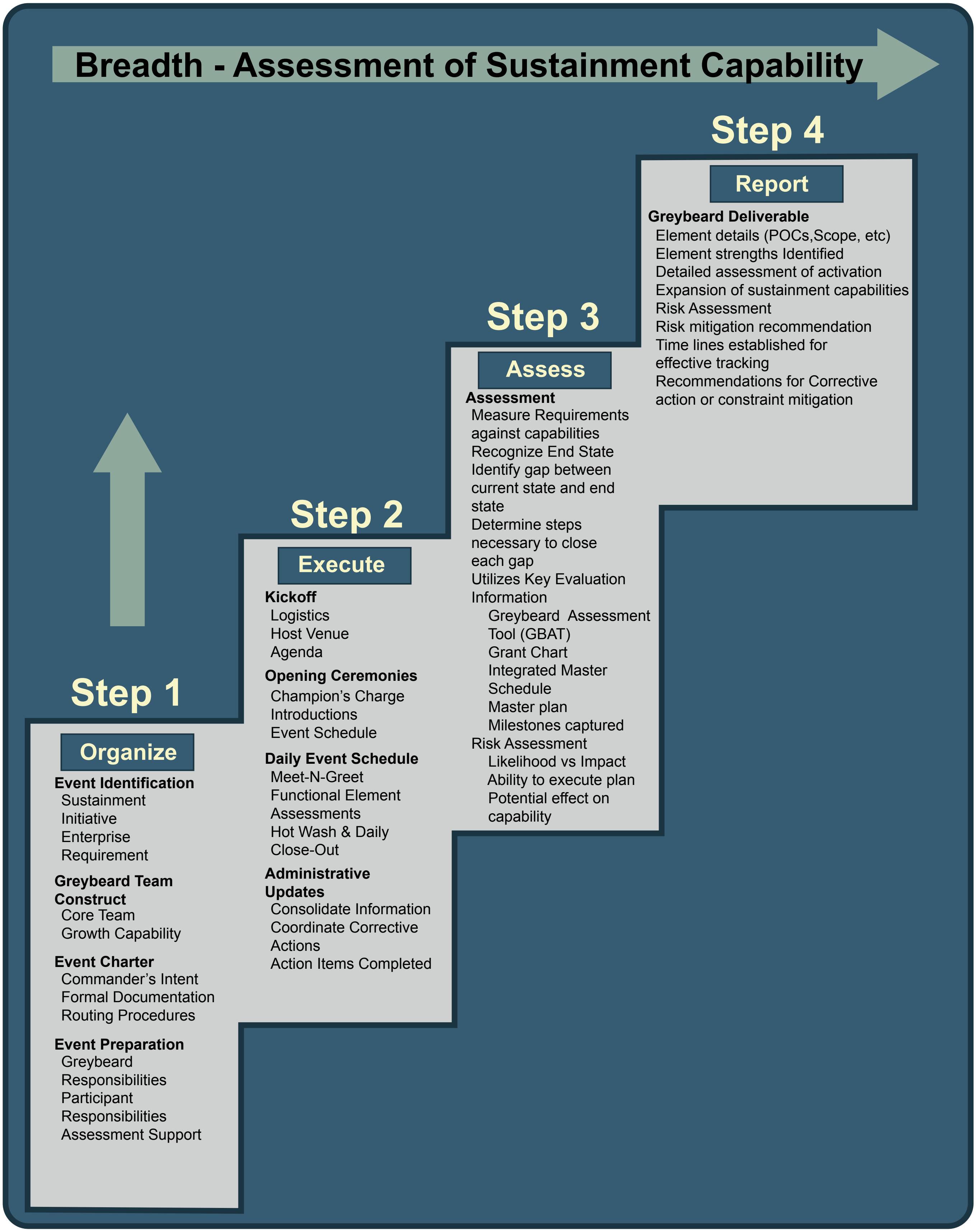


Figure C.2. Plan Development

Greybeard Best Practices: Examples, Templates, And Tools

The following are a compilation of event best practices and lessons learned, captured from prior Greybeard assessments.

Event Identification

As part of our operational construct, major sustainment initiatives take place that may require additional resources and a closer look to ensure mission effectiveness and project success. Recognizing the cost to perform based on personnel involvement and participation, Greybeard assessments will be directed at the discretion of AFSC/ALC leadership. This ensures "same page" mentality exists among responsible parties as well as facilitating a clear site picture.

Sustainment Initiative

New weapon system activations, significant workload transfers, major air system modifications and ineffective production machines are but a few examples associated with depot operations that may prompt the need for increased awareness and a thorough Greybeard assessment.

Enterprise Requirement

It's important to recognize sustainment from an enterprise perspective. In the past, assessment parameters simply involved "depot maintenance" within the fence line of the Complex. Today, the frame of reference moves well beyond the boundaries of the Complex to include aspects of the Air Force Life Cycle Management Center (AFLCMC) community, the Supply Chain Management community, and/or the contractor communities responsible for Product Support Integration.

Greybeard Team Construct

While the design of the Guide Book is to document a repeatable process for the purpose of removing reliance on personality, it's important to note the significance of assignment – both in early interations of the assessment team as well as in executing to a matured level. Participation in a Greybeard assessment requires a level of experience and proficiency in the individuals current station that suggests the ability to evaluate current state, identify risk associated and as required the wisdom to realize full potential of all aspects of a project plan; hence Subject Matter Experts.

Greybeard Core Team

Initial Greybeard assessment teams to date have been led by the Complex Technical Director (OO-ALC/EN). The discipline of the individual charged with leading a particular effort may lie in several organizations (EN, AS) but should be at the Director/Deputy level for management oversight. The positions associated with the core team should include:

Core Team			
	Greybeard Function		Assignment
1	OO-ALC/EN (Assessment Lead)		TBD
2	OO-ALC/AS (Program Management Lead)		TBD
3	OO-ALC/AS (Logistics Lead)		TBD
4	309 MXSG (Support)		When Applicable
5	Maintenance Planning		TBD
6	Process Engineering		TBD
7	Industrial Engineering		TBD
8	Other		As Required
Existing ADCON	Assessment OPCON	Location: OO-ALC+	Assignments to be Confirmed

Figure C.3. Core Team (click to zoom)

- Engineering
- Program Management
- Project Management
- Logistics
- Maintenance Planning
- Maintenance Support

Core team development should reflect the nature of the sustainment initiative wherein the positions filled and the experiential level of the assignments allows for effective management and execution. For core team representation, the ability to evaluate plans, assess risks, identify corrective actions, recommend mitigation strategies and communicate effectively should be considered highest priorities in pending assignments.

"Growing" the Capability
As with any management skill set associated with capability evaluation or execution, providing a pathway for the development of the workforce is vital to long-term sustainment. Greybeard skills sets are no different. While efficiency and effectiveness are realized by "seasoned" professionals within the sustainment enterprise, identifying promising young talent to mentor through invitation and participation in a Greybeard event leads to increased awareness, enhanced proficiency and continued growth.

Event Charter
As mentioned previously, Greybeard assessments are at the sole discretion of the AFMC/AFSC/ALC leadership. In keeping with current protocol, a signed charter is required in order for any assets to be utilized from across the sustainment enterprise.

Commander's Intent
Clear goals and direction are key ingredients to project success. While potential assessment initiatives are identified at lower levels, it's the responsibility of a specific organization's leadership team to not only approve an assessment but also provide all parties with "Commander's Intent" – thus ensuring the engagement necessary for effective execution.

Formal Documentation
Charter documentation has been standardized and is currently used for event planning supporting transformation initiatives and major projects at the Complex level. Key tenants to a proper event charter include:

- Identification of Champion, Process Owner, Greybeard Team Lead, dates & location
- Commander's Intent or Objective
- Project Evaluation Criteria – Problem Statement, Scope, Affected Users, Stakeholders, Goals & Actions
- Project Schedule – Charter, Event & Out-brief
- Impact to Desired Effects – Productivity, Availability, Agility, Safety /Reliability
- Project Approval – Champion, Process Owner & Greybeard Team Lead

Routing Procedures
A member of the Core Team is responsible for capturing and providing the information required for a formal Charter development (see Formal Documentation). Once the requisite information is listed, the document is forwarded to the Command Section for Commander's review and approval. A copy of the approved Charter will be present and available prior to assignment of Greybeard functional positions.

Event Preparation
OO-ALC will utilize proactive planning and aggressive leadership in preparing for an initiative assessment. The following are minimum requirements for an assessment event.

Greybeard Team Responsibilities
Of equal importance to Greybeard core team construct is the identification of representatives and subject matter experts necessary for successful assessment execution. Depending on the program initiative, the establishment of an enterprise frame-of-reference is vital to event management and necessary for determining the level of effort and degree of difficulty in the event objective. By identifying the functional elements associated with the sustainment initiative, event scope is established and functional position assignments are made.

Normally, functional position team members will be at the GS 13 level or above to ensure sufficient experience and expertise to adequately meet the assessment objectives. Members may be at a lower grade, but must be justified by specific written request with justification from the first O-6 or GS-15 in their chain-of-command provided to the assessment team lead.

A typical Maintenance, Repair, Overhaul & Unscheduled (MRO&U) reference construct is shown below in Figure C.4.:

MRO & U Matrix				
	Sustainment Element	**Element Assignment**		
		OO-ALC	**Program Office**	**Ancillary Functions**
1	Security			
2	Support Equipment (SE)			
3	Facilities			
4	Training (Production & Support)			
5	Manpower (Direct & Indirect)			
6	Supply Chain Management (SCM)			
7	Integrated Master Schedule			
8	Flight Ops (Mission Plan, FCF, Flt Safe)			
9	Maintenance Support (Back-shops)			
10	System Sustainment Engineering			
11	Agreements (PAs & IAs)			
12	Technical Data			
13	Mainenance Planning			
14	ESOH			
15	Funding			
16	Airfield Management			
17	PHS & T			
18	Contracting			
19	Information Systems			
20	Comm/IT			
21	Tooling			
22	Software Management			
23	Configuration Management			
Baseline	Expanded / Assignments			

Figure C.4. MRO&U (Maintenance, Repair, Overhaul & Unscheduled) Element Matrix
The Greybeard Team Lead will establish roles and responsibilities for each member of the assessment team.

Roles & Responsibilities – Core Team

A typical matrix is shown below in Figure C.5.

OO-ALC Greybeard Sustainment Assessment							
Assessment Position Engagement	Assessment Load	Program Mgmt Lead	Logistics Lead	MXSG Lead	MX Planning Lead	Engineering Lead	Ancillary Support
Assessment Objectives							
Internal							
Core Team-Project Preparation	x						
Assessment Project Development	x	x	x				
Ancillary Element Leads-Prep	x		x				x
Greybeard Team-Execution	x	x	x	x	x	x	x
Greybeard Baseline Assessment	x	x	x	x	x	x	x
MRO & U Gap Analysis	x	x	x	x	x	x	x
Mitigation Plan Development	x	x	x	x	x	x	x
Post-Assessment Follow-up	x	x	x				
External							
OO-ALC/CC Project Approval	x						
Assessment Project Kick-off	x	x	x	x	x	x	x
Air Vehicle "Greybeard" Assessment	x	x	x	x	x	x	x
Assessment Status Briefs	x	x	x				
OO-ALC/CC Assessment Out-brief	x	x	x	x	x	x	x
AFSC/CC Assessment Out-brief	x	x	x				
AFLCMC Assessment Out-brief	x	x	x				
Post-Assessment Actions	x	x	x				

Figure C.5. Roles & Responsibility Matrix (click to zoom)

Communication Plan

The Greybeard Team Lead will develop a corresponding communication plan, which include the events, periodicity, objective, stakeholders, and role for the event. A typical communication plan is shown below in Fig C.6.:

Communication or Event	Periodically	Objective	Stakeholder	Role
Greybeard Core Team	As required-Establishes fram of reference for particular assessment objective	Review & status all initiatives "in-work", vector checks for all assessment actions, plan updates, calendar reviews, briefing preps, and other duties necessary for event prep	OO-ALC/CC	Champion
			Greybeard Leadership	Lead
			309 AMXG/CC	Info Copy
			Greybeard Core Team	Participant
			SPO/SPM	Participant
			SCM	Participant
			75 ABW	Matrixed
			OO-ALC/CE	Matrixed
Assessment Preparations	As required-Establishes battle rhythm for Greybeard Assessment efforts	Full assessment of a particular sustainment enterprise including an evaluation of all tasks needed to accomplish the project purpose.	OO-ALC/CC	Invited
			Greybeard Leadership	Principle Presenter
			309 AMXG/CC	Required Participant
			Greybeard Core Team	Participant
			SPO/SPM	Required Participant
			SCM	Participate by Involved
			75 ABW	Invited
			OO-ALC/CE	Product SME
Greybeard Assessment	Once per product to be conducted as soon as practical following "Authority to Proceed"	Full assessment of a particular sustainment enterprise including an evaluation of all tasks needed to accomplish the project purpose.	OO-ALC/CC	Invited
			Greybeard Leadership	Principle Presenter
			309 AMXG/CC	Required Participant
			Greybeard Core Team	Participant
			SPO/SPM	Required Participant
			SCM	Participate by Involved
			75 ABW	Invited
			OO-ALC/CE	Product SME
OO-ALC/CC Out-brief	Periodic review of sustainment "critical" elements	A selective "Hot List" review based on current status as determined by the Greybeard leadership for presenting to the Complex Commander	OO-ALC/CC	Champion
			Greybeard Leadership	Lead
			309 AMXG/CC	Info Copy
			Greybeard Core Team	Info Copy
			SPO/SPM	SME
			SCM	SME
			75 ABW	SME
			OO-ALC/CE	SME
Legend			Champion	OO-ALC/CC
			Greybeard Lead	OO-ALC/EN
			Project Lead	Aerospace Sustainment
			SME	Greybeard Core Team
			Action Officer	All Levels Under Champion
			Participant	Engaged as Required
			Info Copy	Information Provided To
			Info Provider	Information Required From

Figure C.6. Communication Plan

In support of event preparation and team cohesion, Greybeard Team assignments will be made at a minimum of 5 weeks in advance of the assessment to facilitate Team orientation (initiative engaged and methodology utilized), plan development (scope of assessment, scheduling of principles and building of data base), receipt of assessment support material (master plans, master schedules, PMR briefs, etc.), pre-assessment tours and walk-throughs, and securing a host location (typically a large conference room with Audio/Visual and telecom capabilities).

While formatting options are left to the discretion of the Greybeard Team, a minimum level of support should be established to facilitate event organization and expected information to be captured. The following documentation provides basic event management capabilities to ensure assessment success:

Event Plan (excel document) – Provides the "who", "what", "when" and "where"

All participants (including organization and contact information)

- Greybeard Team
- Complex, SPO, SCM & Contractor

Daily event schedule

- Daily Assignments, Hot Wash & Wrap-up

Event Schedule

- Event overview (An event plan excerpt is shown in Figure C.7.)

OO-ALC F-22 Greybeard SAV 6-10 May 2013
Schedule Breakdown
Telecon Number: 555-555-4774 (all week)

Name	Organization	Date & Time	Location
GREYBEARD ASSESSMENT TEAM			
John S.	OO-ALC/EN (SAV Lead)	6-9 May 2013 0730-1600	All
Fred J.	OO-ALC/AS (Program Mgmt Lead)		
Adam S.	OO-ALC/AS (Project Lead)		
Trina G.	309 MXSG (Support Lead)		
Ohmar E.	571 AMXS/MXDXAB (Maintenance Planning)		
Brent T.	309 AMXG (Process Engineering)		
Patricia W.	309 AMXG (Industrial Engineering)		
Cynthia R.	OO-ALC/AS (Supply Chain Management)		
Brian C.	309 CMXG/ENC (LO Sustainment)	6-9 May 2013 0730-1600	All
PRODUCT MANAGEMENT/IMS			
Col "Rock" B.	573 AMXS/MXAD (Squadron CC)	7 May 2013 0800-1000	B674 Main CR
Tom H.	573 AMXS/MXAD (Production)		
Myan P.	573 AMXS/MXAD (Production)		
Ryan H.	309 AMXG/MXAD (Production)		
Rex P.	LM Aero (Site Lead)		
Trevor B.	LM Aero (Program Lead)		
Ben J.	LM Aero (Production Lead)		
Ray U.	LM Aero (Production/Training/Ias)		
Kim G.	LM Aero (Production /Ias)		
Chancey L.	AFLCMC/WWUV (Chief, Business Mgmt)		
Larry W.	AFLCMC/WWUV (Scheduling)		
Ned R.	AFLCMC/WWUV (Logistics Mgmt Spec)	7 May 2013 0800-1000	B674 Main CR

Figure C.7. Event Plan (excerpt) (click to zoom)

Greybeard Assessment Tool (excel document) – Identifies the "how"

Information on how to use the tool, overall performance (assessment) tab for project management, and identification of all aspects of the assessment (PM, functional elements) identifies the "how". The following elements are included in the GBAT:

- Logistic functions required to facilitate event
- Lists all functional elements associated with the event
- Questions/issues listed to ensure effective assessment is performed

A sample from a populated GBAT is shown below in Figure C.8.

Date: 6-10 May 2013			POCs						
Area	Task	Sub-Task	573 AMXS	OO-ALC	SPO	LM	% Complete	Risk	Answer/Comment
ADM	All Admin Task								
ADM	Greybeard Team Development								
ADM		Identify Site Survey Team		Allen W.			100%		Core team meetings established
ADM		Send/get all Visit Requests (if other than US citizens will attend in the SS- be aware of their Visit Requests)		Allen W.			100%		N/A-all external participants will call i
ADM	On Site Support:								
ADM		Identify the POC on base		Allen W.					Allen W.-POC for event logistics
ADM		Reserve a conference room (12-20 people) in B674 for the event		Dave S.					B674 Main CR 5/6-5/9 0700-1600
ADM		Reserve a conference room (12-20 people) in B100 for the event out-brief		Allen W.			100%		Ray Close CR 5/10/2013 1130-123
ADM		Ensure audio/video capability available in all conference rooms		Dave S.					
ADM		Arrange on base transportation (2x15-18 pass, 2x8-12 pass)		Allen W.					
ADM		Inform the LM Team of on base check-in procedures		Allen W.			100%		N/A-LM (external) participants will call i
ADM		What type of internet connections are available on base?		Allen W.					LAN hardline & WiFi (secured & unsecured)
ADM		Arrange an initial base tour		Allen W.					

Figure C.8. Greybeard Assessment Tool (excerpt)

Participant Responsibilities

Organizations participating in the assessment are responsible for providing "subject matter experts" for each applicable functional element associated with the event. In addition, identification of collateral responsibility are required if the element execution lies within the scope of different organizations (i.e. Complex, System Program Offices, or Contractors). Organizations are also responsible for providing detailed information as to the nature of and specifics to the initiative being assessed. Examples of supporting documentation include:

- PMR briefs – Details to the major objective
- Integrated Master Schedule – Complied schedules for all elements of the initiative
- Business Case Analysis – Detailed cost/benefit analysis
- Depot Flow Plan (if applicable) – Intended flow of repairable assets

Assessment Support

Assessing depot sustainability often includes secondary functions necessary for normal processing. As such, identified support offices may be called upon to provide situational awareness of their particular function in support of repairable asset processing. Examples of support functions to consider include:

- Complex Training Office
- 75 ABW
- Civil Engineering
- Maintenance Support Group
- Contracting
- Security
- Personnel (DP)
- Foreign Disclosure Office

- Complex Maintenance Groups (CMXG, EMXG, MMXG)
- Environmental, Safety & Occupational Health

Complex support may be required in conjunction with clearance issues and base access for contracted personnel, visit requests for individuals assigned outside of the Complex and transportation needs supporting large-scale assessments.

Event Execution

There is a direct correlation between the level of effort associated with event planning and the degree of success associated with event execution. The following provides a general guideline for conducting an enterprise assessment for a major sustainment initiative.

Kick-off

The first order of business on "opening day" is the logistics preparation of the host venue. Given the protocol for access & entry has been met, the conference room configuration becomes center stage. Seating charts (with applicable name tents) should be available and primary assignments made. Ensure all necessary audio/visual capabilities are functioning properly with the requisite briefings ready for display. A meet-me number may be useful given travel constraints by responsible parties. The event agenda should be provided to all participants prior to opening ceremonies.

Opening Ceremonies

If at all possible, the event Champion (Complex Commander or DCM) should be invited to provide opening comments. Introductions for principles (at a minimum) or for all participants in attendance (recommended) takes place following Champion remarks. The PMR-level review should follow providing detailed information regarding the projects intent and end-state. Greybeard event schedule will close opening ceremonies

Daily Event Schedule

The daily event schedule provides detailed information for each day's activities to include:

Meet-n-Greet
Scheduled Functional Element Assessment (included elements below):

- Pre-determined blocks
- The Greybeard Team may be stationary or can migrate depending on the element, level of participation and needs of the assessment
- SMEs are required to report with documentation necessary for assessment
- Deep-dive evaluations for all function elements

Hot Wash – A review of the day's activities and associated information
Daily Close-out (included elements below):

- Capture element data on out-brief template
- Begin generating corrective action/mitigation strategies
- Action Items (see example below in Figure C.9.)

Date	Constraint/Issue	Corrective Action	Suspense	OPR	OCR	Org	Phone #	Status	Comments
18-Apr-13	Need to establish expectation level for evaluation participants	Provide 573 AMXS Mgmt at a minimum & the assessment enterprise at a max an expectation notification	25-Apr-13	John S.	Pat B.	OO-ALC/XX	777-XXXX	Closed	
18-Apr-13	Event kick-off shows ILCM-EF brief, but have yet to inform SPO	Request PMR-type Consolidation Plan brief from the F-XX SPO for opening ceremonies	25-Apr-13	Jill W.	Mike R.	OO-ALC/XX	777-XXXX	Closed	Need ILCM-EF type brief presented to the full assessment group right after opening ceremonies
18-Apr-13	Opportunity to provide valuable SA to Col North's replacement	Extend invitation to GB out-brief to Col Johnson	25-Apr-13	Dave Y.	Trina G.	OO-ALC/XX	777-XXXX	Pending	

Figure C.9. Action Item (excerpt) (click to zoom)

Closing Ceremonies

Ample time should be allowed for the consolidation of information and the coordination of corrective actions from the assessment event. Final inputs to the out-brief slide deck should be made with each functional element accounted for, recommendations adequately detailed and action items completed. Once the deck is ready, a final walk-through should be performed to ensure information is complete and presentation responsibility is assigned.

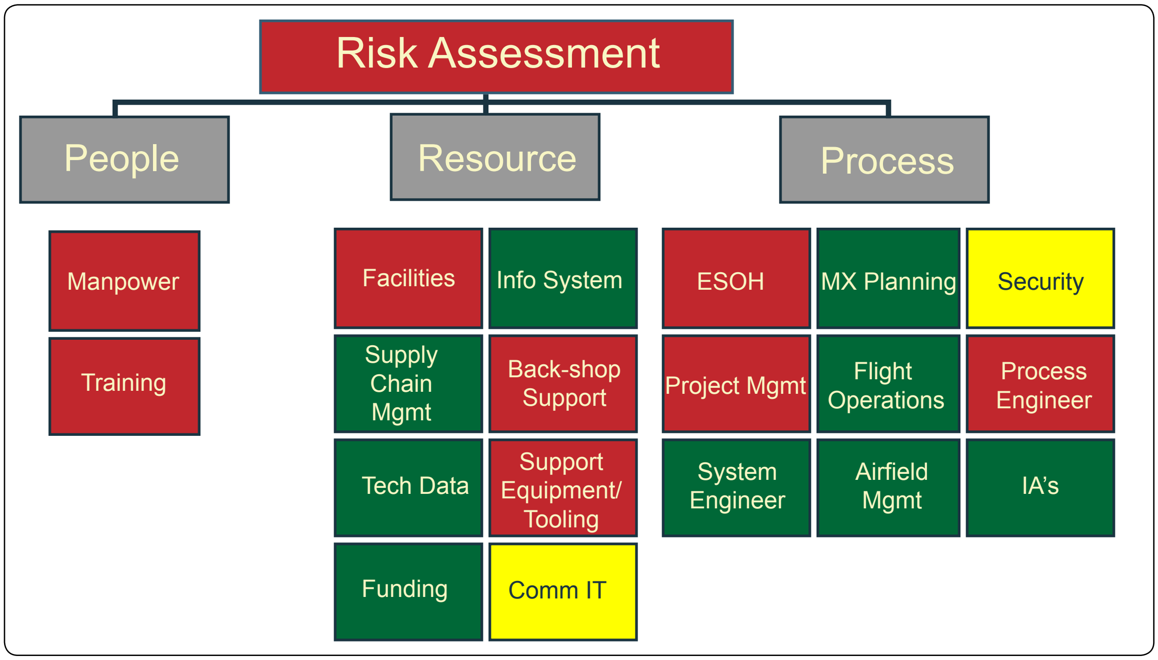


Figure C.10. Health Indicator Chart

Assessment

Each functional element identified by the Greybeard Team as part of the initiative assessment shall have a corresponding "block" listed on the Health Indicator Chart. Color coding for each element will be based on one of two scenarios: 1) the element's current status; or 2) the risk associated with element plan execution.

Risk assessment and status reporting are quantified using the following criteria:

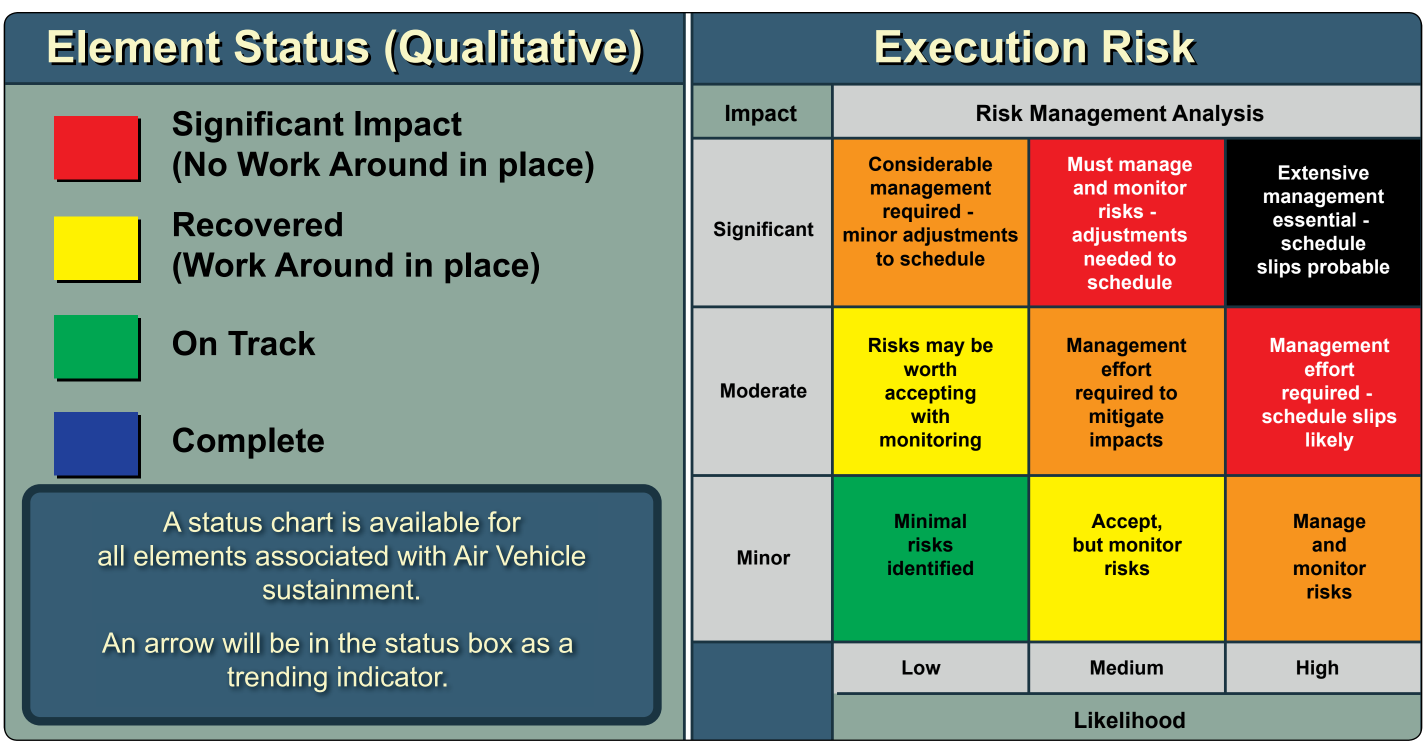


Figure C.11. Element Status and Risk Charts (click to zoom)

Report

A Greybeard assessment is only as effective as the ability to communicate. A formal event out-brief to the event Champion will be scheduled following the assessment out-brief to the O-6/GS-15 process owner and related organizations. Pending incorporation of inputs from the O-6/GS-15 assessment out-brief, the final slide deck will be configured and read a heads provided.

The out-brief's primary objective is to recognize the team members; identify the background, objective, assumptions, roles and responsibilities, and timing associated; relate the team's charter/scope/deliverable, and report the overall "health" of the initiative.

The secondary objective is to provide detailed analysis, which may result in findings, watch items, or observations, for each functional element. This is accomplished via the element quad charts. Quadrants are defined as follows: Element Lead - OPR, scope & ECD, Element Strengths - take the opportunity to relay good news and recognize efforts to date, Execution Risk - risks identified based on above noted criteria, and the associated major drivers, Risk Assessment - qualified as a Finding – an issue or constraint that requires management and/or mitigation, a Watch Item – a situation that warrants close scrutiny , or an Observation – noteworthy characteristic, and Recommendation - corrective action or constraint mitigation.

The following is an example of a quad chart capturing requisite information in Figure C.12.:

FACILITIES

Element Lead: John Smith	Status	Execution Risk
OCR: Mike M.		• Aircraft throughput • Contracts
Anticipated Resolution: Dec 2013		Impact / Probability (X)
As of Date: May 2013		
Scope: Facility transformation plan incorporating utility & security requirements to support maintenance operations		

Element Lead: John Smith	Risk Assessment

• Group Leadership
• Bldg 1407 layout maturity
    • Utilities, POU, LAN drops
• Leaning forward on contract execution
	• Back-shop capacity (F)
	• Union buy-in for personnel issues (F)
	• Contract interoperability (WI)
	    • Facility technical requirements
	• Confirm storage capabilities (WI)
	    • Canopies, tooling, SE

Recommendation
• Establish an integrated plan to include aircraft relocation *OPR: MXSG* • Faces & spaces *OPR: AMXG*

Figure C.12. Facilities Quad Chart

Event Close-out

The remaining actions on the part of the Greybeard Team are to support organizations identified as responsible parties in addressing recommended actions, and to follow-on communication opportunities supporting post-assessment activities. Greybeard Team efforts will be at the discretion of the event Champion.

Countermeasures

The identified deficiencies in sustainment capability, coupled with associated risks lead to recommendations necessary to close operational gaps. These "countermeasures" take into account root cause, methods of implementation and potential transformation tools for execution (JDI's, events & projects); and will be supported by the Greybeard Team as required.

Follow-up

Breakdowns in successfully addressing corrective actions occur relative to: 1) improper root cause; and 2) ineffective implementation of recommendation. Scheduled assessment followups of the sponsored initiative may be performed to ensure full compliance and incorporation of countermeasures. Frequency and content will be at the discretion of the Champion.

Communication

The Greybeard Team may be called upon to out-brief additional levels of management, communicate improvements and lessons learned across the enterprise.

C.8. Summary

The Greybeard Assessment methodology outlined above is designed as a viable instrument for the purpose of identifying, developing, sustaining, and transforming our operational and business processes in order to consistently exceed War-fighter expectations; today, tomorrow, and for years to come. A structured, standardized format for a sustainment assessment will promote: forward thinking, proactive and intuitive processing, and pride in accomplishment. We feel this Guide Book can become an integral part of the Complex's and AFSC's philosophy and culture. Deployment of this plan will be a shared responsibility that starts with a commitment from Senior Management and becomes a 'way-of-life' with every worker.

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D

APPENDIX D: ORGANIC MODIFICATION TEMPLATE

Air Force Sustainment Center: Art of the Possible

Appendix Topics

D.1. What is a Modification?

A modification (often referred to as a "mod") is any enhancement to aircraft weapon system's capability. Modifications are contemplated by operational users and SPO engineers to enhance the warfighting capability of a weapon system. Modifications become depot workload when the SPO determines it is economically advantageous to bring the mod installation workload to the depot. Stakeholders in depot modifications include the SPO (who acts as the modification integrator and engineering authority); Original Equipment Manufacturer (who develops and delivers mod equipment and/or software and installation data to the government); and AFSC Complexes (the maintainers who provide installation touch labor and develop work task sequencing and schedules to install the modification onto the aircraft). Mod workloads are often identified by the SPO via time compliance technical orders. TCTOs ensure modifications are installed with engineering configuration management and controls in force. The TCTO describes the installation instruction details as well as the necessary equipment and/or software required for successful mod installation. Modifications at depot level are typically complex in nature with multiple layers of assembly/disassembly, structural changes and electrical/avionic revisions required. Modifications of this nature are common to organic depot maintenance capability and are comparable to program depot maintenance and heavy analytical condition inspection workloads. Since organic depot modification workloads are repeatable from aircraft to aircraft, mods lend themselves to gated performance metrics tracking and management on accordance with AFSC playbook.

D.2. Organic Aircraft Modification Model

Based on successful integration of aircraft mod programs into depot operations at OC-ALC an aircraft depot modification model has been developed for all Complexes to us as a benchmark for future depot modification workloads within AFSC. The model has been developed over the past 5 years based on lessons-learned from the successful execution of the E-3 Block 40/45 modification (installed in conjunction with programmed depot maintenance), as well as the B-1 Integrated Battle Station modification (installed as a speed-line workload.) Aircraft modification workloads are a "core" piece to all AFSC Complex workloads and are as equally important as PDM, it is paramount that proven methods be employed on all current and future AFSC modification workloads. The OC-ALC mod methodology manages production performance using a gated-scheduling metric to insure full visibility by all management levels into work task completion by flow days. Based on its proven success, the model is being integrated into all new depot mod workloads such as the B-52 Combat Communications Network Technology modification that will begin kit proof installation in conjunction with PDM in July 2013. Other mod workloads that will employ the mod model include C-135 Block 45 (in 2014), E-3 Dragon (in 2015) and KC-46A work (in 2018).

Model success is dependent on early start-up a joint mod working group activities as early as 10-12 months prior to mod induction, as well as dedicated commitment from all stakeholders (SPO/SPM, AFSC Complexes & Mod OEM) and their respective senior managers.

The model is founded on basic four tenants that are common to all mod programs as follows:

D.3. Tenant 1-Joint Mod Working Group Consisting of Stakeholder's Working Level Subject Matter Experts

The JMWG is a critical component in the preparation for any new organic modification. JMWG creates an environment which ensures that all mod related roles and responsibilities are identified and controlled. In addition, the JMWG creates a sense of teamwork that prevents miscommunications and bad hand-offs between stakeholders. The JMWG consists of stakeholders to include SPO, AMXG and OEM representatives. Representatives are empowered by their leadership to accomplish mod related implementation and execution tasks in support of mod stand-up. The JMWG is led by the Mod Program Manager for the SPO to ensure all aspects of mod installation are evaluated and completed. Typically JMWG activities should be initiated as soon as decision authority is granted by a weapon system PEO to proceed with an organic modification installation. JMWG representatives will meet initially to identify mod specific roles and responsibilities by organization to ensure no gaps exist between organizations with respect to areas of primary responsibility. Roles and responsibilities should be documented in a codified matrix and agreed upon by senior leadership to ensure commitment by all stakeholders.

Roles and Responsibilities	AMXG	SPO	Contractor
Program Lead		x	
Integrated Master Schedule (IMS)		x	
Non-Conformance Issue Resolution		x	
Three Party Working Agreement	x	x	x
Modification Performance Responsibility	x		
Mod Design Authority			x
Integrated Change Management		x	
Configuration Management-Mod			x
Configuration Management-Non-Mod		x	
Training for Special Purposes			x
Drawings			x
PDM/Mod Planning	x		
Parts Delivery			x
DD250 Process for Parts		x	
Engineering Change Process-Mod		x	
Document Updates as Required			x
HAZMAT	x		x
PDM/Mod Touch Labor	x		
Emergent Parts	x		
Product Consumables (non-HAZMAT)	x		
Tool Room Equipment	x		
Special Tooling & Special Test Equipment			x
Engineering Support for Mod		x	x

X-Primary Authority/Responsible Org

Figure D.1. Roles and Responsibility Matrix

After clear lines of responsibility have been established the JMWG will meet regularly to assign actions that flow from OPR responsibilities. Typically JMWG actions are categorized into a health indicator chart that provides a snapshot of the health of the modification effort and is briefed at management reviews.

In addition, the JMWG should develop an Integrated Master Schedule that identifies major task sequencing, and critical path definition. In addition, the IMS will ensure that modification kit deliveries match maintenance installation capabilities while meeting statutory guidelines.

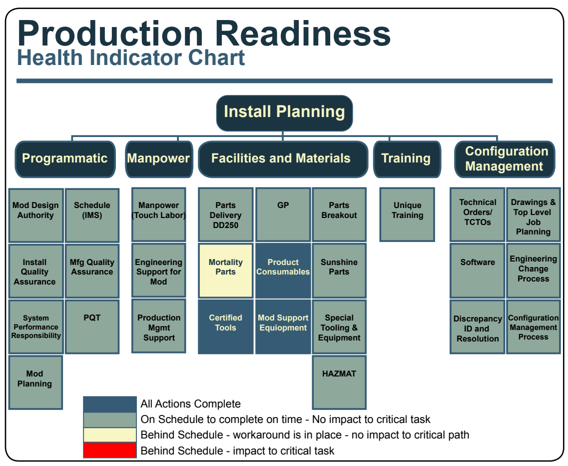

Figure D.2 Health Indicator Chart (click to zoom)

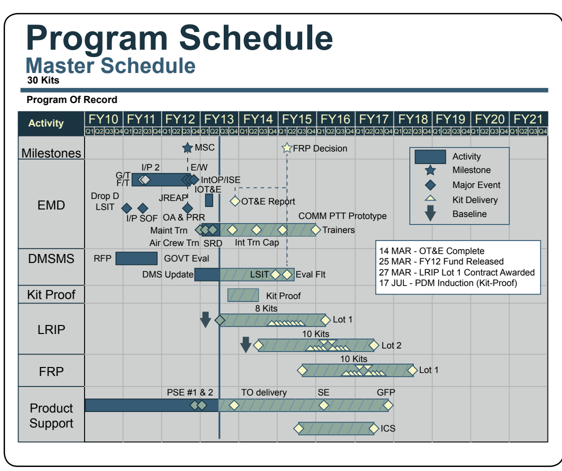

Figure D.3 Top-Lvel IMS (click to zoom)

The JMWG lead will establish a battle rhythm for JMWG working level meetings, as well as monthly reviews at the 0-6/Group Level and quarterly reviews at the GO/Complex level. The JMWG construct which includes on-going management oversight ensures that teammates are accountable for their areas of responsibility.

D.4. Tenant 2-Squadron Mod Prep Activities-Lead by AMXG Mod Manager

In parallel with JMWG activities, the AMXG Mod Manager is responsible for start-up of the new modification and must initiate pre-planning activities at the earliest possible date (but no later than 10-12 months prior to induction for mods anticipated to be >5,000 man-hours of work). Maintenance related pre-planning activities include facility preparation/modification to support new workload requirements. This includes hanger space preparation, adequate power/utility sources availability and controlled storage space mod components (and FOM) are in place to support the mod effort. Mod manager will oversee the work task development based on mod-specific installation data (SOW, drawings, etc). Work tasks definition (commonly referred to as work control document preparation) will be accomplished by maintenance planning. WCDs will be reviewed by OEM engineering to ensure that modification installation meets the design intent of the developer. Maintenance planning will develop a mod installation network plan (GO97) that combines mod workloads with other work requirements (i.e., PDM, other TCTOs, etc.) into a workload plan that can be tracked using a gated flow day scheduling process. The mod manager will work with maintenance planning and production to identify and procure all mod-specific hand tools, shop aids and ground support equipment and include burn down plan for in the JMWG IMS. Facility preparation will include a dedicated kit break-out area to facilitate kitting of mod components by WCD. Squadron leadership will develop a manpower plan to support the mod workload requirement and ensure manpower is in place 90 days prior to the start of the modification. New mechanics will be available at this time for any mod specific training requirements and/or OJT.

D.5. Tenant 3-Triage Team-SPO Lead To Resolve Non-Conformities & Programmatic Issues

A team responsible for ensuring that routine issues are resolved immediately and more complex issues are quickly referred to the proper expert(s) and resolved as quickly as possible. The team is comprised of representatives from OEM and government personnel. An on-site SPO/SPM designated Program Manager acts as leader to the Triage Team and has the authority to make on-site decisions to expedite mod non-conformity resolution. Maintenance planning organizes and leads daily activities that affect the shop floor. The triage team leader chairs daily team meetings to identify and track non-conformity issues as well as interfaces with the Joint Resolution Board and other external entities. The JRB is an 0-6 level leadership team consisting of members from the SPM/SPO, 76 AMXG, User Command and OEM, and are called upon (as needed) to provide general oversight to the ongoing modification and address issues that cannot be resolved by the Triage Team. The Triage Team lead will coordinate the scheduling of a board meeting. The JRB will be chaired by the SPM and will decide on issues where the Triage Team cannot agree upon a course or action, address issues that have significant production schedule/cost trades or effects, assess whether other Government process follow-up actions may be needed, and address any recommended action requiring Working Agreement revision. The Triage Team will maintain a database of mod-related non-conformities (e.g., Kitproof Data Worksheets, Worksheet Write-ups, etc.) to insure mod generated engineering changes and aircraft configuration control is maintained.

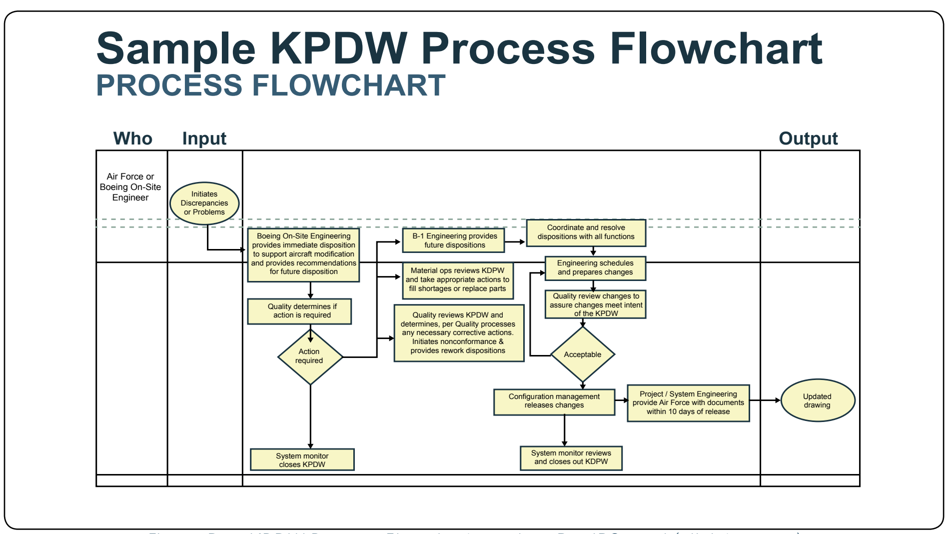

Figure D.4. KPDW Process Flowchart used on B-1 IBS mod (click to zoom)

The database is populated via modification identification/resolution document used to identify and disposition engineering discrepancies, problems, schedules, and track engineering actions required to correct and/or resolve those items identified during assembly, installation and checkout activities for kitproof, performed by Air Force personnel. Documents are initiated by AMXG Planners and/or OEM teammates to document problems identified with engineering drawings/data or kits during kitproof installations. The worksheets require two dispositions, the first disposition for the kitproof aircraft allows work to continue on the kitproof aircraft, and the second identifies disposition action for future aircraft (kits/drawings). The database is available to all mod team members on a OEM managed website and can be viewed by any authorized user of the OEM network (include 76 AMXG and SPM/SPO personnel).

In addition, all Air Logistics Complexes will use the same process (per AFMCMAN 21-1) to document legacy aircraft non-conformance issues. For the IBS modification, an AFMC Form 202 will be used to capture and disposition aircraft issues that are unrelated to the modification. The AFMC Form 202 will be completed and processed IAW the Engineering Technical Assistance Request within the process flow of the SPM/SPO Technical Service Center.

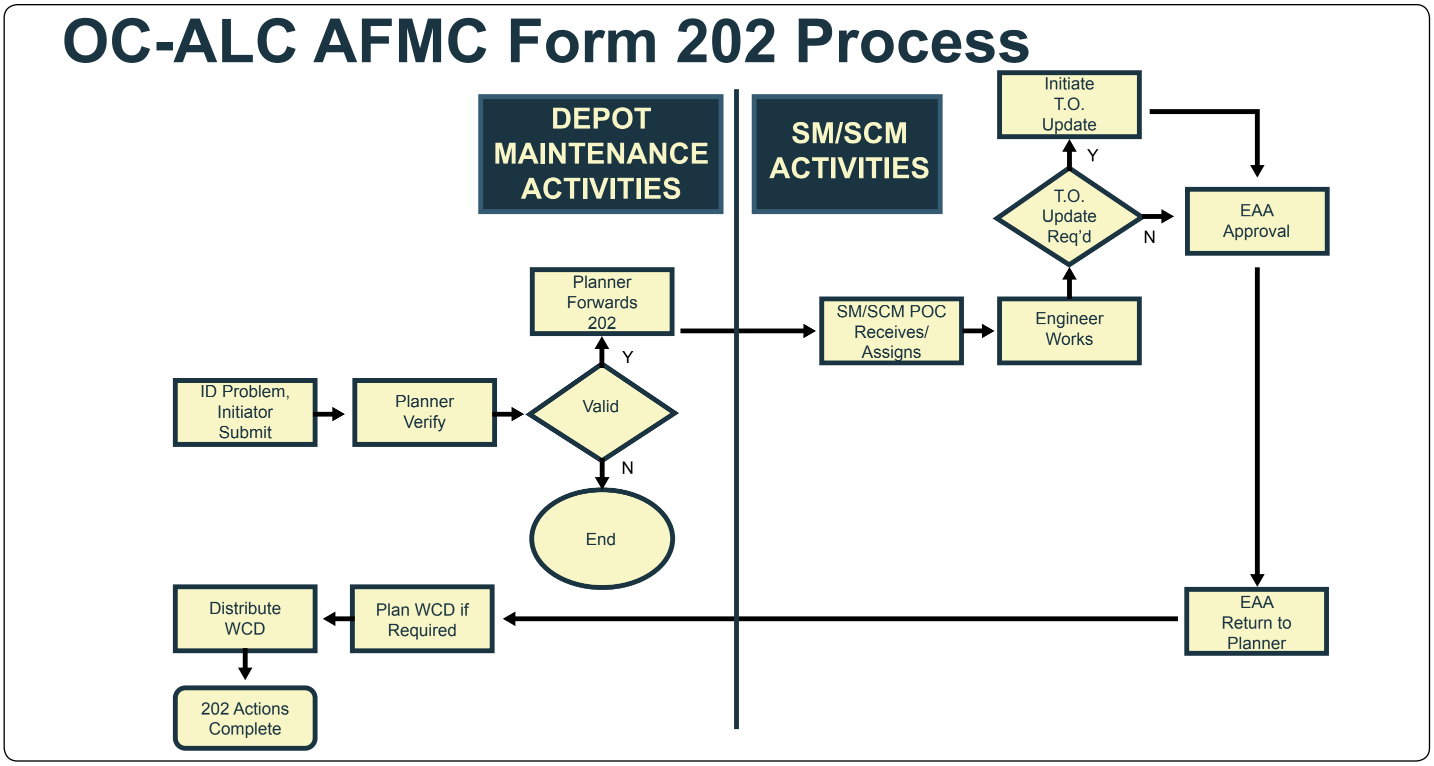

Figure D.5. AFMC Form 202 Process

The Triage Team is the starting place for resolving all IBS installation issues. The Triage Team will be co-located at the aircraft with the AMXG mod installation team and will be highly responsive to on-aircraft modification problems. The Triage Team is responsible for initial screening to ensure routine issues are resolved immediately and more complex issues are quickly referred to the proper expert(s)/organizations. Issues the Triage Team may address can include but are not limited to:

- Installation drawing non-conformities identified by the shop floor
- Broken or lost parts identified by the shop floor
- Installation checkout test failures
- Mod drawing revisions

Other responsibilities of the Triage Team include monitoring "open" Form 202s and mod non-conformity documents related to an aircraft undergoing the modification to ensure they are resolved. The AMXG Planner will be responsible for initiation and monitoring of Form 202s and mod non-conformity documents that directly affect current shop floor operations. The Triage Team Program Management Lead will be responsible for management oversight to ensure timely disposition of all mod non-conformity actions including both legacy and mod specific issues.

The core members of the Triage Team on a day-to-day basis include:

- Triage Team Leader: SPO/SPM member who is the on-site Program Management decision maker for all modification specific issues. In addition, he/she is responsible for all decisions and resolution of issues raised by the AMXG Planner and Production to include all issues that affect the kit parts and mod drawings as well as non-conformities on the shop floor.

- AMXG Planner: Communicates with Production to identify shop floor issues to the Triage Team for disposition. Initiates and ensures compliance with disposition of Form 202s and KPDWs affect the kit parts and mod drawings as well as non-conformities on the shop floor.
- SPO/SPM Engineer: Maintain awareness of potential change activities
- Provide Engineering Dispositions to AFMC Form 202s. Provides expertise legacy and mod-related maintenance processes
- SPM Equipment Specialist: Monitor TCTO Validation/Verification. Provides technical expertise assistance as required.
- SPM Production Management Specialist: Assist with Legacy Over and Above evaluations and develop and monitor aircraft mod execution schedules.
- OEM Engineer: Representative to coordinate mod-specific task assignments and provide OEM provided equipment dispositions to the team.
- OEM Materiel Specialist: Provide insight on parts to aid in decision making as required

Each organization may supplement the core Triage Team with other members as needed to fulfill the issue assessment, validation, and root-cause determination functions of the Triage Team.

During the modification installation, the Triage Team will be co-located with the production operation at the aircraft. Most of the day-to-day operation is expected to be ad-hoc (continuous). Since the Triage Team is co-located next to the aircraft in modification facility, the team is available as needed to support initial assessment of issues that come in from the shop floor. All issues from the shop floor will be brought to the Triage Team for initial disposition.

When a new issue is identified the Triage Team will perform an initial assessment to determine if additional information or clarification is needed from the submitter.

Since it is critical to maintain production installation velocity it is imperative to for Triage Team members to maintain a sense of urgency to insure quick, decisive and accurate non-conformity resolution. The critical steps to timely non-conformity resolution include:

- Validate to issue and agree there is an issue or that it is a candidate production enhancement that will be effective if implemented.
- Determine the Root Cause - Is the issue legacy aircraft or mod-related and is the problem design or production/installation issue?
- Make a Disposition Decision - Take direct responsibility and disposition issues.
- It is advisable that all Triage Team members agree on a course of action however the Triage Team leader has final decision authority.

The team will meet on a formal basis to ensure coordination among members. It is advisable for the Triage Team to meet together daily to review open issues. In addition, team members shall participate in daily Production meetings with AMXG personnel to review mod installation execution status, as well as identify any new open issues on the shop floor. In addition the team shall meeting with the JCB as required to resolve mod-related non-conformity issues that are strategic in nature and could have impacts to major modification design changes and/or long-term installation schedule delays.

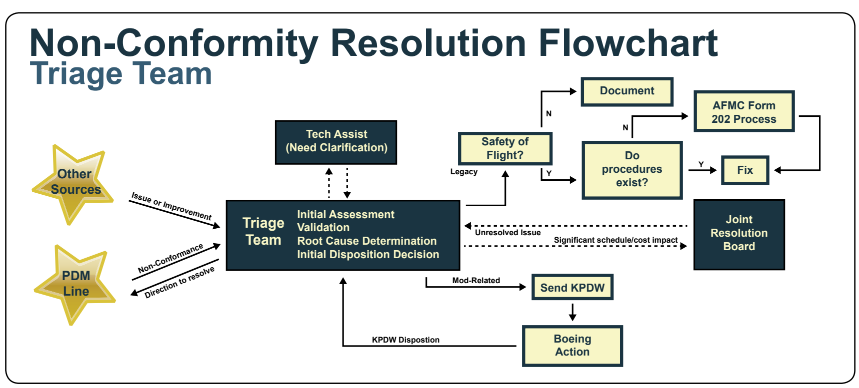

Figure D.6. Triage Team Non-Conformity Resolution Flow Chart (click to zoom)

D.6. Tenant 4-Modification Installation & Execution

Upon successful completion of JMWG, Squadron and triage team pre-planning activities, aircraft induction for modification is ready to start. It is beneficial for SPO, User Command and AMXG to agree upon criteria for incoming aircraft configuration and systems operating status. In many cases, a baseline must be established to ensure the aircraft is capable of accepting the modification. For example if a modification affects communication upgrades existing capability the communication systems must be operational when delivered to the depot for modification. In addition, depot personnel should accomplish an "A-Z" inspection of the aircraft to identify any incoming defects that are discovered upon depot induction. Once aircraft enters the modification hangar it is beneficial for triage team and maintenance supervision to be proactive by looking ahead in the installation plan (typically at one-week intervals) to identify potential problems that were not considered in pre-planning. This activity referred to as the "next big thing" review can protect schedule by identifying non-conformities ahead of installation need dates. The mod manager should identify an "off-ramp" strategy with regular assessment dates in the plan to identify unanticipated delays to the installation schedule. Off-ramps should be invoked to prevent subsequent aircraft inductions preventing bottle-neck conditions at the depot. Squadron leadership will develop a plan for local of manufacture of mortality (mod) and/or sunshine (legacy) parts that could be damaged during the installation to expedite resolution of mod work stoppages. In addition, the maintenance kitting team will work with the SPO to identify components that have a high potential for damage as a result of maintenance access. Maintenance leadership should aggressively integrate all lessons-learned and process improvements into the plan for subsequent aircraft. Mod execution performance will be tracked using "gated" flow day scheduling process to insure visibility at all management levels.

Integration of the four mod model tenants will insure that all current and future AFSC modification workloads are well planned, well executed and employ adequate management controls.

Standardized Organic Modification Checklist

OC-ALC ASD and 76 AMXG have prepared a checklist to assist JMWG participants (including both SPO program managers and maintenance production managers) in preparation and development of a fully integrated organic mod installation program. The checklist incorporates many of the lessons-learned during both the E-3 Block 45/45 and B-1 IBS modifications.

D.7. Organic Mod Checklist

1. Initial Planning Activities

1.1. "Identify participants"

1.1.1. Who is the integrator, who is performing the installation, who is supplying the parts, who has engineering/design authority?

1.1.2. Identify members of the Joint Mod Working Group

1.2. Identify if modification will be integrated with Programmed Depot Maintenance or Standalone

1.2.1. Identify/develop Gated processes

1.3. Identify Modification Location

1.3.1. Identify physical location (i.e. contractor facility or on installation)

1.3.2. Identify Facility Security Requirements

1.4. Discuss maximum/minimum number of aircraft captured at one time

1.5. Establish a Joint Mod Working Group 18 months prior to induction of first aircraft

1.5.1. The Joint Mod Working Group is a team of individuals' from each stakeholder organization that is held accountable for the planning and development of the modification and has the ability/authority to make decisions for his/her organization. Involvement includes researching, providing responses to action items, attending working meetings to identify processes/resolutions and break constraints. (See Multi-party Working Agreement/Responsibility Matrix for members and responsibilities)

1.5.2. Agree to a battle rhythm for meeting times and frequency (telecoms and conferences)

1.5.3. If a contractor is involved, a contractual vehicle will be required to support this effort

1.5.4. Identify host/leader/facilitator for this group (typically the acquisition program office)

1.5.5. Obtain leadership (0-6 level or equivalent) commitment to support the team as necessary

1.5.6. How will leadership stay involved in the progress of this team? (ex. Monthly Out-briefs and weekly report via email)

1.6. Obtain senior leadership (General Officer level or equivalent) commitment

1.6.1. How will leadership stay involved in the progress of this team (ex. Quarterly General Officer Steering Groups)

1.6.2. Develop a "chiclet chart" with back up slides for each category/topic of planning to report status (Health Indicator Example)

1.6.3. Host a Mod Readiness Review 60 Days prior to induction of first aircraft

1.7. Identify Funding profile and ability to purchase kits

1.7.1. Ensure kit delivery and install schedule alignment

2. Documentation

2.1. Build a Responsibility Matrix to codify each organizations primary and secondary duties (Responsibility Matrix Example)

2.2. Document Agreements in the form of a Memorandum of Agreement, ulti-party Working Agreement (WA), and/or contract (Examples)

2.2.1. If the ALC is completing the installation, how will that be documented? Is it an agreement with the acquisition program office? MOA?

2.2.2. Identify level of signatories

2.2.3. WA: Draft, review at JMWG level, and staff through leadership

2.2.4. Warning: Working Agreement can take up to 1 year

2.2.5. If appropriate, update the documents as required

2.3. Document incoming aircraft acceptance criteria.

2.3.1. May be included in the MOA stated above.

2.4. Build an Integrated Master Schedule for the planning stages of the modification

2.4.1. Identify all tasks requiring completion prior to induction of the first aircraft, including interdependencies

2.4.2. Hold a weekly telecom to review status and late tasks

2.4.3. Socialized throughout to get aircraft in at specified time

2.5. Identify risks and contingency plans

2.6. Develop modification performance metrics for leadership

2.6.1. Examples : Number of discrepancies found on each aircraft, how quickly are discrepancies closed and implemented, funding used, part tracking, planned vs. actual execution of the mod

3. Manpower & Funding

3.1. Manpower

3.1.1. Establish an on site team (government personnel/contractor) to address hurdles real time (Triage Team Example)

3.1.1.1. Identify the triage team chair to lead the group and make final decisions

3.1.1.2. Identify all other members required to participate

3.1.1.3. Establish a weekly schedule to meet but this team should also be flexible to fast attack/come together when an issue arises

3.1.2. Identify Government and/or Contractor Manpower requirements

3.1.2.1. What engineering skillsets will be required during the various phases of the mod?

3.1.2.2. What types of technician skills must be present

3.1.2.3. Training

3.1.2.3.1. Is the mod driving any specialized training that the group performing installation does not currently possess

3.1.2.3.2. Can any training equivalencies be met, rather than funding new training?

3.1.2.3.3. If new training specifications exist and no equivalency can be determined, who will fund the certifications?

3.1.3. Identify Contractor CAC requirements & access requirements

3.2. Funding: Establish funding sources and define personnel with authority to use

3.2.1. Who is funding the installation? When will the funding be required for each aircraft (30 days prior to induction)

3.2.2. Delegate Contracting Officer Representative authority to personnel on site

3.2.2.1. Who will have the authority to expend money on funding sources within the scope of the contract

3.2.2.2. Obtain training and contracting officer delegation to perform responsibilities

3.2.3. If the engineering authority is the contractor, what contract action covers personnel to disposition non- conformances?

3.2.4. Is funding available to replace broken/damaged parts

3.2.5. Establish an Over and Above source to cover work outside the scope of what has already been planned. Which organization will fund this?

4. Infrastructure

4.1. Identify any workspace/infrastructure that will be required

4.2. Functional locations

4.2.1. Where will engineering support be located? (i.e. Shipside) What equipment is necessary?

4.2.2. Establish an office for the Integrator: where will they be located (close proximity to the mod)

4.2.3. Where will government engineering be located?

4.3. Is warehouse space needed?

4.4. Is there a Base Support Plan on contract? Research the requirements?

4.5. What types of infrastructure will need to be installed if not in place already? Phone lines, internet connections, LAN drops, electricity?

4.5.1. Is there a need for CONEX storage for explosives?

4.5.2. Electrical needs for Aircraft and tools?

5. Defined Processes

5.1. Identify Learning Curve and when a steady state will be reached (example 88% learning curve)

5.1.1. Plan for Best Case: Be ready to accelerate "Near Critical Path" tasks

5.1.2. Plan for Worst Case: Configuration differences, wire length variations, failure of fragile COTS connectors etc…

5.2. OEM review of Work Control Documents to ensure intended design.

5.2.1. Review ALC Developed WCD to ensure "As-Designed => As-Planned => As-Installed" (As Designed Base Line document verification)

5.3. Define a process for providing engineering direction when non-conformances are identified on the aircraft

5.3.1. Develop process flow to include:

5.3.1.1. How will a discrepancy be initiated and who can initiate it

5.3.1.2. Ensure the triage team chair is included in the process; approves final disposition from engineering authority

5.3.1.3. If the contractor possesses engineering authority, make sure government engineering is involved in reviewing prior to final approval

5.3.1.4. Where will non-conformances be documented? Will this be an automated process? Is there an existing database where the s/w could be developed to automate the new process?

5.3.1.5. When a non-conformance impacts the parts or design for the fleet, discuss how that change will be rolled and when. Will it be incorporated prior to the next a/c induction?

5.4. Identify rotable requirements

5.4.1. Are there any contractual need dates? What are the deadlines for turn in?

5.4.2. What is the process for handling: who will remove the asset, package, and ship it? Define this process flow

5.4.3. What is the classification of the asset being modified when it is sent and returns? Are there any special handling procedures required?

5.5. Is software being loaded for this modification?

5.5.1. If so, define the release process for obtaining the correct version to be put on the aircraft. Are passwords required and if so, who will maintain the fleet list?

5.6. Process Equivalency

5.6.1. Depending on which organization possesses design authority, the technician could be required to perform some efforts according to process specifications. If that should be the case, research and work with the contractor to identify equivalencies between the organizations.

5.7. Transition of the aircraft between using command to the ALC or contractor and vice versa

5.7.1. Will there be an acceptance procedure needed to handover and accept the a/c back?

5.8. Perform simulations 6-8 months prior to induction of the first aircraft to test the processes and measures developed by the triage team

5.8.1. Identify the triage team members that will be participating in the exercise (beneficial to choose individuals that will perform this job during production, especially Triage Team Chair)

6. Parts and Materials

6.1. Mod Parts

6.1.1. Where will parts be kitted?

6.1.2. Where will parts be DD250'd?

6.1.3. Is warehouse space needed to store future mod shipsets?

6.1.4. Identify Facility Security Requirements

6.1.5. Identify process for parts transfer from contractor to government (DD250, 1149)

6.2. HAZMAT

6.2.1. Are there any HAZMAT materials specific to the mod?

6.2.2. Are any of the materials not currently on the waste stream list for the base?

6.2.3. Who is supplying the HAZMAT?

6.2.4. Who will manage the HAZMAT

6.3. Manufacturing Overage/Rotobin

6.3.1. Will there be a surplus of spare parts for use on the mod (1 size up, 1 size down variance). Typical items would be nuts, bolts, screws, etc

6.3.2. Who will acquire and manage those parts?

6.4. Are COTS being utilized for this modification? What will be the impacts when they are upgraded (Tech Refresh)? (i.e. testing)

6.5. Security of Classified Data/Parts

6.5.1. Where will classified data/parts be stored?

6.6. Special Test Equipment, Support Equipment, Special Tooling

6.6.1. Will equipment need to be calibrated?

6.6.2. Has this equipment been used before, training?

7. Drawings/Design & Configuration

7.1. Conduct a tabletop review for quality of drawings 6 months prior to start of modification

7.1.1. Ensure access to technical data resulting from the modification (Data Rights Planning)

7.2. Develop the plan/work package to perform the modification including sequencing of the work

7.2.1. Ensure design authority reviews and approves ALC work package (Work Control Document level)

7.2.2. Identify Drawing storage location (preferable as close to the modification aircraft as possible)

7.3. Discuss the benefit and implement an aircraft configuration audit

7.3.1. One year prior to induction: paper review

7.3.2. 30 days prior to induction: physical inspection

8. Special Circumstances

8.1. Evaluate any flight and testing requirements for the mod

8.1.1. Will a functional or operational check flight be required at the completion of each a/c?

8.1.1.1. Who will fly and certify the a/c?

8.1.1.2. Who is the responsible test organization?

8.1.2. Will any special testing be required for qualification or as part of installation and checkout

8.1.3. Flight release & airworthiness certification responsibilities
8.1.3.1. Get OSS&E focal points involved as early as possible

* Must have justification for N/A response

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E

APPENDIX E: TRAILING MATTER

Air Force Sustainment Center: Art of the Possible

Appendix Topics

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E.2. Abbreviations

AOR - Accumulated Operating Result
AFLCMC - Air Force Life Cycle Management Center
AFSO 21 - Air Force Smart Operations for the 21st Century
AFSC - Air Force Sustainment Center
ADP - Area Development Planning
AoA - Art of Analysis
AWP - Awaiting parts

CONECT - Combat Communications Network Technology
CPI - Continuous Process Improvement
PK - Contracting Organization
CAC - Common access card
CPC - Corrosion Preventive Compound

DOD - Department of Defense
DCM - Deputy Commanders for Maintenance
DOE - Design of Experiments
DBR - Drum Buffer Rope

ETAR - Engineering Technical Assistance Request
EVSA - Enterprise Value Stream Analysis

G&A - General and Administration
GBAT - Greybeard Assessment Tool

HHQ - Higher Headquarter

IBS - Integrated Battle Station
IMS - Integrated Master Schedule

JMWG - Joint Mod Working Group
JRB - Joint Resolution Board

KPDW - Kitproof Data Worksheets

MRO - Maintenance Repair and Overhaul
MRO&U - Maintenance, Repair, Overhaul & Unscheduled
MDS - Mission Design Series
MCDM - Multi-Criteria Decision-Making

OSS&E - Operational Safety, Suitability and Effectiveness
OEM - Original Equipment Manufacturer
OWO - On Work
OCR - Office of Collateral Responsibility
OPR - Office of Primary Responsibility
OEM - Original Equipment Manufacturer

PDM - Programmed Depot Maintenance
POH - Production Overhead
PSB/T - Production Support Branches or teams
PRR - Problem Reporting & Resolution

RIE - AFSO 21 Rapid Improvement Events
RAIL - Recurring Action Item List
RMD - Resource Management Decisions
RCA - Root Cause Analysis

SoS - System of Systems
SA&D - Strategic Alignment and Deployment

TO - Technical Order
TSC - Technical Service Center
TCTO - Time Compliant Technical Order

VSA - Value Stream Analysis
VSM - Value Stream Mapping

WCD - Work Control Documents
WCF - Working Capital Fund
WIP - Work in Process
WIQ - Work in Queue
WSW - Worksheet Write-ups

E.3. Glossary

This glossary is intended as an explanation of terms that may be new or uncommon.

5-Step Modeling Methodology (M&Ms). 1. Collect Data, 2. Define the Problem, 3. Model and Iterate, 4. Formulate Analyses and 5. Recommend and Implement.

6S (Sort, Straighten, Scrub, Standardize, Sustain and Safety). The ordering of a work area into a clearly visual managed area where there is a place for everything, everything is in its place, and the standard established is sustained.

8-Step Problem Solving Method. 1. Clarify & Validate the Problem, 2. Break Down Problem and Identify Performance Gaps, 3. Set Improvement Targets, 4. Determine Root Cause, 5. Develop Countermeasures, 6. See Countermeasures Through, 7. Confirm Results & Process, 8. Standardize Successful Process

Art of the Possible. A process management philosophy that requires the focus of leadership to create process execution Speed by improving under-performing processes and leveraging the capabilities of the enterprise to achieve Art of the Possible results.

AFSO 21 Events (Projects). A Lean, 6 Sigma or TOC event that allows for root cause and the development of countermeasures in more than 5 days.

AFSO 21 Rapid Improvement Events (RIE). A Lean, 6 Sigma or TOC event that allows for root cause and the development of countermeasures in less than 5 days. The preparation and implementation will occur outside of the RIE.

AFSO 21 Go Do It (GDI). A Lean, 6 Sigma or TOC event in which the root cause is known and a countermeasure is enacted immediately.

AFTO-202. Nonconforming Technical Assistance Request and Reply. Process used in AFSC to request engineering disposition to a production process problem.

ANDON. A signal used to call for help when an abnormal condition is recognized, or that some sort of action is required. (ANDON comes from an old Japanese word for paper lantern).
Art of the Possible. Achieving process efficiency and cost effective results that represents the maximum potential of a unit.

Comfortable in Red. Refers to the willingness to set aggressive targets with the understanding the metrics will show as "red" until process throughput efficiencies improve.

Constraint. A problem or issue that negatively impacts a production process.

Critical Path. A sequence of activities in a project plan which must be completed by a specific time for the project to be completed on its need date. The AFSC adaption of this term refers to the linkage of critical elements in a process or project that keep an asset realistically moving forward toward completion.

Drum Buffer Rope (DBR). A schedule methodology that controls the release of work into the system. It is a pull system in the sense that when a job is completed by the constraint resource, it sends a pull signal to trigger the release of a new job into the system.

EXPRESS. An AF system used to drive commodities-type work requirements to an organization.
Flow. The progressive achievement of reducing the friction on tasks and/or information as it proceeds along the value stream. Basic flow principles for any process include: 1) input; 2) create value; and 3) output.

Flowtime. The average time that a unit stays in a production machine.

Inventory Turns. The number of times the inventory is turned over each year depicted as: Annual Inventory Turns = Annual throughput / Average WIP.

Maturity Matrix. AFSC method of measuring organizational maturity with regard to the adaption of principles found in the “Execution” section of the AFSC Radiator Chart.

Production Machine. Refers to the science of the process and implies that any process can be gated in order to measure throughput and focus process improvement activities.

Pull System. A system where products, materials or information is ‘pulled’ (once a demand is placed on the process step then it produces) by consumer requests through a production machine.

Push System. A system where products, material or information are pushed through a production machine based on past order history and decisions are based on long term forecasts.

Queue. Assets awaiting induction to a process. Also a WIP control tool in a gated monitoring system.

Radiator Chart. Model depicting the fundamental components of the Art of the Possible methodology.

Road to… Reflects the throughput-pace required for both the interest of the customer and the organization. The goal that sets the pace of the process.

Root Cause Analysis (RCA). Tracing a problem to its origins (If you only fix the symptoms – what you see on the surface – the problem will almost certainly happen again... which will lead you to fix it, again, and again, and again)

Standard Work. A detailed, documented and sometimes visual system by which members develop and follow a series of predefined process steps.

Takt Time. The rate of customer demand, how often a single unit must be produced from a machine (takt is a German word for rhythm or meter).

Theory of Constraints (TOC). 1. Identify the system's constraint(s), 2. Decide how to exploit the system's constraint(s), 3. Subordinate everything else to the above decision, 4. Elevate the system's constraint(s), 5. Return to step one, but beware of inertia

Throughput. The required output of a production machine expressed in units per time. (Traditional definition based in TOC - The rate at which the system generates money through sales)

Tier System. A meeting alignment approach that aligns production machine discussion and metrics from the shop floor (Tier 1) to Group Leadership (Tier IV).

Traveling Work. Work that should have been completed in one gate, but has been allowed to “travel” to the next gate. Infers the work has been allowed by management to be performed in a subsequent gate. Critical path impacting work should never be allowed to travel to a subsequent gate.

Urgency Tools. Process tools that allow an organization to react and quickly resolve constraints encountered during process execution.

Value Stream Analysis (VSA). A method of analyzing a value stream map to determine value add process steps as well as waste.

Value Stream Map (VSM). A method of creating a simple diagram of the material and information flow that bring a product through a value stream.

Visual Management. The use of simple visual indicators to help people determine immediately whether they are working inside the standards or deviating from it, this must be done at the place where the work is done.

Walk-the-Wall. A Continuous Process Improvement tool used by Senior Leadership to ensure and communicate a lower level (at least to second level) focus on process improvement. A Walk-the-Wall briefing provides both an explanation and a status update of improvement initiatives in the context of a production machine.

WIP Control. Refers to monitoring the amount of assets in work within a process to ensure resources are not "spread thin." Spreading resources thin serves to slow process throughput.