Applying the Lessons of "Lean Now" To Transform the US Aerospace Enterprise

A study guide for government lean transformation

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EXECUTIVE SUMMARY

Lean is common sense and good business sense. As organizations grow and become more successful, they begin to lose insight into the basic truths of what made them successful. Organizations have to deal with more and more issues that may not have anything to do with directly providing products or services to their customers. Lean is a holistic management approach that brings the focus of the organization back to providing value to the customer.

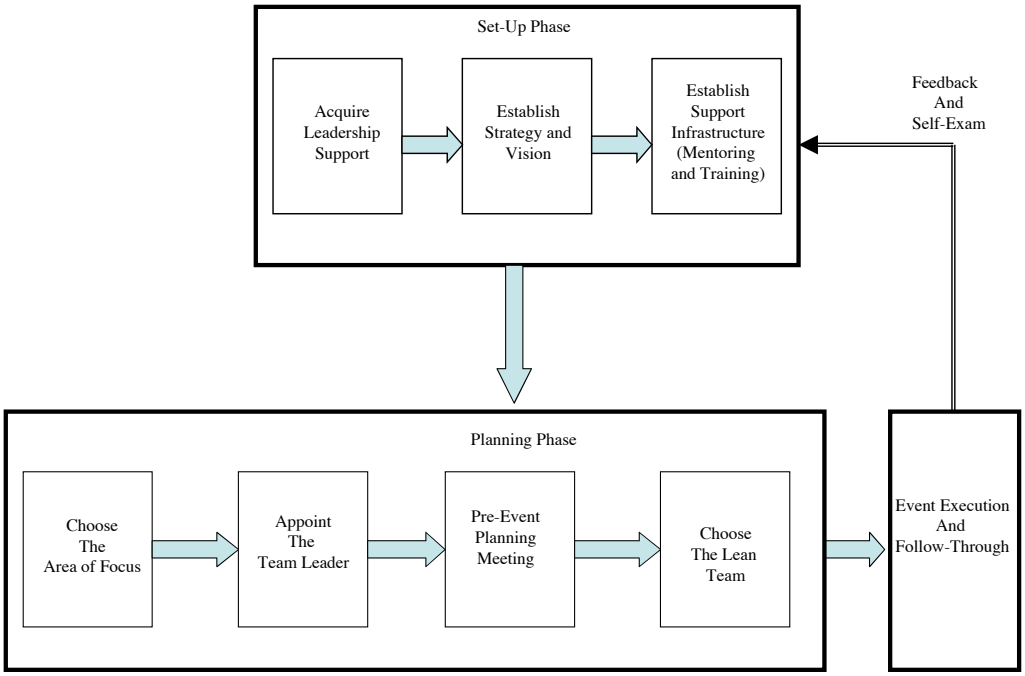
In August 2002, Mrs. Darleen Druyun, the Principal Deputy to the Assistant Secretary of the Air Force for Acquisition and government co-chairperson of the Lean Aerospace Initiative (LAI), decided it was time for Air Force acquisitions to embrace the concepts of lean. At her request, the LAI Executive Board developed a concept and methodology to employ lean into the Air Force's acquisition culture and processes. This was the birth of the "Lean Now" initiative. An enterprise-wide approach was used, involving Air Force System Program Offices (SPOs), aerospace industry, and several Department of Defense agencies. The aim of Lean Now was to focus on the process interfaces between these "enterprise" stakeholders to eliminate barriers that impede progress. Any best practices developed would be institutionalized throughout the Air Force and the Department of Defense (DoD).

The industry members of LAI agreed to help accelerate the government-industry transformation by donating lean Subject Matter Experts (SMEs) to mentor, train, and facilitate the lean events of each enterprise. Currently, the industry SMEs and the Massachusetts Institute of Technology are working together to help the Air Force develop its own lean infrastructure of training courses and Air Force lean SMEs.

The first Lean Now programs were the F/A-22, Global Hawk, and F-16. Each program focused on specific acquisition processes. The F/A-22 focused on the Test and Evaluation process; the Global Hawk focused on Evolutionary Acquisitions; and the F-16 focused on improving the Contract Closeout process.

Through lean, each enterprise made many significant improvements. The F/A-22 was able to reduce its Operational Flight Plan (OFP) Preparation and Load process time of 2 to 3 months down to 7 hours. The Global Hawk developed a new production plan that increases the annual production of its Integrated Sensor Suite from 3 per year to 6 per year. The F-16 enterprise generated and is working 12 initiatives that could result in a contract closeout cycle time reduction of 3 to 7 years. Each enterprise continues to generate more lean initiatives that focus on other areas and processes within their respective enterprises.

From the observations of the three Lean Now prototype programs, a common methodology for implementing lean can be developed. This methodology has three distinct phases: 1) Set-up Phase, 2) Planning Phase, 3) Execution and Follow-through. Within each phase are distinct steps that must occur in order for the lean initiative to be successful. The following figure presents the three phases and their respective steps.



Even though Lean Now focused on acquisition processes, lean is applicable to all aspects of the Air Force. Warner Robbins Air Logistics Center has successfully used lean to improve its repair and manufacturing capabilities; Air Mobility Command (AMC) demonstrated lean's effectiveness in the operational environment; and in July of 2003, Air Force Personnel Center (AFPC) started using lean to improve its civilian manpower processes.

The next phase of Lean Now is well underway. Once again the Air Force is relying on its industry partners to supply the training and expertise to promote change. In order for the Air Force to nurture, grow, and sustain lean and transformation on its own, it must develop its own infrastructure of lean experts and change agents.

I. LEAN NOW

In August 2002, Mrs. Darleen Druyun, the Principal Deputy to the Assistant Secretary of the Air Force for Acquisition asked the Lean Aerospace Initiative (LAI) Executive Board to develop a program to introduce the concepts of lean to Air Force acquisitions. The industry partners of LAI had already started on the path to lean in the mid-1990's and were making significant improvements. These improvements were limited however to mostly production and manufacturing operations. The Air Force on the other hand never seriously considered following suit, believing it was solely industry's responsibility to transform. Mrs. Druyun and the other Co-Chairpersons of the LAI Executive Board realized without government involvement, the US aerospace enterprise could not fully undergo a lean transformation. This was the birth of the Air Force lean initiative, called "Lean Now."

The purpose of the Lean Now initiative was to accelerate transformation of the total government/industry enterprise by:

- Leveraging the collective knowledge and efforts of government and industry
- Eliminating barriers that impede progress
- Capitalizing on government and industry teamwork
- Using LAI venue to facilitate government/industry collaboration (Bryan, 2003).

Lean Now's goals were to 1) leverage the lessons and process improvements made by the prototype programs by deploying them to the rest of the Air Force and 2) create an environment that quickly adapts to new challenges and uncertain circumstances (Bryan, 2003).

The focus of Lean Now was on the process interfaces between government and industry. The interfaces are where the handoff of information, or a product, from one stakeholder to another occurs. LAI believes much of the waste, such as waiting and rework, experienced between enterprise stakeholders occur because of inefficient or ill-defined interfaces.

The LAI Co-Chairpersons in October 2002 selected candidate government/industry processes and chose programs that exemplified these processes. They decided on three prototype programs, each focusing on processes involving both Air Force Systems Program Offices (SPO) and their corresponding contractor partners. They chose the F/A-22 to focus on the Test and Evaluation process, the F-16 to focus on the Contract Closeout process, and Global Hawk to focus on improving Evolutionary Acquisition. The LAI Co-Chairpersons wanted initial results by December 2002, in time for the LAI Executive Board Round Table meeting. The prototypes were to prove if the Lean Now concept of focusing on government/industry interfaces was feasible. It was the hope of the LAI Executive Board that the results and lessons learned from the prototype programs could be applied to other Air Force programs and possibly throughout the Department of Defense (DoD).

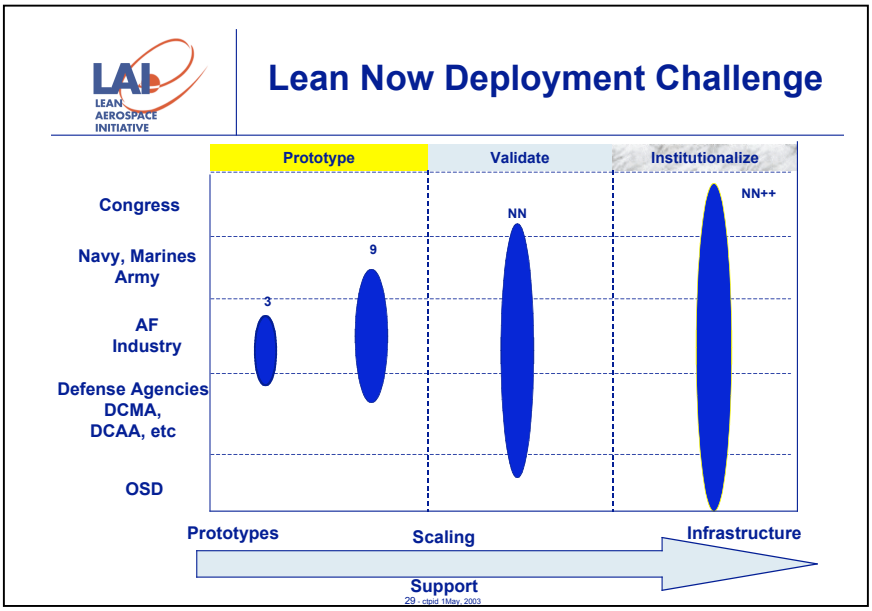


Figure 1. Lean Now Spiral Concept (Bryan, 2003)

Lean Now is a very ambitious initiative. The strategy for Lean Now incorporates a spiral approach, with each spiral limiting the stakeholders involved (Fig. 1). The first two prototype spirals are limited to the Air Force, its contractors, and some DoD agencies. Each successive

spiral will involve more and more organizations and take a wider enterprise perspective. The third spiral or the validation phase, will focus on projects that fully involve all the military services and the DoD agencies. The aim of the institutionalization phase, the fourth Lean Now spiral, is to involve Congress and the Office of the Secretary of Defense (OSD).

Lean Now fully took advantage of the resources of the LAI consortium. It was truly a partnership between government, industry, and academia. Through the LAI venue, MIT provided the knowledge and research-based tools; the industry partners provided the practical experiences of its best lean Subject Matter Experts (SMEs) to kick-start and accelerate the government's transformation. Industry agreed to provide SMEs for the first year of Lean Now to train and mentor the prototype programs. This would give the Air Force a chance to learn from industry experts, while building its own infrastructure of Air Force lean SMEs. To help the Air Force become self-sufficient in lean, MIT and the LAI industry partners are also developing an Air Force SME training course.

The three case studies that follow document the F/A-22's, Global Hawk's, and F-16's Lean Now initiatives. The *Observations and Lessons Learned* section compares and contrasts the three methodologies. The section titled *Implementing Lean Initiatives* offers a methodology for implementing lean initiatives within organizations.

II. LEAN AND THE LEAN AEROSPACE INITIATIVE

What is Lean?

Despite the nature of the industry, lean is not rocket science. Lean is common sense and good business sense. However, as organizations grow and become more successful, they begin to lose insight into the basic truths of what made them successful. Organizations have to deal more and more with issues that may not have anything to do with directly providing products or services to their customers. Lean brings the focus of the organization back to providing value to the customer.

The notion of value is the underlying theme of lean. "Value measures the worth of a product or service to a customer. It is a function of the product's usefulness to the customer, its relative importance to the customer's need, its availability relative to when it is needed and how much the customer has to pay for it" (Rebentisch). Anything that does not add value is either a non-value added necessity or waste. The non-value added necessities are those actions, procedures, or processes that are needed to support the creation of value but do not add value. For example turning on the lights in an office does not directly add value to the products and processes produced but support the workers creating value. The antithesis of value is waste, so continuously identifying and eliminating waste is also part of the lean philosophy. There are eight types of waste that a lean enterprise constantly strives to identify and eliminate (see Appendix B – Types of Waste).

Lean however, is much more than creating value for the customer and eliminating waste. The lean philosophy is also about delivering the right value, at the right time and place. Value is delivered continuously, with customers pulling value, as they require. The lean organization is flexible and responsive to changing customer needs. Never satisfied with the current state, the

lean organization is continuously improving, always striving for perfection. Only through trust-based relationships with other stakeholders can the lean organization accomplish its mission.

The Lean Enterprise

The focus of lean in the early 1990's was on production and manufacturing. Many companies thought of lean only as a way to maximize the efficiency and output of their manufacturing systems. But as companies reduced the waste in their manufacturing and production processes, they realized there were other factors and organizations beyond the factory floor that greatly influenced their delivery of value to the customer, such as other functions and departments within their companies, their suppliers, employee unions, and laws and regulations. In order to become truly lean, an enterprise approach was necessary (Murman, et al, 2002).

Even though the customer ultimately defines value, every organization or stakeholder involved in delivering and producing that value, must also find value in the association. Otherwise there is no incentive for improvement and transformation. "Lean enterprise value" describes the interconnected whole of stakeholders working together, using lean principles, to provide value to a customer while providing value for one another.

The ideas of lean, enterprise, and value are best summed up by the five principles presented in the book *Lean Enterprise Value* (Murman, et al, 2002):

- Create value by doing the job right and doing the right job.
- Deliver value only after identifying stakeholder value and constructing robust value propositions.
- Fully realize lean value only by adopting an enterprise perspective.
- Address interdependencies across enterprise levels to increase lean value
- People, not just processes, effectuate lean value.

History of Lean and the Lean Aerospace Initiative (LAI)

A graduate student doing research at the Massachusetts Institute of Technology's (MIT) International Motor Vehicle Program first used the term "lean" to describe his observations of Toyota's automobile production system. He noted how Toyota systematically and continuously identified waste in their processes and eliminated it. As a result, Toyota consistently produced the highest quality automobiles in the world. James Womack, et al, took a deeper examination of the philosophy behind Toyota's production system and presented his findings in the book *The Machine that Changed the World.*

In the early 1990's Lieutenant General Thomas Ferguson, then commander of Aeronautical Systems Center at Wright-Patterson Air Force Base (AFB) Ohio, read the book. He was so intrigued, he asked MIT if the same philosophy used by Toyota could be used in the aerospace industry. This was the birth of the Lean Aircraft Initiative, later renamed the Lean Aerospace Initiative (LAI) — a consortium of government, industry, and academia working together to meet the challenges facing the US aerospace industry in the 21st century (Appendix A – LAI consortium members).

Lieutenant General Ferguson's inquiry was triggered by the shrinking budgets and the changing nature of warfare caused by the end of the Cold War. He realized a transformation in the US aerospace industry and the Air Force acquisition process was required to meet the new challenges. The events of September 11, 2001 and the resulting war on terrorism have made these challenges even more clear for the US aerospace industry. Now more than ever, the US aerospace "enterprise" must transform to meet threat and competitive challenges.

III. F/A-22 LEAN NOW CASE STUDY

The F/A-22 is the US Air Force's next generation air superiority fighter, replacing the venerable F-15. The fall of the Soviet Union and shift of the nature of war, not to mention numerous cost overruns, has made some in Congress and DoD scrutinize the need for the F/A-22 resulting in greater visibility and pressure on the program. The LAI Co-Chairpersons selected F/A-22 as a Lean Now pilot program for this very reason. The hope is that Lean Now would help the program progress in meeting its cost, schedule, and performance expectations.

Of the three Lean Now prototypes, the F/A-22 was by far the best prepared for the Lean Now initiative. Lean was already a well-established way of life with the major F/A-22 contractors. Lockheed Martin, the program's prime contractor and integrator, along with the major subcontractors Boeing and Pratt & Whitney, were already major participants in the Lean Aerospace Initiative and had been internally practicing and applying lean on their shop floors since the mid-1990's. Each company had also developed and trained an experienced cadre of lean experts to mentor and facilitate company-wide process improvement projects. The challenge of the F/A-22's Lean Now initiative was bringing that same commitment to the Air Force with a focus on the interfaces between the government and contractors. The F/A-22 System Program Office (SPO) never fully considered applying lean within itself prior to Lean Now. Even though lean was already a major initiative among the three subcontractors, a more robust enterprise-wide approach was needed to tie their lean efforts together. The lean initiatives of each company were isolated within the company processes, resulting in islands of successes.

Approximately four years prior to the Lean Now initiative, the F/A-22 System Program Office (SPO), Lockheed Martin, Boeing, and Pratt & Whitney established the Enterprise Lean Team to look for targets of opportunity within each of the contractor operations and to share

lessons learned. Their main focus was to improve production efficiencies and eliminate waste on the shop floor.

The first F/A-22 enterprise-wide event occurred before Lean Now in May 2002, when Mrs. Druyun directed the F/A-22 SPO, Lockheed Martin, Boeing, and Pratt & Whitney take the Lean Enterprise Self-Assessment Tool (LESAT). The LESAT, developed by LAI, identified the current state of the F/A-22 enterprise "leanness" and its readiness to change (See Appendix C – LESAT). The LESAT results showed there was openness to change and improvement but identified the lack of common vision among the stakeholders to implement change. The LESAT also identified a weak understanding of lean among the enterprise leadership.

The Enterprise Lean Team tried to act on the LESAT findings by planning enterprise-wide lean events, but there was no support from the leadership to make it happen. At the time, to even consider an enterprise-wide lean endeavor between the SPO and its contractors was unfathomable. Such a feat had never been attempted; there were no examples or templates to follow for training and implementation and there was no senior Air Force leadership involvement to provide the necessary initiative and top-cover. The F/A-22 was already under scrutiny and pressure to meet production and testing deadlines and taking time and using scarce resources to start a new process improvement initiative was not considered a risk worth taking.

In early fall of 2002, there were already rumors that SAF/AQ was going to direct several Air Force SPOs to start lean initiatives. The Enterprise Lean Team, led by Mr. Greg Staley of the F/A-22 SPO and Mr. Don Handell of Lockheed Martin, had a feeling the F/A-22 was going to be on SAF/AQ's list of prototype projects. If anything, Lean Now gave the F/A-22 and the other prototype programs the excuse to take a risk and try something new. The Enterprise Lean Team

surveyed personnel from across the enterprise for suggestions on possible projects, receiving 18 suggestions.

After the F/A-22 SPO was officially notified in October 2002 that they were a Lean Now prototype, the Enterprise Lean Team met to pick their initial project. As with the other Lean Now prototypes, the LAI Executive Board had suggested the F/A-22's general area of focus – the test and evaluation process. With that in mind, the Enterprise Lean Team first established three criteria that the project must meet. The project: 1) had to have AF involvement; 2) could not effect 2002 negotiated contract deliverables; and 3) could not effect Joint Estimate Review Team negotiated contracts. The projects that made it through these "must" criteria were then put into a weighted matrix. The matrix had eight "desired" criteria, with each criterion having a different weight based on the level of importance. If the project definitely met the criterion, the corresponding weight was multiplied by 3. "Maybe's" were multiplied by 1, and "no's" were given zeroes. The following table lists the "desired" criteria and their corresponding weights.

"Desired" Criterion	Weight
Change within control of the team	10
Can be completed by March 2003	5
First Value Stream Map and Event by 12 December 2003	8
Reduces cycle time for the weapons system	8
Reduces resource requirements	7
Sufficient visibility to gain momentum within the Air Force	10
Transferable to other Air Force programs	7
Transferable to other LAI members	5

Table 1. F/A-22 Project "Desired" Criteria

The project picked by the Enterprise Lean Team was the Operational Flight Program (OFP) Preparation and Load process at the F/A-22 Combined Test Force (CTF), Edwards AFB. Basically, the OFP is the software that runs the systems on the F/A-22 and is highly dependent

on the hardware configuration of the aircraft. There are currently several test aircraft at the CTF, each configured differently depending on the test it has to perform. As testing continues and problems are found and fixed, new OFPs and new hardware configurations are generated. The resulting challenge for the CTF had become keeping track of the many OFP versions and the different aircraft configurations. This challenge prevented the F/A-22 test program from generating test sorties in a timely fashion.

A team assembled at the F/A-22's Combined Test Force at Edwards AFB, CA 3-6 December 2002. The team consisted of 13 members from the CTF and the SPO, and 7 lean Subject Matter Experts (SMEs) from industry to observe and facilitate. The team first did a Value Stream Map (VSM) of the existing OFP Prep and Load process. They identified many issues that caused delays and rework. By the end of the week, the team developed the desired state of their OFP process and generated 144 improvement suggestions to help get to this future state.

The team returned to their respective jobs to start implementing the changes identified during the VSM exercise. Prior to Lean Now, the OFP Prep and Load process took between 60 to 90 days. The results of the initial suggestions lowered the time to 3 to 4 weeks. Through continuous improvement, the team was able to whittle down the prep and load time to 3 to 4 days. Today the OFP prep and load time is approximately 7 hours.

The F/A-22 CTF was so amazed by the results of the OFP Prep and Load lean project that they decided to apply lean to their other processes. On 27 January 2003, the CTF held its own VSM event to identify waste and improvement opportunities in their other processes. They used the results of the VSM to develop a one-year plan to eliminate waste, standardize work, and improve process capability and flow. The CTF hoped that their efforts would help to reduce data

analysis turn around times, improve their management of scarce personnel, spares, and aircraft support equipment, and increase the quality of their mission planning and test execution.

The OFP Preparation and Load process and the CTF Improvement Activity were just a small preview of what was possible through lean. In order to better take advantage of lean, a more strategic view of the entire F/A-22 enterprise was required. On the week of 3-7 February 2003, an F/A-22 Enterprise VSM event was held to develop a strategic lean improvement plan. Key members from the SPO, the Defense Contract Management Agency (DCMA), Lockheed Martin, Boeing, and Pratt & Whitney met to do a value stream analysis of the F/A-22 enterprise from Request For Proposal (RFP) to sustaining a fielded system. Their objective was to develop a detailed lean improvement plan focused on the interfaces between stakeholders.

The F/A-22 used a 10-step approach to map their current and future state VSMs (See Appendix D). To develop their VSM, they examined the program's major phases:

- EMD
- Product delivery
- Sustainment and support
- Modernization
- Programmatic

The enterprise VSM event identified twenty projects for the F/A-22 enterprise to focus their attention. These projects ranged from eliminating multiple identification numbers for the same part to aligning budgets with requirements. Each project was assigned to the stakeholder that owned the process, with an accompanying target completion date.

Today the F/A-22 enterprise is working these 20 initiatives. As the F/A-22 enterprise stakeholders work on these initiatives and identify waste, they find that they are identifying further areas requiring improvement. Some of the original initiatives are generating three or four additional initiatives.

In order to keep track of the progress of all the lean activities and to keep key contractor and SPO leadership informed of the status of the events, Mr. Staley holds a monthly status review. Senior leaders from each of the enterprise stakeholder organizations are tied together via telephone, video teleconference, or by internet teleconference. In this review, each lean event team leader presents, for no more than 5 minutes, a quick summary of all actions and results that have taken place in the last 30 days. This review is meant to engage the leadership in the lean process and to get their support and direction. This forum is also used to bring up issues that cannot be worked through the normal way of doing business. To keep the rest of the enterprise personnel informed the Enterprise Lean Team puts together a monthly program activity report that gives a short summary of all new activities that have occurred in the past month and gives a schedule of upcoming lean events. This activity report serves as a record of events that can be used by anyone in the F/A-22 enterprise to get the latest status of all events.

The F/A-22 SPO has taken further initiatives to increase the awareness of lean among SPO personnel. Whenever new personnel arrive at the SPO, one of their required check-in items is to get a quick 30-minute orientation to lean. They are told to bring up any problem areas they may find, whether they have a solution or not. In order to create its own internal expertise in lean, the F/A-22 has started sending SPO personnel to Lockheed Martin's greenbelt training classes. Lockheed Martin agreed to set aside two or three slots for SPO personnel in their monthly training classes. To date, 5 SPO personnel have already been through the training course, with 5 more slated for training in the upcoming months.

IV. GLOBAL HAWK LEAN NOW CASE STUDY

The Global Hawk is the US Air Force's long range, unmanned, intelligence, surveillance, and reconnaissance (ISR) platform. It has the capability to fly half way around the world and loiter over station for an extended period. The program has a very aggressive "spiral acquisition" approach where capabilities are added in each successive development spiral. The Global Hawk System Program Office (SPO) found that one of their greatest challenges to staying on their development schedule was the time it took to put a new spiral on contract. One of the focus areas of the Global Hawk Lean Now project was to decrease the time to put a new capability spiral on contract. Another focus area of the Global Hawk lean effort was to reduce cost and lead-time of the platform's subsystems. As with the other Lean Now prototype programs, the Global Hawk's contractors were intimately involved in the process. Northrop Grumman is the prime integrator and responsible for the production of the airframe. Raytheon is the subcontractor for the Integrated Sensor Suite (ISS) and L-3 Communications is the subcontractor for the Integrated Communications Suite (ICS).

Lieutenant Colonel (Lt Col) David Riel, the Global Hawk SPO's affordability team lead, was charged with the program's lean effort. He was no stranger to lean, having taken part in lean events in previous assignments in the F-22 SPO and during Education with Industry with Pratt &Whitney. Lt Col Riel's first action was to determine the objectives of the Global Hawk Lean Now effort and to establish a timeline of events. As with the other Lean Now prototypes, Global Hawk wanted to show some initial results in time to present to the LAI Executive Board Round Table on December 12, 2002.

For the first event, members from the Global Hawk SPO, Northrop Grumman, and Raytheon met 9-13 December 2002 to map the value stream of the Integrated Sensor Suite (ISS). Lt Col

Riel chose to tackle ISS as the first event because he knew it would yield results quickly and would help build momentum for future lean projects. The ISS is a high dollar system on the Global Hawk, costing as much as the airframe and engines. It was also the critical path item for Global Hawk, with an 18-month lead-time. Because of this long lead-time, aircraft would be delivered without ISS.

Global Hawk started out as an Advanced Concept Technology Demonstration (ACTD) program that explored the feasibility of a long range, long duration, and unmanned aerial ISR platform. As an ACTD program, the prototype Global Hawks and its subsystems were handcrafted by a group of specialized engineers. When Global Hawk was eventually approved to transition from ACTD to a full acquisition program, its production never fully transitioned. Many of the systems, including the ISS, continued to be crafted by job shops. The SPO wanted to transition the ISS production process from a job shop operation to more of an assembly line operation in hopes of driving down costs and production time.

The ISS lean team, with facilitation by LAI SMEs, completed a value stream map (VSM) of the current ISS production process from request for proposal to first flight. Using this VSM, the team identified barriers and opportunities for improvement. Through the use of the VSM, the ISS team established a plan that transitioned production to more of an assembly line operation, increasing the production capacity from 3 per year to 6 per year, and a savings of $2 million per ISS. The ISS will now be on-board the aircraft during delivery. These results did not come without an upfront investment, however. The VSM showed an investment of $29 million is required to provide specialized test equipment (STE) to decrease production cycle time. The VSM also identified other potential opportunities for further decreasing cost and production time, which the team is currently exploring.

Once Global Hawk met their goal to show initial results by December 2002, the program could now regroup and start the process of introducing lean to both the Air Force program office and the contractors. The LAI SMEs held training workshops for the SPO and the contractors in January 2003. All SPO members received at least three hours of lean training, while the SPO and contractor leadership received eight hours of training.

With a lean event and some training already underneath their belt, the Global Hawk focused next on the Integrated Communications Suite (ICS). The goals of the ICS lean event were similar to the ISS: to look for opportunities to lower costs and decrease production and delivery time. The makeup of the ICS lean team was slightly different with the addition of members from L-3 Communications, the subcontractor for the ICS. All members of the team were knowledgeable in their respective areas. Through value stream mapping, the team identified opportunities for savings and cycle time reduction. They examined requirements for specialized test equipment (STE) and found with an investment of $2.8 million, they would get a return on investment of 2.5 and eliminate $3.6 million of other STE. This would also result in reducing lead-time between 2 to 3 months. The ICS team also identified the possibility of using open system architecture and common modules to reduce life cycle costs. Members of the ICS team took the action to further examine this option.

The ISS and ICS lean events both met their objectives of identifying ways to reduce cost and lead-times. However these gains are minor compared to the potential gains in other areas of the program. In order for the Global Hawk to make even more gains in cost and lead-time reduction, an enterprise-wide VSM was required to understand the program's key processes, their interrelationships, and the interfaces between the various stakeholders. The VSM would serve as

a visual model of the current state of the enterprise and to focus their lean efforts by identifying areas of non-value added and opportunities for improvement.

In February 2003, key personnel from the SPO and all the contractors met for a week to map the value stream of the entire Global Hawk enterprise. The VSM team established four objectives: 1) map key process interfaces within the program; 2) identify and agree upon areas to improve; 3) establish cost and cycle time reduction targets and metrics; and 4) establish a schedule for follow-on lean events (See Appendix E for Global Hawk enterprise VSM summary charts).

From their VSM, the Global Hawk team identified five enterprise level processes for future lean events: 1) the AF requirements definition, planning, programming, and budgeting system; 2) Alpha Contracting; 3) engineering, manufacturing, design (EMD) and testing; 4) production and supply chain management; and 5) the engineering change process. It's important to note at this time that the identification of these five key processes is not the most important result of the VSM exercise. In fact, a VSM would not have been necessary to identify these. The importance of the VSM exercise is that it identifies the interrelations of these processes with one another and the impacts to the different stakeholders.

The final lean event accomplished by the Global Hawk in this first phase of Lean Now was the value stream mapping of the Alpha Contracting process. Alpha Contracting is a streamlined process used by Global Hawk and its contractors to co-produce a proposal for a contract. The current Alpha Contracting process was not fast enough to support the desired pace of the Global Hawk's "spiral" acquisition approach. With the current Alpha Contracting process, the average time to produce a formal proposal was 265 man-days.

An Alpha Contracting VSM was held in February 2003. As with the other VSMs, a team was assembled composed of members from the program office, Northrop Grumman, and the major subcontractors. The result was a lower Alpha Contracting process of 166 man-days, a reduction of 37%. Through the use of the VSM, the team identified that much of the wasted time was due to each organization sequentially waiting for another organization to complete and review their part of the proposal. The Global Hawk enterprise continues to examine the Alpha Contracting process to find further opportunities to reduce cycle time. In order to fully take advantage of their spiral acquisition strategy, the Global Hawk SPO would like to see the Alpha Contracting eventually down to 80 man-days.

In the revised Alpha Contracting process, the entire government/contractor proposal team will meet at the very beginning of the process to jointly write and then review all the contractual documents. This means more work up front for the proposal team, but the result is a faster contracting cycle time. The Alpha Contracting lean team also developed a guide and templates to use in their new process. The SPO will start making the use of the guide and templates mandatory for its contractors.

The Global Hawk lean effort is now in its second phase. Not satisfied with their initial results, the Global Hawk continues their work on the ISS, ICS, and Alpha Contracting projects to further reduce cost and cycle time. They are finding that in order to make further headway, they must get assistance from organizations such as Air Force Materiel Command, the Defense Finance Accounting Service, and the Defense Contract Management Agency. They have also started lean initiatives on the other processes identified in the enterprise VSM, with similar objectives of cost and cycle time reduction.

V. F-16 LEAN NOW CASE STUDY

The F-16 Lean Now prototype program chosen by the Lean Aerospace Initiative (LAI) Executive Board was the Contract Closeout process. Contract closeout is actually made up of many activities and processes. A contract is considered complete once both parties have completed their obligations to one another as stated in the contract. Contract closeout is the activities associated with reconciling the terms of the contract with the products and services delivered. These activities include reconciling accounting records to make sure the contractor has been paid and the funds used were the correct appropriation; ensuring all equipment and documents have undergone the correct disposition; and verification of all transactions as being fair and reasonable.

The LAI Executive Board chose contract closeout for the F-16 because the program has some of the oldest and most complex contracts in the US Air Force, with some dating back to the 1970's. Contract closeout is a process that plagues all DoD programs. The LAI Exec Board presumed any headway made in closing out some of the F-16's old contracts could be applied to other Air Force and DoD programs. The process is long (on the order of 8 to 10 years) and is very resource intensive. To the government and contractors, this means having to expend resources in accomplishing the administrative aspects of the contract long after the product has been delivered. The goal of the F-16 Lean Now initiative was to reduce the cycle time to close a contract, increase the efficiency and reduce the resources required, and to eliminate the backlog of contracts that are currently inactive yet remain open. For clarification, the term inactive in this context describes a contract that is open but has had no billing activity for the past 6 to 12 months and all contract requirements have been fulfilled.

Even before the Lean Now initiative, the F-16 program had been working to close the backlog of inactive contracts. In 1994, an ad hoc group consisting of representatives from the F-16 SPO, Lockheed Martin, DCMA, and DCAA started to look at the Contract Closeout process when the accounting system they were (and still are) using, MOCAS, was slated to be replaced with a new accounting system. Under the transition rules, programs could only transition active contracts to the new system. Approximately six years later, the AF-Lockheed Martin Joint Management Council (JMC) took over the work of the ad hoc group to try to close out the backlog of inactive contracts. It should be mentioned that both the ad hoc group and the JMC made significant gains in the Contract Closeout process.

Mrs. Kendra Kershner of the F-16 SPO was charged with heading up the Lean Now effort. Her boss told her the F-16 Lean Now project was to be her fulltime job until its completion. The Contract Closeout Lean Now team consisted of member of the F-16 System Program Office (SPO) at Wright-Patterson AFB and Hill AFB; Lockheed Martin Ft Worth; the Defense Contracts Management Agency (DCMA) Ft Worth and Headquarters DCMA**;** the Defense Contracts Audit Agency (DCAA) Ft Worth office and the DCAA regional headquarters office; the Defense Financial Accounting Service (DFAS) Columbus office; and the DFAS Air Force Materiel Command client exec office. Some of these individuals also worked on the Contract Closeout process for the ad hoc group and the JMC.

The new F-16 Lean Now team met for the first time in November 2002 to discuss their task and to decide where to concentrate their efforts. At this point, most of the team members were not familiar with lean and its concepts. To most of them, it was no more than the Air Force's new management fad of the day. During their first meeting, the team, led by a Lockheed Martin SME, brainstormed all the issues preventing the successful closeout of contracts. All the

possible focus areas were then rank ordered using a set of criteria in a weighted matrix. The lean SME suggested using a weighted matrix similar to the one used by F/A-22. The F-16's project criteria were: 1) can be influenced by the team, 2) can be completed by March 2003, 3) transferable to other programs, 4) reduces cycle time, 5) better utilizes resources, and 6) transferable to other Lockheed Martin programs. The team further weighted their decision matrix by assigning a score of 3 if the criterion applied to the given issue, 1 if the criterion could possibly apply, and a score of 0 (zero) if the criterion did not apply. Figure 2 is the F-16's project selection weighted matrix.

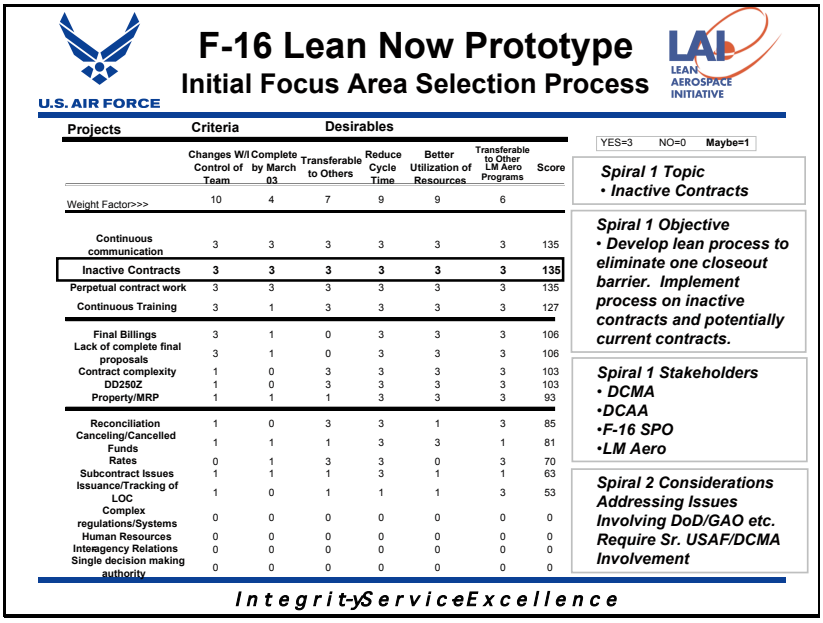


Figure 2. F-16 Project Selection Matrix

Through the use of this matrix, the team decided to focus their efforts on the "Inactive Contracts". As previously defined, inactive contracts are contracts that are seemingly complete because all contract requirements have been fulfilled and no activity has occurred on the contract within the last 6 to 12 months. However, these contracts remain open for one reason or another.

There is currently a backlog of approximately 1200 Lockheed Martin inactive contracts for the F-16, with some dating back to the late 1970's. The focus of the team's effort was directed towards finding and eliminating the barriers that keep these contracts on the books and to reduce the backlog. In preparation for the next lean event, the DCMA and Lockheed Martin team members were charged with sampling 25 inactive contracts and collecting data as to why those contracts remained open.

The next lean event occurred in January 2003. The purpose of this 4-day event was to provide the team training on the concepts of lean and to analyze the collected data to identify the barriers to closing these contracts and possible solutions. The event started out with a lean training workshop introducing the basics of lean principles and techniques. The workshop also gave the team a chance to get to know one another and increase communication. Even though many of the members of the team had worked on the ad hoc group and the JMC contract closeout project, some had never actually met prior to the start of the Lean Now initiative.

The analysis of the 25 inactive contracts yielded "work order closeout" as a major barrier. When the AF issues a contract, the contractor generates an internal work order to track progress and effort accumulated against the work package. Work order closeout process ensures a task or work order from the Air Force has been completed and documented. Many of the inactive contracts had work orders that were never properly closed out and documented. The lean SMEs planned to use a VSM analysis to determine these reasons.

Traditionally, most lean events start off with a Value Stream Map (VSM) of the process, to understand the stakeholder values and their relationship to the process. Despite the attempts of the LAI Lean experts running the meeting, the team came to a consensus not to do a VSM of the current process. The team felt the prior work done under the JMC charter was sufficient in

understanding the process. Instead of a full-blown VSM, the Lean experts were able to get the team to flow chart the current process, both the formal and informal processes. Even the simple flow chart exercise proved invaluable by providing a common base of understanding. It turns out that many of the team members had a very narrow insight into the process and had no idea what other team members did within the flow. The team looked for areas of waste and came up with 40 improvement ideas. The team then categorized each of the improvements into one of five categories to see if there were common approaches to implementing the improvements based on their groupings. The five categories were: funding, reconciliation, resources, subcontracts, and "other." Unfortunately, the team realized at the end of the four-day event that their proposed changes did little to reduce the time to closeout contracts. Influencing the process would require initiatives and actions of their managers and leaders.

Since the initial precept of Lean Now was to find changes that could be implemented within the span of control of the team, the members of the Lean Now team were not in positions required to make the sweeping changes required. Rather than identifying changes to the underlying problems, the team was attempting to put a band-aid fix on an already existing band-aid. Taking what they learned from this event, the Lean Now SMEs held another Contract Closeout event in March 2003. For this second event, the SMEs, SPO, and Lockheed Martin decided to form a new team consisting of senior management of the stakeholder organizations. Before these senior managers met, the original F-16 team met once again to brainstorm the barriers to contract closeout, but this time they widened their scope of inquiry—this time no idea was too wild for consideration. The team did root cause analyses of the barriers to understand the real causes.

From this session, the team developed 18 initiatives for senior managers to review and take-on. The senior managers met the following week to review and discuss the initiatives. They deleted three and placed three on hold to be worked later, leaving 12 viable initiatives (See Appendix F – F-16 Contract Closeout Initiatives). Of these 12, eight are within the control of the team ("Just Do It's") and the remaining four have to be elevated to an even higher level. If all twelve initiatives can be implemented successfully, the projected minimum cost avoidance to the F-16 program is $2.4 million and an estimated cycle time reduction between 3 to 7 years.

To garner support for their Lean Now initiatives, Mr. Chuck Jackson, the F-16's deputy System Program Director, Brigadier General Ed Harrington, commander of DCMA, and Dr. Bill Kessler, industry co-chairman of LAI Executive Board met with Mr. Michael Wynne, the Deputy Under-Secretary of Defense for Acquisition and Technology. Mr. Wynne was highly enthusiastic of the notion of Lean Now and the possibilities of applying the F-16's achievements to other DoD programs.

At the time of this writing, three of the eight "Just Do It's" have been completed and closed. The coordination and mechanics of the remaining five are being actively worked. Of the four elevated issues, the first has been determined already doable under existing guidelines and regulations. The second initiative has been closed as not possible due to manpower constraints, but because Lean Now highlighted the issue, a senior Air Force leader at the Aeronautical System Center provided a work around solution resulting in the same desired outcome. The third elevated issue is awaiting the outcome of FY04 Congressional language to see if Congress addresses the issue. The last elevated issue is being worked jointly at the DoD level with a similar Army initiative and is going through a DoD working group coordination and review.

VI. LEAN NOW OBSERVATIONS AND LESSONS LEARNED

This section compares and contrasts the different approaches of each prototype's lean journey. These lessons and observations are intended to help future Air Force and DoD lean efforts. The Lean Now prototypes have to be commended for their "willingness" to participate and endure the growing pains of such a monumental and revolutionary endeavor. They have paved the way for future Lean Now efforts.

As already discussed in the case studies, the three Lean Now prototype programs were notified in October 2002 that they were lucky enough to have been selected by the Lean Aerospace Initiative (LAI) Executive Board, then co-chaired by Mrs. Darleen Druyun of SAF/AQ, to be the first three Air Force acquisition programs to embark on the journey to lean. You can imagine the thoughts of the SPO leaders and the team leaders after hearing this declaration. Imagine too what they thought when they were told that the LAI Executive Board wanted to have some initial results in time to showcase them in their 12 December 2003 Executive Board Roundtable meeting.

Of the three SPOs, the F/A-22 by far was the most prepared for the challenge, having previously instituted lean in some of its contractor's operations and having participated in its contractors' lean events. However the challenge for the F/A-22 SPO was to institute lean within itself and across its interfaces with its contractors and with other Air Force and DoD support agencies. Both Global Hawk and the F-16 SPOs faced the daunting challenge of introducing "yet another management fad" into their respective organizations.

Leadership Support Is Essential

- Lean requires a top-down push
- Visionary leadership is required to understand the long-term benefits of lean

The Lean Now prototypes were lucky enough to have the attention and support of very senior Air Force leaders. Mrs. Druyun was instrumental in deciding it was time Air Force acquisitions take the leap industry had taken a decade earlier. When she retired from government service, General Lester Lyles, commander of Air Force Materiel Command (AFMC), took over where she left off, endorsing the decision to implement Lean Now. Major General Michael Mushala, director of requirements for AFMC and long time lean visionary, was also a major force behind the push for Lean Now. He provided a leader's vision with a practitioner's insight. These visionary leaders believed in the principles of lean and what it could do for the Air Force. They provided the necessary sponsorship and "top cover" for each of the Lean Now initiatives. They were willing to champion any issues the Lean Now prototypes needed to elevate to higher Air Force and Department of Defense (DoD).

The leadership of each Lean Now SPO fully supported lean, doing their part to push lean from the top down. Mr. Chuck Jackson, the deputy director for the F-16 SPO, first heard of lean while attending a Defense Acquisitions University course. Even before Lean Now, he knew lean could work for F-16. On his own, he started several lean initiatives within the SPO. Colonel Tom Owen, F/A-22 SPO director, experienced firsthand the results of lean while he was SPO director for the C-17 and while assigned to Warner-Robins Air Logistics Center, GA. Colonel Scott Coale, Global Hawk SPO Director known for thinking out of the box, personally took part in his organization's enterprise VSM event. Each of the leaders made it known to his organization and to their respective contractors that they fully supported Lean Now and expected their support. The importance of leadership support cannot be understated.

Setting the Strategy and Vision for Lean

- Integrate lean into the enterprise strategic plans
- Understand how lean can be used to achieve the organization's strategic goals
- Lean requires patience and long-term commitment
- Use the Transition To Lean Roadmap to pave the enterprise's lean journey

Because implementing lean on this scale in the government has never happened before, no expectations or visions could be given to any of the three prototype programs other than the typical mantra of meeting the challenge of cost, schedule, and performance. Mrs. Druyun and the rest of the LAI Executive Board envisioned lean helping Air Force acquisitions be more responsive to its customer, the warfighter. The LAI Executive Board's initial strategy with Lean Now was to pick several prototype Air Force acquisition programs and do quick lean events to show some initial results in hopes that lean would catch on with other acquisition programs. The prototype programs would serve as a learning experience from which the Air Force could further refine its approach to implementing lean.

Without any more guidance than to go forth and become lean, the prototype programs did not know what to expect. The prototypes expected "lean" to be over within a few months and they could get back to their real jobs. But, lean is not a series of events that can ever be completed. Lean is a philosophy of constantly examining the value of what you do, in the context of not only your customer's perception of value, but of the other stakeholders of your enterprise. Because of the push by senior Air Force leaders to show results quickly, the three prototype programs did not have time to do any lean strategic planning. Each of the Lean Now SPOs, before starting any other lean projects, should first determine what they expect to accomplish from lean. Future Lean Now programs should begin by integrating lean into their strategic planning.

Strategic planning will enable the enterprise to answer the following questions:

- Do we truly understand the concepts of lean?

- Do we know why we want to implement lean?
- What do we expect lean to do for us?
- Do we understand the resources requirements for lean?

According to research done by MIT's Sloan School of Management, most organizations starting process improvement initiatives will eventually fail because the organization cannot stomach what it takes to make the initiatives successful. Not being able to withstand uncomfortable growing pains, shortsightedness, and impatience were common reasons for failure. The research further showed it took approximately two years of constant pushing by leadership before the initiatives showed self-sustaining results (Repenning and Sterman, 1997).

For enterprises looking for guidance on how to implement a strategic lean initiative, LAI developed the Transition To Lean (TTL) Roadmap. This tool, based upon lean principles and practices, provides a logical flow of steps necessary to initiate, sustain, and continuously refine the transformation to lean (See Appendix G – TTL Roadmap). The TTL shows the major strategic steps to become lean and identifies the specific activities of each step.

Once the enterprise determines it's strategic hopes to accomplish with lean goals, it can then concentrate on the tactical or specific tasks for getting to the lean state.

Timely and Sufficient Training

- Provide sufficient but not excessive training up front
- Provide additional training on specific tools and methods as needed
- A training program is required to provide consistency in methods and terminology
- Enterprise leaders must understand the concepts of lean and its strategic implications

Interviewing participants of the Lean Now prototypes, most felt they received enough training to understand lean and to accomplish their events. Several industry and MIT lean Subject Matter Experts (SMEs) met in October 2002 to develop and build a basic Lean Now training course. The course covered the basic concepts, tools, and history of lean. The course also included a case study of a non-manufacturing use of lean.

The LAI lean SMEs gave these training workshops before the start of each Lean Now event. The training workshops were scheduled for either one or two days, depending on the time available. Any complaints of insufficient training occurred during the very early days of Lean Now in November 2002 before LAI finished developing the lean training workshop. At this time, the Lean Now teams were just starting to meet and discuss their strategies for implementing lean. For example, during the F-16 Lean Now planning meeting in November 2002, a group of approximately forty people representing all the stakeholder organizations met to brainstorm ideas of where to focus their efforts. Even though there was an LAI lean expert facilitating the planning event, the participants only had a vague idea of the concepts of lean, and were not sure of the overall objectives of the project they were brainstorming. Upfront training is a prerequisite for gaining the team's confidence and motivation for success. There is however the right balance of not enough training and too much training. LAI stresses "just-in-time" training, where the lean expert teaches the right tools and techniques, as the situation requires.

As the first spirals of Lean Now come to an end, the industry lean SMEs currently assisting the Air Force will start returning to their companies. The Air Force will have to bear the burden

of training its lean teams. LAI is helping the Air Force with this transition by helping them establish their own lean training and certification program. LAI is currently developing an extensive lean training program based on MIT research and on the industry members' own course materials and experiences. Training is not only important for providing the know-how, but it also provides a means to standardize the methods and terminology of the Air Force's lean infrastructure. This standardization is a key to sustaining and spreading the Air Force's lean culture.

The Air Force leaders of each SPO are responsible for making sure that they and their personnel properly understand the concepts of lean. A SPO leader does not have to know about the mechanics of the lean tools, but should be familiar enough with the concepts of lean to understand their strategic implications. The greatest detriment to lean is leaders that do not understand lean, yet claim to espouse lean principles.

Role of the Lean Subject Matter Expert

- Facilitate and promote change
- Train and certify other lean experts
- Provide feedback to leadership
- Network with other programs
- Communicate and collaborate with other change agents
- Provide consistent training and methods

The three Lean Now prototype programs could not have successfully started their lean journey without the help of a lean Subject Matter Expert (SME). The lean SME helps the team identify where they are, where they want to go, and shows them the path. The job of the SME is not to lead the team down the path or to make sure they are executing their plan; that is up to the team leader and the team.

LAI, through its industry partners, have stood up a highly experienced team of lean experts and resources to facilitate the transformation of Air Force acquisitions. Each program was provided at least one dedicated SME and several more during lean events. For this first year of Lean Now, the industry partners of LAI agreed to provide SMEs free of charge to facilitate the Air Force's transformation. Specifically these lean SMEs have been charged with:

- Promoting change
- Training and teaching lean concepts and methods
- Providing feedback to Air Force leadership and LAI
- Networking across other projects
- Communicating and collaborating with other government and industry change agents
- Provide consistency of training and methods throughout the Air Force

Industry has invested heavily in time and resources to deploy a full time cadre of change agents throughout their companies. These change agents are responsible for training and facilitating change. For example, over 1% of Raytheon's workforce are active lean experts, assigned to carryout lean initiatives throughout the company. Their typical tour of duty as a

change agent is two years after which they return to the company's workforce. Having this experience is considered a career enhancement. An "expert" certification is even a prerequisite for some director positions. Raytheon trains approximately 100 new change agents every year. Since the inception of Raytheon's lean program, the company has documented over $1.3 billion of real savings, versus cost avoidance (Bryan, 2003). Lockheed Martin, Boeing, and Northrop Grumman also have similar company-wide lean infrastructures, each with their own cadre of lean change agents. The Air Force should do no less than to grow its own lean experts and change agents in order to reap similar benefits and to sustain the gains of Lean Now.

Both the F/A-22 and F-16 SPOs have taken the initiative to send some of its employees to its industry partner's "green belt" training programs. This week long training program teaches in depth the principles and tools of lean. It also teaches facilitation and mentoring skills. Upon returning to their SPOs, these individuals will be responsible for facilitating all future lean events. The Air Force is currently in the midst of determining how it should go about selecting, training, certifying, and deploying lean experts of its own as Lean Now moves into its next phase.

Role of the Team Leader

- Keeps the team focused on the goal of the lean initiative
- Understand the process being examined
- Lead the planning and execution
- Keeps information flowing through constant communication

The team leader must be identified early enough in the process to be properly trained. He or she does not have to be an expert in lean, but must be familiar with the tools and concepts. The team leader is primarily responsible for leading the planning and execution of the lean initiative and for keeping the team's focus on the issue at hand. To accomplish this, the team leader must understand the process under examination, the culture of the enterprise, and the underlying goals of the activities. The leader's level of familiarity of the process depends on the complexity of the process and the magnitude of change desired. Depending on the level of complexity of the lean initiative the team leader position may be a full-time job.

Before the start of the lean event, the team leader along with the SME must do the upfront planning (see next section). During the event, the leader acts as the checks and balances to the team, ensuring the discussion is not controlled by only a few team members. He or she also ensures the team remains on the stated objectives.

The most important job of the leader, and the most difficult, comes after the lean event when the team members return to their respective organizations to implement the resulting actions. The leader has to keep everyone motivated and doing his or her part. This is done through constant communication. One of the Lean Now team leaders called this the "cheerleader" phase.

Keeping the enterprise leadership up to date and informed is also important. This gives insight to the leadership and will allow them the opportunity to help out if any problems arise that cannot be handled at the team level.

Pre-project Planning Meeting (Between the Team Leader and the Lean SME)

- Shares expectations between team leader and lean expert—sets the expectation of the lean events
- Ensures the team leader is familiar with lean
- Identifies the program champion and how to engage, if required
- Establish early the plan to capture lessons learned

Prior to the kickoff of a new lean project, the team leader and the lean SME must meet to set the objectives of the project. The team leader will familiarize the SME with the project and the SME will ensure the team lead is up to speed with lean concepts and tools. They will discuss the goals of the project, schedules, and resources available. At this time, the SME can start to plan the event's facilitation. There should also be a frank discussion of expectations, especially if the team leader is new to lean or if the SME is unfamiliar with the organization or project. It's important to get an understanding between the team leader and the SME upfront. Expectations also include discussion of the possible limitations of the project

During this phase, the initiative's champion should be identified. The champion is a senior leader who is in a position to further elevate any issues the team cannot resolve on their own. The F-16 Contract Closeout and Global Hawk Alpha Contracting are both in situations where further success are dependent on the help and assistance of senior leaders not on the lean team. The team leader and the SME should engage the champion as soon as possible to let them know they may need their help. This is when the project's champion should be identified. In the Air Force bureaucracy, identifying the appropriate champion can be a challenge, as the F-16 lean team has come to find out. Because of the complexity of the Contract Closeout process and the interrelationships of many organizations and agencies, it is hard to find that one person in the position to elevate issues.

Finally there needs to be a discussion of how the lessons learned will be captured and spread throughout the rest of the organization. Organizations typically wait until well after the project has ended to capture and document lessons learned. Waiting until the end usually results in loosing valuable knowledge. It is best to continuously capture the lessons as the project proceeds.

Role of the Team and Picking the Team

- Understand the projects organizational and technical complexities to choose the team
- The team must be empowered by leadership
- Make sure all stakeholders are represented
- Don't limit the creativity of the team

In order to choose the members of the lean project team, both the organizational complexity and technical complexity of the initiative must be understood. Organizational complexity refers to the level of involvement of different stakeholders. Indicators of organizational complexity include:

- Large number of organizations or functions involved
- Need for approval from a number of separate organizations to implement a change
- Processes requires many people with different backgrounds to operate
- Difficulty to schedule meetings (Keating,et al, 1999).

Technical complexity of a process describes the details and intricacies inherent in the process. Characteristics of technical complex processes include:

- Long cycle times,
- Difficulty of performing experiments, or
- The requirement for a high degree of technical know how (Keating, et al, 1999).

The Lean Now projects showed that organizational complexity is a good determinant of the level of authority each lean team member must have and technical complexity of the project is an indicator of the level of expertise required by the team member. Ideally, the team members should possess both the correct level of authority and expertise, but getting that right person on the lean team may not always be possible. In this case, it is best to weigh process expertise over authority as long as the team member has the ear of his or her leadership.

Even though the members of the team may not have direct authority over the processes, it is important not to define the boundaries of the solutions too narrowly. One of the stipulations given to all the Lean Now programs was to limit their solutions only to actions that the

individual team members could implement. The F-16 Contract Closeout team started off to a slow start because of this stipulation. Initially, the team only considered solutions the members themselves could physically implement. By the end of their first lean event, they realized their solutions did little to meet their objective of closing contracts.

The most important aspect of forming the lean team is making sure all stakeholder organizations are represented. As already mentioned, F-16 and Global Hawk would have benefited if there was representation from other outside organizations to explore more possibilities than the assembled team could offer. The F/A-22 OFP lean team also learned this lesson – they were assigning tasks to individuals not even present at the lean event.

Another aspect to consider when forming the lean team is the number of people on the team. The minimum number of members on the team is the same as the number of stakeholder organizations, with one representative from each. A team that is too big will become cumbersome and unmanageable.

As the team assembles for its training and first lean event, the leader and SME must provide the expectations, goals, and objectives. Many of those involved in the Lean Now prototypes had no idea of the effort and time required.

Choosing the Project

- Have real expectations of what is possible
- Have real expectations of when a project will show results
- Leadership support determines the level of change
- Sense of urgency determines motivation for change.
- Start with small quick projects, building up to more difficult projects as the enterprise gains experience.

The LAI Co-Chairpersons chose the broad area of focus for the three prototypes: F-16 Contract Closeout, Global Hawk Spiral Acquisition, and F/A-22 test and evaluation. Each of the three SPOs then took different approaches to further narrow the scope of their projects. The F/A-22 and F-16 used a weighted matrix. The Global Hawk already had the ISS, ICS, and Alpha Contracting picked out from the start. Both F/A-22 and Global Hawk used their enterprise-wide VSM to choose their next round of projects.

A consideration to project selection is having realistic expectations of what the initiative can accomplish and when the results will appear. The "what" can be determined through analysis of the current process, experienced estimates from those currently working the process, and by benchmarking other organizations that have done similar initiatives. The time expectations for an initiative to start showing results is a function of organizational and technical complexities (Keating, et.al., 1999). Organizations usually always underestimate the time for process improvements to show tangible results. Figure 3, which is a result of an MIT study of companies undergoing process improvement initiatives, shows that as both organizational and technical complexities grow, the time to achieve a 50% improvement increases (Keating, et. al., 1999).

The Lean Now results followed the expected times shown in Figure 3. The F/A-22 OFP Prep and Load process is, for the most part, isolated to the Combined Test Force (CTF) and the changes made are under the control of the CTF. The F/A-22 was able to have major results within a few months.

On the other hand, F-16 Contract Closeout and Global Hawk Alpha Contracting processes have more diverse stakeholders and are influenced by many other diverse processes. Both programs face very high organizational and technical complexities. As predicted, both have yet to make the substantial gains experienced by the F/A-22 and both still have a long way to go.

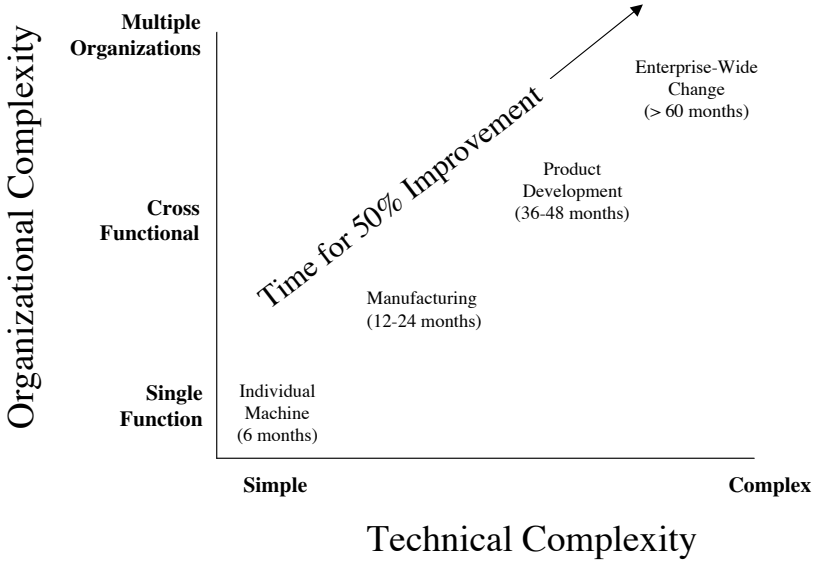


Figure 3. When to expect results. (Adapted from Keating, et.al, 1999)

The initiative's level of leadership support is also a consideration in choosing a project. The higher the leadership support for the initiative, the broader and more ambitious it can be. As already discussed, leadership support will determine the success or failure of any lean initiative. Lean Now is truly fortunate for having support from very high levels of the Air Force.

The sense of urgency surrounding the project should also be considered. It goes without saying, urgency relates to team motivation and leadership support and interest. For those organizations and enterprises starting lean, it may be best to start off with the hot issues. There will be greater zeal in team members and leadership. There are examples of both high urgency projects and low urgency projects in the Lean Now prototypes. The F/A-22 is continuously under the scrutiny of senior Air Force and DoD officials and right now its flight test program is

under the gun to increase the number of test sorties. The F/A-22 lean team knew the stakes were high and were motivated to find and remove waste from their processes. The F-16 lean team on the other hand, had been working the Contract Closeout process for several years, with most of its "low hanging fruit"—projects with greater opportunities for success—already taken. Essentially, the F-16 team felt they had already "been there" and "done that" when Lean Now came along and that there was nothing else that they could do.

Ideally the best way for an organization and an enterprise to start its lean journey is to do many small and quick projects. The organization should take a look at their day-to-day processes, looking for the eight types of waste. Lean teams should then be organized to work on those processes to eliminate the waste. These easy and early successes will pave the way for more ambitious initiatives. As the organization starts to see what lean can do, the scope of the initiatives can be widened to include other stakeholder organizations. The focus should be identifying and eliminating waste at the interfaces or "hand-off" points between organizations.

As LAI and the Air Force expand Lean Now into its next phases, the strategic aim is to broaden the scope of the projects to include more of an enterprise-wide flavor and to include higher level Air Force and DoD agencies. This means less focus on isolated processes and program-specific applicability and more focus on the enterprise-wide processes that effect more than one program. Because of the increased organizational complexity of the enterprise-wide approach, patience and persistence is a must because substantial improvements will not be instantaneous.

Understanding Stakeholder Value

- Stakeholder values must be defined upfront to provide a clear statement of objectives to help focus their efforts.
- Values are based on the stakeholder's strategic vision for meeting customer requirements.
- Values can be used to define metrics to measure progress
- Waste is the antithesis of value
- Value Stream Map shows the interrelationships of stakeholders in creating value—promotes communication.
- All stakeholders must find value in being a member of the enterprise
- Suboptimization occurs when initiatives are taken without understanding the enterprise value stream
- The enterprise values stream is not static—periodic reevaluation is required to understand how the enterprise is transforming

Throughout this report is the notion of value as being the driver for stakeholder involvement in lean. Stakeholder values must be defined upfront to provide all stakeholders a clear statement of objectives to help focus their efforts. Values define what is important to an organization and is based on the strategic vision of the organization. If stakeholders do not understand their value propositions, their lean initiatives may not be effective in addressing the true issues and problems. From these values, stakeholders can define concise metrics to measure their progress.

The objective of lean is to eliminate waste and create value for all stakeholders, not just the customers. Value means different things to different stakeholders, but the idea behind lean is stakeholders working together to optimally maximize value for the customer and one another. Organizations band together as enterprises because no one organization can create and sustain value on its own. In a large enterprise, it may sometimes be difficult for one stakeholder to understand another stakeholder's definition of value. The Value Stream Map (VSM) is the major tool used in lean to graphically show the linkage and interrelationships of different stakeholder value throughout a process. This linkage of all the value in a process is known as the value-chain or value-stream.

A VSM is more than a picture of the steps in a process. A VSM analyzes each step to determine why the step occurs, what happens during the step, how long it takes, what resources are used, and what is produced. Any step in the process that does not directly add value is either waste or a non-value added necessity **(**See Appendix B — Types of Waste**)**. A non-value added necessity could be described as a step or process that is mandated by law or regulation or a process or expense that supports the creation of value. Providing electricity to light an office is an example of non-value added necessity.

The non-value added areas of the VSM are very good candidates of focus for lean projects. The non-value added waste can be considered the low hanging fruit, which the enterprise can take advantage of immediately. The non-value added necessities areas are good candidates for future lean endeavors to examine why they are necessities and to see if they too can be eliminated.

The power of the VSM is that it not only serves as a tool to identify value and non-value added areas, but it serves as a model describing the interrelationships among all stakeholders. Since building the VSM requires participation of all stakeholders, it can be used by each stakeholder to understand the current state of the value chain, and their role and others roles in the value chain. Once there is an understanding of the current state, the VSM is used to map the desired future state. Metrics to measure the progress from the current to the future state can be identified. These metrics, when used in conjunction with the VSM, can give all stakeholders an excellent visual tool for common understanding (See Appendix H – VSM).

As the non-value added areas of the value chain are addressed and changes and improvements increase, it is important to periodically reaccomplish the VSM. One of the biggest mistakes an enterprise can make is to assume their value chain is static. The VSM is only a snapshot of a

past state of the value chain. Therefore, it is important to periodically reevaluate the VSM to understand how the value chain has changed.

A VSM can be accomplished at any level in the enterprise. The Lean Now projects used VSMs to examine particular processes and to examine the entire program enterprise. It is important to do both. The enterprise-wide VSM shows the relationship of the stakeholders at the enterprise level and can be used to identify areas of focus for enterprise lean teams.

An enterprise-wide VSM will also help prevent suboptimization. As one process or area is "leaned," it may cause problems in other areas of the enterprise. A VSM will help enterprise leaders understand the effects of their decisions.

In the Lean Now prototypes, the F/A-22 and Global Hawk used the VSM successfully to map several of their key processes and to map their program enterprise. Through the use of the VSM they were able to identify areas of non-value added waste to make significant reductions in program schedules and cost (see case studies).

The most common comment from Lean Now participants on the process of creating a VSM was how the process enhanced the team's understanding of the entire process. The VSM gave them a common basis of understanding and a starting point from which they could look for targets of opportunity. The participants also noted the improved communication among the team members. For once, they finally understood everyone else's part in the value chain. Even the F-16 team, whose members have been working Contract Closeout before Lean Now, commented on how process mapping gave them better insight into the roles of other team members and improved their communications.

Execution and Follow Through

- The leader must keep the team motivated after the lean event and ensure they are all following up on action items
- Keep the enterprise leadership informed
- Be aware of resource constraints
- Capture and proliferate lessons learned
- Use lessons learned, LESAT, and VSMs to refine the enterprise strategic plan

The Lean Now team leaders agree the most difficult period of their Lean Now initiatives is the execution and follow-through of the actions identified during the lean event. When the team members return to their organizations, they have to fit in their lean action items with their "real jobs." It is important for the team leader to keep the momentum going through constant communication and periodic status updates. This is crucial to prevent the possibility of dropping the ball on an initiative. It is also important to keep the leadership of all the stakeholder organizations informed and up to date. The leadership must be aware of any issues or barriers that prevent the team from accomplishing their objectives.

Possible resource constraints may also impede a lean initiative. Some lean initiatives will require extensive manpower. For example, in the F-16 Contract Closeout project, there are approximately 1200 inactive backlogged contracts that are open for one reason or another. Lean may yield solutions that can keep future contracts from becoming inactive, but to close out the 1200 inactive contracts will require extensive manpower and time. As shown in the Global Hawk case study, some lean initiatives will require substantial upfront monetary investments in order to yield the desired results.

Even though capturing lessons learned is more often considered an afterthought, it is an important part of an enterprise's transformation. Lessons learned allow the rest of the enterprise to avoid mistakes and to exploit the successes of others. A plan to collect lessons learned should

be part of any preplanning event. It is much easier to collect lessons learned along the way rather than waiting until the end, avoiding the loss of valuable experiences.

The enterprise is a dynamic entity, constantly changing and adapting; to assume it is static would be a mistake. As lean takes hold in an enterprise, the enterprise will undoubtedly transform. Focusing on continuous improvement and learning is crucial to nurturing, perpetuating, and sustaining the lean transformation. The enterprise must continually monitor its lean state and refine its lean strategic plan based on new knowledge and self-assessments. Periodic reassessment includes the use of the Lean Enterprise Self-Assessment Tool (LESAT) and reaccomplishing an enterprise-wide VSM. The resulting insights from these tools along with lessons learned from lean initiatives must be used to refine the enterprise's lean strategic plan.

VII. IMPLEMENTING LEAN INITIATIVES

The TTL Roadmap (Appendix F) shows the enterprise's strategic path to a lean transformation. When implementing actual lean initiatives and projects, such as the Lean Now projects, a more tactical view is required. From the lessons learned and observations of Lean Now prototypes, it is clear that all followed the same general methodology. This section describes the generic phases and steps of implementing a lean initiative or project. Refer to the Observations and Lessons Learned section of this report for more discussion on each step.

Lean Now's implementation methodology can be divided into three phases: 1) Set-up, 2) Planning, and 3) Execution (See Figure 4). The first step in the Set-up Phase is acquiring leadership support. The next step is to set the vision, strategy, and goals of the initiative. The final step in the Set-up Phase is ensuring the organization has the infrastructure to support the initiatives. This infrastructure includes having a lean SME and a lean training curriculum. The Lean Now projects relied on LAI's industry partners for their support infrastructure. Until the Air Force establishes its own lean support infrastructure, enterprises and organizations not lucky enough to be designated a Lean Now project must either rely on consulting companies for their lean mentoring and training or they can learn by self-study and do it themselves. The latter is the less expensive option and may build a more robust internal lean expertise, but it requires more time and patience.

Once the Set-up Phase has been accomplished, the organization can begin the Planning Phase. The first step in the Planning Phase is to choose the area of focus. From our Lean Now prototypes, we see several methods were used: 1) pick the program with the greatest sense of urgency, 2) use a decision matrix, 3) use the VSM, or 4) have someone else choose it for you. Referring back to the "Choosing the Project" section, the organization must take into account the

time it will take for the initiative to show results. Remember, these are dependent on the organizational and technical complexities of the project.

The next step of the Planning Phase is to choose the initiative's team leader. The team lead must be knowledgeable and experienced in the processes to be examined. The leader must be a good communicator, open to new ideas, and possess the ability to juggle many things at once.

Once the team leader is chosen, he or she meets with the lean subject matter expert. First the lean expert makes sure the team leader is familiar with the basic concepts of lean. Next they discuss the project, its goals, resource availability and constraints, and any possible barriers to implementation. They also plan the lean event, including the team training requirements and the lean methods and tools to be used during the event.

The next step of the Planning Phase is to choose the lean team. All stakeholders must have a representative on the team. In order to make the team effective, each team member must have a practical experience in the process to be examined and have the backing of his or her leadership.

Once all the previous steps have been accomplished, it is now possible to hold a lean event. Depending on the event, the lean SME will facilitate the team's use of the appropriate lean tools and methodologies. After the lean event, the team leader must ensure each member of the team follows through on his or her assigned action items. This is done through constant communication and periodic status updates. The team leader is also responsible for communicating the status of the initiative to the organization or enterprise leadership. As the results from the lean initiative begin to materialize, it is important to apply any feedback or lessons to continuously improve the process. These lessons are also continuously collected, documented, and shared throughout the organization and enterprise.

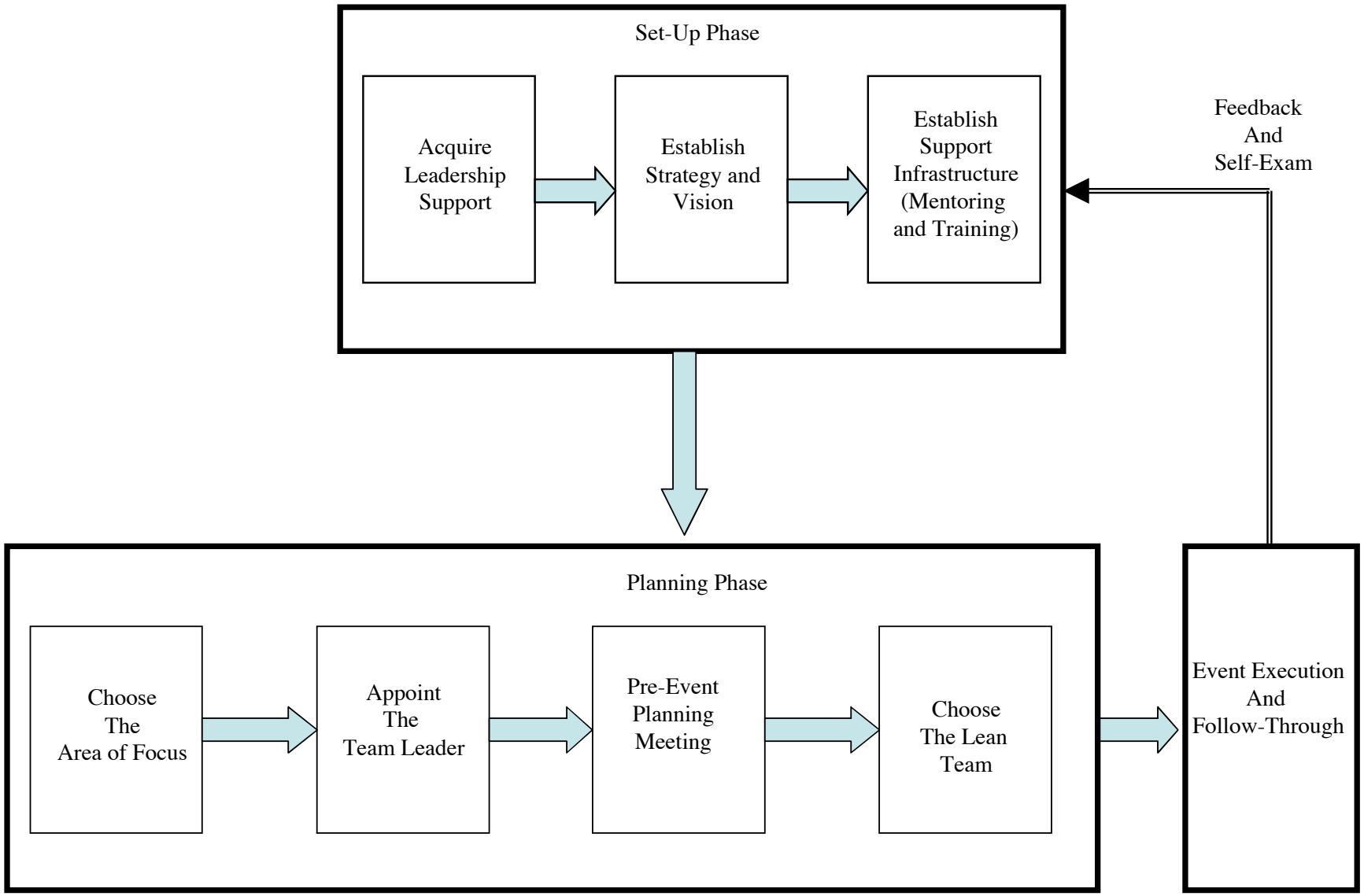


Figure 4. Lean Now Implementation Methodology

VIII. MOVING BEYOND LEAN NOW

Lean Now's first spiral of programs proved the feasibility of a government-industry focus on process interfaces to create enterprise-wide change. The results of the Lean Now prototypes are just the tip of the iceberg of what is possible when value is viewed from the enterprise level and all stakeholders are engaged. Change at the enterprise level is hard work and there are no shortcuts. No longer can one or two stakeholders make decisions affecting the entire enterprise. It takes the total enterprise working together to transform. Lean is a way to manage using this holistic approach.

Lean first caught on in the manufacturing setting because of its ability to reduce cost and time to manufacture a product, while increasing quality. Companies accomplished this by eliminating wasteful processes and by strategically partnering with its suppliers. There are many opportunities for lean in the Air Force synonymous to manufacturing. For the past few years, Warner-Robins Air Logistics Center has been using lean in its aircraft repair lines. They have been able to dramatically improve the F-15 stabilizer production and repair facilities' output by 60%. They decreased the time to repair by 80% and reduced the excess work in progress by 72%. The C-5's programmed depot maintenance line has used lean to increase its throughput of aircraft. Before starting lean in 2001, its throughput was 17 aircraft per year. Projections show they will reach their goal of 23 aircraft per year before the start of 2005. These accomplishments have not gone unnoticed. Delta Airlines recognized Warner Robins as "cutting-edge" and has started modeling their aircraft repair facilities after Warner Robins' operation (Wetekam, 2003).

Lean can also be used in the Air Force operational setting. The F/A-22 OFP Preparation and Load event was an example of lean's power on the flight line to increase sortie generation. Another example of the use of lean in Air Force operations was Air Mobility Command's

(AMC) lean initiatives from 1996 to 2001. AMC's initiatives started when it's commander at the time, General Walter Cross tasked Major Steve Newlon to increase the efficiency of the Travis AFB Aerial Port. Even with limited knowledge and training in lean, Major Newlon and his team were able to reduce Travis AFB's cargo processing time from 32 hours to 12 hours. Because of the results at Travis AFB, General Cross sent Major Newlon and his team to visit other AMC bases to lean out other processes. At McGuire AFB, the team was able to reduce the 621st Air Mobility Operations Squadron deployment processing cycle time from 10 hours to 3.5 hours, reducing man-hours from 320 to 32, and eliminating 50% of the process steps. Major Newlon and his team also leaned out processes such as mail processing, passenger processing, and aircraft washing. Realizing the power of lean, AMC established a lean facilitators course to train personnel from various AMC wings to facilitate and lead lean events. The AMC lean initiative was very successful in accomplishing command wide improvements until General Cross's retirement in 2001 (Newlon, 2003).

In July 2003, the Air Force Personnel Center (AFPC) announced it was using lean to improve their Civilian Fill Action Process. In AFPC's current process, it takes over 135 days from the time a job is announced to the time someone is in place. AFPC's initial work on the process is already showing results. Their first lean events have generated over 40 suggestions that will cut the time to generate a list of eligible candidates after the job is announced from 31 days to 12 days. AFPC has more lean events scheduled for the upcoming months focusing on other aspects of the process.

Even though Lean Now was focused at the enterprise level with multiple industry and government stakeholders, any Air Force organization can use lean at lower levels to achieve

results. The examples of Warner Robins ALC, AMC, and AFPC show that lean is applicable at all levels and throughout the entire range of Air Force processes and operations.

The next spiral of Lean Now is well underway. Once again, the Air Force is leveraging the LAI consortium's knowledge base and expertise to train and mentor these next round of initiatives. Once again, the LAI industry partners are providing the lean SMEs to promote change. In order for the Air Force to nurture, grow, and sustain lean and transformation on its own, it must develop its own infrastructure of lean experts and change agents. Only through a long-term commitment can the Air Force hope to make significant improvements to its processes.

Commitment starts with leadership. Air Force leaders must do their part by educating themselves about the principles of lean and exploring the possibilities lean brings to enterprise-wide change. It is important leaders truly understand the concepts of lean before pushing their organizations. Misuse of "lean" will only lead to employee frustration and resentment making lean just another passé management fad.

The first three Lean Now prototypes had very high top-cover from very senior Air Force leaders. This allowed the enterprise leaders and lean teams the opportunity to take risks and try options never before considered—they knew it was OK to make mistakes. The senior Air Force leaders fully understood the lean principle of learning and continuous improvement and knew the only way to fail is to not try. In order for lean to spread, future leaders must continue to champion continuous improvement and the risk taking mindset. If the Air Force truly wants to embrace the concepts of innovation, transformation, and have an expeditionary mindset, they must back up their words with actions. The Air Force needs to reward not only results, but also

the willingness to take a chance and try something new. In this way, the spirit of innovation will be institutionalized.

Whatever the final outcome of the first three Lean Now prototypes, it is safe to say lean has made an impact on the F/A-22, Global Hawk, and F-16 programs. The real value of Lean Now is not the discrete results achieved but the building of an infrastructure for change and transformation. Through Lean Now, awareness of lean throughout the Air Force has grown and an infrastructure for change has emerged.

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APPENDIX A

Members of the Lean Aerospace Initiative Consortium

APPENDIX B

Types of Waste

1. **Excess Inventory** – Any unnecessary supplies or materials that does not support jus in time delivery.

Characteristics include:

- Long process lead times
- Interest charges and opportunity costs
- Build up of material between processes (queues)
- Extensive rework when problems arise
- Additional material handling

2. **Unnecessary transportation** – Any unnecessary material movement that does not support a lean value stream.

Characteristics include:

- Multiple moves of material
- Multiple storage locations
- Damaged materials
- Poor facility layout

3. **Over-Processing** – Effort which adds no value to a product or service, including work that can be combined with other processes or enhancements that are transparent to the customer.

Characteristics include:

- Process bottlenecks
- Lack of clear customer expectations
- Redundant approvals
- Extra copies and excessive information
- Insufficient policies and procedures

4. **Waiting** – Idle time in which no value added activities take place, including people waiting and products waiting to be processed.

Characteristics include:

- People waiting for a machine
- People watching machines run
- Machine or material waiting for a person
- Long setup times
- Inconsistent work methods
- Lack of proper equipment or materials

5. **Unnecessary motion** – Any movement of people that does not add value to the product.

Characteristics include:

- Looking for tools and parts
- Excessive reaching or bending
- Material too far apart
- Picking up things only to set them back down
- Poor facility layout

6. **Producing defects** – Repair of a product or service to fulfill customer requirements.

Characteristics include:

- Questionable quality
- Incapable processes with excessive variation
- Extra manpower to inspect, rework, and repair
- Additional inventory
- Missed shipments, deliveries, and deadlines

7. **Overproduction** – Producing more than needed, including working ahead and producing faster than needed.

Characteristics include:

- Inventory stockpiles
- Extra or oversized equipment
- Unbalanced material flow and confusion about priority
- Build ahead of demand
- Extra storage locations and manpower

8. **Injuries** – Work-related personnel injuries causing employees to miss work. Leading causes are poor ergonomics and slips, trips, and falls.

Characteristics include:

- Injured personnel
- Near misses
- Lost work days
- Poor flow of goods and services.

*Adapted from the LAI Air Force Lean Now Facilitators Course Training

APPENDIX C

Introduction to the Lean Enterprise Self-Assessment Tool (LESAT)

The Lean Enterprise Self-Assessment Tool (LESAT) was developed by the LAI consortium to help leaders assess their enterprise's current state of "leanness" and readiness for change. If accomplished periodically, the LESAT can provide a measure of effectiveness of the enterprise's lean initiatives. The LESAT can also identify areas requiring more attention. The LESAT however, cannot be used to compare and contrast the lean state of different enterprises. Because enterprises have unique goals and objectives, the results of a LESAT assessment are only meaningful to a particular enterprise.

The LESAT, as originally developed, focused on industry business processes. As government organizations started to embrace lean, it became necessary to develop a version of LESAT that could assess government unique processes. The Government LESAT was developed by LAI in the Spring of 2003 and is currently undergoing testing.

The LESAT is organized into three sections: 1) Lean Transformation/Leadership, 2) Life Cycle Processes, and 3) Enabling Infrastructure. Each group contains enterprise level processes that must transform in order to achieve a lean enterprise. LAI structured the LESAT to give enterprises a better understanding of the hierarchy of its processes.

- Lean Transformation/Leadership – The processes and leadership attributes nurturing the transformation to lean principles and practices
- Life Cycle Processes – The processes responsible for the product or service from conception through post delivery support
- Enabling Infrastructure – The processes that provide and manage the resources enabling the enterprise operations.

Each section of the LESAT is comprised of lean practices that enterprise leaders use to rate the current state of their enterprise. The ratings are on a scale of 1 through 5 -- a Level 1 means there is some awareness of the particular lean practice and that there may be sporadic improvement activities underway; a Level 5 means the enterprise does exceptionally well applying the lean practice, using a well-defined and innovative approach to deploy it throughout the enterprise. ***It is important to remember that all practices in these three sections are expressed at the enterprise level.***

References:

Lean Enterprise Self-Assessment Tool (LESAT). Lean Aerospace Initiative, Massachusetts Institute of Technology, Version 1.0, 2001. (http://web.mit.edu/lean)

A copy of the LESAT and the LESAT Facilitators Guide are available on the LAI webpage.

U.S. AIR FORCE

F/A-22 Enterprise VSM Event Plan Summary

Event Description : Conduct a value stream analysis on the enterprise value stream for the F/A-22 weapon system focusing on the interface processes between the F/A-22 Team Members.

Preliminary Objectives :

-Develop a detailed lean improvement plan
- -- Clear, achievable targets in cost and span reductions
- -- Data driven decisions on improvement areas
- -- Milestone-driven schedule of lean events to achieve targets

Boundaries/Value Proposition: This activity will document the breadth of the F/A-22 value stream running from issuing RFP to processes that support the fielded system. The focus will be on the key interfaces between the AF SPO team (SPO, DCMA) and the contractor team (LM, Boeing, & P&W). Interfaces above the AF SPO team (ie, those with AF staff or DoD) as well as interfaces below the contractor team (ie suppliers) will not be documented and analyzed during this event.

Process Information: Value stream mapping has been used as a tool on the F/A-22 Program, primarily in the build team area. Past VSM activity will be used as input for this event where appropriate.

Event Dates: February 3-7, 2003
Dayton, OH

Co-Leaders : Don Handell (LM F/A-22)
Greg Staley (F/A-22 SPO)

Team Members:

Briggs (LM)	Sackett (F/A-22 SPO)
Baker (LM)	Thurling (F/A-22 SPO)
Alliston (LM)	Anderson (F/A-22 SPO)
Autry (LM)	YFS (SPO)
Pieczonka (LM)	YFF (SPO)
Gall (P&W)	Bryan (LAI)
Young (LM)	Sudderth (DCMA)
Nuttbrock (Boeing)	McDaniel (DCMA)
Smith (Boeing)	Phillips (DCMA)
Wheat (LM)	YFK (SPO)
Tier II IPTs On Call	YFX (SPO)

Process Owner: Ralph Heath (LM) & Col Thomas Owen

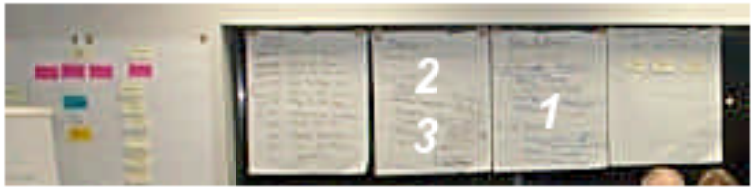
Coach: Tracy Houpt (LAI SME)

Current Situation and Problems: A strategic lean implementation plan across the entire F/A-22 weapon system has not been developed. The plan is needed to help prioritize, schedule, and capture savings from future lean events to support F/A-22 Program Goals. This event will define a portion of the overall strategic lean implementation plan.

Value Stream Map Process

U.S. AIR FORCE

1) Define Boundaries
2) Define the Value
3) Define the Outcome
4) Walk/Understand the Flow
5) Observe and Gather Data
6) Map the Value Stream
7) Analyze the Current Condition
8) Develop Ideal State
9) Develop Future State Map
10) Develop Action Plan (Chart 15)



U.S. AIR FORCE

Top 20 Lean Projects From VSM Event

Title	Owner	Target Date
Data input to IMIS	Ktr	March & June
Develop Parts Shortage Database for Recurrency	Ktr	March
Multiple Part ID	Ktr/SPO	March
Pre-Design Kaizen of Modernization Process	Ktr/SPO/ACC	March
Develop Process to Reduce Source Inspection	Ktr/Subs	March
Increase Emphasis on Corrective Action on High SR&R	Ktr	March
Readily Available Chase Aircraft	Ktr/SPO/ACC	March
Readily Available Pilots for Marietta	SPO/DCMA	March
Reduce Finishes Rework After Flightline Activities	Ktr	April
Program Budget and Requirements Alignment	Ktr/SPO/ACC	April
CCB/CRB/AVA Training/Reduce Returns	Ktr	April
Baseline Master Schedule to Manage Program	Ktr/SPO	April
Redundancy of Contractor and SPO AVA and CCB Boards	Ktr/SPO	May
Load MRP with Firm Schedule at LL Authorization	Ktr	3rd Qtr. 2003
Optimize Value Stream Map for PALS	Ktr/SPO/ACC	3rd Qtr. 2003
Distribution of Budget to EVMS	Ktr	3rd Qtr. 2003
Optimize Value Stream for Training System	Ktr/SPO	3rd Qtr. 2003
Redundancy of Acceptance Flights	Ktr/SPO/DCMA/ACC	4th Qtr. 2003

Top 20 Projects Will Improve Program Execution

Global Hawk Enterprise VSM

U.S. AIR FORCE

Event Description:
Conduct an enterprise level value stream analysis for the Global Hawk program focusing on the key interface processes between major stakeholders of the Global Hawk enterprise level team members.

Preliminary Objectives:
Enterprise Level Value Stream Mapping of Global Hawk
- Map Key Process Interfaces Within Program
- Identify Agreed Upon Improvement Areas
- Establish Targets and Metrics for Cost / Cycle Time Reductions
- Determine Schedules / Milestones for Follow-on Events

Value Proposition :
This activity will enable the Global Hawk program to implement continuous process improvement initiatives by utilizing the enterprise level value stream map as a meaningful model (roadmap) for applying lean principles throughout the Global Hawk enterprise.

Process Information:
Value Stream Mapping is being used as a primary lean tool within the Global Hawk program to identify key areas of waste by documenting "current state" conditions and providing clear visibility to prioritize and implement improvement initiatives.

Event Dates: February 3-7, 2003 NG Fairborn, Ohio

Co- Leaders: Lt. Col. David Riel, USAF
Chris Cool, Northrop Grumman

Team Members:

Tim Miley (GH)	Candy Henderson (USAF)
Joe Sanfilippo (GH)	Tony Braswell (ASC/RAV)
Joy Trott (GH)	Bill Goetz (GH SPO)
Dave Corbeil (GH)	Jim Crouch (GH SPO)
Bill Eddins (GH)	Nancy Byrge (USAF)
Eric LaMoure (GH)	Dean Porter (ASC/RAV)
Jerry Owen (GH)	Randy Carpenter (ASC/RAV)
Chris Paulsen (GH)	Jon Specht (USAF)
Pete Sterling (GH)	Vic Mehta (GH DCMA)
Tom Moss (USAF)	Ken Fehr (USAF)

Process Owners: Col. Scott Coale & Carl Johnson

Coaches: Robert Goetz (NG / LAI SME)
Terry Bryan (LAI / MIT SME)
Nancy Fleischer (Raytheon/LAISME)
Renee Linehan (Raytheon/ LAI SME)

Current Plan For Action:
Global Hawk Lean Now Initiative Plans Include:
Supplier Focused Events – ISS Event Raytheon El Segundo
ICS Event L-3 Communications
Lean Now Workshop Training – Rancho Bernardo
Enterprise Level VSM – Wright Patterson AFB
Alpha Contracting Event – Rancho Bernardo
VSM Follow-on Kaizen Events & LESAT Assessment

Lean Now Enterprise VSM Event Ohio

- Created Global Hawk Enterprise Value Stream Map
  - Developed Tier 1 & Tier 2 "Current State" Global Hawk Program VSM's
  - Selected 5 Key Processes for Follow-on "Kaizen" Events
    - AF Requirements Development and Program Planning
    - Alpha Contracting
    - EMD Development and Test
    - Production / Supply Chain
    - Change Process
- Events Planned to Focus on Agile Processes, Cycle Time Reduction, Improved Quality and Cost Affordability in Support of Spiral Concepts

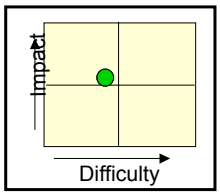
APPENDIX F
F-16 Lean Now Initiatives

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #1

Monitor/Improve Cancelled funds process

X Work within team

Elevate



Estimated Start Date: 1-30 Apr 03
SPO develop tracking spreadsheet identifying each current-for-cancelled requirement. Status to be provided bi-weekly.

Process Owner:
2Lt LaTonya Kelly (YPF)

Potential Team Leaders & Members:
Tom Frye (SPO), DFAS, DCMA,
Tom Carney (LM), Pattie Boyd (LM)

Implementation Costs:

Description:
When contractor sends an invoice up for payment – there is no feedback on status if the contract has cancelled funds
DCMA is usually aware that a contract has cancelled funds – maybe a feedback loop from DCMA/SPO to LM Aero

Reason for Activity:
Replacement of cancelled funds on a more timely basis.
Use feedback to drill into the reasons for the delays and work corrections as necessary

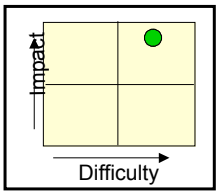
Impact:
- Data available to identify process delays
- Better information and possibly more timely payment

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #2

Human Resource Allocation

X Work within team

Elevate



Estimated Start Date: (1) Identify choke points and process to eliminate them;
(2) Use existing techniques to reallocate resources as required;
(3) Identify and provide any training that will enhance efficiency and effectiveness;
(4) Modify contract closeout process for smaller value contracts to expedite closeout;
(5) Identify specific work that could be eliminated, reduced, modified, or not value-added, including metrics;
(6) Identify effort(s) to be automated;
(7) Investigate use of OSD/higher headquarters mandated metrics versus creating new metrics – where applicable;
(8) HQ DCMA provide "Tail Chart" (regarding F-16) to SPO/LM

Process Owner: Chuck Jackson (SPO) - Champion; Mark Perehoduk (LM); Jeff Gardiner (DCMA); Larry Syrus (DCAA)

Potential Team Leaders & Members:
Mark Perehoduk*/Tom Frye – JMC Metrics (action plan to ensure added value);
Jeff Gardiner (DCMA) and Mark Perehoduk* (LM), LAI/LM21 SME -- Choke Point Identification

Impact:

Implementation Costs: TBD

Description: Contract closeout process is human resource constrained. Requires forensic science skills from a limited pool of experts. Resources are currently "task saturated".

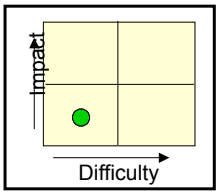
Reason for Activity: Backlog of inactive contracts is not being eliminated in a timely manner. Limited resources sometimes are moved to non-contract closeout efforts, or to close-out *related* work (i.e. process redesign, metrics/reporting) but the effort does not progress the contract closeout process.

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #3

Establish Guidelines for Closure via Negotiated Settlements (subcontracts)

X Work within team

Elevate



Description: Slow closeout of low dollar cost-plus subcontracts delays prime contract closure as assist audit appear to be required for all cost-type subcontracts. Subcontracts must be closed in order to close out prime contracts. Consumes additional resources, takes additional time, and may be minimal value.

Proposed Action: Establish enterprise-level MOA between DCMA and LM Aero. Possible JMC action required.

Reason for Activity: Contractor needs to demonstrate adequate accounting systems are in place at subcontractor. As there is no threshold associated will assist audits and/or negotiated settlements. May not be cost-effective to perform subcontractor audits on small value cost-plus subcontracts. Audits required by FAR or policy (needs to be verified).

Estimated Start Date: (1) 30 Apr – 15 May 03 Team needs to determine what requires audits on cost-type contracts. (2) 1 Jul – 30 Aug 03 Once audit requirement and scope identified, present issue to management to determine whether or not to pursue. (3) NLT 30 Sep 03 Investigate other LM solutions.

Process Owner: DCMA

Potential Team Leaders & Members: Viola Dean* (DACO), Karen Scarberry (DCMA), Linda Carpenter (DCAA), Dan St. John (DCAA) Don Wheat (LM Aero)

Implementation Costs:

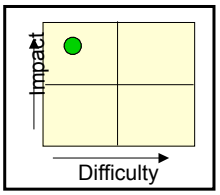
Impact: TBD – Contract closeout process may be shortened.

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #4

Establish Vehicle to Change Data Purchase Order Accountability

X Work within team

Elevate



Description: "Life of program" data requirements from subcontractors require long-term purchasing agreements. Data deliveries extend beyond prime contract period of performance.

Proposed Action: Company-owned work orders (no cost) for continued data requirements would facilitate prime contract closure. (Utilize same philosophy as Property Accountability contract.)

Reason for Activity: LM Aero current purchase orders are tied to prime contract via work order system.

Estimated Start Date: 24 Mar – 30 Apr 03

Process Owner: LM Aero Business Management (Tony Viotto*)

Potential Team Leaders & Members: Marilyn Decusati (LM), Vince Blankenship (LM), John Larson (LM), David Glidewell (LM)

Implementation Costs: TBD

Impact: Impacts all production prime contracts. Also drives strategy on other long-term purchased requirements.

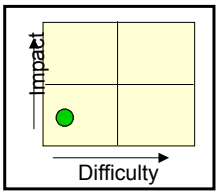
F-16 Contract Closeout Lean Event - Mar 17-20, 2003

#5

Post-Award Audit – Schedule & manage tasks within close-out schedule

[X] Work within team

[ ] Elevate



Description: Cannot close contract with Post-Award Audit issues open – probable defect pricing audit. Example: 2120 (1 FMS buy) – needs physical completion letter from PCO.

Possible alternative – settle using Set-Aside process .

Reason for Activity: Prevent contract closeout delay.

Estimated Start Date: JDI – Meeting scheduled for week of 24 Mar 03 (LM Aero & DCAA). Estimated completion date 15 May 03.

Process Owner: Bob Weese*

Potential Team Leaders & Members: Larry Syrus/Bruce Bartlett (DCAA), Bob Weese (LM Aero), Judy Kahler (ASC/PKF)

Implementation Costs: N/A

Impact: Two or three major F-16 program contracts' issues will be resolved (Peace Vector IV)(USAF Multi-Year III)(Peace Onyx I)

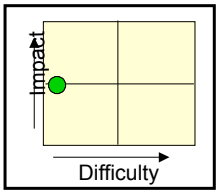
F-16 Contract Closeout Lean Event - Mar 17-20, 2003

#6

Timely Purchase Order Closures

[X] Work within team

[ ] Elevate



Description: Some subcontract closures do extend past planned prime contract closure date.

Planned Action: Realign and track subcontractor closure schedules to match prime contract schedule in ECS.
Investigate interface with material purchasing management system module (PMS) and Electronic Contracting System (ECS).

Reason for Activity: ECS automated system now available to track subcontractor closure schedules.

Estimated Start Date: 24 Mar 03
ECD 30 Jun 03

Process Owner: Marilyn Decusati*

Potential Team Leaders & Members: Don Wheat (LM), Bob Weese (LM), Paul Mahar (LM), Ralph Beaugez (LM), Nancy Bell (LM IS&T)

Implementation Costs: TBD

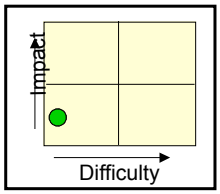
Impact: Avoid delay in prime contract closure.

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #7

Eliminate False Loan-Borrow Signals

X Work within team

Elevate



Estimated Start Date:
Week of 24 Mar 03 – Accounting will provide LM Contract Closeout list of work orders. Investigate problem and develop action plan to resolve and close issue – ECD 30 Jun 03.

Process Owner: David Glidewell* (LM Aero Accounting)

Potential Team Leaders & Members:
Don Wheat (LM Aero); Bob Weese (LM Aero); Nancy Bell (LM IS&T)

Implementation Costs: $200

Impact: 132 work orders affected

Description: Run "Spec Prod" or similar software more than one time a year to expedite contracts entering audit phase. Automated process desired – currently process is manual.
Also, Work Order closure, as a whole, needs to be investigated – expedite closeout

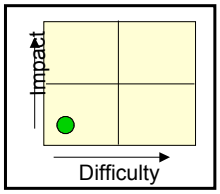
Reason for Activity: Expedite work order closeout for prime contract closeout. Eliminates "loan-borrow" loops in software which prevents work order closure.

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #8

Settlement versus ACRN-Level Reconciliation #1

X Work within team

Elevate



Estimated Start Date: 24 Mar – 7 Apr 03: Resolve questions below within 1-2 weeks. (1) Provide Susan Carter with a list of contracts being held up in DFAS and DFAS POCs. (2) Determine why 2038 final mod has not been processed. (3) Determine if DFAS has philosophical disagreement with settlement process. If "no", institutionalize process or assign one DFAS POC for all F-16 contracts.

Process Owner: Mark Jordan (ASC/YPK)

Potential Team Leaders & Members:
Tom Frye (ASC/YPK); Susan Carter (DFAS-CO)

Implementation Costs: TBD

Impact:

Description: Historically, F-16 has successfully settled large-value contracts. There is concern that GAO July 01 audit (#01-747) and DoD IG will prohibit use of settlement procedures. However, settlement was correctly accomplished on all F-16 contracts (including posting adjustments). Desire institutionalization of settlement procedures.

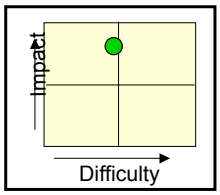
Reason for Activity: Need for institutionalizing settlement process to reduce amount of resources and time required to process and approve final contract mod.
Develop cost-benefit analysis tool to determine when reconciliation is not cost effective for contract closeout and settlement should be pursued. DAU--Scoop Cooper and Kevin Carman are investigating and developing this risk management tool.

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #9

Expand DCMA Q-Final Authority

Work within team

X Elevate



Estimated Start Date: (1) 1 Apr – 31 May 03 HQ DCMA and Ft Worth DCMA review FFP contract examples to determine applicability of Q Final authority expansion. (2) 1 – 30 Jun 03 After sample contracts reviewed, work with DFAS to determine if authority can be expanded.

Description: Expand Q Final authority to fixed price contracts. Currently Q Final only applies to cost-type contracts.

Proposed Action: Annotate in ACO notebook, excess or remaining funds and remove from contract without deobligation mod.

Process Owner: Nayda Katzaman (HQ DCMA)

Potential Team Leaders & Members: Simone McDuffy (AF Accounting – CPAS OPR, DFAS Dayton); Karen Scarberry (DCMA), Bob Weese (LM)

Reason for Activity: Expansion of this authority eliminates the need for a final deobligation contract mod resulting in resource savings -- manhours. Additional effort required for final mod may not be cost effective. Also, contract closeout process may be shortened by the change in this closeout step.

FAR 42-302 addresses need to accomplish deobligation mod.

Implementation Costs:

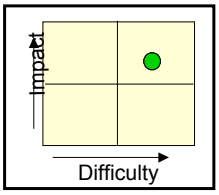
Impact: Estimated $2K per contract to write/process final contract mod * 10% of 1,200 contract backlog = $240K minimum savings now + savings on future contracts being closed.

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #10

DFAS one POC for F-16 Contracts

Work within team

X Elevate



Estimated Start Date: 24 Mar – 30 Jun 03

Process Owner: Lt Col Bruce Johnson* (HQ AFMC DFAS Client Exec)

Description:
Create a Pilot team for F-16 (DFAS representative with a SPO contracting officer)
When a issue occurs (funding or reconciliation). Assign a DFAS champion to work issues

Potential Team Leaders & Members:

SPO, DFAS, DCMA

Implementation Costs:
Resources driven

Reason for Activity:
Reduce length of close-out process
Resource allocation concerns
Multiple contacts create Muda

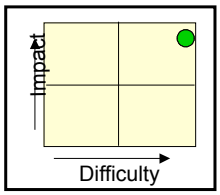
Impact:
- More timely contract close-out.
- Improved communication and reduced frustration

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #11

More Cost Effective Approach for Small Value Cost-Type Contracts

Work within team

X Elevate



Description: Many resources expended on small-value cost-type contracts (under $10K). Do not realize the value is small until investigation effort is complete. Current procedure uses billing rates to expedite closure.

Reason for Activity: More effective, cost efficient use of contract closeout resources (i.e. use on cost-type T&M contracts) ("dollars chasing after dimes"). Focuses government to function more like a business as directed by SecDef.

Develop a business case to assess if resource costs to closeout contract are excessive and would not be a good return on investment – applies common sense approach.

Work towards implementation of CACWS or limit audits to sampling. No audit exceptions have occurred at LM Aero over the past three years, therefore risk is manageable.

Estimated Start Date: (1) 24 Mar 03 -- Utilize DoD Ad Hoc working group to interject this issue for review. Provide HQ DCMA with contract samples to take forward for consideration; (2) Ad Hoc Working Group reports out – event driven; (3) Evaluate idea for SPI – Topic for 30 Jun 03 JMC;
Other Actions: (4) 24 Mar 03 -- HQ DCMA to provide T&M quick closure procedures already in place; (5) Develop quick estimate for closeout process using historical MOCAS data using "de minimis" approach; (6) Apr 04 -- Apply DAU study results (risk management approach to contract closeout);

Process Owner: Chuck Jackson* (SPO)

Potential Team Leaders & Members:
(1) Chuck Jackson; (2)Nayda Katzaman/Denise Eldridge* (HQ DCMA), Karen Scarberry (DCMA), (3) Mark Perehoduk* (LM

Implementation Costs: TBD

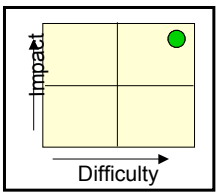
Impact: 20% of F-16 contracts affected: 50 to 100 manhours saved per contract => $10K minimally saved per contract; $10K/contract * (20% of 1200 contracts) = $2.4M F-16 savings + all future contracts

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #12

Settlement versus ACRN-Level Reconciliation #2

Work within team

X Elevate



Description: Historically, F-16 has successfully settled large-value contracts. There is concern that GAO July 01 audit (#01-747) and DoD IG will prohibit use of settlement procedures. However, settlement was correctly accomplished on all F-16 contracts (including posting adjustments). Desire institutionalization of settlement procedures.

Reason for Activity: Need for institutionalizing settlement process to reduce amount of resources and time required to process and approve final contract mod.

Estimated Start Date: TBD – Estimated 15 Apr 03 Release of IG Audit Report.

Process Owner: Mark Jordan* (ASC/YPK)

Potential Team Leaders & Members: Nayda Katzaman, Denise Eldridge (HQ DCMA), Tom Frye, Chuck Ingram (SPO), ASC/PK, Dan Rosner (SPO), ASC/ACE, OSD, Susan Carter (DFAS)

Implementation Costs: TBD

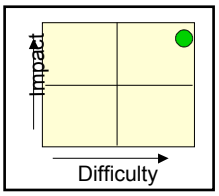
Impact: Potentially only applies to 1% of contracts if based on MOCAS database

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #13

Address Unintentional Consequences of M Account Removal

☐ Work within team

☒ Elevate



Estimated Start Date: TBD – Team needs to scope issue and bring back to management team for decision to go forward or not go forward.

Process Owner: SPO

Description: Issue identified: Closeout delayed due to resources working canceling or cancelled funds issues.
- M Account was available to pay cancelled year bills. Perceived abuse caused legal action to repeal the account. Punitive legislation was put in place to ensure funds propriety is followed.

Potential Team Leaders & Members:
Leader: Karen Scarberry/Pattie Boyd
Members: Kendra Kershner, Dan Rosner, DCMA, DCAA, DFAS

Implementation Costs: TBD

Reason for Activity:
Unintentional consequences have occurred as a result of the M Account going away. Relief is requested from these consequences: (1) unreconcilable contracts (appropriation integrity maintained); (2) resolving NULOs; (3) increased focus on canceling year – 74 contracts with ULO of $363M – final billing cancelled amounts unknown

Impact:
Driving current-for-cancelled bills and impacting new war-fighter capability
Inefficiently using human resources to deal with canceling/cancelled year problems and pulling the personnel from contract closeout.

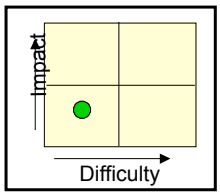
Place in Parking Lot

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #14

Consider Settlement Write-off

☒ Work within team

☐ Elevate



Estimated Start Date:
1 to 3 months

Process Owner:
LM Aero

Potential Team Leaders & Members:
LM Aero, SPO, DCMA

Description:

Consider settlement write-off of remaining low dollar tasks, on large F-16 contracts. (99% complete)

Consider as a possible offset in the settlement process

Implementation Costs:
- Strain on program resources
- Difficult to define write-off
- Must define CTC

Reason for Activity:
- Remaining low dollar tasks prolong the length of the contract.
- Possible strategy going forward

Impact:
- Only one F-16 contract to benefit, maybe two (0037,0247)
- Close-out process is already at capacity
- Contracts should close more quickly

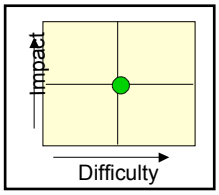
EXTERNAL TO LAI – NOT PART OF INITIATIVE – Put in Parking Lot

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #15

Waivers

[X] Work within team

[ ] Elevate



Estimated Start Date:

Process Owner:

Potential Team Leaders & Members:

Description:

Reason for Activity:

Implementation Costs: TBD

Impact:

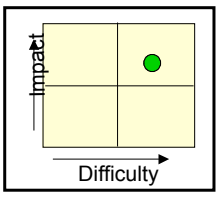
Place in Parking Lot

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #16

MOA to Close low dollar contracts (funding)

[ ] Work within team

[X] Elevate



Estimated Start Date:
1 to 3 months

Process Owner:
DCMA & LM Aero

Potential Team Leaders & Members:

DCMA, LM AERO, DCAA

Description:
Request a MOA to close low dollar contracts (with cancelled funds) by using O/H pool.
Proposed to settle < $ xx
Waiver for appropriation of funding (federal appropriations law)
Identify possible candidates

Alternative: Gather several contracts together with cancelled funds and request funds (one time event)

Reason for Activity: Currently have a MOA for final invoice < $ 1k in use at Fort Worth ($ <5k Palmdale)

Implementation Costs:

Impact:
- Reduce close-out time for old contracts
- Concern of O/H pool used for cancelled funds
- Possible payment twice

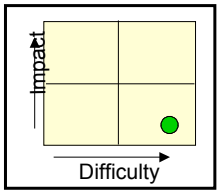
Eliminate

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #17

Moving Existing tasks (active, almost complete contracts)

[X] Work within team

[ ] Elevate



Estimated Start Date: LM Aero needs to identify the remaining tasks to be accomplished on "Tom Carney's contracts" – ECD 31 Mar 03

Process Owner: LM Aero, Tony Viotto

Potential Team Leaders & Members: F-16 SPO, DCMA, LM Aero (John Larson, Mark Perehoduk), DCAA

Description: To evaluate moving existing task to a new contract vehicle allowing quicker closure of the contract. This applies to older large contract that are virtually complete (99%).

Implementation Costs:
- Strain on program resources
- Manpower/cost to change WOs/create new contracts and close (LM Aero, SPO, DCAA)
- Difficult to define work to move
- Must define CTC
- Must a lot current year funds - immediately

Reason for Activity: Expedite the contract into final closeout.

Impact:
- Only one F-16 contract to benefit, maybe two (0247,0037)
- Close-out process is already at capacity
- Contracts should close more quickly

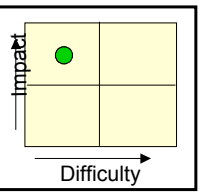
NOT PART OF LEAN NOW INITIATIVE – Eliminate

F-16 Contract Closeout Lean Event - Mar 17-20, 2003 #18

Relief on 1% limit on current for cancelled (funding)

[ ] Work within team

[X] Elevate



Estimated Start Date:

Process Owner:

Potential Team Leaders & Members:

Description:
Fold into the "M" accounts issue
We have not run-up against this limit in the past.

Implementation Costs:

Reason for Activity:

Impact:

Eliminate

APPENDIX G

Introduction to the Transition to Lean Roadmap (TTL)

The Lean Aerospace Initiative's Transition To Lean (TTL) Roadmap provides a conceptual framework for an enterprise's strategic transition to lean. It provides a flow of actions required to initiate, sustain, and continuously refine the enterprise's effort to becoming lean.

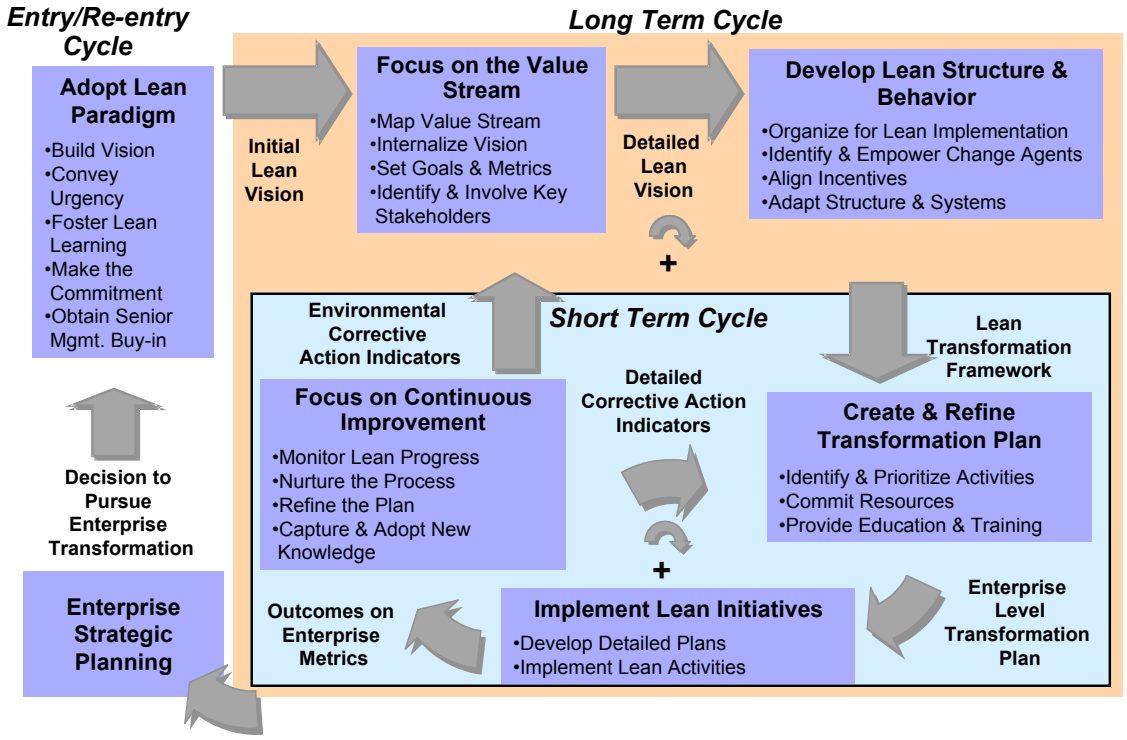


Figure G. Transition To Lean Roadmap

Based on the principles of lean, the TTL shows the top level of flow of primary activities and then breaks down each activity into key tasks. It prescribes a logical path to follow when implementing lean. It also shows that there are some activities that have to occur before performing any lean activities. These activities build on one another and skipping any will result in a less than optimum implementation.

Reference:

Transitioning To A Lean Enterprise: A Guide for Leaders, Vol. I, II, III: Roadmap Explorations. Lean Aerospace Initiative, Massachusetts Institute of Technology, 2000. (http://web.mit.edu/lean, then click on "Products")

APPENDIX H

What is a Value Stream Map?

The Value Stream Map (VSM) is the major tool used in lean to graphically show the linkage and interrelationships of different stakeholder value throughout a process. This linkage of all the value in a process is known as the value-chain or value-stream.

A VSM is more than a picture of the steps in a process. A VSM analyzes each step to determine why the step occurs, what happens during the step, how long it takes, what resources are used, and what is produced. Any step in the process that does not directly add value is either waste or a non-value added necessity (See Appendix B--Types of Waste).

The power of the VSM is that it not only serves as a tool to identify value and non-value added areas, but it serves as a model describing the interrelationships among all stakeholders. Since building the VSM requires participation of all stakeholders, it can be used by each stakeholder to understand the current state of the value chain, and their role and others roles in the value chain. Once there is an understanding of the current state, the VSM is used to map the desired future state. Metrics to measure the progress from the current to the future state can be identified. These metrics when used in conjunction with the VSM can give all stakeholders an excellent visual tool for common understanding.

There are three basic steps to in mapping out a value stream:

- Arranging the process steps and information flows
- Collecting performance data on the tasks and information flows
- Evaluating how value is created (McManus, 2003).

McManus (2003) offers some basic advice for developing a VSM.

- Follow the work: To understand the true process, you have to know all the steps and procedures the product goes through. Start with the inputs to the process and follow the product until the end of the process, continually asking, "What happens next?" If there are some variations in the process, follow a "typical" job. This implies knowing the boundaries (start and end) of the process. If you don't know where your process starts, start with the output and work backwards. If the process is complex, you may want to trace the work both ways.
- Collect the information yourself: The best way to follow the work is to physically walk the process. The key here is to understand how it is "really" done versus the documented procedures. You should talk to those actually working the process to get an idea of what it takes to do the task and why they do it that way.
- Exploit existing process information resources, cautiously: Use all available data on the process to help you understand the process. This includes time cards, databases, quality reports, and test reports. You may not need to know the information in the report, but the dates of the reports may give you insight into important factors such as cycle time.
- Map "in pencil": McManus advises against "spawning" multiple versions or revisions. Use the same VSM and revise it on the spot. Many teams use butcher paper covering the walls of a room and "post-it" notes to map their value streams.

- Map the whole value stream: It's important for everyone to work on the entire value stream first before breaking out into groups. The goal is to achieve a holistic, big-picture view of where the value is created versus a step-by-step process chart.

Refer to the following for more information on Value Stream Mapping:

1. "Product Development Value Stream Analysis and Mapping Manual (PDVSM)." Metis Design, Lean Aerospace Initiative, Massachusetts Institute of Technology. Draft version, Feb. 24, 2003. (currently a draft – contact LAI for copies).

2. *Learning to See: Value Stream Mapping to Add Value and Eliminate Muda*, by Mike Rother and John Shook. Lean Enterprise Institute, Brookline MA, 1999.

3. Lean Aerospace Initiative, Massachusetts Institute of Technology, Cambridge MA. (web.mit.edu/lean).

4. Attached is Lockheed Martin's VSM Preparation Checklist

Value Stream Mapping (VSM) Event Checklist

PREPARATION

By: _____ **Date:** _____ **Prep. % Complete:** _____

Team: _____

3rd Week Before Event: (% Comp:_____)

- ☐ 1: Select area and topic. (Complete Project Summary)
- ☐ 2: Meet with Program Manager(PM)/Functional Leaders(FL) to:
  - Prioritize Value Streams within Area
  - Secure Full Time Participation of Team Members
  - Obtain PM/FL Commitment to Event Follow-up
  - Determine location and schedule of event
- ☐ 3. Determine Initial Event Boundaries
- ☐ 4: Define team leader, co-leader and the team members required based on event boundaries
- ☐ 5: Identify Team Members. Target 1/3 of the team to be from the area affected.
  - Teams size of 6 - 8 are recommended
  - If Team size is Large, Determine Strategy to Utilize Effectively
  - 1 - 2 outsiders on a team to bring new persepectives is ideal

  Ensure funding is available for travel and participation
- ☐ 6. Confirm Event Facilitator(s)/Consultant(s)
  - Select Local Blackbelts/Greenbelts
  - Contact LAI SME for Support
  - Obtain External Consultant Report As Req'd
- ☐ 7: Define the deliverables expected from the Event team (eg. Quality Improvement, Reduced Span Time, Reduced Cost, reduce hand-offs etc.)
- ☐ 8: Select 2 -3 measurements and targets for the team that will help define success for the team.
- ☐ 9: Review deliverables, measurements and targets with the external or internal consultant. Revise if needed.
- ☐ 9: Ask a few hard questions (then revisit 1, 2 and 3):
  - Will this team improve your area'a performance?
  - Are you focusing your scarce resources on the right priorities?
  - what is the business case for analyzing this Value Stream?

2nd Week Before Event: (% Comp:_____)

- ☐ 1: Review "3 weeks before", resolve open items
- ☐ 2: Gather data on current state
  - Identify sources of data on current process (Financial Reports, Flow Charts, Command Media etc)
  - Run reports on actuals etc.
- ☐ 3: Determine current customer steady state demand
- ☐ 4: Determine actual output (if not available use most current predicated or budgeted figures)
- ☐ 5: Determine top 5-10 categories of problems noted from the information collected (eg. shortages).
- ☐ 6: Review actual customer issues, audit results, CPARS etc. List top 5 issues.
- ☐ 7: Determine key individuals needed to support on ad hoc basis:
  - Brief on upcoming VSM Event
  - Secure ad hoc support based on proposed event schedule
- ☐ 8: Secure Confernce Room For Event
  - Ideally room should be located near work area
  - Room must be available for entire duration of event
- ☐ 9: Obtain all necessary supplies for event
  - Post it Notes
  - Tape, Scissors
  - Flip Charts & Markers
  - Overhead Projector & Blank Overheads
  - Buthcer Paper (rolls)
  - Access to laptop to document event
- ☐ 10: Issue written invitiation to team members include event particulars and time expectations and deliverables.
- ☐ 11: Review and confirm Event team leader, co-leader and members (reconfirm 1/3 of team from area).
- ☐ 12: Brief team co-leaders and members: Event sch., measurements, targets and action deliverables
- ☐ 13: Make sure that each team member understands that they are committed for the whole event!!!
- ☐ 14: Review LAI Web Site. Download any related activity or studies/papers and review.
- ☐ 15: Schedule Key Leadership for Attendance at Outbrief Session

1st Week Before Event: (% Comp:_____)

- ☐ 1: Review "3 weeks before" and "2 weeks before" checklists. Resolve open items.
- ☐ 2: Revisit Items 8 & 9 from 3 weeks before has anything changed?
  - Confirm funding for travel and participation
- ☐ 3: Revisit initial event boundaries:
  - Are these boundaries still valid?
- ☐ 4: Hold final prep meeting with Team lead & co-leaders, resolve any open issues or concern
- ☐ 5: Arrange for working lunches for team
- ☐ 6: Review event status with facilitator/consultant.
- ☐ 7: Train the team members. This should include an overview of the Basics of Lean and the LAI 10 steps of Value Stream Mapping. Training can also be done in the 1st four hours of day one of the VSM event
- 8: Prepare training material for team:
  - ☐ Make a copy of LAI VSM booklet for each team members
  - Make a copy of LAI Basics of Lean for each team member
- ☐ 9: Reconfirm participation/commitment of team members member, supervisor, maint. person and contractor.
- ☐ 10: Reconfirm attendance of key leaders at Outbrief Session

Developed by Lockheed Martin

APPENDIX I

Resources for Learning More About Lean

1) All of LAI's tools and products described in this report are available on the Lean Aerospace Initiative website: (http://web.mit.edu/lean).

Lean Enterprise Self-Assessment Tool (LESAT). Lean Aerospace Initiative, Massachusetts Institute of Technology, Version 1.0, 2001. (http://web.mit.edu/lean -- click on products)

Lean Now Facilitator Training Course Material. Lean Aerospace Initiative, Massachusetts Institute of Technology, 2003. (http://web.mit.edu/lean -- click on products)

McManus, Hugh. "Product Development Value Stream Analysis and Mapping Manual (PDVSM)." Alpha Draft, Feb. 24, 2003, Lean Aerospace Initiative, MIT.

Transitioning To A Lean Enterprise: A Guide for Leaders, Vol. I, II, III: Roadmap Explorations. Lean Aerospace Initiative, Massachusetts Institute of Technology, 2000. (http://web.mit.edu/lean -- click on products)

2) *Lean Enterprise Value* by Earll Murman, et al. Published by Palgrave, 2002.

3) *The Machine That Changed the World* by James P. Womack, Daniel T. Jones, Daniel Roos. Published by HarperPerennial, 1991.

4) *Lean Thinking* by James P. Womack and Daniel T. Jones. Published by Simon&Schuster, 1996.