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2020 Program Excellence Awards

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Thank you for participating,

Gregory Hamilton
President
Aviation Week Network

Acknowledged, agreed, and submitted by

Nominee's Signature ______________________ Date: 10 April 2020

Nominee's Name (please print): Kurt Knust

Title (please print): Director, F-21 Integrated Fighter Group India Program

Company (please print): Lockheed Martin Aeronautics Company

NOMINATION FORM

Name of Program: F-16 Production Restart

Name of Program Leader: Kurt Knust

Phone Number: 817-777-2453 office or 817-821-4021 mobile

Email: kurt.g.knust@lmco.com

Postal Address: Lockheed Martin Aeronautics Company, POB 748, Mail Zone 1287, Fort Worth, TX 76101

☒ Customer Approved

- Date: 07 April 2020

  Contact (name/title/organization/phone): Mr. Greg Brown, F-16 Deputy Director AFLCMC/WWM, United States Air Force Systems Program Office, Office: 801-777-5873

☐ Supplier Approved (if named in this nomination form)

- Date: ____

- Contact (name/title/organization/phone): ______________________________

CATEGORY ENTERED

Refer to definitions in the document "2020 Program Excellence Directions." You must choose one category that most accurately reflects the work described in this application**. The Evaluation Team reserves the right to move this program to a different category if your program better fits a different category.**

Check one

☐ Special Projects

☐ OEM/Prime Contractor Systems Design and Development

☒ OEM/Prime Contractor Production

☐ OEM/Prime Contractor Sustainment

☐ Supplier System Design and Development

☐ Supplier System Production

☐ Supplier System Sustainment

Abstract

In 150 words or less, why is this program excellent in terms of execution?

The F-16 production transition from Fort Worth, Texas to Greenville, South Carolina was managed and measured through a very structured process with a foundation in systems engineering spanning from the site selection through activation, launch, and day one production readiness. A multi-disciplined team developed a systematic approach of capturing the production knowledge during the build of the last three aircraft prior to the gap to enable an effective production restart. A Smart Shutdown / Knowledge Continuity Strategy was developed and executed to mitigate the impacts of the F-16 production gap. These efforts yielded positive enablers for the production restart of the F-16 Bahrain Production Program in terms of risk mitigations and cost/schedule reductions. The Greenville production start coincides with growing international demand for new production F-16s. F-16 production bolsters international partnerships and is creating thousands of new U.S. jobs, supported by more than 400 suppliers in 42 U.S. states.

Purpose

Provide a 150-word description of the purpose of this program, spelling out all acronyms and correct acronyms

In anticipation of a production gap, a Smart Shutdown / Knowledge Continuity Strategy was developed and executed to mitigate the production gap impact which yielded positive enablers for the production restart in terms of risk mitigations and cost / schedule reductions. The F-16 production restart approach was executed across five key areas: facility refurbishment in Greenville, South Carolina, supplier readiness, tooling transfer, planning, and tribal knowledge capture (Smart Books). F-16 tooling and equipment was transferred from Fort Worth, Texas, and installed in a newly refurbished hangar in Greenville, South Carolina, where manufacturing F-16 Block 70/72 aircraft has begun. Execution of the F-16 production restart strategy enabled Lockheed Martin to meet the growing international demands for new aircraft and positioned the F-16 supply chain for growth.

Bio for Program Leader:

Kurt G. Knust
Lockheed Martin Aeronautics Company
Director, Integrated Fighter Group F-16/F-21 Program

Kurt Knust is Director, IFG F-21 India Program for Lockheed Martin Aeronautics. In this role, he is responsible for the overall direction of the IFG organization, coordinating the F-21 team new business activities for the India pursuit, and identifying Make In India plans to meet Lockheed Martin Aeronautics international sales obligation.

Mr. Knust joined Lockheed Martin in 1982, at that time was General Dynamics. He started his career in Manufacturing Test and Engineering (MT&E), transitioned to hardware avionics design, and F-16 system design gaining wide-ranging engineering experience. His other assignments were in the F-16 Program Office including the production transition, startup of an overseas office for Lockheed Martin Aeronautics which allowed him to gain experience in manufacturing engineering, scheduling, operations, contracts, quality, international program office, and International Technical Assistance (ITA).

Before becoming Director, of the F-21 India program, he served as Director, F-16 Production Restart coordinating a plan for the F-16 production transition. Prior to that he served as Director, IFG ITA, where he was responsible for the start-up planning, contracting, build, and delivery of F-16 parts and components from worldwide Industrial Partners. He served as Senior Manager of F-16 ITA leading the activities in Israel, F-16 aircraft modification programs in Greece, Taiwan, and Egypt, and the F-2 ITA activities in Japan. Mr. Knust served as the In-country Deputy Director of the F-16 Peace Marble V Program. In this position, his duties included establishing the international office, negotiating contracts with 16 Israeli suppliers, daily interface/coordination with the Israel Air Force and Ministry of Defense, and the daily operations of the Israel deployed team.

In 1998, Mr. Knust was the Systems Engineer leading the development of new F-16 configurations. He was responsible for the overall aircraft configuration development for new customer requirements. In this assignment he gained systems engineering experience and design development for new avionics and systems.

During his engineering assignments from 1990 – 1998 he was responsible for the design, development, and integration of the Joint Helmet Mounted Cueing System, weapons integration, and core avionic systems. His responsibilities included hardware and software design and systems integration.

Mr. Knust graduated from Purdue University with a Bachelor of Science in Electronics Engineering Technology in 1982.

He and his wife, Ilana, have two sons and a daughter.

Executive Summary: Make the Case for Excellence *(Value: 15 pts)*

What is the vision for this program/project? What unique characteristics and properties qualify this program for consideration?

To manufacture any product, one needs to consider the 4Ms – Manpower, Methods (planning or work instructions), Machines (tooling), and Materials. Manufacturing a complex advanced fighter aircraft like the F-16 is no different. When Lockheed Martin became aware there would be a production gap of the F-16 fighter, plans were developed to mitigate the production gap. It was unknown at the time how long the F-16 production gap would extend. The purpose of the team was to develop an approach to minimize the impacts of the production gap. With a gap the ability to manufacture atrophies and will need to be overcome. For example, a few of the obstacles include learning loss, manpower loss either by transitioning to different programs or exiting the workforce, and potential for tooling loss or damage. These obstacles are common regardless of the supplier size and capability.

To overcome these obstacles a team was created in the F-16 program office to develop a strategy for bridging the production. The team was led by program management with support from business management, engineering, production operations, quality assurance, supply chain management, and sustainment. The team created an "all in" attitude developing a strategy for bridging the production gap.

The team developed the concept utilizing Smart Shutdown (SS) / Knowledge Continuity (KC) principles. The basic concept to the SS/KC approach was executed across five key areas: 1) Preservation of work information at Fort Worth and the supply chain base consisting of manufacturing dashboards capturing critical production and quality performance data and locating all this data in a single repository. 2) Development of Smart Books (SB) at Fort Worth and the supply base consisting of compilation of annotated pictures and narrated videos documenting key assembly operations, segments and task load/unload movements, with specific focus on "what to watch for" & "things to avoid". The SBs concept was utilized to capture the unwritten tribal knowledge of each manufacturing sequence to supplement the planning or work instructions. 3) Product Process Verification (PPV) consisting of 255 floor reviews at Fort Worth toward ensuring best practices and tribal knowledge were captured in production planning. 4) Tool scanning consisting of 3D mapping, photogrammetry and white light applications within forward and center fuselage component build and final assembly geared towards augmenting existing start-up processes with on demand dimensional and graphic data from a production configuration known to be good. 5) Supplier Risk Modeling was conducted enabling insight into risks by supplier and by part number. Also, the Lockheed Martin developed SB concept was shared with and implemented by the supply base.

Major achievements:

- 125-plus SBs (600+ photos/36 Videos) across 9 Work Breakdown Structure (WBS) build elements created illustrating the manufacturing process
- 255 PPV floor reviews across 9 WBS build elements resulting in updates to 250+ planning cards
- Tool scanning resulted in 7GB of Hi-Def photos and 302 Catia models
- More than 2200 tools transferred from Fort Worth, Texas to Greenville, South Carolina
- 400-plus Suppliers evaluated and prepared for restart readiness
- 2 buildings refurbished at Greenville, South Carolina
- The F-16 Block 70/72 is the newest and most advanced F-16 production configuration, combining numerous capabilities and structural enhancements

VALUE CREATION *(Value: 10 pts)*

Please respond to the following prompt:

- **Clearly define the value of this program/project for the corporation beyond profit and revenue**
- **Clearly define the value of this program/project to your customer**
- **Clearly define the value of this program/project to members of your team**
- **Clearly define the contribution of this program/project to the greater good (society, security, etc.)**

The F-16 continues to define multi-role capability and international partnerships. Approximately 3,000 operational F-16s are in service today in 25 countries and counting. New production aircraft and structural and capability upgrades ensure the international F-16 fleet can operate to 2060 and beyond. The F-16 fighter franchise consists of parts and components manufactured in 42 states and internationally around the world employing thousands of workers with varying skillsets. Avionics, systems, detail structural parts, and major aircraft structures are manufactured both domestically and internationally. The F-16 supply chain extends to more than 100 Tier 1 and Tier 2 suppliers domestically and across 15 countries.

These worldwide F-16s provide air defense capabilities to each respective country by executing air-to-air, air-to-ground, maritime, and reconnaissance operations. Lockheed Martin leverages its F-16 experience to increase the commonality and interoperability of F-16 fleets around the world. Lockheed Martin has more than 36 years of weapon integration experience with the F-16 and provides exceptional value and support to our customer's missions around the world. Demand continues to soar for new production F-16 aircraft and F-16V upgrades. The restart of the production line created the first F-16 Block 70/72 configuration. The F-16 Block 70/72 features advanced avionics, a proven Active Electronically Scanned Array (AESA) radar, a modernized cockpit with new safety features, advanced weapons, conformal fuel tanks, an improved performance engine, and an industry-leading extended structural service life of 12,000 hours, and the life-saving Automatic Ground Collision Avoidance System (Auto GCAS). To date, four international customers have publicly confirmed their selection of the F-16 Block 70/72 – Bahrain, Slovakia, Bulgaria, and Taiwan – and Lockheed Martin is in discussions with multiple other potential customers about new production F-16s.

Lockheed Martin's organizational construct is centered around functional teams by specific discipline, for example business management, engineering, production operations, quality assurance, supply chain management, and sustainment are separate teams focused on each respective discipline. The F-16 program gathered team members from each of these functional organizations creating an Integrated Product Team (IPT) focused on working the F-16 production restart project. Each team member brought a unique skill set to the team and the brainstorming sessions developing the SBs through the concepts of KC.

One of the basic principles to create a high performing team is satisfied employees perform better, make fewer mistakes, and improve overall efficiency. There are any number of ways to gauge the satisfaction of the team such as employee surveys, informal team member interactions, and employee morale event participation. All these techniques were used to demonstrate a high level of interest and engagement from the team, but they provided only a qualitative assessment of team satisfaction. The F-16 production gap team also had a quantitative technique by measuring the KC capture of the data and use of the data by the manufacturing team on the last aircraft delivered prior to the production gap.

After a three-year production gap, several of the F-16 production operations team members returned to the F-16 program. Some of the techniques to motivate employees to return to the F-16 production program included providing stretch assignments, using employee recognition programs to reward employees, and offering opportunities on F-16 modification programs.

To date, 4,588 F-16s have been produced, and as stated previously there are approximately 3,000 operational F-16s in service today in 25 countries and counting. These F-16s provide air defense capabilities to each respective country securing peace and stability around the world. The restart of the F-16 production line created the first F-16 Block 70/72 configuration. The continuation of the F-16 production line has strengthened the United States (U.S.) economy through job creation. Direct job creation is expected to be in excess of 500 in Lockheed Martin's Texas and South Carolina facilities alone. The program will also be responsible for creation of thousands of jobs across the 400-plus suppliers utilized in production of F-16 materials and components. Inclusive of indirect jobs, the re-start of F-16 production is estimated to contribute to the employment of more than 16,000 Americans plus thousands of people worldwide further stimulating the world economy.

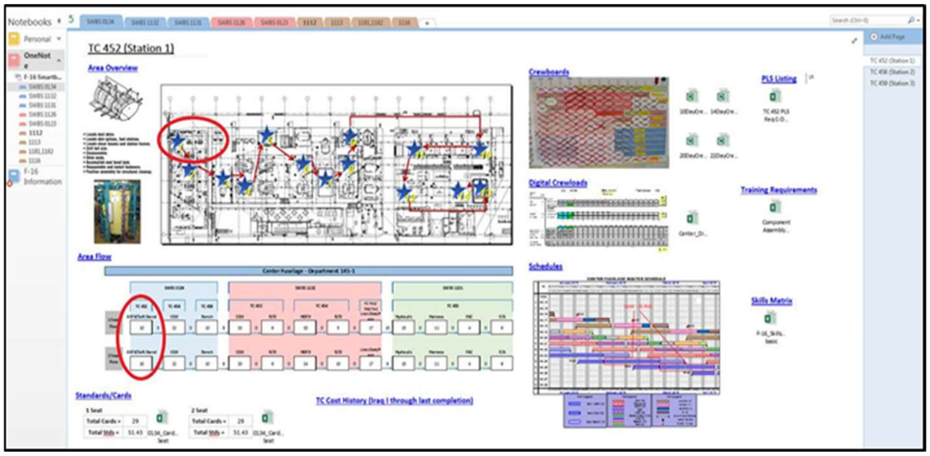
F-16 production promotes U.S. national security interests by strenghening international alliances and domestic defense base capabilities. The new production deliveries and continuing capability upgrades ensure the international F-16 fleet can operate to 2060 and beyond. As it has since the 1970's, the F-16 remains a critical tool for U.S. defense and national security.

METRICS *(Value: 10 pts)*
Please respond to the following prompt:
- **How do your predictive metrics drive action toward program excellence?**

In any production environment on any aircraft, there are quirks and nuances to completing the build that are typically learned and institutionalized over time and are seldom 100% captured in the official work planning and/or engineering. To overcome this information gap, Lockheed Martin initiated two efforts while the remaining build efforts were ongoing in Fort Worth in order to retain as much information related to compliant build practices. These two predictive efforts for the build process were SBs and Tool Scanning.

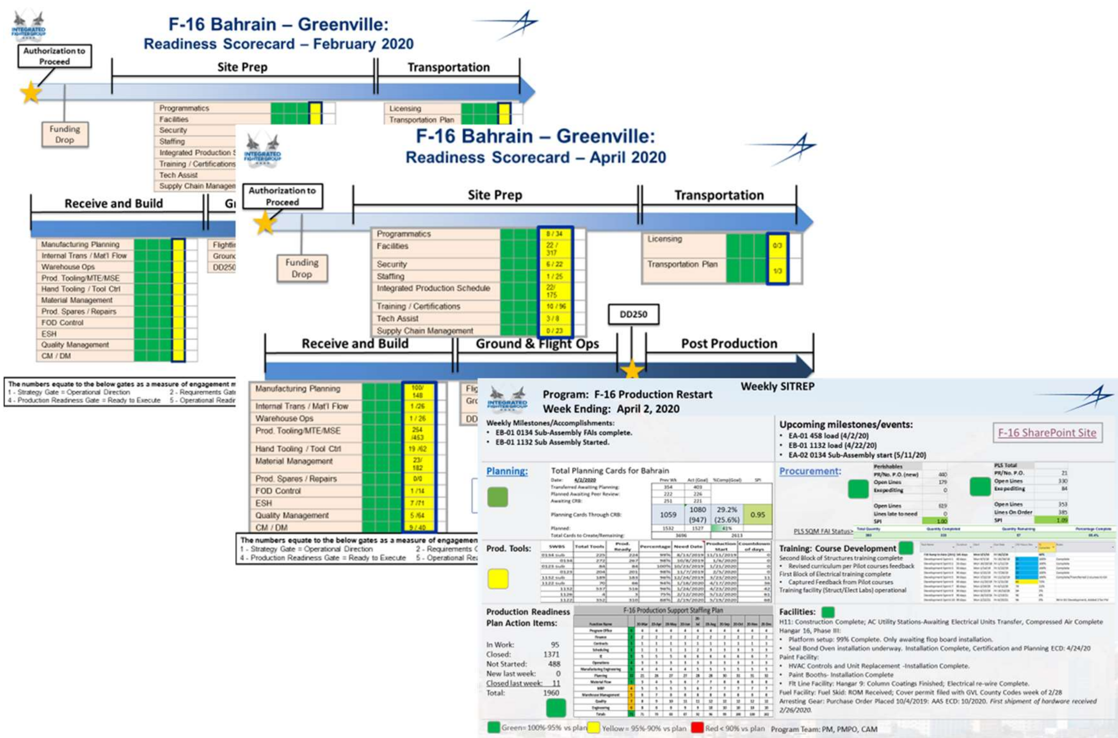
SBs were created by the teams that worked on the floor, either directly on or in direct support of the aircraft. These SBs are photo and/or video documentation of the mechanics performing the task, with annotations and/or commentary aligning with the graphics to further the explanations. A picture is worth a thousand words and the 125-plus SBs contain more than 600 photos and videos across nine WBS build elements. The processes that were chosen were done so by the people with the most relevant knowledge on the build – the mechanics working directly on, or the team working in direct support of, the aircraft. An example includes installation of the fuel tank ("bladder bag") – a task that only a handful of resources knew how to complete over the tenure of the Fort Worth production line. The resultant step-by-step visual documentation of notoriously complex processes provide a near-hands on experience for the new mechanics to leverage.

The SBs were in fact part of a broader effort aimed at retaining information related to successful production operations. The remaining data elements include hardware lists, training requirements, crew plan examples, and work card information. The whole package was compiled into a dashboard format for easier review and use (example below). The dashboards and backup information, to include the SBs, were transferred to Greenville early in the process, and the content provided has proved invaluable in multiple areas – from training preparations to facilities requirement identification, work instruction validation and crew planning/task sequencing. Capturing this data via the SBs served as a learning tool and quick reference guide for the new mechanics in Greenville. Allowing them to predict what the eventual tasks would encompass before the build started.



Smart Book Dashboard Example

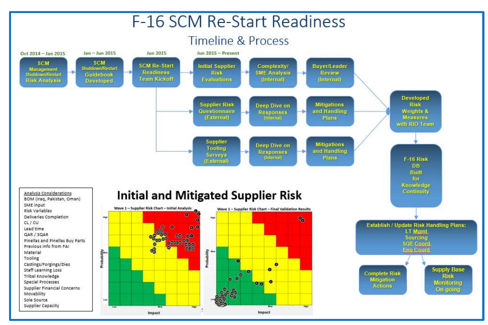
Day 1 Roadmap & Planning scorecards are a "living tool" that was routinely updated as the baseline for defining all team transition and stand-up actions, as well as a mechanism for ensuring leadership visibility of the stand-up progress throughout the restart activities, more detail on the roadmap scorecard is provided later.



In addition to the various tools deployed to manage the First Article Inspection (FAI) and PPV process, it was critical to ensure the multiple customers were kept informed. **The program team worked hard to create portals for these customers to see the work in progress, measure, and give feedback. These portals included weekly action item tag ups, manufacturing readiness reviews, quarterly FAI/PPV deep dives** as well as regular ad-hoc discussions about the progress and quality of product and processes. Additional visibility into the FAI process was provided to Defense Contract Management Agency (DCMA) through an audit on a random sample of part numbers to review not only completion to schedule but quality of documentation. Beyond formal program reviews, Lockheed Martin participated in many customer engagements to provide visibility into program activity, including traveling to Wright Patterson

Air Force Base to deep-dive Lockheed Martin command media and links between Greenville, Fort Worth, and U.S. Air Force F-16 System Program Office (SPO) requirements. On several occasions the Lockheed Martin team were thanked for the openness and excellent working relationships created on the F-16 start up efforts. The efforts were truly collaborative across functions and customer agencies to drive success. The customer support for these efforts was key and the engagement was world class.

The SCM Risk Modeling tool included 45 risk variables/measures. Over half of the variables/measures applied to gapped and new supplier sourcing. The database was updated monthly with information from 400-plus potential suppliers providing insight to potential risks by supplier including co-producers and by part number.



DEALING WITH PROGRAM CHALLENGES (VOLATILITY, UNCERTAINTY, COMPLEXITY, AMBIGUITY, OR VUCA)
(Value: 25 pts)
Please respond to the following prompts:

- *10 pts:* **Describe overall VUCA faced by your project/program.**
- *15 pts:* **Cite specific example(s) and how your team responded.**

Dealing with VUCA Challenges: Leveraging Lessons Learned to Restart for Success

Prior to the production line gap and subsequent relocation, the F-16 production line in Fort Worth had been in continuous production for 40 years. The level of expertise that had been accrued in Fort Worth over the course of that tenure was impressive, but at the same time daunting – how do you not just capture, but retain and present in a usable manner those decades of lessons learned?

The nature of KC retention is to rely on the people that have the subject matter expertise to either capture that knowledge and transition to the new user or to leverage that knowledge directly in the project. When it was realized the F-16 was going to experience a gap in production, with a high probability of restart in a new location, Lockheed Martin leaned forward and implemented a variety of techniques to achieve the above, spanning the transition timeline from final build out of production units in Fort Worth, to the actual transition to and stand-up of Greenville, and finally with the first production unit builds in Greenville.

Lockheed Martin implemented multiple process and tool improvements to address the complexity of this production re-start.

- Smart Books
- Tool Scanning
- Creation of unique and non-design tooling

Once the build of the final units in Fort Worth was complete, the focus naturally shifted to preparing for the physical transition to Greenville. One of the fundamental tenets of the line transition was to pick up and move the assets and tools that were used in Fort Worth to successfully build F-16 aircraft to Greenville for use there. However, to do so meant packing and shipping to Greenville over 2,200 pieces of tooling and equipment. Lockheed Martin chose to make the investment to enable significant validation of the required tools and equipment prior to shipment to Greenville. This included a validation of every tool against a planning card to ensure its ongoing usefulness for production, calibration and/or inspection of tooling and equipment prior to shipment to ensure usability at point of receipt, and review (and potentially rework) of tools and equipment prior to shipment. The result was hundreds of crates, each with a detailed inventory list that linked the contents to the WBS in which they were used, enabling the receiving team to efficiently organize the crates and subsequently their contents.

In January 2015 Supply Chain Management (SCM) stood up a Green Belt Problem Solving team to further evaluate supply chain re-start risks. The team reviewed over twenty previous program out-briefs and interviewed those Program Managers about their biggest challenges. Examples such as the F-22 Re-start Study strongly indicated a need for taking action to protect knowledge while the F-16 was still in production at the Fort Worth facility. These lessons learned were compiled and documented helping shape the team's approach in development of SCM's re-start guidebook.

The SCM Guidebook outlines a structured approach for SCM in making business-based decisions. The guide's 7-step process provides a strategic approach for programmatic shutdown and facilitates preparations for production continuation in a way that reduces risk, mitigates cost impacts, protects schedule, and preserves KC.

A specific F-16 SCM re-start team was created to address impending shutdown, transition and restart of the F-16 Production line. Key members from previous activities were carried forward to start execution of SCM plan and to act as members of the LM F-16 Production Re-start team. Some of SCM team activities included:

- Collaboration with SCM Risk Team to perform deep dives on supply base and material risks
- Compiling information on long lead, critical path and historically troublesome parts
- Conducting a supplier tooling assessment based on Manufacturing Engineering needs
- Conducting SCM assessment of Greenville manufacturing facility and material impact issues
- Performing assessments of demand planning and lead time validation standardization
- Identifying long lead, critical path, and historically troublesome parts requiring early authorization
- Developing/Compiling a risk data base by part number for data preservation

Utilizing data from the SCM Risk re-start team, SCM was able to identify areas for advance planning, prepare for early actions, and to develop risk mitigation and handling plans.

F-16 co-producers assemble large sections of the aircraft – aft and forward fuselages, wings, vertical fins – and therefore comprise assembly and manufacturing facilities of their own. Consequently, approximately half of the parts Lockheed Martin procures for the F-16 are delivered to co-producers with the balance being delivered to Greenville for aircraft assembly. In executing the program, co-producers are using past experienced mechanics and management to execute start-up activities. Previous systems with planning, engineering, and tool drawings were archived and have been regenerated for the restart. Co-producers restarted with a span growth from previous program spans to support FAI and adjust due to learning loss for first component builds.

The Greenville campus required a significant amount of facilities refurbishment to support the F-16 production restart. This effort was enabled by a Fort Worth facilities engineer. His insight into how and why we operated in Fort Worth, subsequently proved invaluable in setting up the Greenville facilities. Another significant activity was the tooling installation. Using SMEs with significant tooling knowledge provided efficiency in tooling set up that would have been difficult for the Greenville team to achieve and provided a learning opportunity for Greenville. A ME from Fort Worth deployed to Greenville to assist with their production preparations. His insights into tool use, platform/area set-up, and actual build tasks were invaluable to the Greenville team.

ORGANIZATIONAL BEST PRACTICES AND TEAM LEADERSHIP *(Value: 40 pts)*
Please respond to the following prompts:

- *15 pts:* **In executing the program, what unique and innovative practices, tools and systems frame your program and help you achieve program excellence**?
- *15 pts:* **What unique and innovative processes and practices are you using to develop people and transfer knowledge and how do you know they are working?**
- *10 pts:* **What unique practices are you using to engage customers and how do you know?**

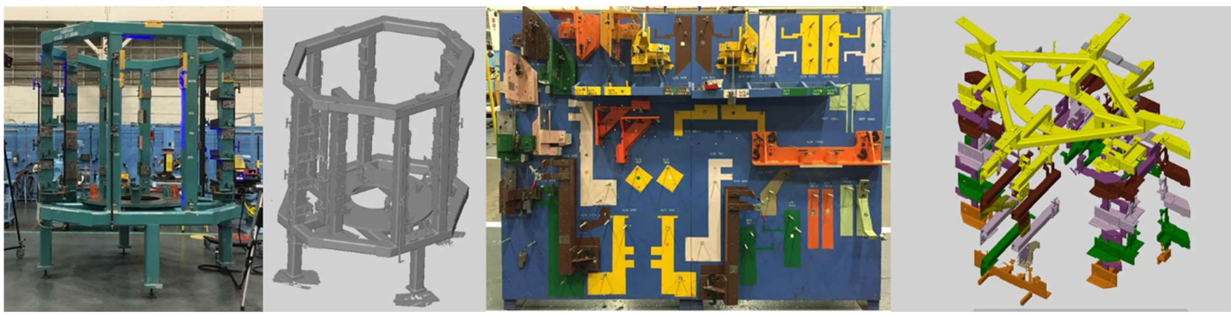
Knowledge Continuity

The F-16 program's utilization of a dedicated-16 production IPT created a unique opportunity for knowledge sharing. Lockheed Martin blended mechanic's experience level across the build process to retain the knowledge base and concurrently grow the next generation of F-16 SMEs. The Greenville site is utilizing on-site talent and former F-16 mechanics and SMEs to begin production. There are *hundreds* of years' worth of total structures experience amongst this blended team of mechanics that is being leveraged to begin the build process to ensure a successful program from the start. To build the next generation of skilled mechanics, Lockheed Martin has partnered with Greenville Technical College to introduce and cultivate apprentice mechanics into the process enabling the continued success that the F-16 remains the most dominate multi-role fighter ever produced!

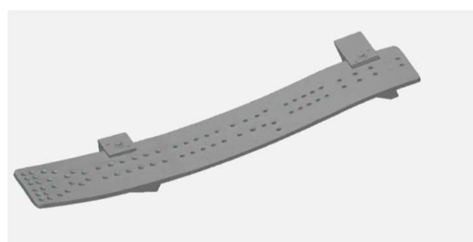
The other opportunity that was initiated during the final build activity in Fort Worth was tool scanning. The F-16 is a mix of digital data and hard gauge tooling. Much of the tooling was designed and built in the late 1970s and early 1980s using blueprints, loft lines, and the theodolite and scalebar measurement systems in common use at that time. Over time that tooling has been changed and reconfigured across multiple aircraft blocks and configurations. Some tooling has been enhanced with digital reference systems as laser trackers became industry standard equipment while others still use the original theodolite system.

F-16 assembly is complex and requires a precise fit between mating components. Ensuring the tooling came back online in the same configuration and with the same locational tolerances was critical to a successful restart and staying on schedule. While digital scanning has been around for some time, large volume high precision scanning is still relatively new, but we were convinced it was an ideal application for troubleshooting and reestablishing the tools.

In 2016, a study was launched to evaluate the potential and limitations of digitally scanning tools as it would apply to F-16. The article of the study was a fuselage component assembly tool that was coming due for periodic inspection (PI). This tool had many removable details and had to be relocated to perform the PI, so it presented an excellent opportunity to test and validate digital scanning. During the PI, the tool weldment and each detail were independently scanned and then reassembled in digital space. The resulting scan data was then compared back against the tool in real world conditions both pre and post move to replicate its intended use on the program. The study was a resounding success and paved the way for scanning the most critical tools as Fort Worth production ended.



Digital Scan of Complex Designed Tooling

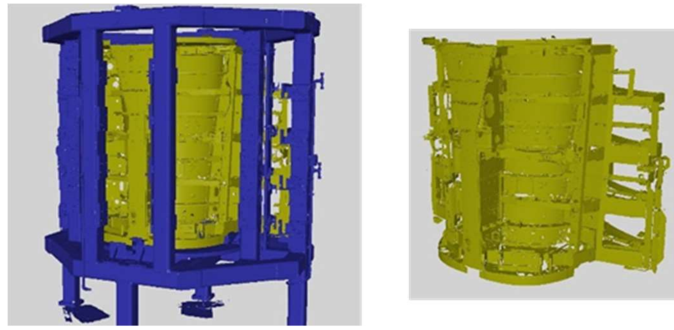


Scan of Complex Non-Design Tool

Another opportunity to protect production restart was to mitigate the risk of loss or damage to unique and non-design tooling. Gauge driven programs tend to generate tools and production aids over time that ease repetitive tasks such as laying out and marking floating drill patterns. These come from a variety of sources, from simple sheet metal templates created by assemblers, to more complex shapes pulled from splashes of aircraft or other tooling. Further study demonstrated, the ability to not only capture these tools, but use the models generated to accurately grow and replicate them should the need arise.

Tools are thought of as unfaltering, unerring monuments, but they are a living and everchanging record of production. In the case of F-16, it wasn't just about capturing dimensions, locating features, and key characteristics, it was also necessary to capture and visually catalogue the tools. Previous experience has taught there is a strong tendency among new users to clean and repaint tools without understanding what can be lost in the process. Scribe lines, wear patterns, and reference notes are all important artifacts left from prior use. High resolution imagery was an important biproduct of the chosen scanning method. This provided a means of recovering these important details if they were lost in the transition.

The new F-16 program restart wasn't just a production gap, but also incorporation of a major block change. As engineers began the F-16 Block 70/72 updates and redesign of parts to increase service life, they weren't aware of potential tooling conflicts these changes could create in production. One of the first, and likely most valuable, applications of the tooling scanning effort was to provide design engineers with accurate digital tooling models that could identify these conflicts and provide resolution prior to first article build. This is standard practice for digitally designed platforms, but this was the first-time tooling models had been widely available for design use on F-16. This made design reviews more effective and efficient, and greatly reduced the opportunity, magnitude, and complexity of reworks and work arounds required in Greenville as depicted in the graphic.



Fit Check with New Design Engineering

A key part of the restart was ensuring methods and practices were in place to validate supplier, co-producer and aircraft assembly quality capability. Based on Lockheed Martin adopted aerospace standards (i.e. AS6500, AS9100 and AS9102), several preventive actions were embraced by the restart team. This included a stringent FAI program to manage the 11,000-plus FAIs required over a span of just 30 months – volume that Lockheed Martin had never before had to manage. Beyond the volume and density alone, the effort was further complicated by the effects of production restart, such as training new suppliers on these requirements and reengaging legacy suppliers that hadn't performed FAIs in decades. A core FAI team was established, involving collaboration from supply chain, fabrication, supplier and program quality assurance, co-producers, and Greenville, in order to leverage lessons learned from F-35, implement a risk-reduction strategy and deploy new tools to manage the effort. Multiple tools were developed to support the execution of FAIs around the U.S. and at multiple international suppliers. A key enabler was the creation of a new **Tableau dashboard dedicated solely to the first lot of F-16 production parts**. This allowed for real-time tracking of supplier performance as well as extensive detail on geographic location, vendor, and Supplier Quality Engineer (SQE) workloads, and notes from the field to give visibility into where resources were needed. Another tool leveraged **was Remote Augmented Reality (Remote AR)** for key suppliers allowing for quick feedback and engineering support for complicated part issues. **The FAI dashboard and Remote AR are now standards used across LM Lines of Business.**

Many of the methods used to support supplier and internal FAIs transferred into the PPV process as assembly operations started in Greenville. PPV is a complete review and documentation of all aspects of a build operation to verify production methods can repeatedly produce an acceptable item as specified by engineering drawings/specifications, planning, and purchase order. The PPV provides objective evidence that engineering, manufacturing plans, tooling, training, planning, and supporting documentation, are correctly understood, accounted for, verified, and function together. PPVs were conducted by a cross functional team to validate every operation planning card prior to release making many corrections, clearing up challenges, identifying tooling needs and generally making the planning more user friendly.

As stated previously, **the program team worked hard to create portals for the various customers including the F-16 SPO and DCMA to see the work in progress, measure, and give feedback. These portals included weekly action item tag ups, manufacturing readiness reviews, quarterly FAI/PPV deep dives** as well as regular ad-hoc discussions about the progress and quality of product and processes**.** Lockheed Martin participated in many customer engagements to provide visibility into program activity, including traveling to Wright Patterson Air Force Base to deep dive Lockheed Martin command media and links between Greenville, Fort Worth, and F-16 SPO requirements. On several occasions the Lockheed Martin team were thanked for the openness and excellent working relationships created on the

F-16 start up efforts. The efforts were truly collaborative across functions and customer agencies to drive success. The customer support for these efforts was key and the engagement was world class.

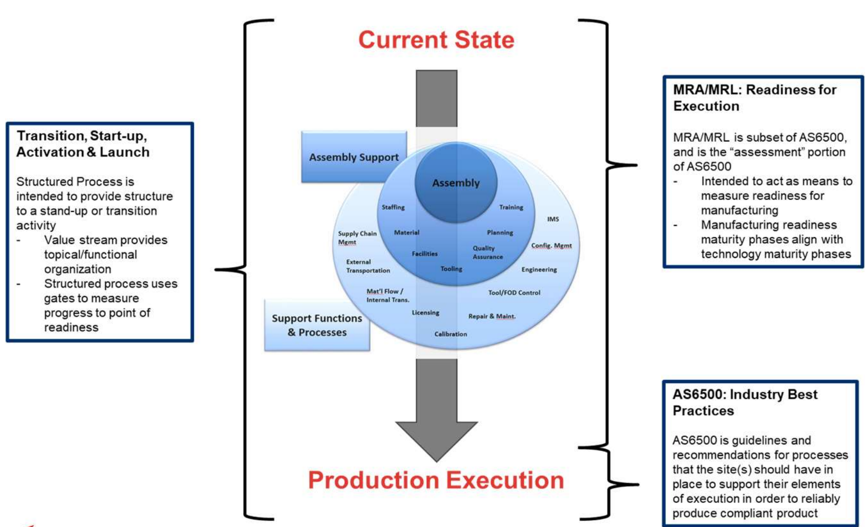
To develop people and transfer knowledge co-producers developed SBs (i.e., Visual Aids, Videos) based on Lockheed Martin guidance to support restart activities and Lockheed Martin provided experienced technical support at co-producers. Catia V5 is now available at the co-producers for the Lockheed Martin Manufacturing Engineers (MEs) to aid in real time troubleshooting activities. During Block 70/72 engineering development and design releases, engineering held unprecedented iterative all-inclusive meetings with MEs, SCM, tooling, planning, quality assurance, Greenville personnel and many other functional groups to assure knowledge of Block 70/72 changes that could impact downstream functions. This allowed each function and the Greenville team to understand the incremental design changes and proactively plan the production build. F-16 has several detail parts that are made from sand castings. Since this is a process that is vastly becoming a Diminishing Manufacturing Source (DMS) issue, Lockheed Martin engineering converted the design of these parts to a machining alternate. This process change enabled consistency in part fabrication and solved DMS issues.

To engage our customers, Manufacturing Readiness Level/Manufacturing Readiness Assessment (MRL/MRA) events were held at each co-producer with USAF SPO attendance. High customer ratings of 7s and 8s were achieved.

Structured Transition & Stand-up Process

The entire stand-up effort and all sequential milestones were aligned with the Program Operative Life Cycle Milestones (i.e., Milestones A, B, PDR, CDR) and provided a foundation for the MRL/MRA efforts worked throughout the stand-up with the customer at both Greenville and co-producers. The Stand-up, Activation and Launch process utilized is arguably a "best practice" built around and focused on four key tenets and is **being used by other Lockheed Martin Lines of Business**:

- Full integration of the "pitch and catch" - The process facilitates the bridging of the gap from the originating element, thus ensuring that the receiving element has a voice and the information necessary to be successful.
- Comprehensive Understanding of Requirements – Ensured full requirement understanding and alignment with the Greenville concept of operations, addressing all gaps and areas requiring attention.
- Vetted Plan on How to Execute Defined Requirements Built around the 4Ms (Manpower, Methods, Machines and Materials) – Focusing on the identification and resolution of gaps. A defined time-phased plan was developed with "table setting" actions centered around the overall

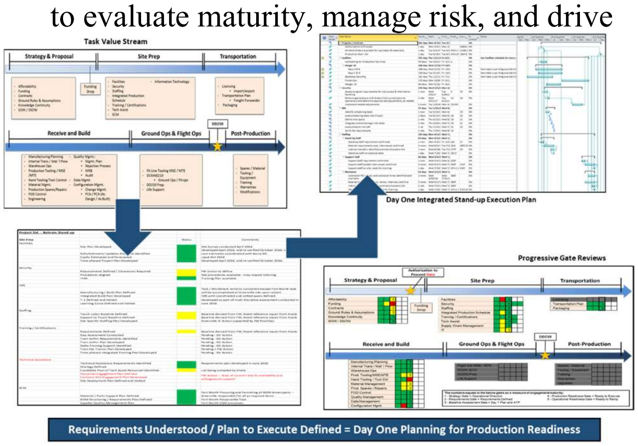


concept of operations for manpower/disciplines required. Process development/tailoring with integration of best practices and KC as well as functional alignment/realignment considerations were a significant element of this effort.

- Day 1 Roadmap & Planning – The "living tool" that was routinely updated and stood as the baseline for defining all team transition and stand-up actions, as well as a mechanism for ensuring leadership visibility of the stand-up progress.

The foundation of the structured Stand-up Activation and Launch Process is the Value Stream. The Value Stream is a tool utilized to assist in the full consideration of all pertinent elements across the production lifecycle and sequencing of requirements. The Value Stream walks through execution elements spanning site preparation, transportation, build & deliver, ground ops/flight ops and sustainment. It was paired with a Transition Execution database that is a repository of SME inputs and lessons learned captured from previous project/program executions. The database, which receives routine updates, allows data to be extracted and tailored to specific focus areas to guide and drive conversation and actions for stand-up strategy, planning, and execution. The framework of the stand-up process is achieved through series of targeted workshops, Kaizen and Structured Improvement Activity (SIA) events as well as simulation and flow mapping exercises. Validation is accomplished through series of "Day in the Life Events" and SME peer reviews. The combination of these tools with the gated systems engineering approach provides a forum to evaluate the development and progress of the transition and stand-up. The overall approach yields a Day 1 Roadmap, which is evolved into a time-phased project plan and ultimately blended with the gates to provide an overall stand-up scorecard as a measurable of the maturity and progress toward Day 1 and production readiness.

The process used provided a gated approach to evaluate maturity, manage risk, and drive cross functional coordination to ensure program and customer milestones are met. The benefits of this process yields key stakeholder engagement and voice throughout the effort and overall leverages lessons learned, cross platform experiences and best practices with a risk reduction tool used as a guide. The diverse perspectives of each team member enabled learning of the other disciplines from each respective team member. This innate learning process provided respective insights into other functions operations performance and critical thinking.



SUMMARY

The F-16 remains the world's most successful, combat proven fourth generation fighter aircraft. In 2018, Bahrain became the first F-16 Block 70/72 production customer and led to the re-establishment of the production line in Greenville, SC. Bahrain, Slovakia, Bulgaria and Taiwan have all selected the F-16 Block 70/72 – new aircraft orders and pending awards total more than 100 F-16 aircraft altogether. Additional customer interest remains strong and the Greenville production line may ultimately deliver in excess of hundreds of new F-16 aircraft. The continued strong demand speaks volumes for the value the product delivers to our customers in protection of their national sovereignty.