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Gregory Hamilton  
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Acknowledged, agreed, and submitted by



Nominee's Signature

June 2020  
Date

Nominee's Name (please print): J. Patrick Donnelly

Title (please print): Director – US Military & Foreign Military Chinook Program

Company (please print): Boeing Company – Vertical Lift Division

### NOMINATION FORM

Name of Program: CH-47 F Production Program \_\_\_\_\_

Name of Program Leader: J. Patrick Donnelly \_\_\_\_\_

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Customer Approved

- Date: May 20, 2020 \_\_\_\_\_
- Contact (name/title/organization/phone): LTC Danielle Medaglia/US Army / PM Cargo  
Production Project Manager (256) 313-3396 \_\_\_\_\_



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

And Development



OEM/Prime Contractor Production



OEM/Prime Contractor Sustainment



Supplier System Design and Development



Supplier System Production

Design



**J. PATRICK DONNELLY**

**Program Director – US Military Chinook  
Boeing Vertical Lift**

J. Patrick Donnelly is the Director of US Military Chinooks, responsible for the execution of all US CH-47 including US Army Block II, Special Forces MH-47G and Foreign Military variants. He is responsible for the day-to-day execution for all development, manufacturing and delivery aspects of these aircraft.

Previously, he was Program Director for International Chinook Programs. Prior to that, he was Program Director of all rotary wing activities from Boeing Phantom Works, including the Joint MultiRole program with Lockheed/Sikorsky Aircraft.

Pat joined The Boeing Company in 1980 in the design group of the Boeing V/STOL Wind Tunnel and served in a variety of roles in engineering and support including: manager, Operations Analysis (1984); senior manager, Product Assurance (1986); manager, Tactical V/STOL Systems (1989); and Program Manager Proprietary Rotorcraft (1996). He has practitioner and/or management experience in mechanical design, operations analysis, weapon system integration, survivability technology, supportability and program management.

Pat holds a Bachelor's degree in Mechanical Engineering from Rensselaer Polytechnic Institute, a Master's degree in Mechanical Engineering from Cornell University and a Master's in Business Administration from Widener University. Pat has also completed the Advanced Program Management Course from the Defense Acquisition University at Ft. Belvoir, VA.

Pat is the Director for the Mid Atlantic Region for the American Helicopter Society and on the board for the Delaware Valley chapter of the Army Aviation Association of America.

### **Abstract**

Boeing Vertical Lift delivered the first production CH-47F on November 17, 2006. Our 500<sup>th</sup> F Model was delivered on January 13, 2020, delivering every aircraft to each aviation unit on schedule. The five hundred aircraft were made up of new build and renew aircraft. The latter refers to aircraft in which some of the high value components (transmissions, rotor heads, blades, etc.) were overhauled rather than built new. Overhauling components added a level of risk due to unknown condition of receiving parts. Yet this did not deter the program from missing a due date. They were delivered to not only the US Army customer but also several international countries as part of the Foreign Military Sales program. In addition, the Chinook factory achieved nearly 2% CoRRS, no lost workdays and nearly FOD free this past year.

### **Purpose**

The CH-47F Chinook is a heavy lift helicopter used by the United States Army and many countries around the world. It represents the most technically advanced of the Chinook family. Its primary purpose is transportation of troop and cargo across the battle space. With a gross weight of 50,000 pounds, the Chinook can carry more than 17,000 lbs of cargo and equipment over 100 miles at Sea Level conditions. The tandem configuration is an efficient design for lift. As such, it has excellent high altitude/high temperature performance as well. This made this aircraft the workhorse for Operation Enduring Freedom in the country of Afghanistan.

The F Model has many new features from the D Model it replaced. Specifically, a machined aluminum airframe for maintainability improvements, a digital “glass cockpit” for better situational awareness and a Digital Advanced Flight Control System (DAFCS) that provides the pilot unprecedented maneuver control while reducing his/her workload. Many other changes were also included in this upgrade program resulting in approximately 25,000 man-hours per aircraft of upgrade work.

## Executive Summary: Make the Case for Excellence

Boeing Vertical Lift delivered the first production CH-47F on November 17, 2006. Our 500<sup>th</sup> F Model was delivered on January 13, 2020. Boeing delivered every aircraft to each aviation unit on schedule. The five hundred aircraft were made up of new build and renew aircraft. The latter refers to aircraft in which some of the high value components (transmissions, rotor heads, blades, etc.) were overhauled rather than built new. Overhauling components added a level of risk due to unknown condition of received parts. Yet this did not deter the program from missing a fielding date. The aircraft were delivered to not only the US Army customer but also several international countries as part of the Foreign Military Sales program. In addition, the Chinook factory achieved nearly 2% CoRRS, no lost workdays and nearly FOD free this past year. This is a significant milestone achievement and worthy of recognition.

The initial contracting approach by the US Army were annual contract awards. This is typical during the initial ramp up in production. Of course, this introduces production risks as annual contracts are flowed down to the supply base. Both Boeing and the supply network do not have guarantees of multiple years of production limiting initiatives to produce large quantities and factory streamlining. The CH-47F contains over 5000 parts acquired from over 400 suppliers. The timeline to build a Chinook is approximately three years from order to delivery. The number has fluctuated based on demand and working lead times directly with the supply base. Management of parts delivered for on-time installation is critical to the success of the program. Boeing's Supply Chain organization has the task of coordinating all of these suppliers, distributed across the globe.

After four annual contract awards, the Government awarded two multiyear contracts, each being five years in duration. For industry, this was key to providing production stabilization. For the Customer, a minimum cost savings of 10% is expected over annual awards due to benefits of stable quantities. Following the first multi-year, a series of configuration changes was incorporated into the production line. While adding additional capabilities for the warfighter, changes in production flow and operations had to be incorporated. The second multiyear contract took the program to the end of the CH-47F production program of record. The Army operates over 450 Chinooks. The additional quantities, sprinkled throughout the delivery profile, included Foreign Military Sales, as well as wartime replacements

Throughout quantity fluctuations, configuration changes and contract variability, every CH-47F was delivered, not only ahead of aircraft fielding requirements but also to the warfighter to support their enduring needs.

## VALUE CREATION

### ➤ **Clearly define the value of this program/project for the corporation beyond profit and revenue**

Boeing is a leader in the US Defense Industry. The vision of the Boeing Company is to Connect, Protect, Explore and Inspire the World through Aerospace Innovation. Our strategy involves both commercial and defense manufacturing. Throughout the years, the company has been successful with this balanced portfolio since, if one side falters, the other side picks up the slack. Our Chinook program is one of the stalwart elements of the Defense portfolio and has contributed financially throughout the CH-47 production run. Having been in continuous production since 1961, the Chinook remains in service throughout the world. It is scheduled for retirement no sooner than 2060. It is set to become the US Army's first "100 year" aircraft.

Beyond its financial contribution, the Chinook production program has served as the base for manufacturing in Boeing's Philadelphia site for many years. The average number of CH-47F aircraft delivered each year was over 35, providing a stable base for not only the Chinook but also the V-22 Osprey also produced at the Philadelphia site. In addition, Direct Commercial Sales added an average of additional 7 more Chinook variants. These sales were a direct extension of the success of the CH-47F with the US Army. Nearly 5000 people are employed at the Philadelphia site. Generations have worked on the Chinook program. There are several instances in which grandfather, son and grandson have all worked for Boeing in Philadelphia. Stable employment also creates the cottage industry that supports our factory. The local community has benefitted from the company presence and that has been solidified by the presence of the Chinook production line.

The Chinook presence not only helps the local community but it also nurtures a workforce and other resources that the company has utilized across the remaining portfolio. Our success with CoRRS reduction is being replicated across multiple sites. The production line has other programs visiting to witness our practices and take home the lessons learned. Our subject matter experts are called upon to support programs such as the AH-64 Apache in Mesa, Arizona. Our program leaders also branch out and share their experiences on programs such as 737 and T-7. Even our Defense leader, Leanne Caret, was once the leader of our Chinook program during the early phase of the F production.

### **Clearly define the value of this program/project to your customer**

The United States Army has been reliant on the Chinook across the Globe for many years. It has evolved to stay technically relevant and to support the evolving needs of the warfighter. The CH-47F introduces the glass cockpit to the pilot, significantly reducing their workload so that they can concentrate on the mission at hand. The introduction of the machined frame fuselage significantly reduced requirement on maintenance. This not only saves money for the warfighter but also allows the aircraft to increase its availability for whatever mission is at hand. One of the changes added mid-production, driven by user requests, the Cargo On/Off Load System (COOLS) provided an imbedded roller system for cargo handling. The earlier version of Chinook required a kit to be installed



on the aircraft. It was labor intensive and caused the versatile aircraft to be dedicated for a cargo mission. The CH-47F aircraft with COOLS can be configured in 15 minutes to transition from a troop configuration to cargo. The system travels with the aircraft so it truly adds mission versatility. Perhaps the most significant technology introduction by the CH-47F is the Digital Advanced Flight Control System (DAFCS). The system provides the capability of a fly by wire aircraft without the costly introduction of a new flight control system. Our aircraft can now perform maneuvers with extreme precision. As was prevalent during the Iraqi conflict, many military aircraft were lost due to brown out, the enveloping of the aircraft with the dust and sand of the local environment.



CH-47 in brownout conditions

The Chinook DAFCS system provided the pilot a fail-safe capability to land the aircraft with great control. DAFCS has been a game changer for the Army and the current operations.

During the war in Afghanistan, the Chinook even took on additional role of assault aircraft. Due to the mountainous terrain in that part of the globe, the US Army assault aircraft was unable to effectively operate in the high/hot terrain. The Chinook with its tandem rotor configuration and T55 engines was able to operate even in the highest elevations.

➤ **Clearly define the value of this program/project to members of your team**

Talk to anyone on the Chinook program and you will see the sense of pride they have for their involvement with the product. Chinook is used every day by someone around the world, saving lives, helping others. The entire Chinook team has a level of comfort due to the stability it provides to their daily lives. The CH-47F production has spanned 14 years and while the US Army has received their allotment, many countries around the world are evaluating the benefits of the aircraft to their needs. The marketing team is working hard to leverage the benefits of the CH-47F configuration for future sales and more workforce stability.

While the product provides stability for jobs, there is also an allure of working in aviation that attracts talent, particularly engineering. The CH-47F had significant development and continued need for technical support throughout its production period. Operations, engineering, quality, supply chain and logistic functions have all benefited from creating

and producing this latest configuration. Pride, stability and challenge best describes how this program provided value to the team.

➤ **Clearly define the contribution of this program/project to the greater good (society, security, etc.)**

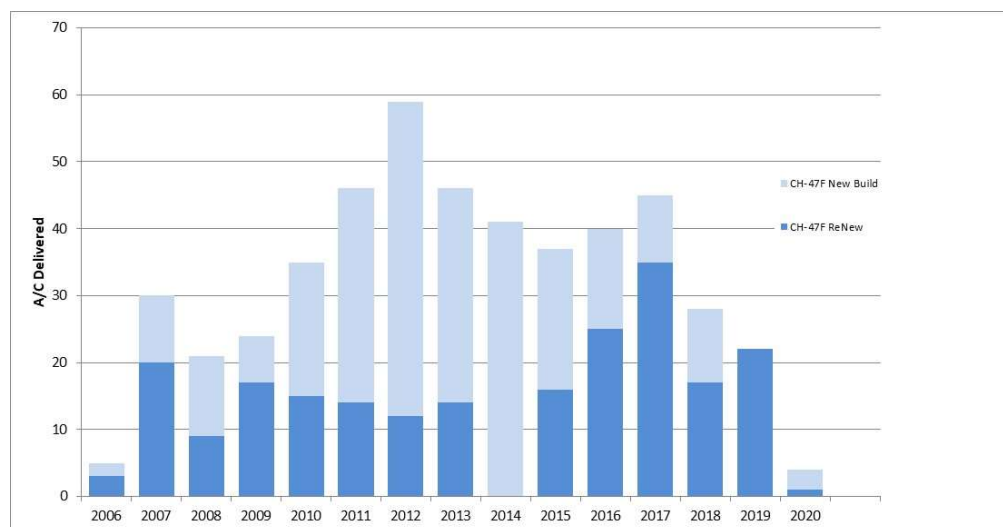
The CH-47F provides the US Army with a capability for military actions around the globe. The conflict in Iraq and Afghanistan saw a significant contribution with the CH-47F. Other countries, like Australia and UK flew Chinooks side by side with the US Army.

It is widely known for its capability on the battlefield but it also provides humanitarian relief wherever it is needed. It is not unusual to see the Chinook in the nightly news supporting some natural disaster. Earthquakes in Pakistan stranded people from basic necessities. Chinooks were there to help. Recently the South Carolina National Guard used the CH-47F to transport PPE in support of the COVID-19 pandemic.

## METRICS

➤ **How do your predictive metrics drive action toward program excellence?**

The production of the 500 Chinooks spanned 14 years. As illustrated in the figure, the quantities varied by year and type mix (new Build/Renew). This adds to the complexity for factory operations as variation is difficult to manage.



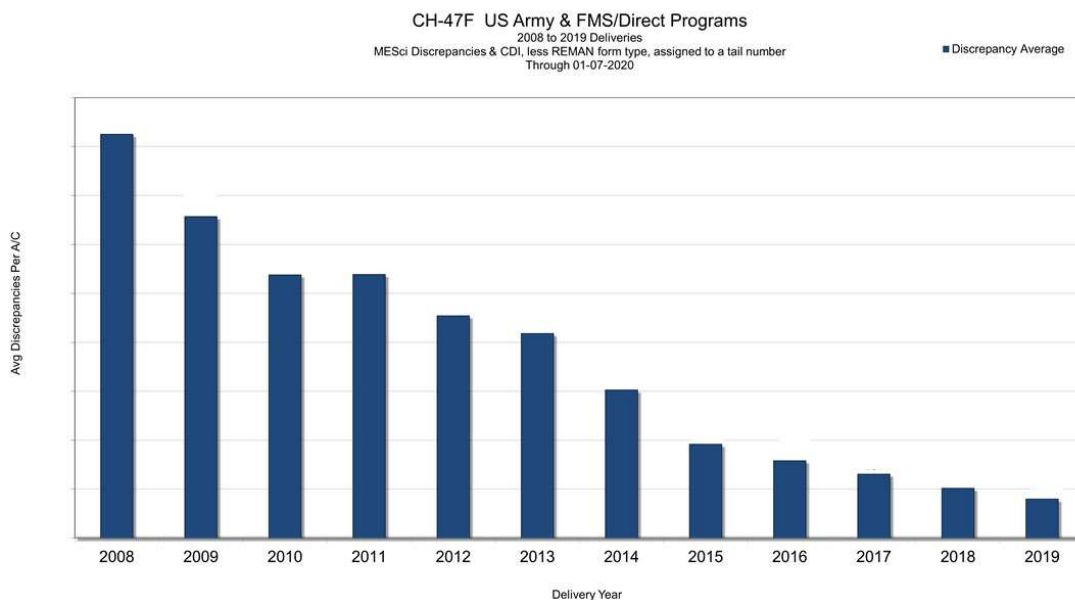
US Army CH-47F delivery profile

Boeing uses a standard series of production metrics across the enterprise to monitor production and provide the program manager an opportunity to make the necessary changes for optimal results. The Key Performance Indications that will be discussed as it applies to the Chinook are: production costs, first time Quality, Cost of repair, rework and Scrap (CORRS) and Travel Work. These metrics are reviewed weekly by Chinook leadership allowing for early corrective action as required.

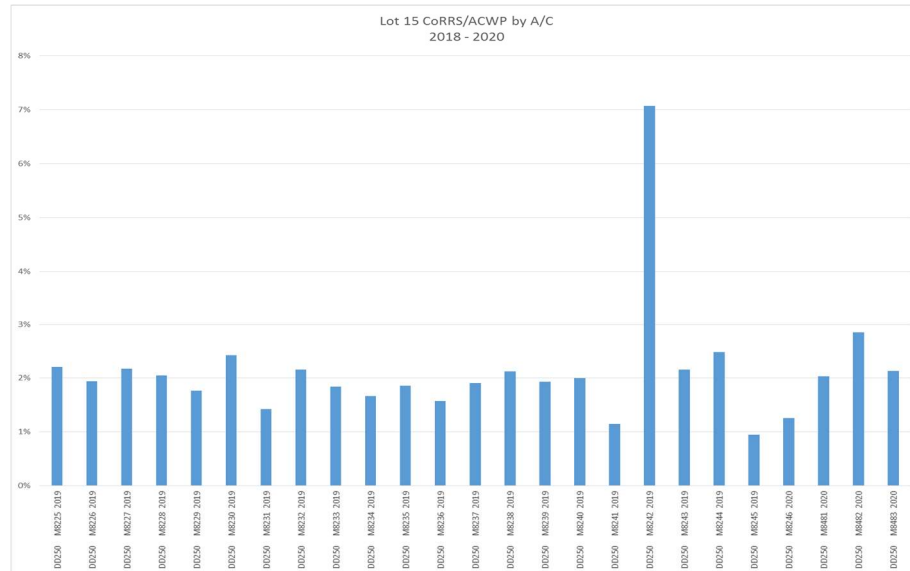


Production costs is a metric that not only establishes the revenue and profit margins for the company but also monitors the performance on the factory floor. Boeing measures production costs on the factory floor daily using typical earned value metrics (EVM). While the data is measured daily, weekly analysis is performed and presented to program leadership. While certain costs are only available monthly, weekly monitoring of production hours is a standard best practice for Boeing and the CH-47 program. The easiest EVM to understand and measure production health is Cost Performance Index and Schedule Performance Index. These indices measure actual cost against planned costs. An index of 1.0 reflects that the production is on plan, greater than one means ahead of plan or under costs (a measure of goodness). The metrics for the last year of the CH-47F production were CPI of 1.03 with the SPI of 1.00. The last year of production could experience tail up (cost increase due to end of production) so finishing with a 1.03 is testament to the management agility as the program winded down.

Discrepancies through the life of the program is reflected below. It is discrepancy that leads to assessment, rework and/or repair. As shown, the program led a major initiative to drive down this metric. We reduced the average discrepancy account by an order of magnitude over the build period.



Cost of Repair, Rework and Scrap (CoRRS) for the last year of the CH-47F production is shown below. Our metric is the amount of rework compared to the basic work spent on the particular aircraft. Our last production lot experienced an average of 2.13%, a mark that is an aviation industry leader. The one outlier for the last lot had a composite rotor blade scrapped, reflected in the spike, and driving up the average.



Lot 15 CoRRS as a percentage of labor hours

The success of the improvement in the CoRRS metric not only allowed for better schedule performance but also reduced cost. It was the primary focus for Chinook. First time quality save rework. Less rework reduces cost and improves schedule. Reduced cost not only provides additional profit to the Boeing Company but also reduces cost of goods to our primary customer, the US Army and eventually the tax payer.

## DEALING WITH PROGRAM CHALLENGES (VOLATILITY, UNCERTAINTY, COMPLEXITY, AMBIGUITY, OR VUCA)

Please respond to the following prompts:

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

The production of a CH-47 Chinook is a complex assembly as a US Army aircraft. As mentioned earlier, there are approximately 5000 parts. Many of these received parts are assembled by our supply base so they contain many parts on their own. Boeing assembles the entire aircraft and test flies the completed product at the Philadelphia site. The Army then takes delivery and flies them out to deliver to whatever unit is scheduled to receive them. With just in time delivery, parts on the dock is the first challenge in uncertainty. Our parts are scheduled to be received by Boeing approximately two weeks before needed. The part deliveries are staggered to reflect need installation time as the Chinook moves down our assembly line. A simple 2% late part metric implies 100 parts would be late to installation, many of them critical potentially holding up the next task.

A larger contributor to the assembly uncertainty is the parts that we receive from the Government to be overhauled and installed in the aircraft. We refer to this configuration of the F Model as a Renew. The major risk is the condition upon which we receive them. Most parts have many flight hours on them and the condition varies due to operating

environment, skill of maintainers, and time on wing. Boeing receives these parts when the Customer removes the asset from service at the start of our production lead time. Upon receipt, the parts are disassembled and inspected. Elements that do not meet our specification must be replaced. While Boeing maintains some material stock based on historical conditions, there are cases where parts must be ordered, usually within lead time. Without strong management intervention, these parts could be late and impact our assembly performance.

This production program was not without challenges. During the production, between the years 2009 and 2011, the factory was completely gutted and rebuilt from the concrete floor on up. Production did not stop and was forced to relocate over that time period within the same production space. The production chart, shown earlier, actually shows that the production ramped up during this period and peaked as the factory revitalization completed. Tools had to be moved, workers relocated and receiving parts had to be tracked while sections of the floor were shut down and reworked. The resultant production lay-out provided the mechanic on the floor access to parts, tools and instructions without having to leave their station. Through this modification, the production team reduced the production man-hours by over 10%.



Before and after images of the new factory

Another initiative instituted during this timeframe was an emphasis to significantly reduce the Cost of Repair, Rework, and Scrap (CoRRS). This last year of production, the program achieved an industry leading 2%. This last year also showed no lost work days due to injury, another industry leading metric.

The Chinook success should be attributed to the culture that has been created by the entire team, leadership to factory worker. Many programs have attempted to improve CoRRS and reduce FOD with less than stellar results. Leadership have made these issues their priority. The entire Chinook team understands the circumstances from their actions. We continue to help our fellow programs but until the culture is changed, their results will not be similar.

Contract stability was also a challenge for the team. The initial contracting approach by the US Army were annual contract awards. An order is placed each year with no guarantee of production the following year. This is typical during the initial ramp up in production. Of course, this introduces production risks as annual contracts are flowed down to the supply base. Both Boeing and the supply network do not have guarantees of multiple years of production limiting initiatives to produce large quantities and factory streamlining. The CH-47F contains over 5000 parts acquired from over 400 suppliers. The timeline to build a Chinook is approximately three years from order to delivery. The number has fluctuated based on demand and working lead times directly with the supply base

After four annual contract awards, the Government awarded two multiyear contracts, each being five years in duration. For industry, this provided production stabilization. For the Customer, a minimum cost savings of 10% is expected over annual awards due to benefits of stable quantities. This provided a challenge for Boeing and the supply base to drive down costs. The team set a goal for 15% cost reduction and were successful. The second multiyear contract took the program to the end of the CH-47F production program of record. Again another 10% cost reduction was expected and achieved. The Army operates 473 Chinooks. The additional quantities, sprinkled throughout the delivery profile, included Foreign Military Sales, as well as wartime replacements

## **ORGANIZATIONAL BEST PRACTICES AND TEAM LEADERSHIP**

**Please respond to the following prompts:**

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

The CH-47 program has delivered over 500 aircraft, every one of them ahead of need date. During the 14 years of production several innovative practices have been introduced. As was mentioned earlier, some highly effective practices have set the Chinook apart from other programs within Boeing. The focused factory initiative was introduced halfway through our production timeline. Our team took best practices, particularly from our commercial 737 program, and completely revamped the line for

improved efficiency. We focused on point of use by locating tools, parts and fixtures at the station performing the task. The Chinook uses a pulsed line system where tasks are performed at stations within a given takt time. The mechanic assigned to that station not only has the equipment at his disposal but also people resources sitting shipside that can provide technical help as required. We have also created work packages or jobs that do not exceed 8 hours. That way we can measure progress daily without significant Work In Progress (WIP).

While we revamped the factory, we also improved creature comfort with advanced lighting and climate control. At the start of the CH-47F production run, the factory had a floor that shifted due to the influence of tides from the nearby Delaware River. There was also no air conditioning so the team opened the high bay doors in the summer time hoping for airflow from outside. The resultant factory earned many environmental awards as well as improving efficiency. It remains one of the model factories in Boeing.

We also instituted the “Cut the CoRRS” program as the program had high cost of rework on our production line. By emphasizing the costs and tracking the rework back to the source, our effort has made the line a model for other parts of Boeing to follow.

Foreign Object Debris (FOD) is also something that can plague a production line and create dissatisfaction with the receiving customers. FOD can cause damage to the aircraft and risk the lives of the operators. Efforts by the leadership have resulted in a mindset embraced by the entire team. Much like CoRRS and the focused factory, other Boeing programs have come to witness and replicate our best practices in FOD control.

All of these elements creates a workforce that is motivated and competent. It is Boeing practice to move personnel across programs for knowledge transfer. The first benefiting program from our Chinook is the neighboring V-22 production line. Shop mechanics have been loaned and/or permanently transferred to help this program gain from our initiatives. We have also moved leaders across the enterprise to share their learning. The AH-64, 737 and T-7 all have leadership who were once associated with CH-47F. Even our leader for Boeing Defense was a Chinook Program Manager early in the CH-47F period.

The direct customer to Boeing for the CH-47F is the Program Management Cargo within the Program Executive Office for Army Aviation. They are the acquisition office who procures the aircraft on behalf of the fielding units as well as the foreign countries buying the Chinook through the Army. Our engagement with the project office is daily. We also conduct face-to-face meetings quarterly both at the program level and the leadership level. In addition, Boeing has representatives who work directly with the fielded units both in United States as well as deployed units.

One connection that Boeing supported was directly with the fielded units. Boeing always conducted these engagements hand-in-hand with PM Cargo. In the first instance, when the aviation unit received their complement of aircraft and the appropriate user training, we would recognize the unit for their accomplishment. It provided an opportunity to

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thank the group for their service and provided an opportunity for them to share their initial thoughts. A more important connection was post deployment. When the unit returned from their first deployment to combat with the CH-47F for the first time, Boeing and PM Cargo would meet and discuss lessons learned. This was a very valuable opportunity to understand how they operated the Chinook and get their impressions ranging from the product to the training they received. The team actually made improvements to the F Model through such engagements. The COOLS floor is one of the mid-cycle improvement that was incorporated after the initial production of the CH-47F. It was incorporated into our production line and a retrofit was made to the remaining fielded fleet.

The CH-47F is the best heavy lift helicopter in the world today. Boeing, teamed with our customer PM Cargo, has provided the US Army with a great capability. Boeing delivered 500 aircraft ahead of schedule, fulfilling the Army requirement to help make the world a better place.