2014

Aviation Week
Program Excellence Award Submission
2014 Program Excellence Award

I. Program Overview

<table>
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<tr>
<th>Organization Name/Program Name:</th>
<th>Canadian CH147F Medium/Heavy Lift Helicopter Program (MHLH)</th>
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</table>
| Program Leader Name/Position/Contact information – E-mail, Phone | Steve Parker  
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610-591-5068 |
| Program Category | System level R&D/SDD program or project |
| **Program Background:** What is this program all about? (No more than one page). Describe: | The Canadian CH147F Chinook is the most technologically advanced Heavy Lift Helicopter in the world. The aircraft combines the best of an existing platform with the latest system enhancements to produce the work horse the Canadian Military needs for multi-mission performance. To achieve the mission capability required by Canada, significant design enhancements were made to the US Army CH-47F configuration baseline. The CH147F is an advanced multi-mission helicopter featuring a modernized monolithic airframe capable of supporting the extended range fuel system, a fully integrated digital cockpit management system, enhanced self-protection systems, and new electrical system. Development of the CH147F capability required more than 1.2 million hours of non-recurring engineering and a 300-hour flight test program making it the most challenging developmental effort in the past 15 years of the Chinook program. Boeing’s Vertical Lift, Philadelphia, PA, facility was awarded the firm fixed price contract from the Government of Canada to develop and deliver 15 new aircraft. Boeing has also been tasked with developing CH147F training devices for pilots and maintainers. These aircrews and maintainers have been appointed by the Government of Canada as a new squadron to deploy and operate the new CH147F fleet. The In-Service Support phase of the CH147F program has concurrently been initiated and is contracted for 20 years. To date fourteen aircraft have been delivered to Canada all ahead of the original baseline schedule. The final CH147F delivers in June 2014, 60 months from contract award and on schedule. |

II. **Value Creation = 20 points**

| Value | Value to customers: The CH147F is the Royal Canadian Air Force’s (RCAF) solution to provide heavy lift |
The CH147F program is on schedule to deliver the 15th aircraft in June 2014 and Initial Operating Capability in 2014.

**Value to Company:** The CH147F is the Boeing Company’s most advanced international Chinook and is currently being offered to several international customers. The lessons learned during the design of the airframe, the electrical system, and the mission equipment package grew and sustained not only Boeing’s engineering workforce, but the engineers of over 100 team Chinook suppliers, they have reduced schedule and technical risk for multiple international campaigns, and they have already been leveraged to support the award of the MH-47G contract to build 8 additional aircraft. The CH147F program has proven invaluable to the Boeing Company.

**Scientific/technical value:** The technical value of the CH147F program is a successfully developed 3D Model Based Definition (MBD) design that enabled rapid development while providing an improved baseline to support future enhancements. In addition, Boeing developed and integrated an affordable new electrical system using primarily off-the-shelf components, and made significant design and integration improvements to the cockpit management system. The new baseline will be used for future programs to maximize design and capability reuse.

**Excellence and Uniqueness:** The CH147F program is the largest advanced technology development program to be undertaken at Boeing’s Vertical Lift, Philadelphia PA,
facility in the past fifteen years. More than 1.2 million hours and 300 hours of flight testing were applied to develop and deliver to customer requirements. In addition, initial cadre training for aircrew and maintenance technicians and creation of an In-Service Support element were required to support initial aircraft deliveries. This highly complex endeavor was successfully accomplished, on schedule, within 60 months of contract award. Process improvements, technology advancements, and lessons learned from this program have all been applied to follow-on US and International Chinook programs to reduce cost and improve schedule.

### III. ORGANIZATIONAL PROCESSES/BEST PRACTICES: (HOW DO YOU DO THINGS) = 30 POINTS

#### Strategic: Affordability Management – Describe how your program has addressed affordability from a solution, operational, business process, sustainment, strategic or other perspective.

Flight testing is a significant cost and schedule driver for any developmental program and the strategy to manage this was implemented early in the program. The decision was made to have the Boeing Test and Evaluation (BT&E) organization manage the flight test program and conduct Chinook flight testing at Boeing’s Mesa AZ facility. The CH147F program was the first time that the Chinook program team worked alongside BT&E, which has its heritage in Boeing Commercial fixed-wing airplane programs. Partnership with BT&E offered an opportunity to utilize new test planning, execution, and reporting tools and resources proven to improve efficiency on other model development test programs. The collaboration led to completion of major flight testing ahead of schedule, significantly reducing risk to meeting an aggressive production schedule.

#### Strategic: Opportunity Management - Describe how your program has identified its operational and business opportunity, and manages this opportunity throughout the program’s life cycle.

The CH147F program utilized existing, proven designs, processes, and tools to the greatest extent possible to improve affordability and reduce risk to the program. The program was able to capitalize on the MH-47G Digital Avionics Fight Control System (DAFCS) development success by integrating it into the CH147F baseline. This was a cost and schedule opportunity for Boeing and provided additional benefits to the customer by easing pilot workload and providing additional functionality. The decision to proceed was decided based on a business case. As the DAFCS integration matured, performance was managed weekly to confirm cost and schedule remained within the proposed scope so the opportunity was realized throughout the program’s life cycle.
**Strategic:**
Strategic Supply Chain Integration and Cost Effectiveness Management:
- Describe how your program is integrating its supply chain to assure visibility and adapting long-term cost effectiveness up and down the supply chain.

The CH147F program utilized a number of subcontractors who were all critical to the development of the aircraft. Integrating the supply chain into the program and planning for long-term cost effectiveness began with Requests for Proposals (RFPs). Suppliers were required to provide a detailed development and qualification schedule as part of their proposals. Supplier schedules were integrated with the master program schedule to link interdependent tasks and to facilitate rapid identification of supplier schedule slips impacting the program critical path. Supplier contract awards included the scope for design, qualification, and delivery of production assets as well as initial spares to support initial setup of aircraft facilities in Canada. This robust contracting approach reduced cost by virtue of this economic order quantity buy approach. Early identification of risks and issues was an expectation clearly communicated to the suppliers so proper actions could be taken to mitigate risks to the program. To accomplish this, weekly executive level briefings were held for highly developmental systems.

**Operational Integration and Systems Engineering –**
Describe the challenges faced by your program in terms of integrating the system into its operational environment and its impact on systems engineering planning and management.

The CH147F program was a complex effort involving major physical airframe integration and functional integration of the numerous aircraft subsystems, with a focus on the stringent certification requirements. Physical integration relied heavily on 3D MBD and the use of new technology tools such as Virtual Reviews (VRs). This approach allowed all engineering functions to visually represent their designs in a 3D environment, minimizing potential inter-system physical interferences while optimizing for operator interaction. Systems Integration Labs (SILs) were also developed and utilized for the major developmental areas to validate functionality and identify issues prior to on-aircraft installation. This enabled the program to achieve the first flight milestone six days ahead of schedule.

**Operational:**
Planning, Monitoring, and Controlling - Describe your planning and resource allocation processes. How do you monitor and review your program’s progress and make corrections to keep the program on track? How have you worked with your customer to assure quality and communication without creating non-value reviews and audits that do not “fit” your program effort?

The CH147F program co-located its leadership team with engineering, finance, scheduling, supplier management, contracts and support to increase communication and foster a collaborative environment. The leadership team immersed itself in fostering an open culture and a sense of urgency, which were key enablers to driving quick resolution of complex and time-critical issues. The program operated under a disciplined weekly battle rhythm where program leadership reviewed cost and schedule status performance; Risks, Issues, and Opportunities (RIOs); material cost management; and change requests. The customer was embedded with the program and design teams and involved in these weekly reviews, eliminating the need for additional
reviews. Meticulous attention was afforded to efforts off-plan to ensure the full scope of impacts to the program were identified and comprehensive corrective action plans implemented, while ensuring quality. The program’s open culture provided the customer great insight into the program, and a sense of confidence that they fully understood the program status.

### Operational: Supply Chain and Logistics Management

What processes, tools and relationship-building methods have you used to develop, refine and improve supply chain and stakeholder integration? Please indicate methods used to analyze/fact-find regarding supplier proposals. *This is one of the most critical needs of our industry* – please provide specific details and data that assisted you in gauging the effectiveness.

A fully networked program schedule was the first step to integrating the supply chain into the program. Assumed development time, based on historical data, was integrated into the master program schedule to determine the need date for supplier contract award to meet the program schedule. Proposal evaluations included a cost/price analysis utilizing similar-to historical data to identify a contract negotiation price basis. Following contract award, the program used one focal to track all supplier contract commitments and ensured risks and issues were detected early to allow mitigation plans to be implemented quickly. In the more complex developmental areas, on-site technical representatives and supplier program managers assisted suppliers throughout the development process. Critical elements of the supply chain also utilized weekly executive level reviews to communicate progress and to discuss help needed. Monte Carlo analysis was performed for critical deliveries every three months.

### Operational: System Integration, Testing & Reviews

Describe the activities and processes used to succeed in your system integration, and testing. How did you conduct system design and technical reviews? What innovations in processes or tools were used to further evolve this capability?

Customer engagement throughout the program was key to the success of the design, integration, and testing. Being able to gain customer insight into the intent of the requirements while working through the preliminary design gave the Boeing team a better appreciation for the final design. During the preliminary design, Boeing used an innovative process called Verification Data Sheets (VDS) which identified specific artifacts necessary to verify the designs satisfied the requirements. This interaction also gave the customer a sense of confidence that the product would match their vision and needs for the aircraft. The customer was also involved in the 3D virtual reviews and witnessing of SIL testing during the critical design phase. Close collaboration and an open access culture allowed for design reviews to focus on risks associated with the design, as opposed to presenting the customer the details of the design and explaining why particular decisions were made.

### Operational: Risk/Issue/Opportunity Management

Describe the processes used to identify both risks and opportunity

RIOs were managed by a CH147F-dedicated program planning and integration focal. Any member of the team was empowered to suggest an item be included as a RIO in the bi-monthly management meeting. The program manager would
and to assure potential for both is addressed effectively. Please indicate any forward-leaning processes to support.

have final authority to accept a RIO into the program baseline. The tool used to manage RIOs captures likelihood, consequence, and the plan to mitigate. Financial impacts were also assessed, tracked, and reflected in quarterly financials.

**Team Leadership:**
Team Culture and Motivation - Describe how you created your team spirit and culture, and accomplished entire team integration and individual team member motivation. Given the economic environment and changes in the global marketplace, how did you assure your team changed swiftly and with agility?

The need to embrace a strong sense of urgency was a persistent message from program leadership that all members of the CH147F Program understood and accepted. This mindset allowed the team to be agile and enabled quick resolution to technically complex and time-critical issues. The sense of urgency was unilaterally embraced by all team members including suppliers and the customer. Integral to this message was the implementation of a “no surprises” and help-needed culture, where all members of the team felt empowered to raise risks and issues as they were identified so that the entire team could offer assistance to support resolution.

**Team Leadership:**
Lessons Learned and Knowledge Management - Describe how you collect lessons learned and best practices, and how they are shared with your team and company to improve performance. Also how are you capturing expertise and knowledge to assure availability over the life of the program?

Documenting and communicating lessons learned was part of the weekly battle rhythm of the program. As changes to the baselines were presented at the Change Control Board (CCB), team members were also required to present a brief Root Cause/Corrective Action (RCCA) explanation of what caused the issue and what was being implemented by the team to prevent it from recurring in the future. This focus on finding a solution at the time of identifying the issue allowed teams to implement corrective action in a timely manner, preventing problems from reoccurring on this and other programs. The program also used company-wide resources, to include enterprise engineering, ahead of finalizing developmental design when dealing with significant risk and issue topics. Multiple Non-Advocate Reviews (NARs) were conducted to gather feedback and lessons learned when finalizing developmental designs such as the electrical system.

As the program progressed through design and into production and finally flight testing, team members transitioned to new roles and programs to ensure the transfer of knowledge and experience was applied to other programs.

**Team Leadership:**
Leadership Development - How do you develop your team’s skills and prepare/develop future leaders?

Delegation of authority was firmly embraced, empowering people to make timely decisions. Many individuals were rewarded with increasing leadership responsibilities, demonstrating their leader’s confidence in their abilities and judgment.

The leadership of the program also conveyed and modeled to the team the expectations they had of themselves, demanding
self-accountability to commitments. This objective of self-commitment, empowerment and personal accountability was driven to all members of the team and is a great example of how to develop future leaders by setting expectations and modeling behavior.

**Best (& Next) Practices:**

Identify your program’s specific Best Practices *that you believe are unique, and could be shared with others and become industry’s Next Practices.*

The need to embrace a strong sense of urgency was a program best practice and was a persistent message from the program leadership that all members of the CH147F program understood and accepted. The axiom for the CH147F program is “Maintain the Rage,” the “rage” being a metaphor for high expectations of success. This proved inspirational to the team to relentlessly push past obstacles to find a way to achieve results. Program leadership successfully inspired the sense of urgency within the culture which was a major contributor to the success of the program.

**IV. Adapting to Innovation and Complexity: (How do you deal with your program’s unique complexities) = 20 points**

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<thead>
<tr>
<th>Identify the Program’s Market Uncertainty level</th>
<th>The need for a Heavy Vertical Lift platform is not new, but it is always expanding. The CH147F is a derivative of the venerable CH-47 Chinook that is currently operated by 19 countries around the world. What makes the CH147F unique is it is the first machined monolithic airframe capable of supporting the extended range fuel system and is the first Chinook with a fully updated electrical system to satisfy the need for today’s and tomorrow’s digitized mission systems, and it provides an improved cockpit management system and aircraft survivability system. These upgraded aircraft subsystems reduce the work load for maintainers while increasing situational awareness for the pilots. It truly is a technologically advanced aircraft with room for growth, and multiple customers are already leveraging the design that went into the CH147F or they are negotiating to purchase an identical configuration.</th>
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<td>- <strong>Derivative</strong> – an improvement of an existing product/system.</td>
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<td>- <strong>Platform</strong> – a <em>new generation</em> in an existing product line.</td>
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<tr>
<td>- <strong>New to the Market</strong> – a product or system adopted from another market</td>
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<td>- <strong>New to the World</strong> – breakthrough product, never seen before</td>
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<td>Identify the Program’s Technological Uncertainty using the definitions below. Then describe how you deal and address this uncertainty:</td>
<td>The CH147F program is based on the US Army CH-47F and uses existing technology modified to meet the new customer design requirements. Technology uncertainty existed due to using components and systems designed for other applications. Requirements and testing to verify operation in the unique H-47 environment were established early in the program and part of the Supplier RFPs. Risk of compliance to these requirements was evaluated ahead of supplier selection to reduce risk to the program. For example, an existing fielded Auxiliary Power Unit (APU) was utilized and</td>
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<td>- <strong>Low-tech:</strong> application of mature, well-established technology</td>
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<td>- <strong>Medium Technology:</strong> existing technology modified to meet new</td>
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design requirements
- **High-Technology**: recently developed new technology
- **Super High-Technology**: non-existing technology that needs to be developed during the program.

mounting provisions were modified for the unique installation on the CH147F aircraft. This modification was validated during flight test and production incorporation supported on-time first aircraft delivery. Uncertainty also surrounded the development and integration of the new electrical system designed and certified to the latest military standards. Critical to this success was early involvement with Boeing certification experience from across the company as well as closely working with the customer. These relationships commenced with requirements development so the requirements for all stakeholders were fully understood ahead of design and testing. This was an important upgrade to the CH147F from the customer’s perspective and was greatly successful based on full stakeholder involvement from the onset.

Identify the level of your **System Complexity** using the definitions below. Then explain how you are dealing with this level of complexity:
- An **Assembly** performing a single function.
- A **Sub-system** fitting within a larger system.
- A **System** – a collection of subsystems performing multiple functions.
- An **Array** – a “System of Systems”; a widely dispersed collection of systems serving a common mission.

The CH147F aircraft represents a true array, or system of systems. CH147F development impacted nearly all aircraft systems and introduced new systems onto the aircraft. This integrated aircraft fulfilled the goal of reducing pilot workload, increasing situational awareness, and providing defensive protection, with resulting airframe and electrical system upgrades to accommodate needed capabilities. Managing this complex development started with establishing the requirements baseline early in the program, with the customer’s buy-in, to include certification requirements due to their impact to the full life cycle of system design. Physical integration of the aircraft systems utilized 3D MBD, which allowed for virtual reviews to coordinate installations and interfaces across the aircraft while reducing interferences and issues that could show up during production. Interface Control Documents (ICDs) were the basis for delineating electrical interface and communication requirements. Multiple SILs were created for integration testing to support the initial verification and validation of aircraft systems, and resolve issues prior to ground and flight testing.

Identify the **Pace and Urgency** of your team’s effort using the definitions below. Then describe how you deal with the program’s pace requirements:
- **Regular timing** – no specific time pressures.
- **Fast/Competitive** – time to market is important for competitiveness.
- **Time Critical** – there is

The CH147F program was a time-critical, firm-fixed-price effort. The contract with the Government of Canada required 36 months from contract award to first flight, 48 months to first aircraft delivery, and 60 months for delivery of all 15 aircraft. In addition to aircraft development, manufacturing, and testing, the contract also called for comprehensive training of the initial cadre of pilots and maintainers, delivery of comprehensive technical and maintenance publications, and commencement of the initial In-Service Support lifecycle phase. To overcome technical and schedule challenges, the CH147F Program emphasized the “One Boeing” model that
an absolute and critical-to-success deadline. 
*Blitz* – there is a crisis element driving the need for immediate response.

leadership brought to the team, applying the expertise and empowerment of many people’s talents across multiple Boeing organizations such as Boeing Military Aircraft (BMA), Global Support & Services (GS&S), and Boeing Test & Evaluation (BT&E).

**Other Complexities & Uncertainties** -
Describe other complexities and unknown factors faced by this program and how you addressed them.

The Direct Infrared Counter Measure (DIRCM) system in particular presented many unique challenges with regard to stringent aircraft installation accuracy, precision and coverage requirements, test asset availability, and overall stakeholder coordination. Associated risks were identified and trade studies were conducted to identify the best overall installation and integration approach. The results were validated via a Boeing Enterprise and Original Equipment Manufacturer (OEM) Non-Advocate Review. The OEM was involved during the installation and integration design phases, providing concurrence to the final installation design and supporting functional testing on the aircraft. Frequent discussions were conducted with the various stakeholders to identify near- and long-term asset requirements, along with recovery plans for mitigating late asset arrival. Close coordination and execution of the processes implemented by the CH147F program enabled successful installation and operation.

V. **Metrics (How do you measure program’s performance) = 30 points**
(Note: We are not looking for $ results, but the relative percentage achieved. In particular indicate what specific metrics and data you are using that drive the program beyond standard measures of schedule, budget, and performance, and which have contributed to your program’s focus and its success.)

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<th><strong>Customer</strong> - How do you measure the impact of your program on your customer and your customer’s satisfaction? Include a description of your metrics, as well as numerical evidence.</th>
<th>The customer was involved in the daily and weekly battle rhythm meetings, which included full access to the engineering and production metrics, risk, issues and opportunities and schedule status. The integration of the customer within the team added to the productive environment of teaming and assisted the program in fully understanding the value that the customer provided in risk mitigation and problem solving.</th>
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<tr>
<td><strong>Performance</strong> - How do you measure your program’s performance in traditional terms such as schedule, budget, requirements, and business results?</td>
<td>The CH147F program utilized weekly Earned Value Management (EVM) to measure the program performance. EVM integrates work scope, schedule and cost and provides weekly visibility into the performance and health of the program. The program performance included all business units and functions associated with the program. This integration and performance tracking allowed the program to identify issues real time and deliver on commitments.</td>
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<td><strong>Preparing the Future</strong> - How do you measure and track progress related to this program and the CH147F future?</td>
<td>The success of the CH147F program is critical to the future of the entire Chinook program and Boeing’s Vertical Lift program.</td>
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assess the long-term contribution of your program to the corporation/organization?

Division, and to date, this program has been a complete success. The CH147F program demonstrates that complex development efforts can succeed to plan with the proper leadership focus, metrics, and teaming culture. The key to this success lies within the inclusive environment throughout the entire program team. The open culture with the Customer allowed for a shared vision of success and ability to handle difficult situations without impact to the program. The sense of urgency modeled by leadership and demonstrated throughout the team was critical to keeping focus on the priorities and completing activities on schedule. This culture has since spread throughout the H-47 program as a whole and is the benchmark for other programs not only at Boeing but with our supplier teammates as well.

Team - How do you measure and assess the impact of your program on your team development and employee satisfaction?

Each member of the team was empowered to make decisions for their respective areas. This instilled confidence in the team and drove a sense of pride that each person was directly impacting the program’s success. This was measured by the team unity felt on the program and resulted in many team members being assigned to leadership roles on other programs to further disseminate lessons learned and best practices.

Unique Metrics - Describe any unique metrics you are using to measure your program’s progress and how do you focus it for outstanding success.

A significant accomplishment for the program was successfully accomplishing the extensive 300 hour flight test program within the allotted schedule. A BT&E tool called Test Planning, Execution, and Reporting Tool (TPERT) was used to develop this test condition matrix for the program. The matrix was used to develop the baseline plan test condition burn-up metric which was used to chart progress to plan. This metric included a plan for the test team to collect the data, but also a plan for the engineering team to review and disposition the data as pass/fail. The Combined Test Force (CTF), which included Boeing and the Customer, utilized the daily stand-up meeting to discuss unexpected barriers to test, track actions to resolution, and develop alternate plans. The team discussed a detailed four week plan on a daily basis to assess consequences to the plan and re-align the appropriate resources. The team also tracked metrics based on the test events log and the 8 hours per week flying rate to identify trends that could be used to drive efficiencies. The combination of these metrics into an integrated status allowed the team to coordinate efforts across the flight test and supporting teams, focus on the problem areas that affected the plan, and re-align the plan to take advantage of each day during the flight test portion of the program.