

AVIATION WEEK

Program Excellence Awards 2022

November 2, 2022

The Watergate Hotel • Washington, DC

Nomination Form

INTELLECTUAL PROPERTY

(This section must be signed)

Individuals **outside your company**, including the companies listed above and other third parties, potentially including your competitors and others in your industry, may receive and/or review award submissions. All information submitted should address the program's management, leadership, and processes in a manner that you are comfortable sharing with third parties freely and without restriction, and may not include any classified or proprietary information or materials. Do not include any materials marked Confidential or Proprietary or bearing any similar legend. All responses and other submissions, whether in whole or in part ("Submissions"), shall be deemed not to be confidential, proprietary, and/or nonpublic information of any sort for any purpose.

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Thank you for participating,



Gregory Hamilton
President
Aviation Week Network

Acknowledged, agreed, and submitted by



Nominee's Signature

Nominee's Name (please print): Justin Appel

5/16/2022
Date

Title (please print): Lockheed Martin LRHW Program Director

Company (please print): Lockheed Martin Space

NOMINATION FORM

Name of Program: **Long Range Hypersonic Weapon (LRHW) System Integration Prototype (SIP)**

Name of Program Leader: **Justin Appel**

Phone Number: **(256) 217-6176**

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Postal Address: **Lockheed Martin Space, PO Box 070017-7017, Huntsville, AL 35807**

Customer Approved

○ Date: May 9, 2022

○ Customer Contact (name/title/organization/phone): Barbara Cantrell, Army Hypersonic Project Office, Agreement Officer Representative, 256-336-6036

Supplier Approved (if named in this nomination form)

○ Date: Not applicable

○ Supplier Contact (name/title/organization/phone): _____

**PLEASE REFER TO PROGRAM EXCELLENCE DIRECTIONS
AS YOU COMPLETE THIS FORM.**

EXECUTIVE SUMMARY: Make the Case for Excellence (Value: 10 pts)

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

(12 pt. Times New Roman) LIMIT YOUR NARRATIVE TO THIS PAGE.

The importance of a Hypersonics Strike Capability to our nation and more importantly to the men and women of our armed forces cannot be understated. Through unique partnership and implementation of “go fast” principles, the Long Range Hypersonic Weapon (LRHW) program fulfills an urgent operational need and delivered the first hypersonic battery to the U.S. Army in 2 years from contract award. This significant milestone is the first key enabler to realize the target set by then-Army Secretary Ryan McCarthy in 2019 to develop and build the country’s first hypersonic missile in a little more than four years.

LRHW provides the United States a first of its kind hypersonic weapon system that is a deterrent towards those adversaries that could employ similar weapons against the United States. In the event deterrence is unsuccessful, this U.S. Army’s road mobile, air transportable conventional deep-strike land-based hypersonic weapon provides a highly survivable and lethal capability to destroy coastal and deep inland time critical anti-access and area denial (A2/AD) targets, suppress adversary Long Range Fires and engage other high payoff/time-sensitive targets. This system was required to be operational to support Army objectives within two years from the program start date.

Teamed with the Army Hypersonic Program Office (AHPO) within the Rapid Capabilities and Critical Technologies Office (RCCTO) led by LTG L. Neil Thurgood, Lockheed Martin (LM) was responsible for the development and production of the first LRHW Battery. The LRHW Battery included four Transporter Erector Launchers (TEL); a mobile Battery Operations Center (BOC); a BOC Support Vehicle (BSV); and all Peculiar Support Equipment (PSE) and other support and training materiel required for Soldier New Equipment Training (NET), transportation, operations, and sustainment. LRHW integrates an All-Up-Round (AUR) missile – common with the Navy’s Conventional Prompt Strike program – that is comprised of a 34.5” booster and a Common Hypersonic Glide Body (CHGB). The complete hypersonic weapon system includes integration with environmentally controlled canisters for the AUR, suitable for Army environments.

The development and more importantly the production of the first Battery had to be completed and delivered to the Army by September 30, 2021, two years after contract award. Realization of this aggressive goal was achieved by a true customer/contractor partnership grounded in complete transparency and common understanding of success. The joint LRHW team established new methods of doing business; overcame multiple challenges including the COVID-19 pandemic; kept a laser focus on schedule execution and ultimately delivered 22 semi-trailers of new equipment to the Army two days ahead of the baseline delivery date.

In just 24 months, the combined LM, contractor, and government team turned an idea into the Nation’s first LRHW. This successful production and delivery of the first Army Hypersonic Battery on September 28, 2021, is what qualifies the LRHW program as exceptional and worthy of consideration for the OEM/Prime Contractor System Production Award.



Figure 1: Joint LRHW Team at Delivery

Do not exceed 10 pages in responding to the following four descriptions; allocate these 10 pages as you deem appropriate, but it is important that you respond to all four sections. DO NOT REMOVE THE GUIDANCE PROVIDED FOR EACH SECTION.

VALUE CREATION (Value: 15 pts)

Please respond to the following prompt:

- Clearly define the value of this program/project for the corporation
- 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.)

(12 pt. Times Roman)

LRHW is one of the Army's top modernization priorities since 2019. The intrinsic value of the United States to maintain parity with their near-peer adversaries cannot be over emphasized. The LRHW program has positively impacted LM, the team and the individuals responsible for its delivery and production through its unique execution and mission.

Value to the Greater Good: One does not have to look far to see the significance of hypersonic weapons for the United States. While the U.S. was an early leader in hypersonic technologies, the War on Terror diverted resources to more pressing needs. Meanwhile, our near peer adversaries took steps to weaponize these technologies. Hypersonic weapons provide a significant military capability not only in their strike speed, e.g., above Mach 5, but also in their unpredictable trajectory, making them highly survivable against missile defense systems. The current changing geopolitical climate with potential near peer adversaries continues to dictate a need for the U.S. to gain velocity in maturing and fielding our hypersonic capabilities.

The Long Range Hypersonic Weapon provides the Army with its first mobile deep strike capability. The mere existence of this effective precision strike weapon system acts as a formidable deterrent to adversaries. LRHW provides a key component to the Nation's arsenal.

Value to the Customer: In early 2019, the Army RCCTO was given a mission to deliver an Army hypersonic capability by FY2023. Schedule was a top priority and the first major milestone was to select a team, award a contract, and then deliver the LRHW Battery by FY2021. The LRHW program adopted innovative prototyping capitalizing on existing and proven technologies to meet this audacious goal. LM and AHPO embraced "decision velocity" to establish key meeting venues where data driven decisions were brought forward and selected to move to the next level of program incorporation with minimal impact. The collective teams worked to quickly understand what commonality could be leveraged from heritage programs and then drove the procurement of those components. Software architectures were assessed and a road map was established to leverage heritage programs in an agile development environment. This level of customer and LM transparency enabled accelerated execution of the program objectives. The LRHW program's ability to take on risk and drive to the successful delivery of the initial Battery while maintaining a partnership and transparency with AHPO was a key value for the Army.



Figure 2: SECARMY Honorable Wormuth with LRHW Team

The Army was also fully integrated into the program execution with full partnership in all meetings. It was often that the customer leadership learned of challenges at the same time the program manager. This commitment to openness and transparency provided a trusted partnership for the customer.

Value to the Corporation: While the LRHW performed exceptionally well on the financial and programmatic metrics to drive corporate profit and revenue, the value of LRHW to LM goes well beyond these metrics. LRHW was one of LM's key entries into the new and highly competitive hypersonic strike market. LM, through its position on LRHW, chairs the industry Board of Directors; an entity consisting of key industry leaders, which ensures the industrial base, meets the Army's fielding needs and provides industry feedback.

LRHW was also a key enabler in driving innovative processes and procedures for accelerated development and production. The production schedule for LRHW necessitated a new way of doing business. AHPO utilized an Other Transaction Agreement (OTA), rather than the more traditional DoD FAR-based acquisition approach, to accommodate the accelerated delivery schedules. From the beginning, the team has worked to tailor the LM LRHW method for execution in order to successfully meet schedule. From a 13-page concept paper through design, procurement and into manufacturing, LRHW had to operate in a more streamlined agile method to assure LM met the Army and the Nation's needs. Tailoring did not equal short cuts. Rather, it focused on a detailed management of risk to facilitate execution. All critical gate reviews were met through ship readiness and DD-250 delivery to the Army. The innovation and lessons learned on LRHW are influencing how LM executes on aggressive and complex schedules to deliver for our customers.

Value to the Team: LRHW was a sought after assignment with the opportunity to truly do things differently to accelerate a mission of unequal importance. The critical nature of the program allowed LM team members to create innovative engineering solutions to complex challenges in order to meet critical delivery milestone dates that would not be possible within the construct of a "normal" program. Many team members brought domain knowledge from previous programs and applied them in a pioneering manner. The new 'go fast' process including the utilization of advanced list of materials to support early procurement in lieu of released engineering; detailed tracking of all hardware being received and alignment of this hardware to inch stone assembly, integration and test schedules; streamlined parts and materials procurement; and utilization of additive manufacturing in support of an accelerated production schedule. The LRHW program provided growth opportunities for the team members as they were challenged to find new processes, methods and to think differently about the contractor/customer relationship.

METRICS (Value: 15 pts)

Please respond to the following prompt:

- What are your predictive metrics?
- How did you perform against these metrics?
- How do your predictive metrics drive action toward program excellence? Please provide examples.

(12 pt. Times Roman)

The most important metric for the success of LRHW was the early delivery of the initial Battery. In order to achieve these positive results, LRHW worked to enable predictive measures in procurement, schedule execution, and manufacturing procedures.

In discussing the greater LRHW program in December of 2019 with LM Senior Leadership, LTG Thurgood challenged the team to come up with innovative ways to streamline processes and procedures to accomplish the critical Army outcomes required for the system. One of those outcomes was the delivery of the first Battery in FY2021. The LRHW team was faced with the dichotomy of how to unburden itself from the time proven processes and procedures which might not work at the pace required while still providing a robust set of metrics to ensure a successful outcome. Early on it was established that the senior leaders within LM, key suppliers, and the Army would all be shown the same metrics based performance. This allowed a single message to be brought forth eliminating effort to align program and program office assessments.

Timely procurement permits accelerated production: LRHW recognized from the onset that supply chain and procurements would be one of the major challenges to produce a full operational Battery in just 24 months. Upon award, the team held a Structured Improvement Activity (SIA) to proactively evaluate the procurement process and establish predictive metrics to track and address challenges in the supply chain. The SIA identified key areas for improvement, established goals for execution and predictive metrics to capture this data.

One of the key metrics was tracking procurements as the piece parts moved through the material acquisition process. Focus was put on each “slice” of the acquisition process to ensure it was moving efficiently through the process and looking forward to ensure the next step in the process was appropriately resourced and prepared.



Figure 3: Material Acquisition Process Flow

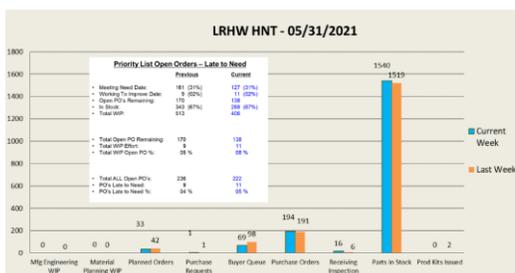


Figure 4: LRHW Procurement Metrics

Each Purchase Request (PR) was tracked via aging metrics to enable timely ordering of hardware. Additionally, each Purchase Order (PO) was tracked to prioritize parts in stock to guarantee the production line was moving forward with the part in hand when needed. While the team encountered multiple challenges throughout the process, due to both the accelerated nature of the production and the ongoing COVID-19 pandemic (reference VUCA section for additional details), these forward looking metrics allowed the team to address delays or material shortages. LM LRHW consistently worked with our industry partners to help mitigate/alleviate constraints in support of schedule. These results can best be seen by the early delivery of the Battery to the Army.

Laser focus on schedule execution: Near perfect schedule execution was a necessity to meet the production timelines. While the program started out with normal schedule and earned value metrics, the team quickly transitioned to current execution index (CEI) as a key predictive measure. CEI measures how accurately the program is forecasting and executing its forecast from one period to the next and is designed to encourage a forward looking perspective to the Integrated Master Schedule (IMS). LRHW decomposed the predictive nature of the metric further – rather than utilizing the CEI metric as a monthly rear facing metric to evaluate how the team performed in their forecasting. The team estimated CEI tracked schedule execution weekly, and more importantly managed CEI and schedule execution in a forward looking manner.

The program created a culture where CEI forecasts were “commitments” to be kept instead of an after-the-fact evaluation of their forecasting accuracy. Using CEI, the Program Management team established a culture of “every task, every day” – challenging any schedule slip or deviation. Summary Baseline Execution Index (BEI), CEI, and critical path metrics were reviewed weekly in the joint program status meeting and managed in weekly schedule execution meetings. Utilization of CEI as a key metric allowed the team to keep the focus on executing to plan as opposed to discussing whether a task had sufficient float to slip with impact to critical path or downstream tasks.

The result of this forward-looking schedule discipline was evident in the following summary level metrics as of 30 September 2021:

- Baseline Execution Index (BEI): 2,176 Complete / 2,174 Baselined to Complete = 1.0
- Average Current Execution Index (CEI): Nov '19 through - Sept '21 CEI = 0.800
- Inception to Date EVM Cost Metrics: 1.04 CPI/\$8.8M CV
- Inception to Date EVM Schedule Metrics: 1.00 SPI/\$0.7M SV

UID	Name	Finish	Baseline Finish	Finish Variance
760	LRHW - Contract Award	8/30/19	8/30/19	0 d
2710	LRHW - SRR Complete	10/29/19	10/29/19	0 d
2707	LRHW - PDR Complete	5/7/20	5/6/20	0 d
2708	LRHW - CDR Complete	12/10/20	12/9/20	1 d
2726	(DLVR) DD250 - BOC #1 (Incl. BSV)	8/16/21	7/27/21	14 d
2722	(DLVR) DD250 - TEL #1	8/23/21	8/2/21	15 d
2723	(DLVR) DD250 - TEL #2	8/26/21	8/2/21	18 d
2724	(DLVR) DD250 - TEL #3	8/26/21	9/27/21	-21 d
2725	(DLVR) DD250 - TEL #4	8/26/21	9/29/21	-23 d
2272	LRHW - End Item Deliveries Complete (4 TEL, 1 BOC, SW B1.0)	9/27/21	9/29/21	-2 d

Figure 5: Milestone Schedule Performance

DEALING WITH PROGRAM COMPLEXITY (VOLATILITY, UNCERTAINTY, COMPLEXITY, AMBIGUITY, OR VUCA) (Value: 25 pts)

Please respond to the following prompts:

- 10 pts: Describe areas of VUCA faced by your program and why.
- 15 pts: Explain how your team responded to these challenges.

(12 pt. Times Roman)

Unprecedented LRHW weapon systems production timelines challenge the status quo and bring with them a degree of volatility, uncertainty, complexity and ambiguity – these challenges were further magnified by a global pandemic. LRHW embraced these challenges, never losing focus on the vision to deliver for the mission.

While there are many instances of VUCA that the team overcame, three specific examples stand out when discussing how the team responded to these challenges. The first area was embracing a rapid prototyping methodology creating a functional and safe system without creating barriers to the future. The stated objective to meet the production timeline for LRHW was to provide an experimental prototype solution that provides a safe and effective weapon system for Soldier New Equipment Training (NET), standing at

alert in a deterrence role, and if called upon, execution of operational combat missions. On the surface, this appears to be an ideal solution that allows flexibility in the technical solution to meet demanding program schedules. But at execution, it is much more difficult to implement as teams grapple with multiple options and best solution. The second instance of VUCA disruption was COVID-19 impacts during 2020 and 2021 while producing a first article Battery for LRHW on an accelerated schedule. Supply chain commitments were volatile, changing overnight and requiring the team to address the ambiguity of these critical deliveries. These supply chain challenges, in parallel with the workforce shifting to remote operations, required unprecedented focus to overcome. The first example of VUCA disruption was the lack of an established industrial base while delivering a product on an accelerated schedule. LM led the collective team of subcontractors and suppliers to establish a robust supplier base as well as develop new industry partnerships to help the team overcome the many challenges resulting from first time prototype development. The all-out push from the team was able to overcome these challenges resulting in the critical on-time hardware delivery to support NET.

Embracing rapid prototyping, overcoming ambiguity and uncertainty: Common understanding and shared visualization came from the top, but was adopted by each level of the organization. LTG Neil Thurgood’s vision for the organization, “1 BOC, 4 TELs by midnight September 30th, 2021” was engrained in the fabric of the LRHW organization. This vision, adopted by the LRHW team, not only provided a common understanding of success, but also became the measuring stick by which all decisions were made. Consistent workforce engagement by LTG Thurgood and LM senior leadership helped to continuously reinforce our program execution methodology. This mantra was further refined to indicate that not only did LRHW need to deliver the first operational battery in 2021, but also at the same time it could not create barriers to the future as the prototype Battery will become a Program of Record under Program Executive Office Missiles and Space.

Production of the LRHW Battery required an extremely high “decision velocity” to maintain the pace required. In order to maintain a rapid prototyping methodology, the nature of engineers to study options and select the optimal solution had to be adjusted. The mission was to develop a safe and effective product, not achieve perfection, and drive the team to continually move forward. Utilizing the common understanding and shared visualization of delivering a safe and effective Battery by FY2021 without creating barriers to the future provided succinct evaluation criteria for assessment of any option or decision.

- Does the decision create a safety issue?
- Does the decision impact technical key performance characteristics?
- Does the decision impact or drive risk to the Battery delivery schedule?
- Does the decision create barriers to future development of LRHW?

While these questions are simplistic in nature, they strategically covered the critical aspects of LRHW, leaving open trade-space for rapid decisions. First and foremost, LRHW is providing a formidable weapon system. It must be safe for Soldiers to Operate and meet key system performance characteristics.

Second, the Battery needed to be delivered no later than September 30, 2021. While this seems a simple schedule imperative, it also had an impact on the technical solution and optimization of that solution. The willingness of both the customer and the prime contractor to define an acceptable solution was key in reducing ambiguity and providing clarity.

Finally, while the LRHW team was willing to defer optimization into the follow-on program of record activities, it was not open season to take short cuts and provide an inferior product. Rather, each deferral was evaluated to ensure it didn’t create unrealistic barriers to future production of LRHW.

The key to the successful utilization of this common understanding and shared visualization was the alignment across both the customer and contractor organizations and within all levels of each organization. Although there are always differences in technical positions or program direction, the team aligned to this vision and quickly drove to an agreed to path forward. The shared visualization of the desired end state and road to achieve that end state minimized LRHW's uncertainty and ambiguity.

COVID-19 procurement, addressing the volatility and ambiguity of a global pandemic: The manufacturing of an entire Battery in under two years is a challenge of the highest degree in its own right. Add to that a global pandemic impacting both the workforce and the supply chain and the result are extreme challenges. The issues presented and successfully overcome by the LRHW team fall into two general areas: availability and lead times at time of order placement; and volatility of delivery post-order placement. LRHW took defined steps in both of these areas to address and combat the VUCA induced by the pandemic.

Throughout the procurement phase and up to order placement, three specific tools were used to combat the volatility and ambiguity of supply chain availability and lead times. First, the engineering teams released procurement bills of material based upon initial engineering. Engineering designs to support the production of the system were based upon historical knowledge of the supply chain. This created the potential for procurement of unused materials if the design changed and added additional effort for the engineering team to reconcile materials upon final engineering designs. However, this cost risk was determined to be lower than the schedule risk associated with procured parts and material. With less than 24 months to manufacture the hardware, early procurement was required to minimize the risk. Second, the team “engineered to availability” to ensure procurement of parts in support of production. Within the framework of the rapid prototyping methodology, there was a tight coupling between the procurement team and the engineering design team. Any parts or materials with limited availability or long lead times were designed out of the system with alternate parts or designs. Finally, funding was allocated to the procurement team to pay expedite fees to improve delivery dates. Approvals were in place with the finance and procurement teams to avoid any delays and allow the procurement team to immediately authorize expedite fees to improve or maintain delivery schedules without higher level approvals.

Even with these tools in place prior to or at the time of placing the order, many suppliers experienced challenges within their workforce or sub-tier suppliers impacting commitment dates and causing delays. Early on, LRHW funded two full time Program Material Managers (PMMs) whose sole responsibility was to talk to suppliers once an order had been placed on a regular basis to evaluate delivery dates. While this did not necessarily improve delivery dates, it gave LRHW early insight into potential delays and allowing the larger team to engage and interact. Once a potential slip was identified, the LRHW team took an all-in approach – blurring lines between the prime contractor and key suppliers and focusing solely on the outcome required for the team. For example, it was routine for the LRHW team to work with a supplier to determine the issue or impact and then engage in developing a solution. Regularly, once a delayed part was identified at a supplier, the LRHW team, including our partners at the AHPO, would expand the search. Many times, LM brought the breadth of the LM enterprise to bear on the problem, helping suppliers to identify approved manufacturers or parts by reaching into our vast databases. In extreme instances, both LM and AHPO identified material within their existing stock and transferred it directly to key suppliers to ensure schedules were held and met. In one instance, the LRHW team overcame a delay due to COVID-19 and assumed responsibility over the day-to-day management of identifying approved aluminum welders in the area – developing the inch stone plan and running daily meetings until the hardware was delivered.

Maintaining Schedule, addressing uncertainty and complexity to meet commitments: As with any first time development of a prototype system without an established industrial base, the team was required to overcome many challenges. Through a singular commitment to meet with the critical schedule milestones without sacrificing safety or functionality, the combined team of suppliers, vendors, technicians, engineers as well as the customer came together to overcome the schedule challenges.

The first order of business to overcome the schedule challenges was to gain a full understanding of the issues to combat the uncertainty that was driving delays and ambiguity in the schedule. The team was collecting metrics that did not accurately reflect the current state of the execution performance. Reporting was refined to show true raw data for items such as drawing releases, procurements, and key production metrics. LM applied significant resources to deep-dive the manufacturing schedules and procurement status to identify and alleviate persisting challenges. The team aligned procurements with the work on the manufacturing floor as well as managed a just-in-time effort to ensure parts were received days or even hours before the manufacturing team required them.

Additionally, the joint LRHW team brought clarity to the manufacturing and test team. Significant detail was not only added to the schedule, but was communicated daily and visibly to the manufacturing team to identify what needed to be completed and more importantly broken down into achievable pieces of work. The combined team focused on “winning today” efforts and challenged the manufacturing team to accomplish those items each and every day. This cultural shift allowed the team to work together on the singular outcome achieving the desired hardware delivery by September 30, 2021.

LM utilized EVMS metrics, established a concise drawing release burn down plan with prioritized procurements, and received hardware aligned with production floor needs. The true measure of success for the team’s ability to overcome VUCA was revealed through the industrial base partnership enabling the accurate and safe manufacturing of the equipment but ultimately ahead of schedule! A true win for LRHW was the close in support provided by LM that allowed the collective LRHW program to deliver the battery to our Army customer two days ahead of original baseline dates.

ORGANIZATIONAL BEST PRACTICES AND TEAM LEADERSHIP (Value: 35 pts)

Please respond to the following prompts

- 15 pts: Describe the innovative tools and systems used by your team
- 10 pts: Define how you developed, led and managed people
- 10 pts: How did you leverage skills and technologies of your suppliers?

(12 pt. Times Roman)

LRHW’s approach to Program Excellence was to create a culture across the entire customer, contractor, and supplier base that was solely focused on a single outcome. This culture, focusing on alignment of the entire team to one outcome, established a vision, drove innovation, and ultimately gave the team a persona that permeated into all aspects of the program excellence.

LRHW innovative tools: One of the key production risks associated with the accelerated manufacturing is the parallelization of activities that are normally performed in a serial manner. While innovation was prevalent across the LRHW production, program two significant examples stand out for the team. First is the utilization of a Soldier Centered Design concept to inform and shape the production of the LRHW Battery. Soldier Centered Design was utilized both in the early design cycle to inform the production and

during the manufacturing of the system to inform the Soldiers and receive feedback. The second tool was the utilization of an efficient change management process.

Soldier Centered Design mitigates some of the challenges associated with concurrent design and production ensuring optimized performance for the warfighters. Given the accelerated schedules associated with production of the LRHW battery, concurrent procurement of materials and design were common. The production team was actively procuring HW while the design activities were underway. To ensure the product met the needs of the end user Soldiers, early Soldier Centered Design activities were utilized for the prototype Battery. This included involvement of the Soldiers early in the design via the Collaborative Human Immersive Laboratory, or CHIL, and regular interaction of Soldiers during the production of the launchers and BOC.

The CHIL is LM's flagship immersive digital transformation technologies. Since LRHW was a brand new program, Soldiers from existing Field Artillery Units were selected to provide feedback into the design and ultimately the production program. Several activities occurred initially in the CHIL facility in Denver, Colorado. First, the Soldiers were provided a virtual environment where they were free to explore the TEL design to gain familiarity and provide feedback. Secondly, the Soldiers along with members of the program office and the program team were able to all be immersed in the environment at a single time. This provided an opportunity to explore ideas and have in-depth interactions with Soldiers who would utilize the system with the designers and producers of the system. As the design matured, the Soldiers were routinely brought back to immerse in the virtual environment and provide feedback.



Figure 6: Soldiers experiencing the CHIL.

A simplistic, but very important example of how Soldier Center Design feedback improved the production, end use, and sustainment occurred during an Augmented Reality (AR) / Virtual Reality (VR) demonstration of the TEL. The dual generators were placed about a foot apart and engineers had assessed it acceptable to allow maintenance of the generators. However, during the CHIL demo, Soldiers expressed concern about their ability to access these maintenance areas in full combat gear and suggested slides to allow the generators to be pulled out for maintenance. This was incorporated in the design and validated with Soldiers during the production of the TELs.

Another Soldier Centered Design activity was to engage the Soldiers in the production of the system to not only get feedback, but also to provide them early hands-on experience with the hardware. By this time in the lifecycle the Unit had been selected to operate the initial Battery, Soldiers were brought into the factory at key times to observe the platforms under production and facilitate understanding of the system. One example in particular was performing loading of a C-17 cargo aircraft with prototype hardware. The Soldiers from the unit worked side by side with manufacturing, design, and logistics team members to load the Battery hardware onto the aircraft. This major accomplishment energized LM, the customers and the Soldiers.



Figure 7: Demonstration of C-17 Transportation

Concurrent design and production required an efficient change management process. Materials for the production were procured early by leveraging heritage program designs where applicable due to day one assessments of heritage drawings. The LRHW team conducted weekly CAD fly through reviews of the designs as they matured with manufacturing engineers, external partners, and customers, which allowed for streamlined peer reviews of drawings. Finally as new designs matured and peer reviews were complete the program leaned forward and procured hardware from these pre-released designs using an advanced list of materials. The materials track to the eBOMs to drawings within our procurement system, thus reducing the risk of escapes once the drawings were released and reconciled within our procurement system. This was a managed risk knowing some materials or parts would change or not be required. However, the team balanced the risk of schedule delays against costs associated with the excess material. This also required additional engineering and procurement efforts once final designs were released to reconcile the material, but the schedule benefits of early procurement, especially in a COVID-19 environment, clearly outweighed the impacts. Additionally, within production, the team utilized a redline process allowing work to continue on the production floor without excessive approvals.

Leading LRHW through vision, empowerment, and recognition: The LRHW team created a mission first, people always culture balancing the national need while creating an environment where members could thrive and grow. The team was unified by the common understanding and shared visualization for the delivery of the first battery by September 30, 2021. This vision began with a commitment to partnership between the customer and contractor team. While many of us have worked in so called “badge-less” organizations before, LRHW truly operated as a single entity. The AHPO program team had an equal seat in all meetings hearing raw program data at exactly the same time as program managers and program leaders. This commitment to transparency provides vulnerability and openness between the program and program office leadership teams.

Execution of the vision required empowerment and accountability of the team to the lowest level. The pace of the LRHW program required not only efficient processes and procedures, but also an empowerment of the entire workforce. There was a concerted effort to drive decision making to the lowest level within both LM and the program office. Technical teams were empowered to drive challenges to resolution; coordinated with customer counterparts and executed within their battlespace. Additionally, on the production floor, decisions were made, the team moved out and paperwork followed. While this culture became second nature for the program, it was not until late in the production that the program manager (PM) fully understood the extent to which the team had adopted and executed this empowerment. During an internal audit in late 2021, the program excellence audit team met with the PM to discuss observations and how the program was executing. When discussing the idea of empowerment and driving decisions to the lowest level, one auditor remarked that it was clear the team was informing the program manager and program office PMs of decisions made, risks associated with that decision and had already moved into executing the decision. They were not looking for approval of decisions. The culture of empowerment and the culture of common understanding & shared visualization were symbiotic to each other, i.e., one both enabled the other and provided the checks and balances to the other.

The idea of empowerment coupled with the innovative nature required to meet demanding schedules made the LRHW program a sought after assignment. At all levels of the organization, employees were able to experience more with more freedoms than on previous programs.

Finally, there was a commitment to recognition of the joint team. In a highly accelerated program, there is a tendency to recognize the major milestone at the end while overlooking interim milestones. In a partnership with the Army Hypersonic Project Office, there was a commitment to recognize the incremental milestones and keep the team motivated and focused moving forward. For junior members of the team, interacting with key members of the program office was key.



Figure 8: Joint Employee Recognition Event

One LM approach to LRHW: LM's One LM

approach allowed AHPO to identify, engage, and utilize the best of the corporation to ensure successful delivery for the Battery. AHPO's approach was to find the best place to perform an operation and then make it happen. Early on, the LM Space LRHW team developed a best of breed, blended approach with our Missiles and Fire Control (MFC) colleagues to leverage their expertise with previous missile launch platforms. Routinely, throughout the production of the Battery, the LM Space team reached out to our business areas to address challenges and keep the program on track. MFC was instrumental in providing weld subject matter experts to not only provide support to the prime, but also to engage directly with our industry partners.

LM also reached beyond the normal supplier base to discover and engage expertise where required. LM identified a need to bring out additional hydraulics subject matter experts. LM contracted with a non-traditional supplier who primarily worked with commercial heavy equipment hydraulics. These SMEs were brought on board and then were provided to facilitate hydraulics testing and troubleshooting. The non-traditional supplier has been instrumental in the hydraulics efforts.