

AVIATION WEEK

Program Excellence Awards 2022

November 2, 2022

The Watergate Hotel • Washington, DC

Nomination Form

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(This section must be signed)

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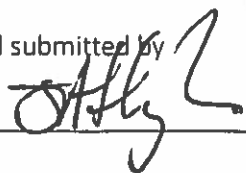
Thank you for participating,



Gregory Hamilton
President
Aviation Week Network

Acknowledged, agreed, and submitted by

Nominee's Signature



23/5/22
Date

Nominee's Name (please print): John Haigh

Title (please print): Executive Product Manager – Distribution and Controls

Company (please print): GE Aviation

NOMINATION FORM

Name of Program: Electrical Power Management System – F35 _____

Name of Program Leader: Chris Newman _____

Phone Number: 00 44 7795 222724 _____

Email: Chris.Newman@ge.com _____

Postal Address: GE Aviation, Bishops Cleeve, Cheltenham, GL52 8SF, UK _____

☒ Customer Approved

o Date: 23/5/22 _____ Secondary approval required and completed 06/28/22 _____

o Customer Contact (name/title/organization/phone): Kyle Becker, LM Supply Chain Director _____

☒ Supplier Approved (if named in this nomination form)

o Date: 23/5/22 _____

o Supplier Contact (name/title/organization/phone): Dave Reynolds, SAFT Cockeysville Site Leader _____

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

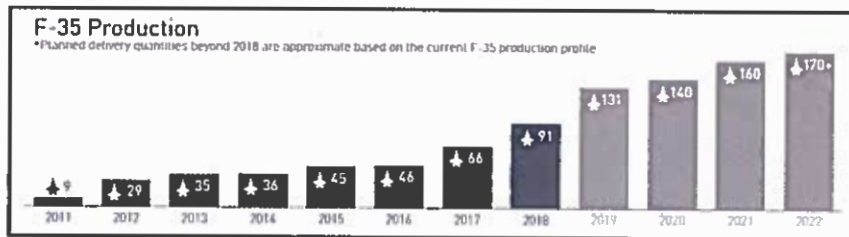
EXECUTIVE SUMMARY: Make the Case for Excellence (Value: 10 pts)

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 Electrical Power Management System (EPMS) is a complex system that controls the flow of electricity and electrical power across the entire F35 jet. It is made up of ten (10) individual units that together serve to manage both the 28V and 270V distribution and energy storage systems on the three (3) variants of this advanced aircraft. It was designed, developed and qualified by GE Aviation Systems, Cheltenham, UK (GE) where now it is manufactured and feeds into Lockheed Martin's aircraft production line.

In September 2018, the EPMS program in GE was at a critical state. The supplier rating was classed "red/red" indicating Lockheed Martin (LM) considered the performance unsatisfactory. In addition, the program was moving to full rate production, with LM looking for confidence that the extended supply base could keep pace with the new build production rates and support this critical program for the United States and its partners.



F35 delivery ramp, published in 2018 at the outset of the recovery effort

At the previous Executive Review, LM leadership had reminded the GE team that 6 Return-to-Green (RTG) plans had been submitted, over 6 years, by successive leadership teams. Each had a compelling justification of why it would succeed. Each then subsequently failed, for LM to then be presented with a new, best yet plan at the next review. Given the importance of the program to the US DoD, its significant contribution to the production volume at GE Aviation's Systems business in Cheltenham along with LM's stated categorisation for suppliers that failed to perform in this way would be at risk and meant this unsustainable situation had to be recovered.

Clearly, doing more of the same was not an option, and in September of 2018 the EPMS Integrated Product Team (IPT) was formed. The GE site leadership recognized that unless the end to end process (value stream) was linked together, we would not be able to pull together and achieve the necessary results that our customer required. This submission represents the work that the team achieved by aligning and driving towards a clear mission statement over the past three years:

Gain and sustain F35 Elite supplier status

1. Proactively manage quality to gain Elite status.
2. Achieve and maintain program OTD. On time every time!
3. LOT by LOT cost reduction positioning for future business.
4. Drive innovation and manage industrialisation of our technology.
5. Be a collaborative team that wins together; delivering with pride.

The team are proud to have delivered:

- 1) The first committed RTG delivered on schedule
- 2) A significantly improved supplier rating to "Performing", including being one of only two F35 suppliers to receive an LM supply chain award in 2020.

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)

The Greater Good

- The F-35 is a key system for the US Government, its DoD Navy and Airforce teams, plus its NATO and RoW allies. Its significance is emphasized today through the increased tensions we see around the globe with others trying to increase their sphere of control.
- UK's involvement in the program as a Tier 1 partner helps support the special relationship ... the UK now has a squadron of the aircraft deployed to its new Queen Elizabeth Class aircraft carriers.
- Achieving aircraft delivery on time means that the warfighter has the tools and capacity to do the job asked of them

To Customer

- The F35 is a key program for Lockheed Martin, therefore it needs to be a success. It helps them demonstrate their skills and capabilities at bringing a major project together across a vast global supply chain.
- Delivering on time, to quality reduces risk to the program and mitigation costs... in doing this it contributes to the affordability goals the US DoD has set for the project team to achieve.
- We also recognise our collective responsibility as part of the significant global supply base.

To Cheltenham

- It is the most significant program for the Cheltenham campus.
- It confirms our capabilities as a tier one supplier not only of designing, developing and qualifying a complex power system but as one that can support production and delivery of the jet and in-service support around the globe.
- Standard work keeps our processes under control and hence our costs, including avoiding the cost of continued return to green plans, moving from a fire-fighting mode to standard production work.
- Strengthens our relationship with LM to one of a trusted partner that performs, puts us on the front foot for winning new business

To our team

- Our people underpin the whole effort involved in delivering the entire statement of work, from bids and proposals through to the Aftermarket and we are proud of the team we have at Cheltenham
- This program directly supports more than 500 employees on the Cheltenham campus and close to 1000 more widely, including three apprenticeship programs
- The opportunity to contribute to a significant turnaround and deliver a complex system for this key program is a powerful motivator, and has contributed to many examples of career development.

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 development of predictive metrics was a critical component of our journey towards becoming an Elite supplier for Lockheed Martin on the F35. As we reflect on the last three years and LM's supplier scorecard, alongside the drivers of each aspects of the measures that make up the quality, delivery and SMI score, has increased. With this understanding, our ability to link our own internal performance with these external measures has become much more mature.

Through the maturation of lean operating rhythms on the Cheltenham site, we have adopted an SQDCP (Safety, Quality, Delivery, Cost, People) approach to our daily management and have used these measures to drive our journey towards overall program success.

Safety

A key part of the core vision of GE Aviation is to "Bring People Home Safely". Whilst this statement can relate to the product safety of our Aviation products and their contribution to safe flights around the world every day, it also relates to our management of a safe working environment, and to that end we have created a culture where the reporting of an unsafe working condition or near-miss is a core part of our operating system. By supporting a safe working environment, we contribute to delivering our vision of being an Employer of Choice and continuing to attract the very best talent to the Cheltenham campus. This progress is clearly visible in the table below:

	2019	2020	2021	2022 YTD
EHS concerns raised	38	171	222	85
First Aid Accidents	9	8	4	0
Recordable Accidents	2	1	0	0



Safety progress 2019-2022 and the Process Safety Triangle

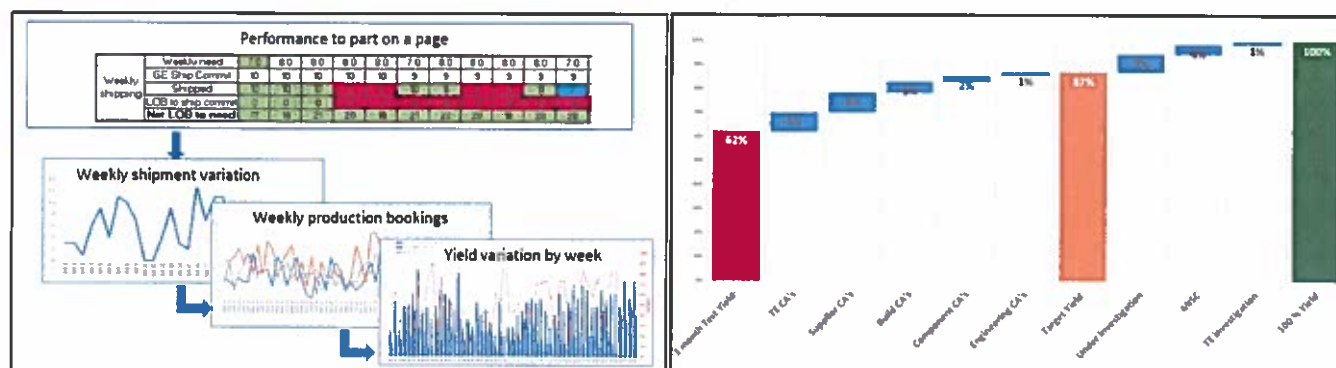
Quality

In the LM customer scorecard, quality is measured by recording the ratio of units that fail from stock to the total number of units delivered. This is our critical customer facing scorecard measure, and through careful consideration we have identified the following as leading quality indicators:

	2019	2020	2021	2022 YTD
F35 production yield	53%	56%	64%	69%
Non-conformances per unit	4.4	3.5	2.1	2.4
External disruptions	91	137	36	4

Quality progress, including the progression of leading indicators 2019-2022

Production yield is the right first time measure of the test process, which is a critical measure of our major bottleneck process. As described in the process flow below, it was highlighted very early that the instability in our yield would prevent us from meeting our weekly commitments.



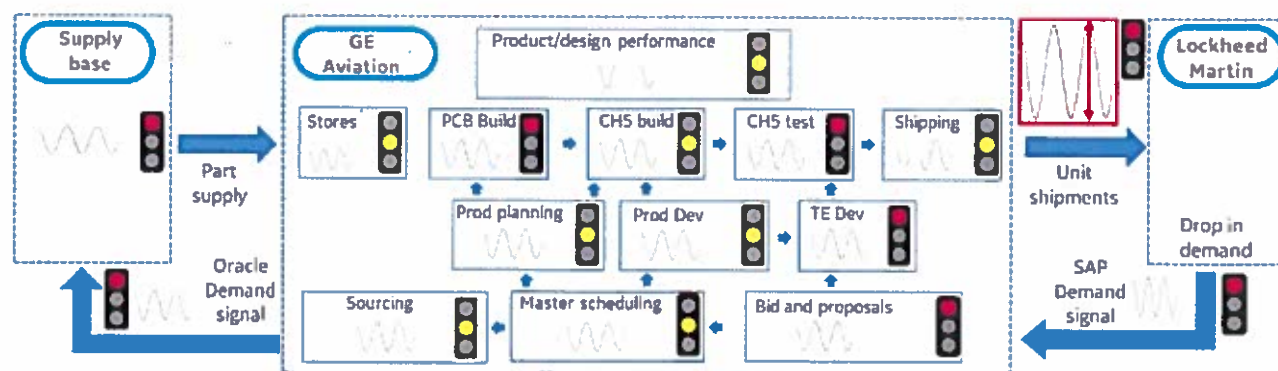
Production yield variation and improvement walk

A plan was therefore created to drive production yield improvement, with root causes understood, projects identified and resourced, with the end result being a 20% improvement over the three-year period. For one product, this included 12 different projects from board level re-spins, connector re-designs, new test equipment introduction and component pre-screening. The work on this product alone took our shortage position from almost 150 behind to a stock position of close to 200.

Delivery

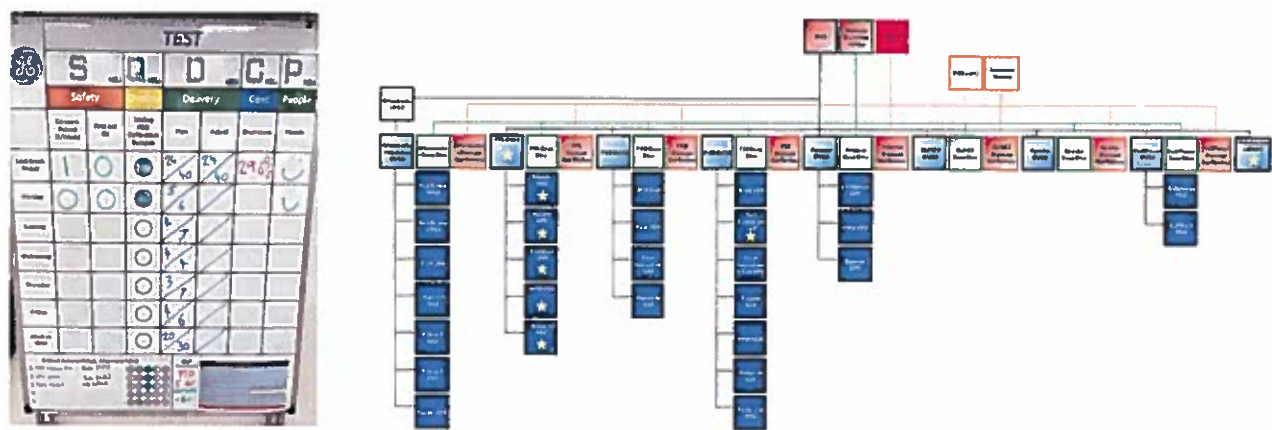
In the LM customer scorecard, delivery is a pure measurement of the on time delivery (OTD) of the contracted line items to the LM production line. This is a function of the number of units delivered and can quite often give a very binary measure of the performance of the total supply chain. We quickly recognised we needed leading indicators on each aspect of the Value Stream to ensure that our end output was more consistent and predictable.

We started by mapping the performance of each section of our value chain, and discovered that ultimately the source of the significant variation in output to our customer was a sum of each small part of variation from all our processes. In the final section, we discuss the approach we used to identify, understand and ultimately address these sources of variation to stabilize our output to the customer.



The F35 EPMS process flow, including identification of significant process variation

Here you can see the range of processes we monitored to ensure overall program health. One aspect of the delivery performance that has remained consistent is the creation and consistent managing of daily management and tiered operating systems. This starts with Cell Control Centres (CCCs) with the shop floor, modelling SQDC, all the way up to the daily Plant Control Centre (PCC). At these we proactively track all aspects of the supply chain process, highlighting any areas which are off plan and need support, along with raising an effective counter measure. The example shown below is the test board, highlighting the performance against the weekly plan.



The standard work and operating system used by the Cheltenham campus

These operating rhythms have not only delivered a significant improvement in internal and external on time delivery, but also improved our own internal measures of supply chain efficiency. Inventory turns, a measure of our ability to have the right parts on time, and not overbuying unnecessarily, have more than doubled over the recent period.

	2019	2020	2021	2022 YTD
On time delivery	65%	92%	99%	100%
Inventory turns	4.2	5.3	9.2	8.4

Delivery performance and inventory turns performance 2019 to 2022

Cost

The program took a significant price reduction challenge over the period of performance, to enable the customer to deliver their stated vision of “5th Generation Capability for the price of a 4th Generation Fighter Jet”.

Continuing the theme of daily management for delivery, the use of leading indicators has included:

- Measures of shop floor productivity daily
- Weekly measures of buy part cost

It was clear from these leading indicators that significant change was needed - resulting in a program wide drive to improve build times, reduce product test time and remove suppliers with poor quality ratings.

We worked with the customer to make design changes to PCB's, removing salvages and replacing these with auto placement parts. We did this across 11 PCB's reducing on average 30% of the labor needed. We gained customer approval to reduce our temperature testing duration on some of our final unit parts. This was achieved by presenting our product part failure rate at all stages of the test schedule, showing that part failures were contained within the first 50% of testing. This approval provided a 28% increase in test capacity per shipset.

Other areas to find cost improvements were through alternative sources for parts on the BOM. We identified key product ranges (connectors in this example) where we were able to see ~ 30% reduction in part costings. Engineering worked closely with the new supplier to ensure product specifications were understood and met so we could provide this evidence to allow customer concurrence of a change of source.

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)

Like many complex sub-systems in the aerospace supply chain there are multiple areas that the EPMS program faces into which could be determined as VUCA.

- 1) Demand stability and understanding
- 2) Electronic component allocation and obsolescence
- 3) COVID pandemic
- 4) The great resignation

For the purposes of this application, we will focus on the following areas:

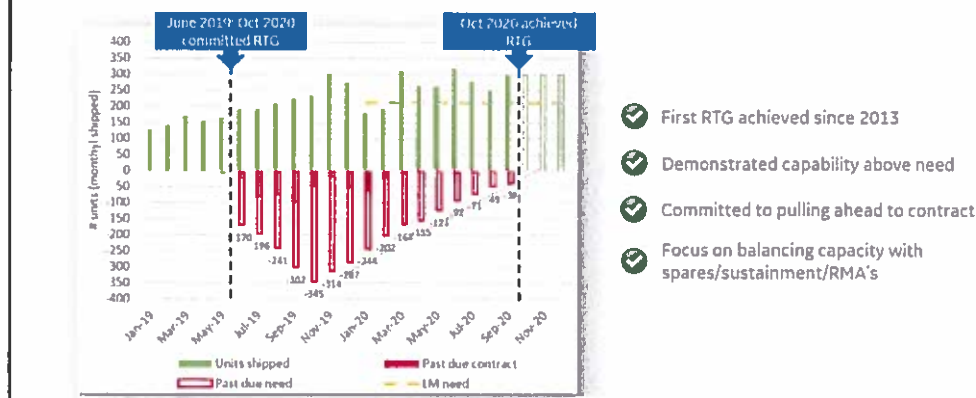
1) Demand Stability and understanding

A consistent challenge within any supply chain is a clear understanding of a demand signal through the Sales & Operations Process (S&OP). In a number of instances we discovered that we were successfully meeting a previously negotiated and contracted delivery profile, to then find that the customer would request expedites or escalate requirements ahead of schedule. Through transparent discussion with the customer leadership, we learned that our measure of success and their measure of success weren't aligned, with our system shielded from any changes in their demand by the contracted delivery schedule.

Once this was understood, we agreed with Lockheed that they would provide a weekly pulse on the program need output from their system, and the true goal of meeting program need became our guiding principle. This signal gave us an early warning system on any likely demand pressures (which could result from unexpected demand, or a stock allocation) and we shared this widely with the internal team. In addition, when trends, or sudden changes in this measure were seen, we were able to work with the buying team to understand them and better predict future contract changes.

In the next chart, you can see that although we successfully recovered the contract delivery dates by March 2020, it took a further six months to recover the LM program to need. This was on schedule to the committed date shared with the LM leadership team and was a significant milestone for whole team.

Get to Green – meeting program need



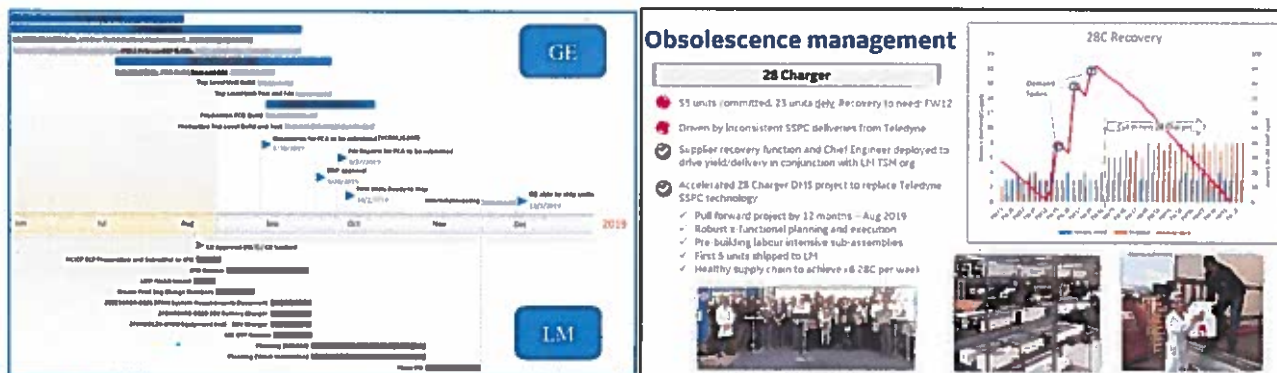
- ✓ First RTG achieved since 2013
- ✓ Demonstrated capability above need
- ✓ Committed to pulling ahead to contract
- ✓ Focus on balancing capacity with spares/sustainment/RMA's

Driving the return to green on schedule - meeting program need 2019 to 2022

2) Electronic component allocation and obsolescence

A long term major redesign had been scheduled for one of our products within the shipset due to multiple obsolescences within the BOM. GE took this opportunity to remove power switching SSPC hybrids, moving to a discrete component solution, providing the customer with a superior product. The project for this major design change ran with great success and we saw it pass through qualification with ease ahead of schedule, successfully reducing the cost of the unit by 52%.

The plan was executed in partnership with LM, driving each element with mutual accountability and successfully delivering the production ramp to recover the delinquency to program need.



The 28 charger re-spin, collaborative project planning and overview

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

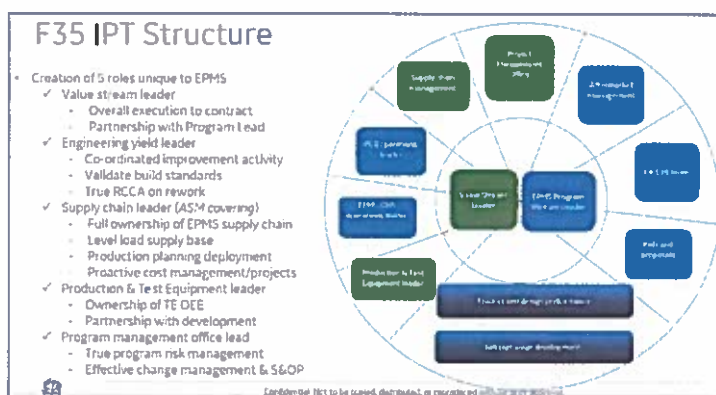
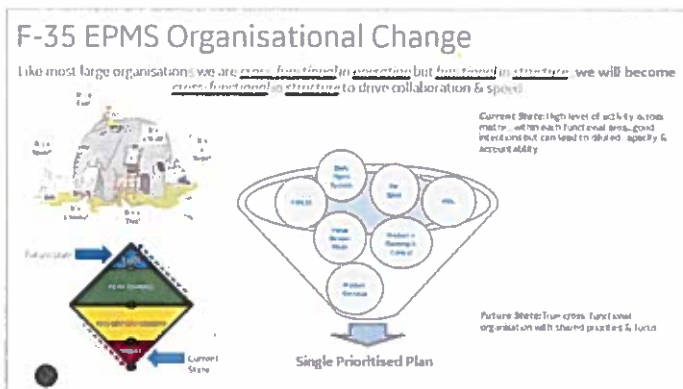
Please respond to the following prompts

- 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)

The introduction of the IPT structure in Cheltenham was one of the most significant organizational changes on the Cheltenham campus for a number of years and was driven out of a clear priority to align the 400 people that support the program to the single purpose of the delivering the necessary recovery on the EPMS program. At its core was a recognition that without a clear alignment of purpose the team could not become successful.

The existing structure was focused on each function delivering what was important to each of their organisations, with measures that would often conflict between the different teams. The end result of these misaligned priorities was an inconsistent output to the customer and a sense of confusion over what needed to be done to improve the situation. The site leadership team at the time recognised this and communicated it honestly to the workforce to reinforce the mandate for change as can be seen from a slide at a site "All Hands" at the time.

The following diagram represents the clearest view of the structure that was put in place, with a circle chosen to symbolize the move away from a traditionally hierarchical organisation, toward a more collaborative culture that put the link between programs and operations at its heart.



Mandate for change slide & F35 EPMS IPT Structure– Aug 2018

Initially, the focus was on clear prioritization with the team collectively aligning around the following core priorities and behaviours. Clearly this list wasn't exhaustive, but looking back now, almost four years later, it is encouraging to recognise them as each playing their own part in the journey.

- Get to Green – Elite supplier status
- Drive production output to meet/exceed capacity
- Cross functional alignment to the customer *
- Fast paced issue identification & flexibility to resolve *
- Fostering a culture of engagement around the program **

We have already covered a number of the above topics earlier in the submission, but we would like to highlight our approach to two specific aspects;

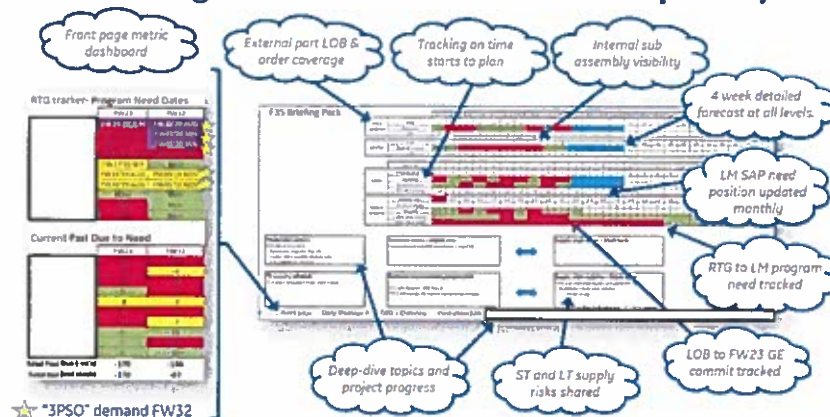
1) Alignment to the customer/issue identification & resolution

It is a complex value stream that delivers the EPMS system from Cheltenham with a large network of sub tier suppliers around the world and internal functions on site at Cheltenham, but we recognised early on that our success would be dictated by our ability to effectively identify and resolve issues both internal to our facility and externally within our supply base. To achieve this, we recognised we needed to create a single source of truth for all our functions that we could use with our customer to drive accountability and performance.

Simply put, we documented for each of the units in the system the recovery plan that would need to be delivered at each level of the build, and shared this up and down the supply chain, alongside any projects that would be necessary to incrementally drive performance. Suppliers (where appropriate) saw the same information that our customer saw and we highlighted risks early and worked collaboratively to mitigate them.

Through this tool, we connected every element of the program to the end result of our performance to program need, which, as previously discussed, we had identified as our core operating measure. This dramatically improved the trust between GE and LM and we also saw a significant improvement in the accountability of our teams. By highlighting the significance of the delivery of a single piece part and connecting this to the overall performance of the program, their understanding of the entire value stream grew and they took pride in the achieving their particular part of the statement of work.

Part on a Page – One Source of Truth & Transparency!



Example Part on a Page – EPMS program

Organisationally, we are not transparent by nature, and it took a significant piece of communication and trust building for the supply chain to understand the reason behind sharing this level of information and partnering with the Lockheed Martin Supply Chain team to visit suppliers and drive recovery plans, but ultimately it was this type of collaboration that achieved the results over the three years. In this way, what started as a simple spreadsheet tracking tool, grew to represent a cultural shift, driving our standard work and teams. This practice has been shared with other programs on the site, driving total on time delivery from 60% to over 90%.

No cultural shift happens overnight, but the time spent explaining the links between each aspect of the venture also contributed to developing our teams. We have had a number of internal promotions with people citing the learning associated with the F35 recovery and the knowledge of the supply chain gained through the process above.

2) Fostering a culture of engagement around the program

Presenting the problem and vision at the high level was never going to be the most challenging aspect of the recovery, and any detailed action planning needed the engagement of those closest to the issues, not the leadership. With this in mind, we took the decision to organize a dedicated two day event to unite the team around a common purpose.

Titled “Path to 3500” to represent the long-term run rate of the program, the agenda was created to offer a group of team members and managers from across 10 different functions the opportunity to do the following:

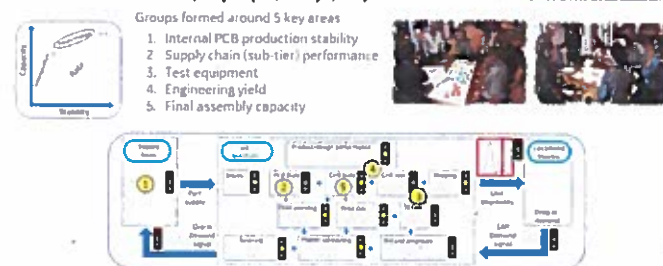
- Understand why what we do on the F35 program matters
- Understand the reality of the current situation – we deliberately didn’t “sugar-coat” anything
- Provide feedback on the root-causes of our poor performance – they didn’t “sugar-coat” anything in response
- Work on potential solutions collaboratively
- Present them back to Executive Site Leadership and gain buy in.

This event has been consistently been cited as a turning point for the team, with shared goal and collective accountability generated to achieve the results on the program.

As another example of driving this type of engagement, we ran a raffle for 20 of our associates on the team to visit RAF Marham, and asked them to report back on the impact that seeing the units that they contributed to delivering fulfilling their purpose.

Improving Our Predictability - Making Sure this RTG Sticks

“Path to 3500” workout, 70 people, 2 days, July 2019



Path to 3500 event (July 2019), GE Aviation visit to RAF Marham (October 2018)

Partnering with our supply base

Our suppliers represent a hugely important part of our value stream, and their engagement in our recovery has been an area where we have had to learn how to be a better customer to them to us to become a better supplier to Lockheed Martin. The transparency developed through the use of “Part on a Page” was extended to the management of longer term, more strategic challenges, engaging suppliers with sufficient context to provide solutions

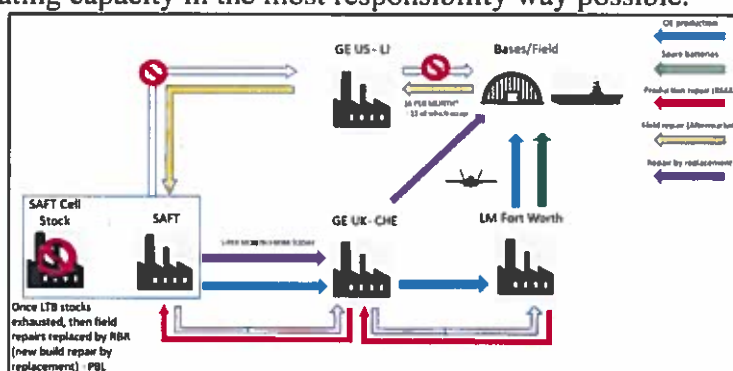
The battery supply chain (providing the power storage for 28V and 270V supply, and providing power back-up in the event of wider generation failure) represents a critical technology within the Power Management System, and the supplier of the battery, SAFT, based in Cockeysville, is a key partner for GE Aviation.

The challenges posed over the last three years included the following:

- 1) Obsolescence – the existing battery cell separator material (critical to enabling the function of the battery chemistry) was identified as going end of life within three years
- 2) Significant total life costs on the program, driven by scheduled replacements every three years
- 3) A complex demand picture, with four different demand streams leading to supply instability and frustration

The approach taken was collaborative, with an initial 2 day work-out on site with the supplier to engage with the problems and the results have been significant for the supply chain:

- 1) SAFT identified a suitable alternative separator and, together with GE, executed a full qualification schedule on plan and within budget
- 2) Using the opportunity of a full requalification, the teams partnered to make more product changes, successfully extending the life of current battery from three years to more than eight years. This single change equates to over \$1 billion program savings. At the time of writing, this represents the largest life cycle cost saving achieved through an obsolescence program in LM Aero history.
- 3) Finally, to truly understand the demand signals, GE took the opportunity to align the entire value stream as part of a three-way collaboration. Allowing Lockheed to describe the dynamics shaping the different sources of demand, GE facilitated a working group to allow the parties to best determine a recovery plan, allocating capacity in the most responsibility way possible.



Battery supply chain complexity

The result of this collaboration has been the creation of an aligned product management plan, with a closely monitored supply chain execution strategy. This plan, although not yet completed, is already delivering improved capability to the field and more successfully supporting fleets around the world.