NOMINATION FORM

Name of Program: Get to Gold - Eliminate Quality Escapes

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   o Date: May 3, 2020

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☐ Supplier Approved (if named in this nomination form)

   o Date: _____

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CATEGORY ENTERED

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

☒ Special Projects

☐ OEM/Prime Contractor Systems Design and Development

☐ OEM/Prime Contractor Production

☐ OEM/Prime Contractor Sustainment

☐ Supplier System Design and Development

☐ Supplier System Production

☐ Supplier System Sustainment

Abstract

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

(12 pt. Times Roman)

The 2018-2019 *Get to Gold* program achieved significant results in a short period of time, but the program management that enabled those results was the enduring mark of excellence. Through this program, Aerospace Composites Malaysia ("ACM") reduced its defective parts delivered to customers ("Quality Escapes") by 88% including a 50% reduction from its previous best year of performance, while also slashing its Cost of Poor Quality by over 80% compared to the prior year. To accomplish this, the program team created and executed aggressive improvements, mixed classic and custom approaches, leveraged data analytics in new ways, challenged long-standing quality management norms, and developed employees for lasting gains. By directly engaging its customers to become part of this *Get to Gold* improvement program, ACM built a coalition of experts that spanned Australia, China, India, Malaysia, and the United States to achieve systemic gains significantly faster and less expensive than benchmarked methods.

Purpose

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

(12 pt. Times Roman)

Aerospace Composites Malaysia ("ACM") is a Boeing joint venture that fabricates and delivers a high-volume and large-mix of composite aerostructures directly to Boeing Commercial Airplanes ("BCA"), or indirectly to BCA through supplying other customers (who deliver directly to BCA). The *Get to Gold* program was a formal effort by ACM to dramatically improve customer quality to achieve "Gold" status consistent with Boeing's highest rating of product quality.

Previously averaging nearly 1,100 defects delivered to customers per-year ("Quality Escapes"), customer feedback and frustration necessitated ACM to launch this transformation program to rapidly identify and eliminate the systemic root cause(s) involved. Through improving customer satisfaction, ACM improved operations for both itself and its customers, while also demonstrating its value to obtain new work packages from these customers to fuel its future growth. This significant program presented a platform for ACM to develop its capabilities and its employees to become world-class problem solvers.

ACM Get to Gold Program Team 2018-2019

Executive Summary: Make the Case for Excellence *(Value: 15 pts)*
What is the vision for this program/project? What unique characteristics and properties qualify this program for consideration?
(12 pt. Times New Roman)

> **"*Perfection is not attainable. But if we chase perfection, we can catch excellence.*"**
> **Vince Lombardi**

Program Vision: The vision for the *Get to Gold* program was to dramatically improve quality for customers through the total elimination of defects being delivered to these customers ("Quality Escapes"). This is in contrast to the condition that existed before *Get to Gold*. ACM had been averaging approximately 1,100 annual Quality Escapes to customers, with outliers occurring one-to-two times per-year that affected as many as 1,400 parts in a single event. These defective parts were discovered either in direct customer inventory, or by other downstream customers that had already received the parts.

When a Quality Escape occurs, customers experience significant disruption as they must scope, contain, evaluate, and disposition the defective parts involved. For customers that deliver directly to BCA, their own reputation and quality ratings are also impacted when their parts contain ACM-caused Quality Escapes. In the majority of circumstances, the nature of the defects involved enable customer engineers to eventually approve those parts for as-is use (without rework or repair); however, the time, effort, cost, and other disruptions encountered by customers to go through the engineering review process significantly impacts their direct operations, as well as the operations of their downstream customers. In other circumstances, the parts must be either reworked, repaired, or otherwise scrapped. As a result, ACM must expend resources and costs as well, including reviews, fees, freight, warranty, disposition, scrap and other tangible costs, in addition to the immeasurable impact to reputation and future sales opportunities. Therefore, this program to eliminate ACM's Quality Escapes was also aimed at reducing these negative effects for ACM, its customers, and all that rely on ACM's products.

Unique Characteristic and Properties: Numerous unique characteristics and otherwise noteworthy properties that qualify the *Get to Gold* program for consideration are described below. Beyond these general descriptions, several of these will be described in more detail later in this nomination.

Size/Location of ACM: ACM is located in Bukit Kayu Hitam, Malaysia. Bordering Thailand, this small industrial village is so remote that the closest town of Changlun contains only about 1,500 residents. Therefore, a unique characteristic of this program is the ability for such a small and relatively remote workforce to significantly innovate in its program management practices, particularly embracing advanced data science concepts, as well as collaborating with leading experts from around the globe. This is a clear example that strong program management and program management innovation can be undertaken by anyone and anywhere.

Approach: *Get to Gold* was architected with a parallel approach that (i) scaled traditional Lean Six Sigma project management concepts to a systemic program management level, and (ii) prepared the organization for change by inventing an organizational improvement technique called the *Flying Fishbone*. Combined, these approaches address the method, skills, and infrastructure for success.

Preparing the Organization for Change (Flying Fishbone): The *Flying Fishbone* was invented and deployed by the *Get to Gold* team to generally and systemically prepare the organization for radical change by simultaneously upgrading company infrastructure and employee skills. This approach was adapted from the classic Ishikawa "Fishbone" diagram that guides teams to brainstorm potential root causes related to the categories of Man(Woman), Machine, Method, Measurement, Material, and Mother Nature. In addition to these classic "Six-M's," ACM added a seventh one to reinvestigate Major Outliers.

Instead of using these comprehensive categories to find one-or-more potential root causes, these same categories were alternately used to identify and execute simultaneous improvements that could enhance the company and prepare it for change. Thus, this version of the "Fishbone" is "Flying" since it elevates the entire organization, while preparing it for new heights. The benefit of the *Flying Fishbone* was that it is a comprehensive improvement guide, for which its traditional "Fishbone" appearance was already familiar to both leaders and the workforce; thus, easy to explain in program strategy and review meetings.

Aggressive Target Setting (Zero Escapes): The *Get to Gold* program set an aggressive "Zero Escapes" target consistent with Phil Crosby's philosophical standard. In the 40-years since Crosby conceived this "Zero Defects" standard in *Quality is Free*, it has generated debate regarding its achievability and the potentially demotivating effects such a difficult target could have on the workforce. To be bold in ambition, but thoughtful in execution, the *Get to Gold* team still set the program target at Zero Escapes, but inspired progress by recognizing all victories associated with it – no matter how big or small. This included highlighting the increasing number of days since the last Quality Escape, celebrating recurring problems that had been eliminated, and showcasing good problem solving examples to customers.

Results: While *Get to Gold* did not achieve the Zero Escapes target during the program timeframe, it did amass significant wins that included reducing Quality Escapes by 88% (outperforming its previous best year by 50%), lowering its Cost of Poor Quality by over 80%, and mitigating over 160 man-months and $1M USD in estimated costs to address problems through audit. In addition, ACM created excellence in its continuous improvement system that will drive the company closer to Zero Escapes in the years ahead.

Challenging Industry Approaches to Problem Solving (Causal Factor Mapping): *Get to Gold* also challenged conventional industry approaches for root cause analysis by abandoning the traditional 5-Why and Ishikawa Fishbone methods by instead deploying a Causal Factor Mapping technique on a systemic level. A critique of traditional root cause analysis methods is the inherent subjectivity, and therefore the inaccuracy and inconsistency of analysis. For example, repeating the 5-Why analysis with different personnel will inevitably result in different "why" responses being identified. The program team recognized the need to overcome this subjectivity in order to achieve systemic results; therefore, the *Get to Gold* program team disregarded these flawed industry standard methods for a niche alternative.

As part of the Methods section of the *Flying Fishbone*, the *Get to Gold* team investigated the American Society of Quality's ("ASQ") membership knowledge archives to find alternate root cause analysis techniques that could be more objective and consistent to use. A 2004 ASQ *Quality Progress* magazine article described an approach called Causal Factor Mapping, with reference to a handbook for further reading. Causal Factor Mapping is based on tracing a trail through one of many potential paths located on a Causal Factor Map that is provided with the article and handbook. Each step in the 9-layers of possible choices goes deeper towards the root cause behind an issue, with each specific layer also displaying reference numbers that correspond to definitions and examples for further context.

This approach is more objective and consistent versus a standard approach of asking "why" five times. As an example, ACM had previously considered the majority of its Quality Escapes to be related to the root cause of "Human Factors" variation that it would attempt to remedy through employee re-training and coaching. While "Human Factors" is a category on the Causal Factor Map, it is only an intermediate cause that has several deeper layers contributing to it such as missing requirements, ambiguous standard work, unanticipated risk, and other specific root causes. Therefore, this method improves the detail and depth of root cause analysis. After introducing this technique to company engineers, they self-initiated the practice of embedding the description reference numbers into their A3 problem solving reports. The program team then standardized this home-grown practice to be part of ACM's problem solving process.

Scaling This Approach (First Pass Root Cause Depth and Root Cause Coding): Beyond embracing Causal Factor Mapping, the *Get to Gold* team innovated that concept even further by using it in employee development and analytics – ways that the ASQ authors had not previously described. The first innovative manner was to use the reference numbers in the Causal Factor Map as a first pass Root Cause Depth metric to measure the proficiency of team members to solve problems correctly the first time. The second innovative use is called Root Cause Coding, which disrupts the traditional practice of collectively analyzing defects for lagging-indicator improvement, and instead enables leading-indicator prevention through root cause analytics. While referenced throughout this nomination, both of these innovative approaches are described in detail in the *Organizational Best Practices and Team Leadership* section.

Leveraging Analytics: The *Get to Gold* program leveraged analytics of different types and complexities at various levels to enable substantial results. This includes the first pass Root Cause Depth metric and Root Cause Coding approach introduced in the preceding paragraph, as well as a big data approach called Text Analytics for Requirements Audit (TARA). The latter is a custom-coded data science application that replaced over 160 man-months of human auditor review with a big data text analytics risk identification algorithm (that also serves as an engineering requirements consumption mistake-proofing tool). TARA will be discuss from several perspectives throughout this nomination.

Program Leader as Teacher: Another unique aspect of *Get to Gold* is multiple roles that the program leader held during the course of the program. In addition to having responsibility for factory quality, the program leader also became the sponsor, program leader, Lean Six Sigma coach, and training instructor for the unique concepts deployed in this program. This ensured that the same constancy of purpose for eliminating Quality Escapes was present in site leadership reviews, program management meetings, working sessions, and training classes. As planned in the *Flying Fishbone*, the program leader personally developed and conducted over twenty A3 problem solving training sessions to factory employees to elevate workforce problem solving skills, and to build better evidence of root causes to systemically improve the entire operation. Also, with *Get to Gold* leveraging many unique and custom approaches, training for those concepts and evolved-uses was not readily available anywhere else; therefore, the program leader developed and executed training for all of these innovative elements as well.

Myers-Briggs Type Indicator (MBTI): To determine the most effective way to structure custom training, and successfully focus the program team, the program leader administered MBTI workshops to leverage team member personalities for program advantage. The use of the MBTI personality sessions included traditional working-together aspects, but also a very specific focus on the inherent personality traits that enable successful programs (including leveraging or mitigation strategies), as well as matching team member personalities to various aspects of *Get to Gold*. Based on the research of Max Wideman (original developer of the *Project Management Body of Knowledge*), team members were aligned to certain aspects of *Get to Gold* according to their personality type's inherent strength for that activity. In addition, MBTI identified that the majority of the program team would learn better if they had real, tangible examples and case studies included in training (rather than just conceptual overviews). This directly influenced how training modules were developed to maximize program management execution.

Global Coalition: A final unique aspect was enlisting customers to become a global coalition for improvement. In addition to the local team that included an American program leader and Malaysian team members, the program leveraged experts from several other countries. From a BCA Singapore supplier quality colleague making introductions, to Boeing India engineers helping upgrade requirements consumption practices, to an Australian data scientist developing customized text analytics, to a Chinese customer sharing audit practices, and American data science and audit colleagues attending non-advocate reviews; the program team obtained world-class results by reaching out across the globe to collaborate.

VALUE CREATION *(Value: 10 pts)*
Please respond to the following prompt:
➤ **Clearly define the value of this program/project for the corporation beyond profit and revenue**
(12 pt. Times Roman)
Beyond profit and revenue, *Get to Gold* was valuable in many ways that include those listed below.

Reputation: *Get to Gold* has improved customer confidence in ACM. Prior to the program, the high number of Quality Escapes, repeat nature of some of the defects, and seemingly random occurrence of significant outlier issues eroded customer confidence in ACM. The now-improved reputation was gained not only from *Get to Gold*'s results, but also from working shoulder-to-shoulder with customers directly as part of the program team so that they shared in program success. The approaches, tools, and analytics coding developed through this program were also made freely available to customers, so that the fruits of their collective involvement in *Get to Gold* can be used in their own operations as well.

Relationships: Through the course of *Get to Gold*, ACM grew its customer relationships beyond mere order-and-supply. By addressing problems collaboratively, and accessing a global network of customer experts that consists of development engineers, data scientists, and management personnel, ACM now has ongoing working-relationships with some of the most innovative and helpful minds in aerospace.

Access to Talent: *Get to Gold* has also changed the talent dynamics at ACM. Prior to the program, problems were addressed using only the skills and experiences available to the internal workforce. Through the course of *Get to Gold*, that approach changed as ACM became more proficient in identifying and obtaining outside expertise. Within the *Flying Fishbone* plan for overall improvement, ACM began leveraging temporary talent. In one example, ACM obtained its first high-potential early-career rotation candidate from Boeing (USA) to implement Business Intelligence applications that advanced the company's data practices, while later hosting its first international intern from the London School of Business (UK) to upgrade its standards for introducing new products. ACM also borrowed talent from its customers through hosting visits from Indian engineers to help improve requirements consumption practices, housing an Australian data scientist to develop a novel text analytics auditing application, and enlisting other American data scientists and audit personnel from the commercial and services units of Boeing for non-advocate reviews and other technical feedback.

➤ **Clearly define the value of this program/project to your customer**
Get to Gold's most obvious value is significantly reducing Quality Escapes to customers by 88%, and reaching nearly one-year of escape-free deliveries to its largest customer (99.99% without Quality Escapes). This is in sharp contrast to the situation that existed before the program. Beyond a manageable-volume of regularly recurring Quality Escapes, significant outlier events were also occurring annually. One-to-two times each year, customers were discovering that up to 1,400 Quality Escapes were currently in their inventory, or that they had already passed on to their next customers. As described in the earlier *Executive Summary: Program Vision* section of this nomination, Quality Escapes cause significant disruption to both direct and indirect customers throughout the value stream. Therefore, *Get to Gold*'s dramatic improvement to practically eliminate ACM's Quality Escapes has nearly erased these cascading problems for all customers involved, whether they receive parts directly from ACM or whether they rely on ACM's customers for their higher-level parts and assemblies.

A secondary benefit to ACM's customers is obtaining the innovative approaches, tools, and analytics coding developed through this program. ACM made these freely available to customers, so that the fruits of their collective involvement in *Get to Gold* can be used in their own operations as well.

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

The value of this program to members of the *Get to Gold* team includes pride of workmanship and professional development.

Pride of Workmanship: The *Get to Gold* program is valued by members of the team for its positive impact to the company, customers, and community; however, the team members (and all employees in the factory) also get the immeasurable value of "Pride of Workmanship." As famously described by W. Edwards Deming in *Out of the Crisis* (1982), Pride of Workmanship is the gratifying sense of having done work correctly, and is considered an essential element in job satisfaction. This concept was highlighted by Deming as #12 of his classic "14 Points for Management" to "remove barriers that rob people of pride of workmanship."

This program directly fulfilled Deming's principle by significantly removing ACM's largest barrier that robbed its employees of their Pride of Workmanship. Before *Get to Gold*, it was commonly assumed by customers, management, and even the employees themselves that poor workmanship and human factors variation were the overwhelming and unpreventable reasons for Quality Escapes. Feedback from ACM's technicians described the frustration that they experienced with not being able to consistently perform operations correctly. As an example, "Paint Peel Off" was the most persistent Quality Escape that had been reoccurring for a number of years. This nonconformance had been investigated and corrected seven times, but continued to appear again every year. Over time, prior investigations believed that the problem was due to various reasons that included powder on latex gloves, equipment speed, training curriculum, employee skill, and employee discipline. This robbed the employees involved of Pride of Workmanship and discouraged the problem solving teams who couldn't solve this repeating issue, as well as the customers who received defective products time and time again.

Through the improvements to employee problem solving skills, data practices, and other aspects of *Get to Gold*, the root cause behind the majority of Quality Escapes was clearly found to be outdated requirements consumption practices that had existed for more than 15-years. This enabled the people involved to not only realize that their workmanship was not flawed, but also allowed the requirements consumption practices to be corrected so that employees could consistently perform operations defect-and-escape free. In the case of the "Paint Peel Off" example previously mentioned, the requirement that was not consumed correctly related to lighting maintenance. Proper lighting is used in inspections to prevent flakes by causing a reflective glare if the part's surface was not sanded enough for the paint to sufficiently stick. Without the customer-required lighting maintenance, paint particles would gradually build up on the lighting and prevent that glare from occurring. This led to otherwise smooth parts appearing suitable to be painted and then flaking. After being addressed in *Get to Gold*, this formerly most-frequent Quality Escape condition has not appeared again for more than two years and counting.

Professional Development: As mentioned throughout this nomination, the *Get to Gold* program invented a comprehensive organizational and employee skill enhancement approach called the *Flying Fishbone* that strengthened the company and prepared it for change. As part of the *Flying Fishbone*, the "Man(Woman)" section addressed employee up-skilling that was relevant to the program's vision. This up-skilling included robust problem solving in A3, Advanced Cause & Effect analysis, and Causal Factor Mapping methods, as well as sponsoring ACM's first-ever cohort of Lean Six Sigma Green Belt candidates. The latter resulted in 26 cross-functional employees developing their problem solving, project management, and data analysis skills, as well as earning a prestigious credential from the International Association for Six Sigma Certification. All of this collective skill development was directly applied to the *Get to Gold* program, but also had the immeasurable benefit of providing ACM's employees with skills and experiences that they will continue to carry forward throughout their careers.

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

Generally: The *Get to Gold* program benefits the greater good, most notably in ACM's surrounding small community of Bukit Kayu Hitam, Malaysia. Benefits such as improved reputation and improved sales ensure that ACM will continue to be one of the largest employers in the Malaysian state of Kedah. This will enable ACM to remain a pillar of employment, economic security, and stability to the region.

Security: The *Get to Gold* program improved security in two ways. First, it significantly reduced the risk of nonconforming parts being used on commercial aircraft, thus improving safety. Customer Source Inspections, and checks throughout customer and BCA Quality build processes are highly tuned to reveal nonconforming conditions. While in most circumstances, ACM's prior Quality Escapes have involved defect types that were approved-for-use without rework or repair, meeting customer requirements is better aligned with product safety. Second, the A3 Problem Solving skills, Causal Factor Mapping, and Root Cause Coding developed through the program's *Flying Fishbone* were applied to root cause investigations involving Environment, Health, and Safety (EHS). By applying these enhanced methods to EHS-related issues, security of ACM's employees and the surrounding community also improved.

Society: Separately, the amount of Quality Escape related-costs that ACM was experiencing terms of Cost of Poor Quality, customer claims, warranties, and auditor fees were threatening to overtake ACM's near-term community giving and support programs. ACM is the leading private provider of donations to the Perik Orphanage, Changlun Rehabilitation Centre, and Yayasan Bunga Raya Girls Home. The speed and savings of the *Get to Gold* program not only allowed these donations to continue uninterrupted, but also enabled ACM to provide extra funding to the orphanage so that it could rebuild after a fire.

METRICS *(Value: 10 pts)*

Please respond to the following prompt:

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

(12 pt. Times Roman)

Predicting the Unpredictable: Prior to the *Get to Gold* program, ACM had been delivering an average of 1,100 Quality Escaped parts per year that deviated from one or more customer requirements, with single outlier events affecting as many as 1,400 units. Within statistical theory, it is impossible to predict when outliers like this will occur and how severe they will be. Without performance being within statistical control, it will continue to be unpredictable until such statistical control is obtained. While it would normally appear that predictive metrics could therefore not be used, the *Get to Gold* team used a creative approach to still utilize predictive metrics to drive program excellence.

Predicting Inherent Performance: First, the Quality Escapes dataset was cut in half using statistical analysis to identify and separate outlier events and quantities. This effectively removed outliers from polluting the predictability of the remaining data, thereby allowing the calculation of the "*Inherent Escapes-Per-Month*" metric that better predicted stable performance. For example, ACM averaged approximately 92 escapes-per-month for the prior year, with a high-variation expected range between 77-236 escapes-per-month within that year (which was statistically unreliable anyway). To contrast, the *Inherent Escapes-Per-Month* predictive metric focused on only stable (non-outlier) data that averaged 27 escapes-per-month, with a much tighter range of 22-29 per month predicted within the confidence intervals for the same timeframe. Without including outlier data, this *Inherent Escapes-Per-Month* also served as a benchmark of potential performance if the root causes of outliers could be eliminated.

This *Inherent Escapes-Per-Month* metric drove action toward program excellence by measuring the inherent range (non-outlier) of escapes-per-month; therefore, enabling the team to target, improve, and control processes that affect normal performance. By removing the effects and statistical complications

of outlier data, the team was able to focus on making its fabrication processes more routine, repeatable, and have less variation. Finally, this metric inspired the team by clearly showing them what their performance would look like if they were successful to eliminate the root causes behind outlier events.

Predicting Outlier Risk: Since it is impossible to predict the frequency and quantity of outlier events, the same approach cannot be used for data containing outliers. Therefore, a predictive risk score was calculated instead. As the *Get to Gold* team identified the root cause behind the majority of Quality Escapes being gaps between customer requirements and ACM standard work, a Text Analytics for Requirements Audit (TARA) tool was developed to specifically address that risk. TARA compares the digital text and measurements of customer requirements documents against ACM's factory standard work, and computes a risk score based on the match. This risk is then assessed and visualized on a tiered-basis at the requirement, process, individual part, part family, customer, and entire portfolio levels to predict the risk of Quality Escapes for production parts, as well as enabling immediate post-consumption checks on any newly consumed parts to assess Quality Escape risk before the parts are even built.

This risk metric and application drove program excellence by enabling measurement, visualization, and action by using data to identify and address the leading areas of risk. The TARA tool contains the ability to show which exact requirements and standard work pairings contribute to the lower scores, therefore guiding teams where to specifically investigate and repair gaps in standard work. This drives very actionable de-risking on multiple levels, as well as being a predictive risk assessment of the potential for Quality Escapes to occur that are related to the specific root cause involved (prior requirements consumption practices that resulted in standard work missing one or more customer requirements).

DEALING WITH PROGRAM CHALLENGES (VOLATILITY, UNCERTAINTY, COMPLEXITY, AMBIGUITY, OR VUCA) *(Value: 25 pts)*
Please respond to the following prompts:
➢ *10 pts:* **Describe overall VUCA faced by your project/program.**
(12 pt. Times Roman)
Program challenges in the form of Volatility, Uncertainty, Complexity, and Ambiguity (VUCA) presented additional obstacles that affected *Get to Gold*.

Volatility: Volatility was experienced through the frequency and severity at which nonconforming parts were escaping to customers. This averaged approximately 1,100 parts on an annual basis, year-over-year, with a wide variation of 77-236 total parts per month and the most extreme outlier event affecting up to 1,400 parts. This volatility was further aggravated by the lack of notice involved in these events, which gave them the appearance of being random, sudden, and without the predictability to control them through the normal course of business. When such events occurred, then the entire factory would be disrupted to respond, often diverting resources otherwise needed to maintain stable operations.

Uncertainty: Uncertainty was experienced through the unknown causes that were behind these outliers, without obvious patterns and an assumption that these must be inevitable in highly manual work (otherwise known as "human factors"). Even after identifying the systemic root cause regarding requirements consumption practices, uncertainty still existed regarding how to quickly and accurately identify and fix these requirements gaps in ACM's portfolio of over 1,000 actively produced parts (other than a comprehensive audit that was estimated to take over 160 man-months and $1M USD to complete).

Complexity: Complexity was experienced through the detailed aerospace requirements involved, and the volume and variety of these requirements, parts, and defects involved. As an example, ACM's part portfolio contained nearly 1,300 unique engineering documents, more than 2,200 unique engineering

requirements, and over 1,100 unique standard work documents. However, the effect of many of those unique instances being applied multiple times gave the program the practical complexity of reviewing over 59,000 total recurring requirements against nearly 3,000 total recurring standard work documents.

Ambiguity: Ambiguity was present, specifically being found as a potential root cause behind a portion of Quality Escapes. Investigation teams frequently cited ambiguity (in the form of requirements or standard work having more than one potential meaning) as the reason for certain Quality Escapes that were occurring. In addition, industry standard and commonly used root cause analysis techniques such as 5-Why analysis and the Ishikawa Fishbone are essentially guided creativity exercises that can result in several ambiguous causes being identified (in the form of having more than one potentially identified root cause based on the subjective creativity of the individuals conducting the analysis).

➢ *15 pts:* **Cite specific example(s) and how your team responded.**
Generally, the team proactively responded to VUCA by using the previously mentioned *Flying Fishbone* to improve the skills and infrastructure to better prepare the company and its people for change, while also using Lean Six Sigma's Define-Measure-Analyze-Improve-Control (DMAIC) process at the program management level. The *Flying Fishbone* was coordinated by the program leader with ACM's Leadership Team, and also included cross-functional stakeholders and project teams for certain portions of *Get to Gold*. The DMAIC process was planned and tracked by the program leader, who (as a Six Sigma Master Black Belt) also coached, mentored, and trained the improvement teams through the concepts and analysis methods contained in each phase. Together, the *Flying Fishbone* and DMAIC processes established the platform to improve the organization, while preparing it to overcome VUCA.

Volatility: Volatility was specifically targeted through attacking the special cause outliers. The Lean Six Sigma Body of Knowledge contains statistical techniques such a Statistical Process Control (SPC) and Box-and-Whisker Plots that identify volatile outliers within a process. The team systemically addressed volatility by using these statistics with better problem solving methods to identify the root causes behind these outliers. Then, future volatility was significantly reduced by upgrading standard work and deploying a novel big data de-risking approach called Text Analytics for Requirements Audit (TARA).

Box-and-Whisker Plots provided a clear summary of both performance and outliers to easily communicate volatility to employees and stakeholders, while SPC charts helped identify which events in the data were statistically driving that volatility. The *Get to Gold* team then re-investigated all outlier events dating back to 2013 (using *Flying Fishbone* techniques of A3 Problem Solving and Causal Factor Mapping) to determine that the previously identified root causes involving "human factors" variation were actually requirements consumption gaps in every case. In addition to discovering this source of this volatility, A3 Problem Solving and Lean Six Sigma training provided the team with skills and methods to improve, control, and otherwise eliminate this volatility. Such training included upgrading standard work and performing better audits; however, the program team significantly improved the speed and scale of these methods by collaborating with engineering experts from Boeing India on best practices for requirement consumption standard work, and enlisting a data scientist from Boeing Aerostructures Australia to develop a Text Analytics for Requirements Audit (TARA) tool that mitigates more than 160 man-months of time and cost associated with a human audit for requirements consumption gaps. Out of ACM's 1,000+ active part numbers, TARA identified 108 parts (and flagged potential requirements gaps within them) that were of medium-to-high risk of having a gap between customer requirements and standard work. This enabled the program team to quickly remedy the gap, or otherwise validate that the requirements were present (while also better-training the model by determining why the otherwise-valid requirements were flagged). Between these approaches, the team addressed actual volatility existing in the part portfolio, while minimizing potential future volatility for new parts to be consumed.

Uncertainty: To address uncertainty behind the unknown root cause(s) behind so many Quality Escapes, the program team analyzed every new case, and re-investigated all outlier events dating back to 2013 to determine if there were common links. One problem encountered by the team was that the industry standard root cause analysis techniques of 5-Why and Ishikawa Fishbone produced subjective and inconsistent results, therefore increasing the uncertainty of discovering the origin of these occurrences. Therefore, the *Get to Gold* team researched an alternate method from the American Society of Quality (ASQ) called Causal Factor Mapping that was previously described in the *Executive Summary* section of this nomination. While this alternative minimizes root cause uncertainty through a structured, objective, and repeatable process, the program team innovated the concept even further. The team adapted Causal Factor Mapping's description numbers to become Root Cause Coding (also previously described). Combined, this aggressively reduced uncertainty by coupling objective-repeatable root cause analysis with the new ability to perform collective analytics on root causes. This is a major innovation versus industry standard approaches that result in subjective-inconsistent root cause identification, and actions based on lagging indicator defects. The approach revealed that 95% of ACM's prior year Quality Escapes (and all outliers since 2013) were actually due to requirements being missed during the engineering consumption reviews that take place during new product introduction analysis. Therefore, this technique enabled certainty by revealing a systemic root cause that had existed for over a decade.

Complexity: The *Get to Gold* team began the effort to identify and fix the systemic root cause (requirements gaps in standard work) by reaching out to its China-based customer, Boeing Tianjin Composites, to benchmark their successful approach and templates used in the past. Since ACM did not have enough trained auditors to begin this process, they then utilized third-party consultants to perform the audit with the same methods. With the complexity of trying to identify and remedy requirements gaps through comparing over 59,000 total requirements against nearly 3,000 total ACM work process documents, the consultants only completed 10% of the audit over 6 months, leaving more than 160-man months of estimated remaining effort that would take months (or years) to complete, as well as carrying over $1M USD in costs. Therefore, using benchmarked practices was going to take too much time and expense for ACM to deliver results to its customers within the *Get to Gold* program timeframe.

As a result, the previously-described Text Analytics for Requirements Audit (TARA) tool was conceived by the program leader. This began with an innovation-thinking exercise to explore alternatives to the human-audit process by evaluating that process through the lens of a Six Sigma Parameter Diagram. This type of diagram aligns variables of a process by input, output, control, and noise parameters to understand how they are involved in the function. Upon reviewing the diagram, it revealed that the process of auditing requirements gaps (by evaluating customer requirements against ACM standard work) could be otherwise conducted if there was a feasible alternative to human comparison. TARA was then developed out of the idea to use big data text analytics as this alternative comparison method.

While TARA greatly reduces complexity, it does not eliminate it all because TARA only addresses "missing requirements"; not "ambiguous", "incorrect", or otherwise "ignored" requirements that human auditors could otherwise identify. Though imperfect, the program team developed TARA since "missing requirements" was the root cause behind 95% of the prior-year Quality Escapes, and the cause of every outlier event since 2013 (totaling more than 67% of the 5,000+ Quality Escapes). Therefore, TARA was viable to target this specific root cause, while also being much faster and affordable than auditors.

The program team collaborated with Boeing Aerostructures Australia to borrow their newly hired data scientist for a one-month Agile/Scrum sprint to help develop TARA. Afterwards, the *Get to Gold* team could now identify and address the largest requirements gap risk factors in its product portfolio; therefore, using big data text analytics to reduce the scope, scale, and resolution-time of the complexity involved.

Ambiguity: The *Get to Gold* team addressed ambiguity in two ways. First, the previously described Causal Factor Mapping approach deployed in this program enabled objective-repeatable root cause analysis to be conducted; thus, eliminating the ambiguity associated with the other subjective and industry standard root cause methods 5-Why analysis and Ishikawa Fishbone.

Second, the *Get to Gold* team made the informed and data-driven choice not to address remaining ambiguity within the program. Causal Factor Mapping validated that ambiguity was one of several causes that contributed to Quality Escapes; however, analytics based on Root Cause Coding revealed that this ambiguity did not cause any outlier event since 2013, and only caused 0.6% of Quality Escapes for the then-current year. Instead, the team focused its efforts on the more significant issue of requirements consumption that Root Cause Coding analytics validated as causing 95% of then-year Quality Escapes.

<mark>ORGANIZATIONAL BEST PRACTICES AND TEAM LEADERSHIP</mark> *(Value: 40 pts)*
Please respond to the following prompts:
➢ *15 pts:* **In executing the program, what unique and innovative practices, tools and systems frame your program and help you achieve program excellence**?
(12 pt. Times Roman)
The program team used several unique and innovative practices to achieve program excellence, including the previously-referenced *Flying Fishbone*, *Root Cause Coding*, and *Text Analytics for Requirements Audit* (TARA). These custom or evolved tools framed the program and enabled excellence by preparing the company and its people for improvement, while providing the systemic methods to accomplish it.
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Flying Fishbone: Detailed in the "*Executive Summary*" section of this nomination, the *Flying Fishbone* takes the familiar form of the classic Ishikawa "Fishbone" root cause analysis tool, but is different because it targets program excellence by preparing the organization for change. It does this with specific and simultaneous development of both the organization and its people. Here, the *Flying Fishbone* laid a comprehensive foundation for organizational change by realigning employee bonus incentives (Mother Nature / Environment), standardizing Quality Escape calculation (Measurement), making the data more actionable (Material), improving employee problem solving skills (Man/Woman), utilizing better analysis tools (Method), leveraging better information systems (Machine), and re-investigating prior year issues (Major Outliers). The combination of all of these improvements systemically strengthened the company so that it could quickly and efficiently find and eliminate the root cause(s) behind Quality Escapes.

Root Cause Coding: The second unique and innovative practice that yielded impactful results was the creation and use of Root Cause Coding. In traditional Quality management, defects are observed and coded for analysis based on defect types. For ACM, flaking paint is coded as "Paint Peel Off". In any given timeframe, all of these defect codes are traditionally aggregated into a Pareto chart to show most frequently occurring defect types. There is, however, a fundamental flaw in this approach.

The defect-type coding approach focuses on symptoms of an issue, rather than the root cause behind it. Sometimes, the same root cause may result in many different symptoms, or the same symptom may be associated with several different root causes. Amplifying the matter, traditional problem solving tools such as 5-Why analysis and Ishikawa Fishbone make it difficult to find systemic root causes, since those approaches are subjective and not consistently repeatable - such as asking different people to answer "why" something is occurring five times and getting an entire spectrum of answers (as with the 5-Why analysis). This is one reason that the same quality problems continue to reappear over and over again at many companies. As previously described, this is consistent with ACM finding many prior subjective and ineffective root causes for its repeated "Paint Peel Off" issue, such as angle of sanding, dust on latex

gloves, employee training, employee discipline, etc. After performing multiple improvements for all of these, "Paint Peel Off" kept coming back as the one of the top recurring Quality Escapes every year.

The *Get to Gold* team created the Root Cause Coding approach and applied it to this program by using the previously-mentioned Causal Factor Mapping description numbers as Root Cause Codes. This enabled root cause analytics to be used on the program and now target systemic root causes (leading indicators of system performance), rather than continuing to pursue defect type symptoms (lagging indicators) on a project-by-project basis like traditional continuous improvement programs. While this may seem like an incremental improvement, it disrupts traditional quality improvement programs.

For example, ACM had previously experienced thousands of Quality Escapes since 2013 due to outlier events. These events involved different parts for different customers, with defect-type codes such as: *pilot hole mislocated*, *composite ply geometry*, *incorrect splicing*, *UV light degradation*, *color mismatch*, *wrong secondary material*, *sampling-scanning technique*, *undersized cutout*, and *elongated hole*. Using traditional methods, these defective conditions (symptoms) were analyzed, investigated, and corrected using defect-type code analysis. While these specific symptoms did not reappear, the subjective root cause analysis (based on lagging indicators) missed an opportunity to prevent future issues.

Root Cause Coding changes this by enabling root cause analytics, which helped the team identify that "*missing requirements*" during consumption reviews was the systemic root cause. This analysis revealed that every prior-year defect-type outlier mentioned above resulted from this same root cause, as well causing 95% of all Quality Escapes for the then-current year. As a result, this new approach created by the program team enabled the linkage of all these seemingly unrelated issues with a common thread that could now be targeted for improvement. Thus, quality can be better-improved at the program level, instead of it continuing on the otherwise disconnected, subjective, and lagging improvement-project level.

Text Analytics for Requirements Audit (TARA): The third unique and innovative practice that yielded impactful results was the development and use of TARA. As previously described, the TARA data science tool leveraged big data analytics to audit 59,000 total requirements against over 3,000 total work process documents, thus eliminating more than 160 man-months of auditor review, as well as the costs associated with it. Being that every outlier event, 95% of then-current year Quality Escapes, as well as at least 67% of all Quality Escapes since 2013 were related to requirements consumption gaps, the TARA tool was specifically conceived as part of the *Get to Gold* program to identify the risk and location of potential requirements gaps causing ACM's Quality Escapes. In addition to identifying various tiers of potential risk, the TARA tool identified 108 medium-to-high risk parts that enabled the program team to quickly validate that the requirements were actually enclosed or otherwise remedy the standard work.

➢ *15 pts:* **What unique and innovative processes and practices are you using to develop people and transfer knowledge and how do you know they are working?**
Several unique and innovative processes/practices were used to develop people and transfer knowledge.

Flying Fishbone: The first method is the previously-mentioned *Flying Fishbone* that identified comprehensive development opportunities for the organization and its people related to *Get to Gold's* mission. Contained in the "Man(Woman)" category of personnel development and up-skilling, the program deployed various levels of problem solving and statistical analysis training, as well as sponsored ACM's first cohort of 26 Lean Six Sigma Green Belts. As an indicator that this people development is working, not only did ACM's people achieve an 88% reduction of Quality Escapes using these methods, but 26 of them scored well on their Lean Six Sigma certification exams and subsequently earned their third party certifications through the International Association for Six Sigma Certification.

Myers-Briggs Type Indicator (MBTI): The next practice was using the previously-described MBTI personality assessments to diagnose and prescribe changes to training that improved people development. The MBTI highlighted personal needs, including each team member's unique needs for managing projects and learning. The MBTI revealed that a significantly high portion of the team required tangible examples and case studies to properly understand and deploy improvement concepts (rather than just general overviews). Therefore, various types of training classes throughout *Get to Gold* were upgraded to include practical examples and case studies to maximize the team's learning and retention.

A3 Problem Solving Example Labs: While training explains the problem solving process, MBTI (above) revealed that many personality types on the *Get to Gold* team responded better to practical examples. Unfortunately, much industry and company training is based on teaching concepts with examples that are too general for these personality types to actually apply. To bridge that gap, the *Get to Gold* team created A3 Example Labs that followed-up A3 Problem Solving training, coaching, and mentoring. These labs contained real examples of actual ACM A3 Problem Solving root cause investigations, combined with peer review and critique. Intended to be different than a program status meeting, this was scoped for group coaching, understanding, and using actual examples to make the A3 Problem Solving process relevant for the MBTI styles that respond better to this type of learning. Over time, the application of the A3 Example Labs also helped make it more comfortable for teammates to give and receive constructive feedback, which has enabled more and better problem solving discussions to take place. From a development and knowledge-transfer perspective, breaking down the barriers for person-to-person discussions helped drive A3 Problem Solving excellence into the company culture since it brought everyone into the conversation (beyond leader-led reviews and questions).

Causal Factor Mapping / Root Cause Coding: From a knowledge transfer perspective, the previously described Causal Factor Mapping and Root Cause Coding approaches provide a better connection to transferring knowledge than traditional quality investigation and coding techniques. Typical subjective root cause analysis techniques like 5-Why only leave inconsistent root causes and questions for future problem solvers to find. Instead, objective Causal Factoring Mapping results and Root Cause Coding analysis provide current and future team members with actual root cause identification and supporting data on both a specific and a systemic basis. Therefore, answers (instead of questions) are retained.

Results – Knowing These Are Working: To demonstrate that employee development and knowledge transfer were working, several surrogate metrics were created to measure effectiveness. The first is an aging metric *A3 Time to Completion* that started with an average of 128 days at the beginning of *Get to Gold*, and gradually reduced to 45 days (including 30 days of post-improvement monitoring). This demonstrates that the employees became nearly 65% faster at solving problems during the project.

Another innovative metric, *Root Cause Depth*, incorporates the previously described *Causal Factor Mapping* and *Root Cause Coding* to measure the degree of problem solving. *Root Cause Depth* uses the 9 layers of *Causal Factor Mapping* codes to evaluate the average depth that team members achieve on their first attempt at solving a problem. By focusing on the first attempt, the measurement is unbiased from the effects of subsequent leadership reviews and coaching that may help drive analysis deeper.

For example, layers 1-3 are considered a depth of 1.0 "*Direct Cause*", layers 4-6 are a depth of 2.0 "*Intermediate Cause*", and layers of 7-9 are a depth of 3.0 "*Root Cause*". The *Get to Gold* team started the practice of requiring *Root Cause Coding* before the investigation can be closed, with a depth of 3.0 "*Root Cause*" being required. That depth is usually achieved after coaching, mentoring, and leadership reviews; however, the more important metric for employee development is the first pass *Root Cause Depth* that measures the first attempt at problem solving without leadership or mentor intervention.

When first using the metric in 2018, the average Root Cause Depth was 1.25, meaning that employees were mostly concluding *Direct Causes* were the reasons behind problems. By the end of that year, this first pass Root Cause Depth had improved to 1.92 and showed that the employees were becoming better at finding the *Intermediate Causes* involved. By the time that the *Get to Gold* program completed in 2019, the average depth metric was 2.6, thus demonstrating that the employees were getting much closer at finding *Root Causes* on their first attempt. The comparison of a 2.6 versus an initial score of 1.25 shows that the degree of employee problem solving development had improved over 200% since 2018.

➢ *10 pts:* **What unique practices are you using to engage customers and how do you know?**
Measure of Customer Engagement (How to Know): The *Get to Gold* program was customer-focused from the beginning, by aggressively targeting Quality Escapes to reduce disruption and costs that customers experienced. The Quality Escapes metric therefore is a surrogate for customer satisfaction, in addition to the feedback directly obtained from customers. ACM reduced Quality Escapes delivered to customers by 88% over the course of the program, including a 50% reduction versus its previous best year. For ACM's largest customer, the delivered-quality reached 99.99% during the course of this program – nearly achieving 12-months of escape-free deliveries. Beyond metrics, the *Get to Gold* team also utilized a very direct and unique practice of engaging customers through making these downstream recipients an integral part of the program. Various types of these practices are described below, with the resulting customer participation in the *Get to Gold* program being a strong indicator of engagement.

Story Boarding: After the launch of *Get to Gold*, ACM created a storyboard presentation to discuss the program and its intentions with its customers, as well as using those discussion to obtain the Voice of the Customer (Six Sigma term for obtaining customer feedback and preferences). It is relevant to note that while ACM's customers are located throughout the United States, Australia, and China, those customers have other business units located around the globe. The goal of collecting the Voice of the Customer was to increase customer awareness, but to also solicit customer suggestions, points of contact, and potential resources to help the program, thus expanding ACM's reach to include this worldwide expertise network.

General Customer Feedback: Initially before root cause analysis was completed, customers could only offer encouragement. After the program team revealed the systemic root cause involved requirements consumption (by using techniques including *Flying Fishbone*, *Causal Factor Mapping*, and *Root Cause Coding*), the *Get to Gold* team circled back again with its customers to provide a program update and to directly re-request expertise to develop and implement countermeasures to improve performance.

Embedding Customer Experts - Consumption: Upon sharing the identified root cause of requirements consumption with representatives from BCA Supplier Quality (customer technical surveillance experts), these Singapore-based colleagues introduced the *Get to Gold* team to engineers through Boeing India that were responsible for new supplier development. Through hosting the Boeing India team onsite, the program team was able to use this customer consultation to develop stronger requirements consumption traceability techniques that are consistent with the best practices used throughout Boeing India today.

Embedding Customer Experts – Risk: Upon exploring alternatives to human auditor review and conceiving the previously-described TARA application, the *Get to Gold* team started an engagement with another ACM customer, Boeing Aerostructures Australia (BAA). BAA had recently hired its first on-site data scientist to expand the use of data within its operation. Upon scoping TARA with BAA personnel, the program team hosted this data scientist for a 30-day Agile/Scrum development sprint to complete the minimum viable product of the application. This engagement was also valuable for BAA, for not only improving the quality of the parts it receives, but also because ACM made TARA (and other aspects of the *Get to Gold* program) freely available for BAA to use or otherwise adapt for its own purposes as well.

Bio for Program Leader:

Jason M. Casebolt
Superintendent of Quality, Boeing Commercial Airplanes (BCA)
(Former) Expatriate Director of Quality, Aerospace Composites Malaysia, A Boeing Joint Venture

During the timeframe of the Get to Gold program, Jason Casebolt was the Expatriate Quality Director for the Boeing Joint Venture – Aerospace Composites Malaysia (ACM). He was responsible for all aspects of ACM Quality, including Quality Assurance, Quality Engineering, Nondestructive Testing, and the Quality Management System. Most relevant for this submission, Jason was responsible creating and executing the Get to Gold program to improve the delivery-quality of composite parts and assemblies that are provided directly to Boeing Commercial Airplanes, or indirectly to BCA through other Boeing Suppliers. As part of this responsibility, he was the program leader for the Get to Gold program, which ran from 2018-2019 at ACM and resulted in significant improvements to ACM's and the quality of products delivered to customers. He has recently repatriated back to the Seattle area where he has begun a new role as the BCA Quality Superintendent for 737 and P8 programs.

Prior to this international assignment, Jason senior managed various groups in BCA Quality, including the functions of process management/improvement, systems administration, business intelligence, data science/analytics, as well as leading early Quality 4.0 development efforts.

Beginning his Boeing career in 2005, Jason spent the majority of his time in BCA's Supply Chain organization, with a particular focus in sourcing aerostructures from Asia. During this time, he served as a Senior Contracts Procurement Agent, Manager of procurement contracting groups, and was the 767/Tanker Partnering for Success Program Leader responsible for affordability improvement.

Jason graduated with a Bachelors in Business Finance from The Ohio State University, a Juris Doctor *Magna Cum Laude* from the Seattle University School of Law, and a Masters of Engineering and Management from the Massachusetts Institute of Technology as a System Design & Management Fellow. He holds certifications as a Six Sigma Master Black Belt, Lean Six Sigma Black Belt, and Design for Six Sigma Black Belt from the University of Michigan, and is a proud second-generation member of the American Society of Quality (ASQ). Most recently, his innovations for using model-based systems engineering for process improvement were published in the January 2020 issue of INCOSE's Systems Engineering Journal.

Members of Get to Gold's Multi-National Team
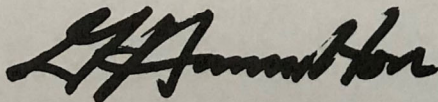

Members of Get to Gold's Malaysia Team

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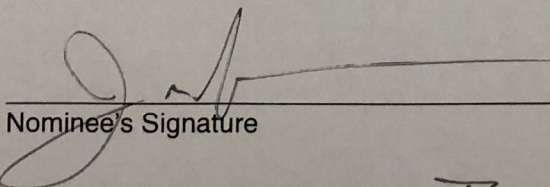
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Thank you for participating,

Gregory Hamilton
President
Aviation Week Network

Acknowledged, agreed, and submitted by

_____   June 15, 2020
Nominee's Signature   Date

Nominee's Name (please print): _Jason M. Casebolt_____

Title (please print): _Superintendent of Quality (former Director of Quality)_

Company (please print): _The Boeing Company (formerly with Aerospace Composites Malaysia, a Boeing Joint Venture)_