

AVIATION WEEK  
**Program Excellence  
Awards**

November 8, 2023  
Washington, DC

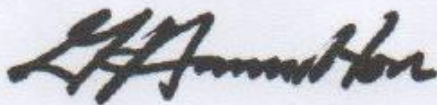
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Thank you for participating,



Gregory Hamilton  
President  
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Acknowledged, agreed, and submitted by

Vanessa Gonçalves  
Nominee's Signature

06/05/23  
Date

Nominee's Name (please print): Vanessa Gonçalves

Title (please print): Sr Program Manager

Company (please print): Embraer Defense & Security Inc.

## NOMINATION FORM

Name of Program: E-99 Modernization

Name of Program Leader: Vanessa Gonçalves

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Customer Approved

- Date: June 5<sup>th</sup>, 2023
- Customer Contact (name/title/organization/phone): Marcones dos Santos Silveira Colonel Aviator / Project Manager / Brazilian Air Force / [pe99m.copac@fab.mil.br](mailto:pe99m.copac@fab.mil.br).

Supplier Approved (if named in this nomination form)

- Date: \_\_\_\_\_
- Supplier Contact (name/title/organization/phone): \_\_\_\_\_

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AS YOU COMPLETE THIS FORM.**

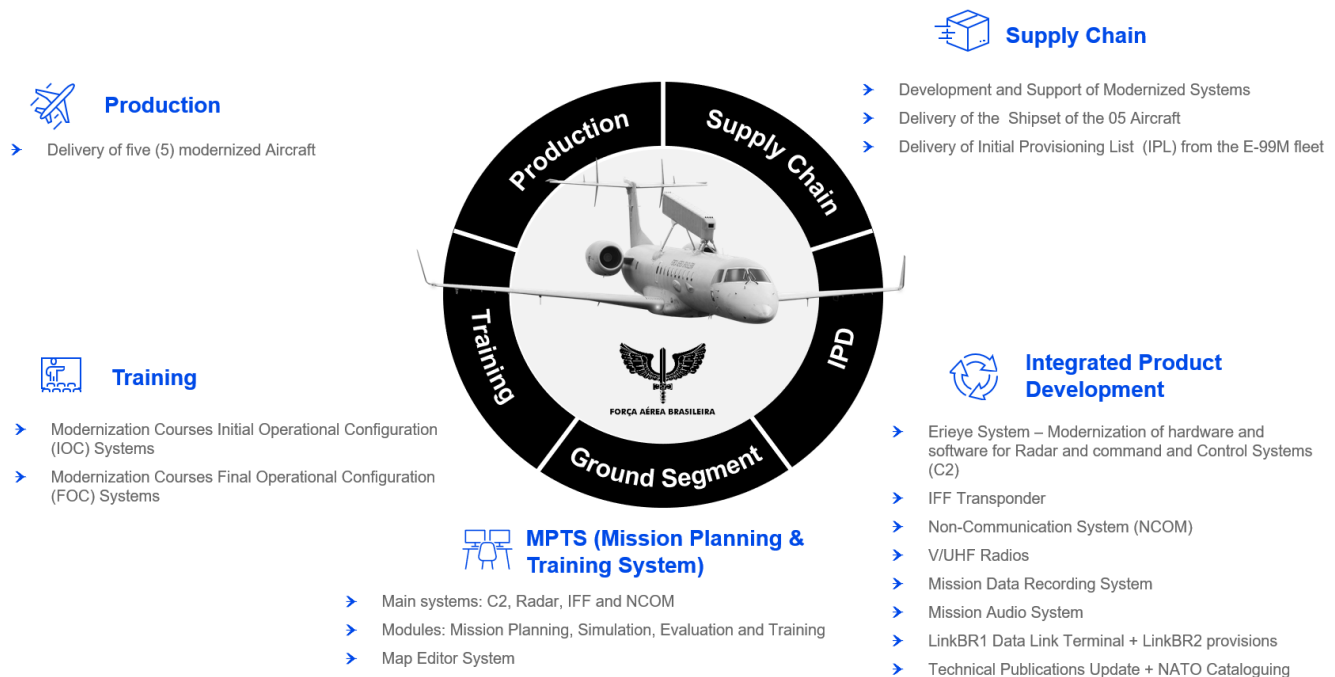
## EXECUTIVE SUMMARY: Make the Case for Excellence

Value: 10 points

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

The E-99 platform is an AEW&C aircraft request by “Brazilian Air Force” (Força Aérea Brasileira – FAB, in Portuguese), designed to be part of the SIVAM project (Amazon Surveillance System), a network of radars and other resources for monitoring air activity in the Amazon region, such as native environmental control, fight drug traffic, illegal mining and other. The system was activated in 2002, when also the aircraft so named E-99 became operational by the Brazilian Air Force.

The E-99 is based on the Embraer ERJ-145 regional jet and has been in service in Brazil for over 20 years. In 2012, the Brazilian Air Force and Embraer signed a contract for a complex modernization of 5 (five) E-99 aircraft and nine years later, in 2020, the Air Force received its first E-99M, a modernized version with updated mission systems and equipment that provides more accurate missions and allows tracking of small vehicles such as cars, boats and hovering helicopter. Figure 1 presents the E-99M Program scope.



**Figure 1 – E-99M Program scope overview**

The biggest challenge during the development of the modernization was to capture FAB's operational needs and turn into a feasible solution with significant increase of the mission systems capacity. It also required integration of many different suppliers and multinational interfaces, especially challenging during the COVID pandemic, considering the technical, commercial, planning, and cultural aspects.

This paper will present how the effective management process led Embraer to fulfill all Contract requirements of the modernized E-99M and how the cooperation with the end customer contributed for the success of the modernization development and E-99M aircraft deliveries, increasing value to the customer, Embraer and community.

## VALUE CREATION

Value: 15 points

Please respond to the following prompt:

**Clearly define the value of this program/project for the corporation; quantify appropriately.**

E-99M program is one of the most important Contracts of Embraer Defense and Security (EDS) with FAB, solidifying a strategic relationship between these organizations since the founding of Embraer in 1969. This contract consolidates Embraer’s knowhow in upgrade of design, integration and testing of modernized system with legacy aircraft, and in requirement management and compliance verification for complex ISR (intelligence, surveillance and reconnaissance) defense aircraft modernization.

The E-99M program reused lessons learned from previous modernization programs and implemented an optimized process to modify pre-owned aircraft and to guarantee the quality of the final product and deliver all contractual milestones. In the end of the day, the E-99M program management was able to combine the process of maintenance of the legacy aircraft and the best product development practices inside Embraer, expanded to main suppliers to integrate the modernized systems. The chart aside summarizes the documentation generated during the lessons learned review.

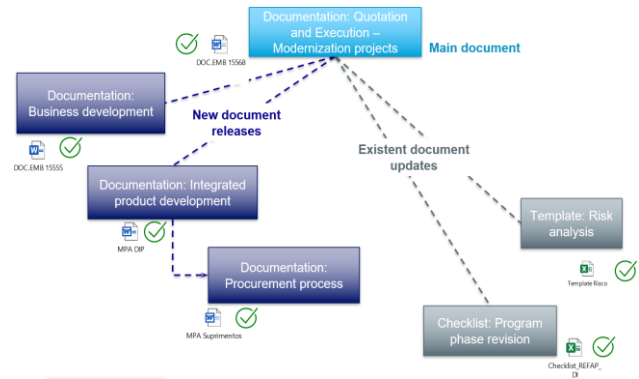


Figure 2 – Lessons Learned documentation

The E-99M program was certainly of great financial importance for Embraer and achieved its expected profit margins in its business plan. However, its greatest contributions were related to development of technical staff, processes, and relationship with client as will be presented in next sections. The E-99M enhanced the capability of FAB and tightened the bond with this major client through transparent communication and trustworthy behavior. The program developed many collaborators in risk management thinking and military requirement certification process as well as transferred Project Management knowledge to other business units of Embraer.

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

The E-99 is a Brazilian military surveillance aircraft, based on the Embraer ERJ-145 regional jet, with Erieye-ER radar manufactured by Saab Electronic Defense Systems, allowing the equipment to work with medium and high-frequency Doppler pulses that reflect off objects over their scanning area and it has been in service with the FAB since the 2002. And now, with the modernized version, E-99M, the FAB has enhanced capabilities to monitor aerial activity in Brazilian airspace.

The E-99 modernization increases the airborne mission system capabilities such as C2 and radar performance, internal and external tactical and secured communication, number of operators, cabin comfort, electronic warfare, and mission recording. All these improvements meet the contractual requirements and the customer value, for which the program had to understand the real need of the end user (aircraft operator) while showing compliance with the requirements to the Military Authority responsible to certify the product. The management team applied efforts to completely understand the needs of the end user and correlate them to the technical requirements, organizing a Requirement Workshop.

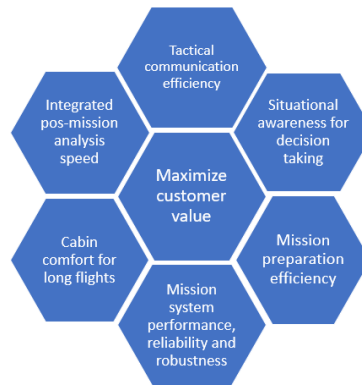


Figure 3 – Customer value

After defining the Customer value for E-99M Program, the management team defined the critical requirements and its dedicated action plan. This was important to guide the decision along the Project duration and to preserve what is most valuable for the end user. The output of the Requirement Workshop was subject to the validation of FAB and to the analysis of Embraer engineering together with main suppliers (Ael international, Rhode & Schwarz, Saab, Safran and Atech – Part of Embraer Group).

A proof of value achieved in the final product is observed in the operation gains during the military exercises and real missions. FAB has demonstrated its satisfaction with E-99M enhanced Radar performance and the increase of tactical communication during mission of Airborne Early Warning & Control (AEW&C), and Airborne Communication Relay Station. Figure 4 shows E-99M during the “EXCON Escudo-Tínia 2022”, with participation of 800 military personnel at Canoas and Santa Maria Airbases.



Figure 4 - EXCON Escudo-Tínia 2022. Ref [1]

➤ **Clearly define the value of this program/project to members of your team; quantify if possible.**

The challenge of working in a modernization project is to design and integrate the modernized system considering the characteristics of the legacy system and the need to treat issues related to the aging of the used aircraft and demands a very experienced and competent technical team. This subject was addressed during the program execution and two examples are: (1) the technical readiness mapping and monitoring since the kick-off and (2) the identification of the lack of knowledge about the operational aspects of mission system. In both cases an action plan was defined and executed, and the E-99M team members were trained and became stronger. Specifically for case (2), an internal educational program on Electronic Warfare was implemented: “Programa de Extensão em Guerra Eletrônica (PEGE)”.



Figure 5 – Launch of Education Program on Electronic Warfare – PEGE

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

The E-99M is a rare bird in South America, with only the Brazilian Air Force operating this aircraft. For the defense of a country, it is a military tool that avoids surprises and finds the problems at a distance, allowing a longer reaction time against a threat. With the E-99M, the FAB has an advanced tool to keep Brazilian airspace safe and secure. Besides playing a strategic role in the airspace defense, E-99M has been employed to combat drug air traffic (on combined operation with Super Tucano A-29) and during humanitarian air support mission (as “Operação Escudo Yanomami”, in English Operation Yanomami Shield in Roraima, avoiding the illegal air traffic of mineral and controlling the air traffic for aid supply on combined operation with C-390 Millennium).



**Figure 6 – E-99M participation on illegal ATC & aid air support coordination. Ref [2] and [3]**

**ORGANIZATIONAL BEST PRACTICES AND TEAM LEADERSHIP**

Value: 35 points

Please respond to the following prompts:

➤ **15 points: Describe the innovative tools and systems used by your team, how they contributed to performance and why.**

The challenges of such a large project, with significant importance to the client and the nation, follow the same order of magnitude. To address these challenges, efficient communication between all stakeholders – client, certification authority, suppliers, engineering, production – reunited as a solid team working as one is a must.

Internally Embraer had to understand and prioritize efforts to keep a focused team while developing other projects. Using a management tool named Integrated Project Management (IPM), the PMO team was able to plan and monitor the execution of all projects and define levels of priority incurring in order of precedence of tasks. The IPM is based in Critical Chain Project Management (CCPM), a concept largely used by Embraer. The tool provides a convenient capability to simulate different priority scenarios that support the decision-making. After all, being successful in one project is a challenge per se, but being successful without jeopardizing many other projects is a much larger adventure in which IPM certainly has been the compass.

To correctly address the activities and keep resources on track of the whole project, regular Obeya virtual rooms were kept throughout project in multiple stages – Production, Engineering, Program Overview. Complementing the macro management provided by IPM, the development teams performed micro-management through JIRA and Microsoft Task Planner and To Do due to the multitude of tasks per person.

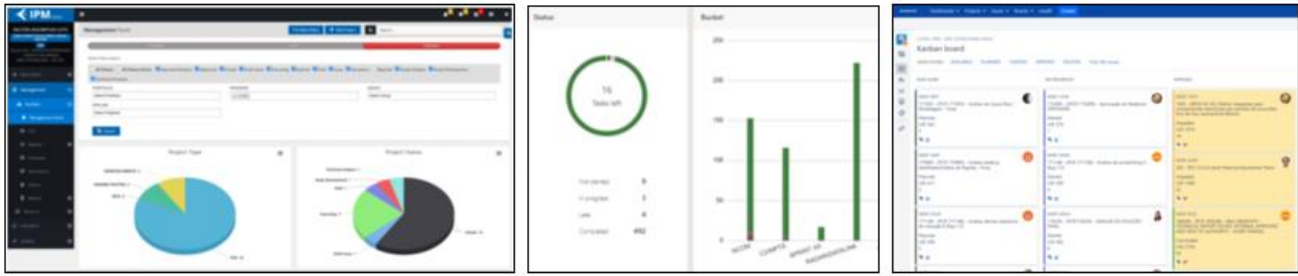


Figure 7 - Management tools. From left to right: IPM; Microsoft Tasks by Planner and To Do; JIRA

Externally, in order to guarantee collaboration with FAB, the program developed a high-trust relationship with transparent and frequent communication in weekly meetings and a simple follow-up spreadsheet of topics and actions. The Program Management Reviews meetings were also planned from the start of the program and done at least twice a year to guarantee all topics had been correctly discussed. Keeping communication simple and clear is one of the main pillars that led to the success of this project. The opportunities raised by the COVID-19 scenario were notably harnessed in which the Microsoft Teams® meetings with client were largely used, allowing at least virtual “face-to-face” communication. Embraer kept an attentive and friendly communication channel to attend FAB’s needs, and this attitude brought significant support in the ending phases of the program to prioritize Embraer’s production needs.

This high-trust relationship was also built with the certification authority through frequent communication, sharing of evidence, and collaborative planning. One of the most innovative tools was the Klaxoon® dashboard co-creation and planning between Embraer and Certification Authority to achieve fast certification documentation and evaluation maintaining a reliable process. The gain obtained is related to parallelism of activities and clear communication between parties involved. Such a gain is significant considering the timing of activities – usually the last activities of engineering development and one of the last before product delivery.

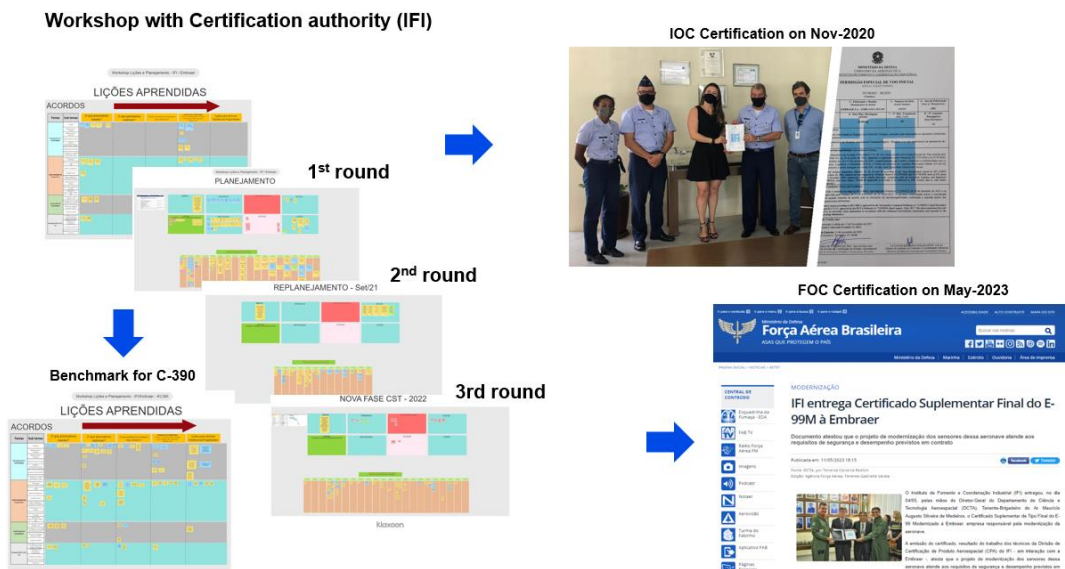


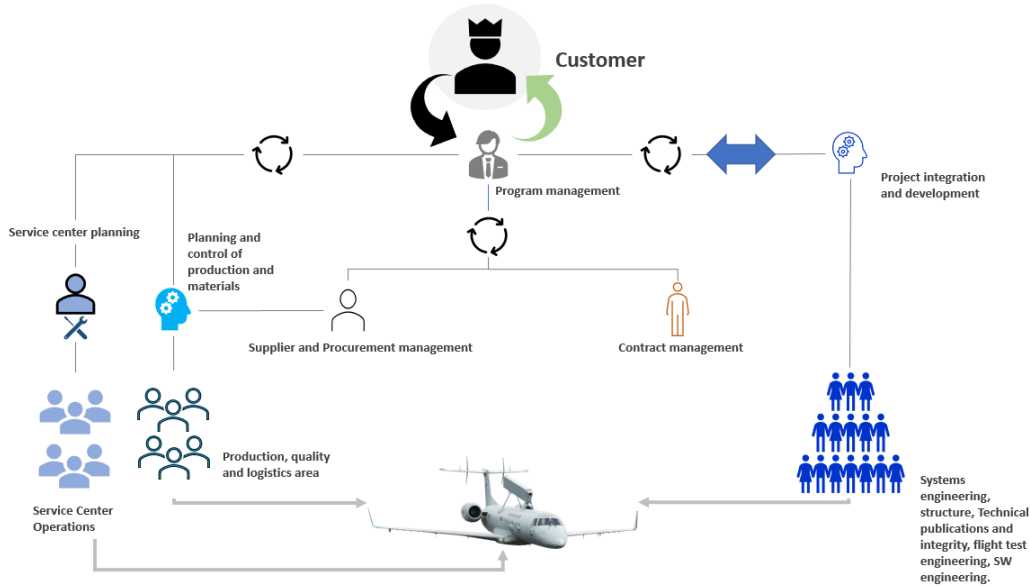
Figure 8 - Dashboard with Certification Authority using Klaxoon. Ref. [4]

➤ **10 points: Define the unique practices and processes you used to develop, lead and manage people?**

Each Embraer Defense and Security contract has a dedicated business plan to clearly state the main operational strategy, the main deliverables and their acceptance criteria, the master phase plan, the main risks and opportunities, and all economic and financial aspects. The business plan managed by a dedicated program management team is deployed to operational areas representing macro processes of development.

On every planning cycle, the business plan is deployed into a yearly operational directive and then into an internal commitment agreement for each operational area. In parallel to that, the budget necessary to assign the resources is validated and controlled periodically.

This link between the business plan and the commitment of the affected areas is important to guide the correct direction of the project. And the close and collaborative management is responsible for keeping the whole project team engaged and guaranteeing exceptional delivery performance.



**Figure 9 - Program Management Overview**

Based on this, Embraer has developed a specific line of reasoning and practices for the E-99M project, which are part of the company's DNA. These practices include:

1. Development of the learning curve: The professionals involved in the project go through a learning process focused on the operation and assembly of the project's aircraft, using lean manufacturing practices.
2. Technical alignments with the client: Periodic meetings established with key representatives of the client to discuss progress in the development of products and processes.
3. Promotion of kaizens and workshops: Kaizens (continuous improvements) and workshops held to analyze the complexity of processes in different phases of the project, eliminating unnecessary steps and optimizing the fluidity of internal and external processes.
4. Engineering Obeyas: Daily Obeyas (follow-up meetings) to ensure the flow and follow-up of the short, medium and long-term deliveries of the project. Several relevant areas and subjects were involved in these meetings, from the actual progress of the aircraft to requests for product changes, supplier management, preparation of technical publications, product certification and flight tests. It also served to resolve emerging issues related to customer requests.
5. Sprints for approving engineering reports: Sprints were used to speed up the approval of engineering reports required for product certification by regulatory bodies. The specific parts of the reports were written in a synchronized way, ensuring speed and quality of the content.
6. Allocation of representatives of the management areas in the "Gemba": Representatives of the management areas were allocated in the "Gemba" (place where the real work is carried out) to closely follow the actual progress of the aircraft and solve problems immediately. This facilitated the work of the operations areas, reducing bureaucracy and allowing for more agile and assertive



project management. In addition, these representatives obtained real-time information that contributed to measurements, project control, risk mitigation and more informed decision-making.

These unique practices and processes in the E-99M project demonstrate Embraer's commitment to promoting innovation, agility, practicality, detail and design safety, while engaging and meeting customer expectations.

➤ **10 points: How did you leverage skills and technologies of your suppliers?**

The close interaction between Embraer, suppliers and FAB during all development phases was responsible for several improvements to the mission system solutions. These improvements demonstrate that Embraer and key suppliers aim to apply differential skills and technological upgrades. It is possible to remark two examples:

1. HMI evolution for the electronic signal intelligence system – NCOM (Non-Communication) System: Important technological updates were made available in the hardware (HW) and software (SW) components by the supplier. These upgrades would allow an important HMI evolution (increasing the satisfaction of end user) and avoid issues of obsolescence. On the other hand, this modification would impact on the compliance of one specific requirement. Then a three-part (integrator, client and supplier) trade-off analysis was conducted, making the evolution possible. Good for the project and essential for the end user.
2. MPTS evolution: the excessively high-level requirements related to MPTS (Mission Planning and Training System) created a conflict of vision of how the solution should be. FAB expectations were to receive a kind of flight mission simulator and the supplier was planning to deliver a portable station with mission software installed. This positive conflict was gradually solved during the requirement review and deployment analysis, allowing all necessary three-part (integrator, client and supplier) decision taking during the development till the final delivery and acceptance of the MPTS.

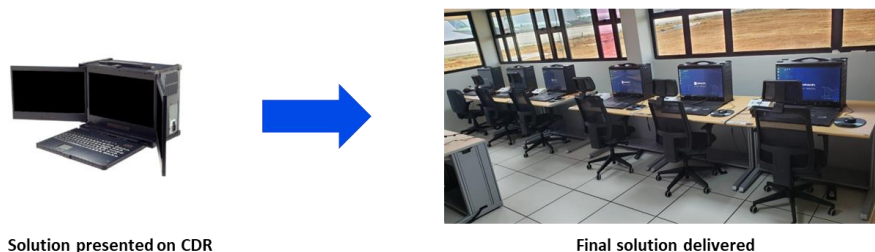


Figure 10 – MPTS evolution

**DEALING WITH PROGRAM COMPLEXITY  
(VOLATILITY, UNCERTAINTY, COMPLEXITY, AMBIGUITY, or VUCA)**

Value: 25 points

Please respond to the following prompts:

➤ **10 points: Describe UNIQUE areas of VUCA faced by your program and why. (Please avoid the issues surrounding Covid-19 pandemic, which was faced by all programs.)**

Volatility and ambiguity

Even before any issue related to COVID-19 pandemic or geopolitics conflict in Ukraine, E-99M Program was impacted by a complete execution pause between June-2014 and April-2017 as presented in Figure 11 the project stopped after the Critical Design Review (CDR) and resumed 3 years later facing the following changes of scenario:

- Assembly line transferred from MRO to Production line environment,
- Design frozen without full understanding of the technical requirements,
- MRP implementation for supply chain,
- Open negotiation with key suppliers, and
- Development of Mission system without full understanding of the technical requirements.



Figure 11 – E-99M Program Master Phase Plan (MPP)

In order to address all the presented issues, the management team established two complementary lines of action: (1) Project organization and (2) Technical reviews, which are detailed in the next section.

Uncertainty and Complexity

Considering the complexity of Systems Integration in an aircraft, anyone could certainly consider the project as inherently immersed in a VUCA scenario, this complexity was also combined with an unusual scenario of system and SW development by 4 different suppliers in different locations without a fully representative test environment. Ael international, Atech, Saab, Safran (Zodiac) and Embraer, as integrator, had the responsibility to develop and integrate a new mission system, as presented in Figure 12. This unprecedented scenario was considered as source of a lot of uncertainty and the response to that was to reinforce the risk management process on E-99M, as presented in the next section.

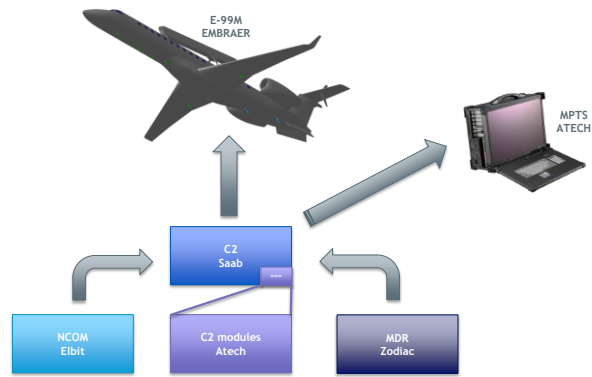


Figure 12 – Mission system high level architecture

The modernization of systems also has a unique complexity for times less explored – the client’s operational doctrines and expectations after replacing systems. One of the modernized systems in the E-99M which fully faced this challenge is the Electronic Signals Intelligence and Electronic Support Measure System NCOM produced by Elbit Systems and integrated by Embraer with the purpose of replacing the previous system NCES from Raytheon Systems. Even though the two systems are similar in terms of functionality, the client rightfully expects the modernized one to perform better. But there comes the tricky part: how to make sure that the performance is correctly evaluated and that the operators fully understand the new ways of operating the system and can extract the best performance of a complex system? An upgraded system

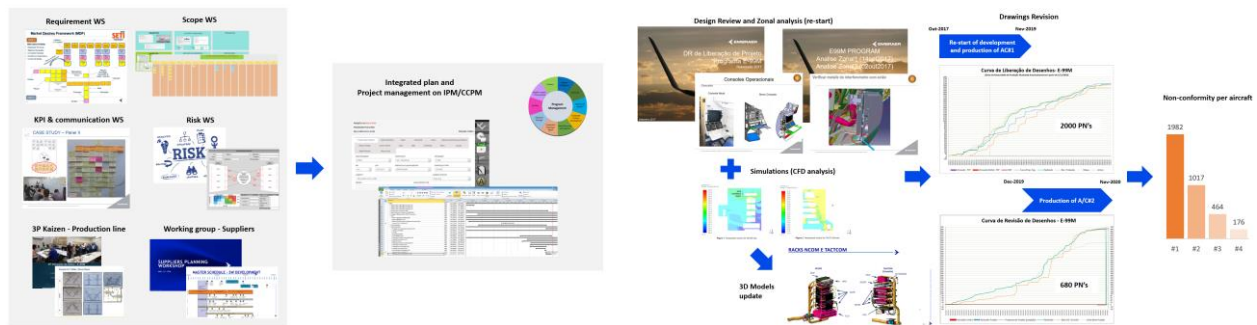
usually does not pose a challenge, but a new replacing system will certainly have new functionalities and probably a different operational philosophy.

➤ **15 points: Explain how your team responded to these challenges. What changes did you make, what were the results?**

Volatility and ambiguity

Detailing a little more the two lines of action put in place by the management team, it is important to remark:

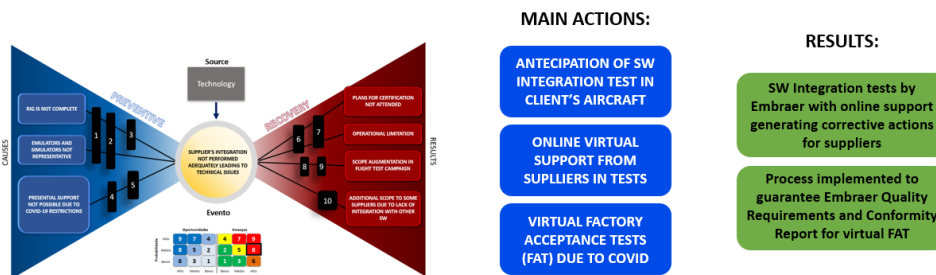
1. Project organization: re-creation of the Core Team, review of the scope (through Scope Workshop), review of the contractual requirements (through Requirements Workshop); review of the metrics and communication plan (through KPI and Stakeholder Workshop), reviews the risk (through Risk Workshop), review of the manufacturing strategy (through 3P Kaizen) and revision of Statement of Work of key suppliers (through Working Group), re-establishing a full integrated plan for the modernization project;
2. Technical reviews: requirements review and deployment with end user and suppliers, multi-disciplinary design review, zonal analysis, use of simulations and technical reviews with suppliers, planning and executing a 100% revision of 3D models and drawings for manufacturing and assembly.



**Figure 13 – Project Organization and Technical Design Review after contract re-start**

Uncertainty and Complexity

The E-99M program invested in risk management capacitation with over 80 people from the development team performing internal classes in the concept and tools that were used throughout the project. Forming the basis of risk management thought was the first essential step to respond to all these challenges. Keeping an aligned team, including client and suppliers, through frequent and transparent communication was the second step that led to success. To combine both steps successfully the bowtie risk assessment methodology was used, and preventive controls and actions were taken as well as reactive actions were planned and aligned beforehand. The method is straightforward and simple enough to facilitate communication. Figure 14 provides a picture of how the method was the basis to adopt actions related to suppliers’ software integration and certification in order to achieve fast and reliable results.



**Figure 14 - Bowtie Risk Assessment example**

As for the challenge related to client’s perception on performance of NCOM System, Embraer, the client (FAB) and Elbit System organized a thorough operational training consisting of a week of all-day-long classes followed by another week of real training using the aircraft with instructions of Elbit’s staff with real life experience. Up to this point, actions not very unusual in this industry, but Embraer, Elbit and FAB decided to stretch it further: with the high-level of confidence of Elbit in its system’s capabilities and Embraer in its complete integration with the aircraft, we tested it against an unknown scenario to any of the developers to fully evaluate its capabilities of intelligence gathering. The result was a gratifying comment from the operators: “the system is better than the previous one”.

Maintenance Task Validation on aircraft assembly and change on aircraft sequence:

As said before, one of the biggest difficulties on modernization programs is to coordinate the maintenance activities with the activities related to the implementation of the modernized systems on the assembly line. Having a team with specialists in both legacy and modernized systems and a schedule that is capable of synchronizing these activities is essential. During the analysis of this critical scenario, the management team could see an opportunity to reduce the total cycle of the final assembly phase of the aircraft, eliminating the redundancy of the maintenance task with the functional aircraft test.

In response to that the management team organized an improvement project with multi-disciplinary team (Engineering, Quality, Production and Program Management) in order to create a new process to validate the maintenance task and eliminate the equivalent function test on the final assembly. The new process was implemented in the production line, saving 3 months of the total cycle.

Another important action realized by the management team was the “Workshop to guarantee the delivery of 2 aircraft in 2020”. Again, a multi-disciplinary team (Engineering, Procurement, Flight Tests, Quality, Production and Program Management) took the necessary decisions to keep the program on track, such as:

- Change the sequence of aircraft assembly and delivery (S/N 263, which started the production after S/N 365, was delivered first),
- Flight tests and training activities once planned for S/N 263 were transferred to S/N 365, and
- Painting of S/N 365 was performed after the delivery in agreement with FAB.

These important decisions followed by incredible well-integrated engagement, close support of the Embraer board and transparent alignments with the final customer have resulted in one of biggest achievement of Embraer Defense and Security in 2020: the delivery of the first two modernized aircraft almost simultaneously.

**METRICS**

Value: 15 points

Please respond to the following prompts, where predictive metrics indicate items that provide a view of how yesterday’s actions and today’s actions will affect the future timeline, cost or other requirement.

Provide charts/graphs that illustrate performance to these metrics:

➤ **What are your predictive metrics?**

As mentioned previously, one of the main tools for managing the deliveries of the program is the Integrated Project Management (IPM) based on the CCPM concept. The tool provides metrics of predicted buffer consumption presented in fever chart which drives recovery plans and definition of new agreements with



**Figure 15 – Delivery of two modernized aircraft in 2020**

client when required. The fever chart is a straightforward tool that allows fast meetings and prompt urgency when required. The details of buffer consumption are closely observed by the PMO team to act.



**Figure 16 - Example of Pipeline of Projects, their Fever Charts and IPM tool (Integrated Project Management)**

➤ **How did you perform against these metrics?**

The predicted buffer consumption is highly volatile throughout the project and may change due to many aspects: reassessment of task duration, reassessment of interdependency between tasks, availability of specific team and priority of projects. The main purpose of the metric is precisely to instigate the PMO team to reevaluate the plan, check inconsistencies and find new ways to achieve the goal faster while keeping the quality. The PMO team acted whenever the indicator started to occupy yellow or red area. In the end, all engineering activities were finished while still in yellow region and the milestone of Supplementary Type Certification was achieved in the expected date.

➤ **How do your predictive metrics drive action toward program excellence? Please provide examples.**

The predicted buffer consumption indication is used in all projects in Embraer Defense and Security and not only in the E-99M program and it grants the predictability required for actions and replanning not only in the dedicated project, but also the concurrent ones. As expected, this indicator is highly affected by the most restrictive resources which are involved in various projects at the same time. By using this indicator and taking the proper actions, the PMO team is able to optimize the resources and understand impacts of unforeseen issues that may arise, a predictive metric to achieve excellence.

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[2] – *KC- 390 Millennium realiza lançamento de cestas básicas em Terra Yanomami*. Força Aérea Brasileira. (2023, January 26). <https://www.fab.mil.br/noticias/imprime/40283/OPERA%C3%87%C3%83O%20YANOMAMI%20-%20KC-%20390%20Millennium%20realiza%20lan%C3%A7amentos%20de%20cestas%20b%C3%A1sicas%20em%20territ%C3%B3rio%20Yanomami>

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