System Engineering and Analysis (SEA): System/System Life Cycle (SLC) - V

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Back, let us with our journey through the stages of the life cycle of systems (CVS). In the latest IYK (32), we presented a summary (as always are these our flashes) about the subphase of preliminary design (Preliminary Design). Now, we move on the detail design subphase or advanced design, and we'll conclude with a brief presentation of the phases of production and operational. We hope you enjoy it.

First of all, we have to clarify that this division of CVS in phases is a convention adopted by the EAS methodology to facilitate the understanding of the evolution of a system. It is something like our human life cycle, when we talk about childhood, adolescence, adulthood, old age and "departure".

The subphases are not exactly sequential, that is, with one starting when the previous one ends. This is not the case. They overlap. There will always be an intersection of sets of activities that constitute one and another.

With the technical specifications of subsystems and equipment/components, the company goes to suppliers with their called RFI (Request for Information), requesting information about them, in order to verify if those items comply with requirements.

Once those items meet the requirements (technical and financial), the company purchases the ones.

With the acquired physical architecture, the company builds a prototype of the main component of the operational subsystem (aircraft), for the realization of tests and evaluations, aiming the refinement of the design, in order to reach the production configuration.

The same happens with Logistics Subsystem Tests are conducted, for example, compatibility tests of GSE (Ground Support Equipment) with the aircraft. It is not uncommon to have to redesign GSE. The so-called scheduled maintenance plan is developed based on the focus of Maintenance focused on reliability (Reliability Centered Maintenance-RCM) today, in General, based on the methodology called MSG-3 (Maintenance Steering Group 3).

This is a time of intense planning, for both subsystems (Operational and Logistic).

The activity of tests and evaluations must be performed with great care and patience because it is from this activity that the company will arrive to the configuration of serial production. Moreover, tests and evaluations will used also to complete the certification process of type design, conducted with the Airworthiness Authority of the respective country (ANAC, in the case of Brazil).

Chapter 6 of Reference 5 provides a comprehensive text on testing, evaluation and validation. At the end, the validation process says that based on the tests and evaluations, the system meets the requirements.

Let's quote some tests that are usually performed.

Performance Testing - Performed to verify if the subsystems present the expected outputs. The main component fulfills the mission with the expected effectiveness and efficiency? And others.

Environmental Tests - Noise, vibration, humidity, pollution, electromagnetic compatibility, and others.

Structural Tests - Characteristics of materials for strength, fatigue torsion, decomposition, and others.

Reliability - MTBF (Mean Time Between Failures), MTBM (Mean Time Between maintenances), lifetime, etc. (See IYKC 28).

Maintainability - $\overline{M}$ (Mean Active Maintenance Time); Mct (Corrective Maintenance Mean Time), and others.

Compatibility of Ground Support Equipment (GSE) - Compatibility of test equipment, handling and transport equipment or subsystems and components.

Testing and Evaluation of the Technical Personal - Verification of the performance of the personnel linked to maintenance tasks, considering the level of proficiency expected from training, the number of staff, etc.

Verification of Technical Data - Effective operational and maintenance manuals.

Software Verification - Checking of the effectiveness of the software programs that are part of systems integration.

System Safety Assessment - See IYK 06, 07, 08, 09, 10 and 11.

These tests are performed in the Development Phase with the prototype, but some of them are also performed during the Operational Phase. Actually the system is always being tested, in the Operational Phase, because it will undergo changes all the time, especially those that affect safety.

Various tests are performed when modifications are introduced on aircraft, like those that are performed to improve the reliability, since the operational reliability is never the reliability reached in the development phase.

Once the tests and evaluations are successfully completed, the development phase is closed in the meeting called Critical Design Review - CDR, and the production configuration is established. This is called the moment of "speak now or forever shut up". This phrase means that anyone who wants to change something has to do it at that time, since after the production be started, modifications are of high costs.

But in truth, there will always be changes and, in fact, they cost very much. We know this very well.

The certification activities are also closed with the issue of a type certificate by the Airworthiness Authority.

Are issued specifications for manufacturing processes, the Quality Plan for Production, and the series production begins.

Each aircraft produced receives a certificate of airworthiness from Airworthiness Authority, getting ready to be used operationally.

Then begins the Operational Phase.

Depending on the system performance and observed safety problems, changes arise (operational and logistic), everything under the control of a configuration management of the Operational Phase.

Once the system meets all expected hours of operation, or it undergoes a process of revitalization (update systems without changing the mission) or a process of modernization (change with change of mission or aggregation of another mission). Another possibility is the disposal of the system, ie the system "dies".

Well, dear readers, we have not had here, even remotely, the pretension of exhausting the subject. The focus here is always "flash," that is, an idea, a familiarization about a subject of interest of those which work in aerospace area (aeronautics and space).

Again, Thanks for your attention.

See you.

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