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IMPLEMENTATION OF QUALITY FUNCTION DEPLOYMENT (QFD) IN FLIGHT TEST PROCESS OF BASIC TRAINER AIRCRAFT

Abstract: In this paper is presented a Total Management tool in process of prototype basic trainer aircraft flight testing. The implementation of Quality Function Deployment (QFD) method in process of flight testing is represented with goal to decrease the time and cost resource. The improvement of general quality process in design, production, testing and deliver to customer is based on permanently discover the dissatisfaction aircraft characteristics in flight and shared with developer and customer with aim to find the best solution to satisfied initial customer requests. The customer satisfaction with flight test analysis is basic principle in implementation of QFD methods in flight test organization.

Keywords: Quality Function Deployment, Basic trainer aircraft, Flight test, Quality System

1. INTRODUCTION

Quality Function Deployment (QFD) is a Total Management tool development to guarantee the quality of new products and services. The ideal tool development is to design and build quality as defined by customer satisfaction and value into new products. In other words, to get it right the first time. Further, QFD looks to improve the new product development (NPD) process itself by reengineering the cross-functional contributions of each department which are involved in project to assure they meet certain standards of timeliness, content, and quality. These two aspects of Comprehensive QFD are shown in the original concept model developed by Dr. Yoji Akao, co-founder of QFD, in Figure 1.

In this paper is presented a management of flight test data, as segment of measuring and analysing in process of development basic trainer aircraft for customer. The QFD methods must be a

part of measuring and analysing flight test data in two reverse directions: to development organisation and to customer.

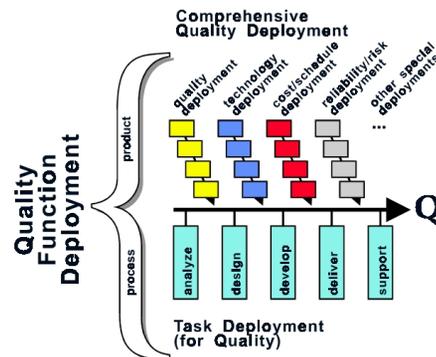


Figure 1 – Comprehensive QFD Concept

This data can be relevant in processes of aircraft development and delivery to customer with aim to decrease time and cost of aircraft acceptance procedures. In this paper is shown a obligation and

presentation of relevant flight test data to developer and customer.

2. DEVELOPMENT OF BASIC TRAINER AIRCRAFT

The development of new basic trainer aircraft for Serbian Air Force pilots is a very complicated, long and expensive process in which are included a large number of institutions from Serbian defense system. In this advisement are significant next participants of project: development, testing and customer institution. The finance (Ministry of Defense) and production institution have a major place in project, in some case, and determining role, but in management procedures of aircraft flight test data they don't have influence.

The aircraft with request characteristics is ordered by customer. The project with this request will be accepted or no from development institution. In case of acceptance, the project of aircraft will be projected by development institution, which will be made in factory. In the same time the flight test institution is involved in whole project with aim to reduce a cost and time of flight testing on first prototype. The test equipment is embedded in aircraft in process of aircraft fabrication. In this case, the flight test institution is involved in two tasks: first, to participate and organize the phase of flight development tests for designer, and second, to prepare a valid and objective results of aircraft characteristics to customer (Serbian Air Force) in accordance with initial requests.

The described process can be present like a continually work to satisfied customer. The flight test organisation is responded to other two institution to understand the satisfaction level of their requirements.

Quality Function Deployment is a tool that has a confirm about of guiding successful programs to answer the voice

from the customer. Although flight test data, in the same time, will be delivered to customer and design institution to develop new relationships and perform services, needed to validate, refine, and adapt these development programs at optimal performance.

In figure 2 is shown a Kano model, which represent request and expectations of customer. They can be arranged in three groups:

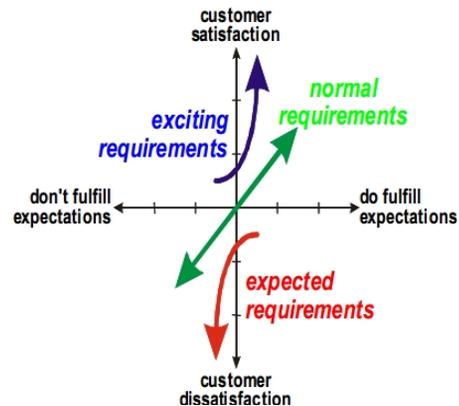


Figure 2 – Kano Model

Normal Requirements are typically. They are requested by customer and are wanted. These requirements satisfy (or dissatisfy) in proportion to their presence (or absence) in the delivered service. This requirements will be observed from flight test team with special procedures, with aim to give a positive mark for that characteristic.

Expected Requirements are typically, in accordance with airworthiness for given type of aircraft. This characteristics are expected by customers, without any request. Because, they are basic expectations of the service, their absence in product can be very dissatisfying for customer. This requirements will be observed too.

Exciting Requirements are beyond the customer's expectations. Their absence doesn't dissatisfy; their presence excites.

The flight test team has a task to explore and discover this characteristics, give explanations and limitation for service in basic trainer program in the future.

Kano model is used for to ratify order of customer satisfaction with first aircraft prototype characteristics. On this satisfaction (voice of the customer), the development are going in the direction to define corrective action to improve all characteristics which on border of satisfaction.

Flight test team, in this situation, have obligation to correspond between customer and developer with aim to neutralize all bad customer voices from second prototype of aircraft. This process is dynamic and demand a enormous effort to detect, classify and rank all dissatisfaction with appropriate action plan to suspend from next prototype.

3. IMPLEMENTATION OF QFD METHODS IN FLIGHT TESTING

First of all, the test plan will be designed. Most test plans fall within the categories of management test plans and detailed test plans. Management plans for aircraft programs are normally called System Test Plans and contain flight test management concepts and general (as opposed to detailed) test plans that only identify the types of tests to be accomplished with aim to satisfy the customer. Test Information Sheets (TISs) are actually appendices to test plans and contain sufficient information for use by a flight test engineer to develop flight test cards and for management to discern the overall technical approach being taken. Therefore, TISs are frequently the key documents that describe the specific tests to be accomplished and how they will be accomplished and satisfied the customer request.

The designated project manager (PM) from the responsible test organization (RTO) is responsible for ensuring that flight test personnel prepare or make inputs to test plans as soon as possible. Flight test personnel should also prepare or make thorough and timely inputs to detailed TISs through integrated product team meetings, test plan working groups or other means. The PM is also responsible for ensuring that test plans are prepared and submitted to the Office of Primary Responsibility (OPR) for Technical Review in time to allow comprehensive technical and safety reviews and to meet program requirements and schedules. The PM is also responsible to assure that test plans are properly coordinated with customer and developer of aircraft and ready for the required reviews. Copies of the plan will be provided to other institution to correlated as soon as possible but normally no later than six weeks before the start of testing.

In period before test starting, the changes will be made with developer and customer suggestions. After this step of correlation, the flight test will be approval. This preparing period can be longer then flight test personnel expect, but customer testimonials in ability of flight test organization must be fully and approval of the flight test plan will be accomplished with this step.

Quality of flight testing organization is depended from guideline for the type of information that should be considered during flight test process. In figure 3 is shown a typical flight test organization with all predefined processes and responsibilities. In flight test process has been included and aspects of all appropriate management, technical, and safety sources which is not included in Figure 3.

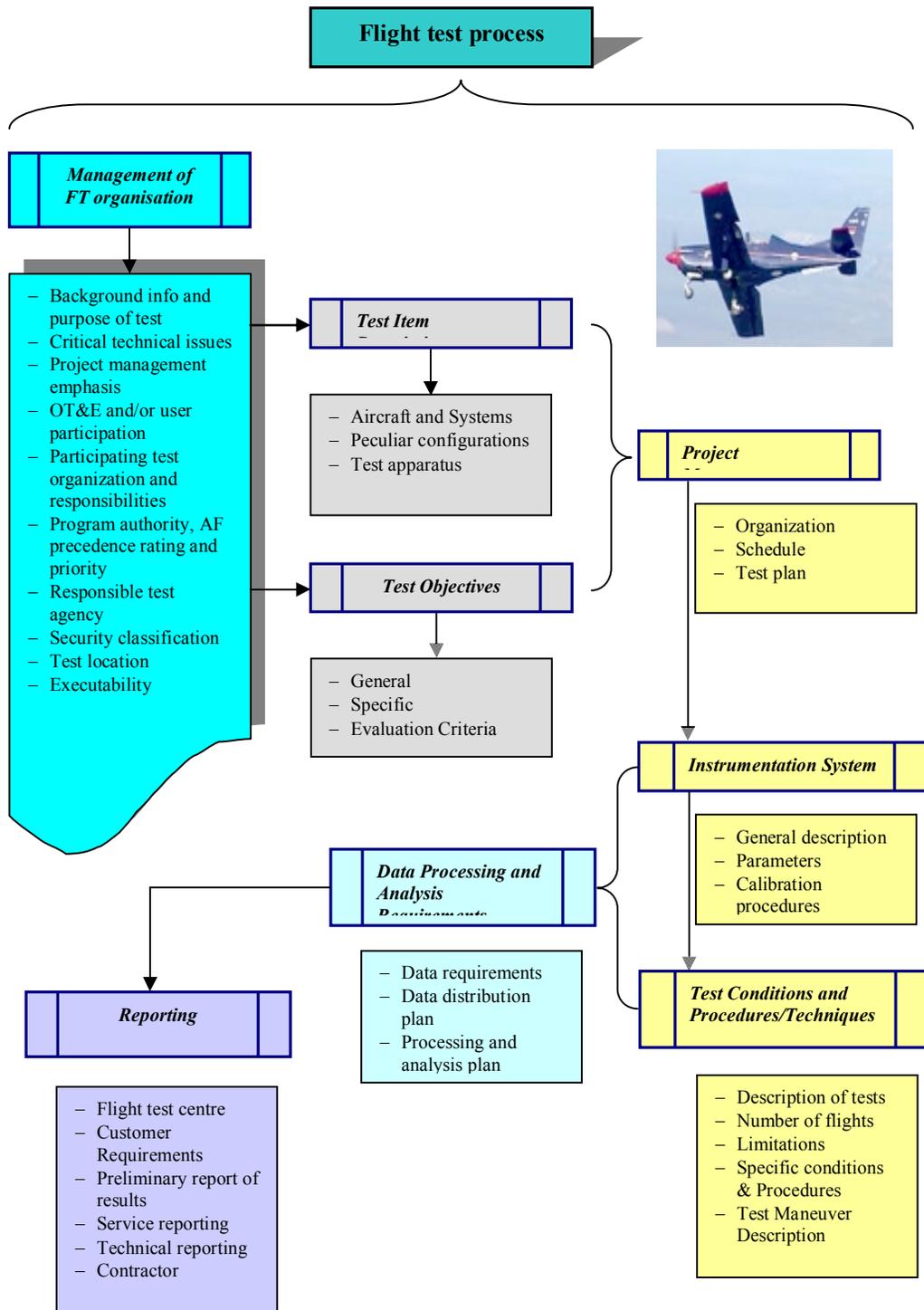


Figure 3 – The project flow chart in flight test organisation

The main steps in flight testing, in which can be discovered satisfaction of established requests, are Test Conditions

and Procedures/Techniques and Data Processing and Analysis Requirements.

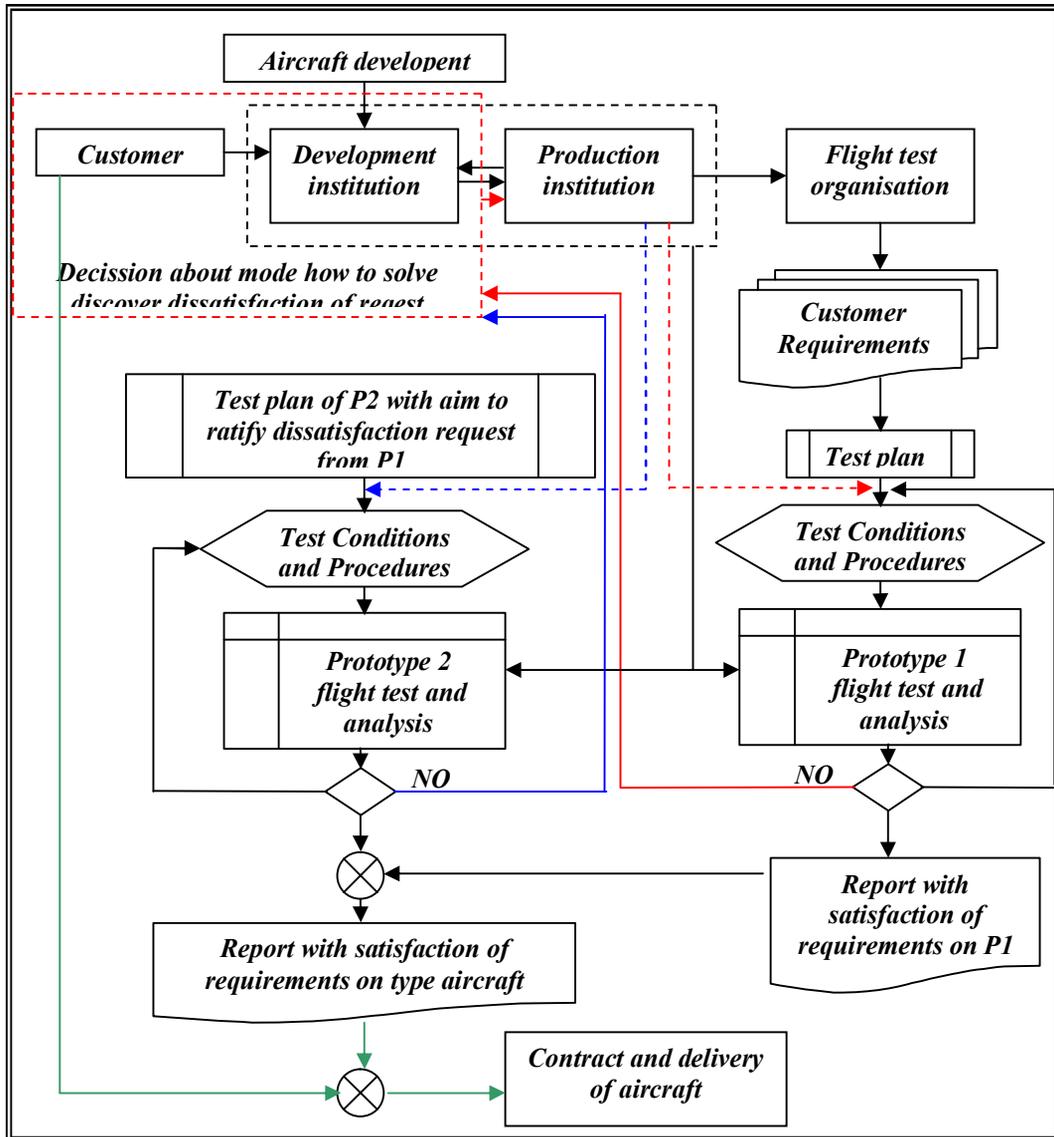


Figure 4 – Complete procedure of flight test with management tool development

This two steps with adequate instrumentation are essence in flight test process. In this steps are involved test pilots, test and instrumentation engineers. This sub process is divided on few phase,

which can be connected with customer request, they are:

- Integration of instrumentation system,
- Ground tests, with aim to give permit of aircraft fly. This requests belong to

the class of **Expected Requirements**.

After this test the flight test team can be entered to flight test.

- Flight test, with aim to verify characteristics of aircraft. After tests and analysis the characteristics from this phase can be divided in groups of **Normal and Exciting Requirements**, but usually they can not be satisfied the basic requests. In that situation the direction of analyzed data is lead to implementation of QFD methods to improve the aircraft development process in coordination with developer and customer. The initial step is information test sheet (ITS). Again, it is important to emphasize that ITS about dissatisfaction characteristics will be delivered to developer and customer, with aim to decision about next step. The decision must contain mode how to improve this characteristic and which aircraft (first or second prototype).

The complete procedure of flight test and is shown in Figure 4, with management tool development to guarantee the quality of new aircraft characteristics.

With this adopted procedures it is very easy to decrease the time and cost of flight testing on second prototype.

Usually the flight test process is performed on two prototypes. On first prototype the complete process will be performed with aim to verify all characteristics and their satisfaction with customer requirements. In case to verify the dissatisfaction of any request, the responsibility of flight test team is to informed customer and developer organization. This two organizations have a responsibility to make a decision how and when that characteristic will be improved, on first or second prototype. The solution to make a improvement on first prototype is better solution, because leave a possibility for one more mistake which can be improved on second

prototype.

The improvement will be tested by flight test team in the some condition to verify the level of satisfaction in order to given requirements. The relevant institutions will be informed about success or failure of improvement in order to make a next steps.

It is not unusually, that in phase of project and flight testing, the requirements are changed by customer. In that situation flight test team must be elastic for new request and be prepare to change a flight test plan.

The quality process in flight testing is depended from efficiency to improve the new aircraft development and fully independency in flight test analysis of any other institution. The fully success of flight test organization is reached when in a short time and with less number of flights verify all relevant characteristics of new basic trainer aircraft.

4. CONCLUSION

The biggest problem which can appear during the flight testing applications is the problem of guidance of quality. This problem becomes more evident especially in communications with other participants in project. The solution of this problem requires pay attention to quality control processes at every dissatisfaction characteristics of development the new aircraft process. The last stand between developer and customer of aircraft is flight test team. This team has a obligation to test, analysis and discover all potential problem in operational services and possibilities to make a agreement for improving that characteristics. It is without doubt known that the described method applied in flight testing organization is a very effective and deliver the products to military organization with fully customer satisfaction. With this methods the time and cost of flight testing is reduced for

20% and 15%, respectively.

If we want to improve the quality at this method, absolute application of quality

management system in the total process is strongly recommended.

REFERENCES:

- [1] Dimsey J., and Mazur G.: "QFD to Direct Value Engineering in the Design of a Brake System ", The 14th Symposium on QFD, Decembre 2002, San Diego, California, USA
- [2] Hilburn T., and Towhidnejad M.: "Software Quality Across The Curriculum", 32nd, ASEE/IEEE Frontiers in Education Conference, 2002 IEEE, November 6 - 9, 2002, Boston, MA
- [3] Huber C., and Mazur G.: "QFD and Design of Six Sigma", The 14th Symposium on QFD, Decembre 2002, San Diego, California, USA
- [4] LePrevost J., and Mazur G.: "Quality Infrastructure Improvement: Using QFD to Manage Project Priorities and Project Management", The 9th International Symposium on QFD, Decembre 12-13, 2003, Orlando, Florida, USA
- [5] Miloradović V.: "Using of QFD method in development of armament and military resource", 2nd Conference of Defance Technology, OTEH 2007, October 2007, Belgrade, Serbia

